# SPECIES ACCOUNT: *Aplodontia rufa nigra* (Point Arena mountain beaver)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; December 12, 1991 (56 FR 64716).

**Physical Description**

In general, mountain beavers resemble a mix between an overgrown pocket gopher and a muskrat without a tail. Its body is generally stout, compact, and cylindrical; is approximately 30.5 centimeters (12 inches) in length; and weighs 0.45 to 1.8 kilograms (1 to 4 pounds). They have long, stiff whiskers on the nose, small patches of hair at the base of each ear, small eyes and ears, and a cylindrical stump of a tail. Their limbs are short, the forefeet have opposed thumbs, and all digits have long, curved claws. The Point Arena mountain beaver can be distinguished from other mountain beavers by its unique black coloration, a distinct outline of the nasals, and its small size (it is the smallest of the California subspecies) (USFWS 1998).

**Taxonomy**

The Point Arena mountain beaver was first described as a separate species (Aplodontia nigra) in 1914 due to its unique color and anatomical features, and then later as subspecies (Aplodontia rufa nigra) of the mountain beaver complex. The Point Arena mountain beaver can be distinguished from other mountain beavers by its unique black coloration, a distinct outline of the nasals, and its small size (it is the smallest of the California subspecies) (USFWS 1998).

**Historical Range**

Historically, Point Arena mountain beaver colonies were reported in a 12-kilometer (km) (7.5-mile [mi.]) stretch between the town of Point Arena north to Alder Creek, with another record reported another 7 km (4.5 mi.) north at Christianson Ranch (USFWS 1998). All known sites occur within 7.2 km (4.5 mi.) of the coast (USFWS 2009).

**Current Range**

The Point Arena mountain beaver is known only from an 85-square-km (33-square-mi.) area entirely in western Mendocino County, California. The potential range is considered by the U.S. Fish and Wildlife Service (USFWS) to include the area from 3.2 km (2 mi.) north of Bridgeport Landing to 4.8 km (3 mi.) south of Point Arena, a distance of about 24.6 km (15.3 mi.) (USFWS 2009).

**Distinct Population Segments Defined**

No

**Critical Habitat Designated**

No;

***Life History***

**Feeding Narrative**

Adult: The Point Arena mountain beaver is a herbivore with flexible requirements for food, consuming a variety of herbaceous vegetation (including but not limited to succulent plant material, roots, and the bark of woody plants) (USFWS 2009). Many of the plants they consume are unpalatable or toxic to other mammals. Mountain beavers exhibit high activity rates, spending approximately 73 percent of their time foraging or handling food. Mountain beavers are predominantly nocturnal, and collect most of their vegetative material at night within short distances of burrow openings. They may eat vegetation outside of the burrow, but most often collect and cut it to consume later in feeding chambers, often adjacent to the nest chamber. They cut and store about 2.5 times more than they eat, and may stockpile as much as a 2-week supply of forage (USFWS 1998). They reach adult size as yearlings, within a year of becoming independent (Carraway and Verts 1993). Mountain beavers exhibit a behavior called "haystacking," in which they cut bundles of plants and lay them on logs or on the ground to wilt for use later as nesting material, for food storage, or to regulate the moisture content of food by mixing fresh and wilted vegetation (USFWS 1998). Mountain beavers have a simple kidney structure that lacks the anatomical features necessary to concentrate urine effectively, and likely can meet their water needs through metabolic water production and preformed water in food. The inability to concentrate urine and the necessity of a large daily water intake may account for their distribution being limited to areas with rainfall and soil characteristics that promote lush vegetation (USFWS 2009).

**Reproduction Narrative**

Adult: Little information is known about the demographics of the Point Arena mountain beaver subspecies—especially information regarding reproduction—and must instead be gleaned from other mountain beaver subspecies (USFWS 1998). Point Arena mountain beavers reach sexual maturity at 2 years of age; however, yearling females ovulate but do not breed. Mountain beavers are monestrous (one litter per year), and display considerable intrapopulation synchrony of estrous timing (Carraway and Verts 1993; USFWS 1998). Nest chambers are constructed belowground, typically deeper than the burrow system, and are lined with an outer layer of coarse vegetation and an inner layer of soft, dry vegetation. The breeding season occurs between late November/early December and May (USFWS 1998), but varies by locale (Carraway and Verts 1993). The gestation period lasts 28 to 30 days, and females nurse their young (USFWS 1998). With litter sizes of two to three young (rarely, four to five) (USFWS 1998) and an expected lifespan of 5 to 6 years (Carraway and Verts 1993), they have a low reproductive capacity of less than 10. Juvenile Point Arena mountain beaver may not be independent until mid-July, perhaps later (USFWS 2009); they are believed to be weaned by 6 to 8 weeks of age, and likely feed on plants carried to the nest by the maternal female (Carraway and Verts 1993).

**Geographic or Habitat Restraints or Barriers**

Adult: Gulches and north-facing slopes in narrow coastal valleys (NatureServe 2015; USFWS 1998).

**Spatial Arrangements of the Population**

Adult: Clumped; distribution limits are associated with rainfall and soil conditions that promote lush vegetation and high humidity (observed as high as 100 percent) in burrows (USFWS 2009).

**Environmental Specificity**

Adult: Narrow; specialist.

**Tolerance Ranges/Thresholds**

Adult: Limited ability to thermoregulate; when exposed to high ambient temperatures, individuals reduce their activity or attempt to escape, and begin panting/salivating. Lethal body temperature is 42 degrees Celsius (108 degrees Fahrenheit). Bright light, warmth, panic, or other conditions may induce a narcoleptic effect (USFWS 1998).

**Site Fidelity**

Adult: High; at least one Point Arena mountain beaver location (at Alder Creek) appears to have been occupied since 1913 (USFWS 2009).

**Dependency on Other Individuals or Species for Habitat**

Adult: Mountain beavers exhibit a "contagious" distribution, in which the presence of one animal in a given area attracts the settlement of others (USFWS 1998).

**Habitat Narrative**

Adult: Point Arena mountain beavers are found in gulches and north-facing slopes in narrow coastal valleys, inhabiting riparian and coastal scrub habitats, where they burrow in moist areas with well-drained soils, a cool thermal regime, abundant food supply, and high percent cover of small-diameter woody material (NatureServe 2015, USFWS 1998). Individuals are able to meet their water needs through metabolic water production, and therefore do not require access to free water (USFWS 2009). Although individuals may share the same contagious and interconnected burrow systems, they do not live in colonies, and are rarely social. Typical burrow territories do not exceed 25 m (80 ft.) and can extend for more than 100 m 330 ft.) in one direction (USFWS 1998). Tunnels run within 0.3 m (1 ft.) of the surface, but can descend up to 1 to 1.5 m (3 to 5 ft.) (USFWS 1998). Mountain beavers exhibit a "contagious" distribution, in which the presence of one animal in a given area attracts the settlement of others (USFWS 1998). The Point Arena mountain beaver has a limited ability to thermoregulate; when exposed to high ambient temperatures, individuals reduce their activity or attempt to escape, and begin panting/salivating. Lethal body temperature is 42 degrees Celsius (108 degrees Fahrenheit). Bright sunlight, warmth, panic, or other conditions may induce a narcolepsy effect, causing individuals to fall asleep (USFWS 1998).

***Dispersal/Migration***

**Motility/Mobility**

Adult: Low

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: Nonmigratory

**Dispersal**

Adult: Low

**Immigration/Emigration**

Adult: Emigrates

**Dependency on Other Individuals or Species for Dispersal**

Adult: Mountain beavers exhibit a "contagious" distribution, in which the presence of one animal in a given area attracts the settlement of others. However, they exhibit little social interaction and are not considered colonial, primarily exhibiting solitary behavior except during the short breeding period (USFWS 1998).

**Dispersal/Migration Narrative**

Adult: Mountain beavers exhibit a "contagious" distribution, in which the presence of one animal in a given area attracts the settlement of others, but juvenile dispersal is primarily conducted through excavation in a burrow system. However, some overland migration has been observed, which requires habitat connectivity between suitable, undisturbed habitats. Point Arena mountain beavers are otherwise nonmigratory, and exhibit low dispersal and mobility (USFWS 1998), ranging up to 564 m (1,850 ft.) (USFWS 2009). Point Arena mountain beavers exhibit little social interaction and, although they co-inhabit burrow systems, are not considered colonial (USFWS 1998). Information concerning gene flow, dispersal barriers, dispersal corridors, and potential dispersal distance is limited, and more research is needed (USFWS 2009). However, based on what is known regarding occupied sites and regional land-use patterns, suitable habitat is likely highly fragmented by roads, agricultural use, and residential development (USFWS 2009).

**Additional Life History Information**

Adult: Juvenile dispersal is primarily through excavation in a burrow system, although some overland migration has been seen (USFWS 1998). Maximum dispersal distances for other mountain beaver subspecies are reported as far as 564 m (1,850 ft.) (USFWS 2009).

***Population Information and Trends***

**Population Trends:**

Decreasing

**Species Trends:**

Decreasing

**Population Growth Rate:**

Slow

**Number of Populations:**

14 populations (USFWS, 2024)

**Population Size:**

Population size is estimated between 200 to 500 (USFWS 1998) to as many as 1,000 individuals (NatureServe 2015).

**Resistance to Disease:**

Unknown (USFWS 1998)

**Adaptability:**

Low

**Additional Population-level Information:**

Historical records of the Point Arena mountain beaver are scarce (USFWS 1998). At the time of the Recovery Plan (USFWS 1998), no data were available on the density of Point Arena mountain beaver populations. Based on population studies of other mountain beaver subspecies (A. rufa ssp.), it is likely that many of these small Point Arena mountain beaver sites with fewer than 20 active burrow openings are occupied by only one or two individuals. To date, a total of 262 individual records (points) with burrow systems have been mapped range-wide. The current status of approximately 80 percent of these occurrences is unknown, because they occur on private lands that have not been visited in recent years, and may have been or may be subject to future development (USFWS 2009).

**Population Narrative:**

Historical records of the Point Arena mountain beaver are scarce (USFWS 1998). In 1998, 26 separate populations of Point Arena mountain beaver had been identified (USFWS 1998), with an estimated 200 to 500 (USFWS 1998) to as many as 1,000 individuals (NatureServe 2015). These populations have been preliminarily aggregated into 14 geographic groups. At the time of the Recovery Plan (USFWS 1998), no data were available on the density of Point Arena mountain beaver populations. Based on population studies of other mountain beaver subspecies (A. rufa ssp.), it is likely that many of these small Point Arena mountain beaver sites with fewer than 20 active burrow openings are occupied by only one or two individuals. To date, a total of 262 individual records (points) with burrow systems have been mapped range-wide. The current status of approximately 80 percent of these occurrences is unknown, because they occur on private lands that have not been visited in recent years, and may have been or may be subject to future development (USFWS 2009).However, given the species' sensitivity to disturbance (crushing of burrows/vegetation) or catastrophic events, the unlikelihood of immigration/emigration, and the limited genetic diversity, the species shows a low resilience to withstand stochastic events, has a low representation to adapt to changing environmental conditions across the landscape, a low redundancy to withstand catastrophic events, a low resistance to disease, and low adaptability. Since 2010, there has been an addition of 255 individual location detections noted in the AFWO records from the previously noted occurrences of 262 records. Approximately 40 percent of the 255 new occurrence records were from public lands and 60 percent from private lands. The majority (206 of 255) of new occurrence records postdated the 2010 Fiveyear review, but the remaining 49 records predated the 2010 Five-year review and were recently (2016–2019) extracted from older maps and reports. A systematic PAMB occupancy survey of suitable habitat within the historical range of the PAMB was conducted in 2013 (Zielinski et al. 2015; see below) with PAMB burrow entrances detected at 33 of 127 (26%) 25-hectare sample units. Additionally, since 2016, the AFWO opportunistically confirmed PAMB occupancy within 10 of the 14 “geographical groupings” (2010 Five-year Review; Figure 2). (USFWS, 2019). The 2019 5-year review did not revise the number of populations, but the Service currently considers the 14 populations as a more accurate representation of the current PAMB spatial distribution than the 26 populations presented in the recovery plan (USFWS< 2024).

***Threats and Stressors***

**Stressor:** Present or threatened destruction, modification, or curtailment of habitat or range
**Exposure:** Direct/indirect
**Response:** Loss/degradation of habitat.

**Consequence:** Degradation of habitat, reduction of quality/quantity of breeding/foraging/upland habitat.
**Narrative:** Urban development, land conversion, and associated activities have led to trash dumping, which attracts predators such as feral and nonferal house pets. Housing developments and associated roads contribute to habitat loss and fragmentation (USFWS 1998; USFWS 2009).

**Stressor:** Predation
**Exposure:** Direct/indirect
**Response:** Mortality
**Consequence:** Higher susceptibility to mortality/extirpation.
**Narrative:** Predators include coyote (Canis latrans), bobcat (Felis rufus), long-tailed weasel (Mustela frenata), spotted skunk (Spilogale gracilis), striped skunk (Mephitis mephitis), great-horned owl (Bubo virginianus), and raptors, as well as domestic and feral dogs and cats (USFWS 1998; USFWS 2009).

**Stressor:** Catastrophic events
**Exposure:** Direct/indirect
**Response:** Mortality, loss/degradation of habitat.
**Consequence:** Mortality, degradation of habitat, reduction of quality/quantity of breeding/foraging/upland habitat.
**Narrative:** Because Point Arena mountain beavers have a clumped and fragmented distribution, they are more vulnerable to localized catastrophic events like storms, fire, flooding, beach erosion, landslides, disease, or prolonged drought (USFWS 1998; USFWS 2009).

**Stressor:** Loss of riparian habitat
**Exposure:** Direct/indirect
**Response:** Loss/degradation of habitat; increased predator activity.
**Consequence:** Degradation or reduction of habitat; increased predation/mortality.
**Narrative:** Unauthorized destruction of riparian habitat through heavy equipment use, vegetation cutting, and/or vegetation burning leads to habitat loss and increased predator activity (USFWS 1998; USFWS 2009).

**Stressor:** Livestock grazing
**Exposure:** Direct/indirect
**Response:** Loss/degradation of habitat.
**Consequence:** Degradation of habitat, reduction of quality/quantity of breeding/foraging/upland habitat.
**Narrative:** Livestock grazing has substantially reduced the extent of historical coastal scrub habitat. Presently, livestock grazing leads to trampling of vegetation, burrows, and runways (USFWS 1998; USFWS 2009).

**Stressor:** Transportation and utility facilities
**Exposure:** Direct/indirect
**Response:** Loss/degradation of habitat.
**Consequence:** Mortality, impeded or eliminated dispersal from natal areas.
**Narrative:** The installation of utilities such as underground fiber optics projects causes noise, vibration, and physical impacts to mountain beaver habitat. New roadways lead to habitat loss; new and existing roadways create higher mortality rates and impede or eliminate the ability of

young mountain beavers to disperse from natal areas (USFWS 1998; USFWS 2009).

**Stressor:** Recreation
**Exposure:** Direct/indirect
**Response:** Loss/degradation of habitat.
**Consequence:** Degradation of habitat, reduction of quality/quantity of breeding/foraging/upland habitat.
**Narrative:** Mountain beavers' semi-fossorial habits and anatomy suggest high sensitivity to ground vibration and noise (USFWS 2009). Recreational activities such as camping lead to off-trail exploration and subsequent trampling of vegetation, burrows, and runways. Trail construction and associated facilities (parking lots, interpretive centers, signage) also increase levels of human disturbance and habitat loss (USFWS 1998; USFWS 2009).

**Stressor:** Pest control
**Exposure:** Direct/indirect
**Response:**
**Consequence:** Mortality
**Narrative:** Direct and indirect (where mountain beavers are mistaken for pests like gophers) pest control programs lead to mortality through lethal chemicals (USFWS 1998; USFWS 2009).

**Stressor:** Exotic plants
**Exposure:** Indirect
**Response:** Loss/degradation of habitat.
**Consequence:** Degradation of habitat, reduction of quality/quantity of breeding/foraging/upland habitat.
**Narrative:** Several exotic plant species have become established and have spread rapidly, reducing the quality and quantity of suitable habitat, displacing native vegetation, and completely covering burrow openings to the point that they are no longer occupied. These plants include German ivy (Senecio mikanioides), European beachgrass (Ammophila arenaria), and ice plant (Carpobrotus edulis). The effects of other exotic plants are still unknown (USFWS 1998; USFWS 2009).

**Stressor:** Small population size
**Exposure:** Indirect
**Response:** Decreased ability to respond to changing conditions.
**Consequence:** Reduction in population numbers, increased genetic effects of population bottleneck, higher susceptibility to mortality/extirpation.
**Narrative:** Point Area mountain beaver population numbers may be so low that the effects of inbreeding among closely related individuals could result in an increase in deleterious genes in the population. Moreover, small populations are subject to the effects of genetic drift, the random decline in genetic variation that can occur in small populations. These limit the flexibility of a population to respond to environmental change (USFWS 1998; USFWS 2009).

**Stressor:** Habitat fragmentation
**Exposure:** Direct/indirect
**Response:** Loss/degradation of habitat; genetic isolation.
**Consequence:** Reduced population size; increase probability of genetic drift and inbreeding depression.

**Narrative:** Habitat fragmentation can increase the genetic isolation among populations of mountain beaver, and can reduce population size, thereby increasing the probability of genetic drift and inbreeding depression. This may result in less variable and adaptable populations of mountain beaver (USFWS 1998; USFWS 2009).

**Stressor:** Global warming
**Exposure:** Direct/indirect
**Response:** Mortality, loss/degradation of habitat.
**Consequence:** Mortality, degradation of habitat, reduction of quality/quantity of breeding/foraging/upland habitat.
**Narrative:** The mountain beaver's unique physiology may make them especially vulnerable to increased drought conditions and temperature. In addition, coastal damage from flooding and extreme storm events such as heavy surf and wind-driven waves could lead to increasing coastal erosion, flooding, and faster cliff retreat, as well as direct mortality to individuals and populations along the coastal bluff edges (USFWS 2009).

***Recovery***

**Reclassification Criteria:**
At least 16 populations are protected from human-caused disturbance in perpetuity. Each population shall contain at least 20 hectares (ha) (49 acres [ac.]) of suitable habitat, of which at least 10 ha (25 ac.) are occupied habitat.

These populations shall have a mean density of at least four Point Arena mountain beavers per ha (1.6 per ac.) of occupied habitat, unless new data show that a lower density is healthy and stable.

All 16 populations are stable (i.e., no more than a 25 percent change in estimated population size from highest to lowest value) or increasing for a period of 10 years (following attainment of criterion #1), as documented through establishment and implementation of a scientifically acceptable population monitoring program.

The amount of additional habitat needed for population interconnectivity, travel, and dispersal habitat has been determined.

Sufficient information is available to permit adaptive management prescriptions, and any management actions necessary to ensure the continued success of these populations (in criterion #2) have been fully implemented.

Recovery Priority Number: 9C

**Delisting Criteria:**
Thirty populations are protected from disturbance in perpetuity. Each population shall contain at least 20 ha (49 ac.) of suitable habitat, of which at least 10 ha (25 ac.) are occupied habitat.

These populations shall have a mean density of a least four Point Arena mountain beavers per ha (1.6 per ac.) of occupied habitat, unless new data show that a lower density is healthy and stable.

All 30 populations are stable (i.e., no more than a 25 percent change in estimated population size from highest to lowest value) or increasing for a period of at least 15 years (following attainment of criterion #1), as documented through establishment and implementation of a scientifically acceptable population monitoring program.

Additional habitat needed for population interconnectivity, travel, and dispersal has been protected and is being managed appropriately.

Adaptive management prescriptions have been determined and implemented for all populations.

**Recovery Actions:**

- Protect known populations (USFWS 1998).
- Protect suitable habitat, buffers, and corridors (USFWS 1998).
- Develop management plans and guidelines (USFWS 1998).
- Gather biological and ecological data necessary for conservation of the subspecies (USFWS 1998).
- Determine feasibility of, and need for, relocation (USFWS 1998).
- Monitor existing populations and survey for new ones (USFWS 1998).
- Establish an outreach program (USFWS 1998).
- No formal guidelines containing conservation measures have been developed for this species. The Point Arena Mountain Beaver (Aplodontia rufa nigra) 5-Year Review (2009) provides a number of recommendations for actions over the next 5 years; including:
- Continue research to characterize the genetic diversity within and among individual occurrences (USFWS 2009).
- Continue to monitor the established survey grids to estimate abundance, survival rates, and recruitment (USFWS 2009).
- Identify and map suitable habitat, potential dispersal corridors, dispersal barriers, and restoration areas (USFWS 2009).
- Delineate appropriate conservation units for management based on data on gene flow, dispersal barriers, and potential dispersal distances (USFWS 2009).
- Develop and implement a noninvasive sampling program to monitor range-wide trends in abundance and distribution. Also develop a sampling plan to monitor habitat quantity, quality, and threats (USFWS 2009).
- Once sufficient information is gathered, revise the current recovery plan to include updated recovery criteria and tasks (USFWS 2009).
- Identify key areas for protection, such as conservation easements and acquisition; this will enable the USFWS to work with partners when opportunities arise (USFWS 2009).
- Identify sites for vegetation management, such as exotic plant removal or livestock exclosures (USFWS 2009).
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***Conservation Measures and Best Management Practices:***

- Recommendations for Future Actions: 1. Estimate range-wide PAMB occupancy using methods described in Zielinski et al. (2015; citation above) on all public lands and accessible (i.e., where access is granted) private lands. Repeat occupancy surveys every five years to monito trends in

PAMP distribution. 2. Identify unprotected suitable habitat on private lands that appear to connect suitable habitat patches on adjacent protected public lands. Seek funding to place target parcels into conservation easements or to purchase outright. Improving habitat connectivity north to south across the Garcia River watershed and east to west on the north and south sides of the Garcia River watershed should be priority; based on Zielinsky et al. (2013b; citation above) suggestion that the Garcia River may reduce gene flow between PAMB populations. 3. Delineate suitable habitat patches on public lands in GIS and monitor for changes over time. 4. Work with the Mendocino County Planning and Building Department to collaborate on county regulations on vegetation removal and ground-disturbing activities within suitable PAMB habitat as part of the Coastal Development Permit approval process. 5. Develop a roadside mowing plan for the California Department of Transportation (Caltrans) to protect PAMB burrow systems along their right-of-way (ROW) within the occupied distribution of the PAMB. The plan would establish maximum mowing widths and minimum vegetation height within occupied portions of the ROW. Similar mowing restrictions have been deployed in limited portions of the Caltrans ROW within the PAMB occupied distribution with good results, but as a systematic approach to all road segment ROWs is needed. (USFWS, 2019)

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Restoration of unsuitable habitat adjacent to occupied habitat patches to increase suitable habitat patch size and improve habitat connectively. Scherbinski and Bean (2019) recommended habitat maintenance and restoration within cool microrefugia to improve PAMB persistence. 2. Identify unprotected suitable habitat on private lands that the Service has determined to be functional corridors connecting suitable habitat patches on adjacent protected public lands. Seek funding to place these private parcels into conservation easements or purchase in fee title. Improving habitat connectivity north to south across the Garcia River watershed and east to west on the north and south sides of the Garcia River watershed should be a priority; based on Zielinski et al. (2013) suggestion that the Garcia River may reduce gene flow between PAMB populations. 3. Estimate PAMB occupancy on all accessible public and private lands within the range of the subspecies. Develop a non-invasive method for surveying suitable habitat for PAMB occupancy, such as the use of unmanned aerial vehicles (i.e., drones) equipped with thermal imagery. Field testing of thermal equipped drones to remotely detect occupied PAMB burrow systems will begin in late August 2024. 4. Extrapolate density estimates from Zielinski et al. (2013) to all suitable habitat delineated by Zielinski et al. (2015) to calculate population size for the entire subspecies. Repeat the occupancy estimation methods (Zielinski et al. 2015), but with modifications to the sampling design and areal extent, and contemporary occupancy estimation methods. 5. Investigate the feasibility of translocating PAMB to unoccupied suitable habitat. Selection of individual PAMB for translocation would be based in part on genetics as reported in Zielinski et al. (2013). Suitability of proposed translocation sites would be based in part on the habitat model (Zielinski et al. 2015) and the climate suitability model for the PAMB (Scherbinski and Bean 2019) (USFWS, 2024).

***Additional Threshold Information:***

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# SPECIES ACCOUNT: *Canis lupus* (Gray wolf (all ssp. within U.S.))

***Species Taxonomic and Listing Information***

**Commonly-used Acronym:** None

**Listing Status:** Endangered/Experimental Population; 04/28/1976, 01/24/1998; Southwest Region (R2) (USFWS, 2016)

**Physical Description**

The gray wolf is the largest wild member of the Canidae, or dog family, with adults ranging from 18 to 80 kilograms (40 to 175 pounds), depending on sex and subspecies (68 FR 15804). The total length of the gray wolf is about 205 centimeters (cm) (80 inches [in.], with a tail of up to 50 cm (20 in.) in length, and a nose pad averaging 3.1 cm (1.2 in.) or more in diameter. The upper canine is more than 1.2 cm (0.5 in.) in anteroposterior diameter at the base, not extending below the level of the anterior mental foramen when the lower jaw is in place. The condylobasal length of the skull is 20.3 to 26.9 cm (8 to 10.6 in.) (NatureServe 2015). The wolves' fur color is frequently a grizzled gray, but it can vary from pure white to coal black. Wolves may appear similar to coyotes (Canis latrans) and some domestic dog breeds (such as the German shepherd or Siberian husky) (C. familiaris). However, wolves' longer legs, larger feet, wider head and snout, and straight tail distinguish them from both coyotes and dogs (68 FR 15804).

**Taxonomy**

Gray wolf taxonomy has undergone substantial revisions in recent years, including a major taxonomic revision in which the number of recognized gray wolf subspecies in North America was reduced from 24 to five: eastern wolf (C. l. lycaon), Mexican wolf (C. l. baileyi), Arctic wolf (C. l. arctos), northern timber wolf (C. l. occidentalis), and plains wolf (C. l. nubilus) (Chambers et al. 2012). The Mexican wolf is considered a morphologically distinct and valid subspecies, based on skull morphometrics and unique genetic markers, and is listed—and therefore treated separately—from the remaining gray wolves in North America (80 FR 2488). The gray wolf differs from the coyote in its larger nose pad, more rounded ears, larger anteroposterior diameter of upper canine at gum level, larger heel pad on the forefoot, longer skull, and relatively shorter canines. Also, the gray wolf holds the tail high when running, while the coyote holds it low. In some parts of central and eastern North America, the coyote approaches the wolf in certain characteristics, due to interbreeding. The gray wolf differs from the red wolf in its larger size, longer skull, and in certain features of the molars; however, the red wolf actually may be a coyote-gray wolf hybrid. The gray wolf differs from the domestic dog in its generally larger size, broader nose pad, more massive skull with heavier teeth, relatively longer rostrum, supraoccipital shield which is larger and projects farther posteriorly, and longer and narrower front foot track (NatureServe 2015).

**Historical Range**

Until the molecular genetics studies of the last few years, the range of the gray wolf prior to European settlement was generally believed to include most of North America. The only areas that were believed to have lacked gray wolf populations are southern and interior Greenland, the coastal regions of Mexico, all of Central America south of Mexico, coastal and parts of California, the extremely arid deserts and the mountaintops of the western United States, and parts of the eastern and southeastern United States. However, some authorities question the reported historical absence of gray wolves from parts of California. Authors are inconsistent in their views of the precise boundary of historical gray wolf ranges in the eastern and southeastern United States (68 FR 15804). The U.S. Fish and Wildlife Service (USFWS) views the historical range of the gray wolf as the central and western United States, including portions of the Western Great Lakes region, the Great Plains, portions of the Rocky Mountains, the Intermountain West, the Pacific Northwest, and portions of the Southwest. All or parts of 29 southern and eastern states (Maine, Massachusetts, Connecticut, New Hampshire, Rhode Island, Vermont, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, Florida, Ohio [the part outside the Western Great Lakes DPS], West Virginia, Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Texas [east of Interstate Highway 35], Oklahoma [east of Interstate Highway 35 and southeast of Interstate Highway 44 north of Oklahoma City], Arkansas, Missouri [southeast of Interstate Highway 44 and southeast of Interstate Highway 70 east of St. Louis], Indiana [the part outside the Western Great Lakes DPS], and Illinois [the part outside the Western Great Lakes DPS]) were not within the gray wolf's historical range (76 FR 26086).

**Current Range**

The present-day geographical area of the eastern (aka Minnesota)/Western Great Lakes DPS is described as all of Minnesota, Wisconsin, and Michigan; the portion of North Dakota north and east of the Missouri River upstream to Lake Sakakawea and east of the centerline of Highway 83 from Lake Sakakawea to the Canadian border; the portion of South Dakota north and east of the Missouri River; the portions of Iowa, Illinois, and Indiana north of the centerline of Interstate Highway 80; and the portion of Ohio north of the centerline of Interstate Highway 80 and west of the Maumee River at Toledo (50 FR 81666). The present-day geographical area of the western (aka Wyoming)/northern Rocky Mountains DPS includes California, northern Colorado, Idaho, Montana, Oregon, northern Utah, Washington, and Wyoming (77 FR 55530).

**Distinct Population Segments Defined**

Yes: Gray Wolf includes all subspecies and areas outside of DPSs identified below): (AL, AR, AZ, CA, CO, CT, DE, FL, GA, KS, KY, LA, MA, MD, ME, MO, MS, NC, NE, NH, NJ, NM, NV, NY, OK, PA, RI, SC, TN, TX, VA, VT, and WV, and portions of IA, IN, IL, ND, OH, OR, SD, UT, and WA), March 9, 1978 (43 FR 9607) Northern Rocky Mountain DPS (western): (excluding Wyoming), April 2, 2009 (74 FR 15123); (Wyoming), April 2, 2009 (74 FR 15123) Western Great Lakes DPS: (eastern) (Minnesota), March 9, 1978 (43 FR 9607); (excluding Minnesota), April 2, 2009 (74 FR 15070)

**Critical Habitat Designated**

Yes; 6/9/1977.

**Legal Description**

On March 9, 1978, the Service issued a final rulemaking which provides for the reclassification of the may wolf in the United States and Mexico, and for the determination of critical habitat for species of gray wolf in Michigan and Minnesota. The reclassification is considered to accurately express the current status of the gray wolf, based solely on an evaluation of the best available biological data. The special regulations being established in Minnesota are deemed necessary and advisable to provide for the future well-being of the species.

**Critical Habitat Designation**

Michigan. Isle Royale National Park. Minnesota. Areas of land, water, and airspace in Beltrami. Cook, Itasca, Koochiching, Lake, Lake of the Woods, Roseau, and St. Louis Counties, with boundaries (4th and 5th Principal meridians) identical to those of zones 1, 2, and 3, as delineated in 50 CFR 17.40(d)(1).

Zone 1 - 4,488 square miles. Beginning at the point of intersection of United States and Canadian boundaries in Section 22, Township 71 North, Range 22 West, in Rainy Lake, then proceeding along the west side of Sections 22, 21, and 34 in said Township and Sections 3, 10, 15, 22, 27 and 24 in Township 70 North, Range 22 West and Sections 3 and 10 in Township 69 North, Range 22 West; then east along the south boundaries of Sections 10, 11, and 12 in said Township; then south along the Koochiching and St. Louis counties line to Highway 53; thence southeasterly along State Highway 53 to the junction with County Route 765; thence easterly along County Route 765 to the junction with Kabetogama Lake in Ash River Bay; thence along the south boundary of Section 33 in Township 69 North, Range 19 West, to the junction with the Moose River; thence southeasterly along the Moose River to Moose Lake; thence along the western shore of Moose Lake to the river between Moose Lake and Long Lake; thence along the said river to Long Lake; thence along the east shore of Long Lake to the drainage on the southeast side of Long Lake in NE1/4. Section 16, Township 67 North, Range la West; thence along the said drainage southeast side and subsequently northeasterly to Marion Lake, the drainage being in Section 17 and 16, Township 67 North, Range 16 West; thence along the west shoreline of Marion Lake proceeding southeasterly to the Moose Creek: thence along Moose Creek to Flap Creek: thence southeasterly along Flap Creek to the Vermilion River: thence southerly along the Vermilion River to Vermilion Lake: thence along the Superior National Forest boundary in a southeasterly direction through Vermilion Lake passing these points: Oak Narrows, Muskrat Ghannel, South of Pine Island, to Hoodo Point and the junction with County Route 697; thence southeasterly on County Route 697 to the junction with State Highway 169: thence easterly along State Highway 169 to the junction with State Highway 1: thence easterly along State Hlghway 1 to the junction with the Erie Railroad tracks at Murphy City: thence easterly along the Erie Raikcmd tracks to the junction with Lake Superior at Taconite Harbor; thence northeasterly along the North Shore of Lake Superior to the Canadian Border; thence westerly along the Canadian Border to the point of beginning in Rainy Lake.

Zone 2 - 1,856 square miles. Beginning at the intersection of the Erie Mining Co. Railroad and State Highway 1 (Murphy City); thence southeasterly on State Highway 1 to the junction with County Road 4: thence southwesterly on County Road 4 to the State Snowmobile Trail (formerly the Alger-Smith Railroad); thence southwesterly to the intersection of the Old Railroad Grade and Reserve Mining Co. Railroad in Section 33 of Township 56 North, Range 9 West; thence northwesterly along the Railroad to Forest Road 107; thence westerly along Forest Road 107 to Forest Road 203; thence westerly along Forest Road 203 to the junction with County Route 2; thence in a northerly direction on County Route 2 to the junction with Forest Road 122; thence in a westerly direction along Forest Road 122 to the Junction with the Duluth, Missable and Iron Range Railroad; thence in a southwesterly direction along the said railroad tracks to the junction with County Route 14; thence in a northwesterly direction along County Route 14 to the junction with County Route 55; thence in a westerly direction along County Route 55 to the junction with County Route 44; thence in a southerly direction along County Route 44 to the junction with County Route 266; thence in a southeasterly direction along County Route 266 and subsequently in a westerly direction to the junction with County Road 44; thence in a northerly direction on County Road 44 to the junction with Township Road 2615; thence westerly along Township Road

2615 to Alden Lake; thence northwesterly across Alden Lake to the Inlet of the Cloquet River; thence northerly along the Cloquet River to the junction with Carrol Trail-State Forestry Road; thence west along the Carrol Trail to the junction with County Route 4 and County Route 49; thence west along County Route 49 to the junction with the Duluth, Winnipeg and Pacific Railroad: thence in a northerly direction along said Railroad to the junction with the Whiteface River; thence In a northeasterly direction along the Whiteface River to the Whiteface Reservoir; thence along the western shore of the Whiteface Reservoir to the junction with County Route 340; thence north along County Route 340 to the junction with County Route 16; thence east along County Route 16 to the junction with County Route 346; thence in a northerly direction along County Route 346 to the junction with County Route 569; thence along County Route 569 to the junction with County Route 565; thence in a westerly direction along County Route 565 to the junction with County Route 110; thence in a westerly direction along County Route 110 to the junction with County Route 100; thence in a north and subsequent west direction along County Route 100 to the junction with State Highway 135; thence in a northerly direction along State Highway 135 to the junction with State Highway 169 at Tower; thence in an easterly direction along the southern boundary of Zone 1 to the point of beginning of Zone 2 at the junction of the Erie Railroad Tracks and State Highway 1.

Zone 3 - 3,501 square miles. Beginning at the junction of State Highway 11 and State Highway 65; thence southeasterly along State Highway 65 to the junction with State Highway 1; thence westerly along State Highway 1 to the junction with State Highway 72; thence north along State Highway 72 to the junction with an un-numbered township road beginning in the northeast corner of Section 25, Township 155 North, Range 31 West; thence westerly along the said road for approximately seven (7) miles to the junction with SFR 95; thence westerly along SFR 95 and continuing west through the southern boundary of Sections 36 through 31, Township 155 North, Range 33 West, through Sections 36 through 31, Township 155 North, Range 34 West, through Sections 36 through 31, Township 155 North, Range 35 West, through Sections 36 and 35, Township 155 North, Range 36 West to the junction with State Highway 69, thence northwesterly along State Highway 69 to the junction with County Route 44; thence northerly along County Route 44 to the junction with County Route 704; thence northerly along County 704 to the junction with SFR 49; thence northerly along SFR 49 to the junction with SFR 57; thence easterly along SFR 57 to the junction with SFR 63: thence south along SFR 63 to the junction with SFR 70; thence easterly along SFR 70 to the junction with County Route 87; thence easterly along County Route 87 to the junction with County Route 1; thence south along County Route 1 to the junction with County Route 16; thence easterly along County Route 16 to the junction with State Highway 72; thence south on State Highway 72 to the junction with a gravel road tunnumbered County District Road) on the north side of Section 31, Township 158 North, Range 30 West; thence east on said District Road to the junction with SFR 62; thence easterly on SFR 62 to the junction with SFR 175; thence south on SFR 175 to the junction with County Route 101; thence easterly on County Route 101 to the junction with County Route 11; thence easterly on County Route 11 to the junction with State Highway 11; thence easterly on State Highway 11 to the junction with State Highway 65, the point of beginning.

**Primary Constituent Elements/Physical or Biological Features**

The Minnesota population represents the last significant element of a species that once occupied a vastly larger range in the lower 48 States, and long-term trends may be working against the wolf. To quote the Recovery Plan. “Future circumstances are unpredictable and those that now exist could change drastically. For example, widespread industrialization, mineral exploitation, and general development could threaten much of the wolf's remaining range, making regulation increasingly significant to the populations left. Additional roads, railroads, power lines, mines and tourist facilities could further carve up much of northern Minnesota. This would disrupt the natural repopulation of depleted areas by wolves and promote higher human densities which would compete with wolves for their wild prey." Moreover, in recent years there has been a decline in deer, the main prey species, in parts of the primary range of the wolf.

PCEs are not described. Based on the text above, it can be inferred that (1) undeveloped lands in Minnesota and (2) deer are major consituent elements for this species.

**Special Management Considerations or Protections**

The provisions for predator control state that wolves may be taken by authorized Federal or State employees in zones 2, 3, 4, and 5, if such wolves commit significant depredations on lawfully present domestic animals. Few, if any, of these wolves will be taken in zones 2 and 3 which have practically no livestock, and nearly all will be taken in zone 4. Essentially then, the wolf population in zones 1, 2, and 3 will not be affected by the depredation control activity. The population in zone 4 might be held below biological potential, but would continue to exist in reasonable numbers. The control of depredating wolves inzone 4 will reduce conflicts with human interests and should create a more favorable public attitude that would be of overall benefit to the wolf.

***Life History***

**Feeding Narrative**

Adult: Wolves primarily are predators of medium and large mammals. Wild prey species in North America include white-tailed deer (Odocoileus virginianus), mule deer (O. hemionus), moose (Alces alces), elk (Cervus canadensis), woodland caribou (Rangifer caribou), barren ground caribou (R. arcticus), bison (Bison bison), muskox (Ovibos moschatus), bighorn sheep (Ovis canadensis), Dall sheep (O. dalli), mountain goat (Oreamnos americanus), beaver (Castor canadensis), and snowshoe hare (Lepus americanus), with small mammals, birds, and large invertebrates sometimes being taken. In the Midwest, during the last 22 years, wolves have also killed domestic animals, including horses (Equus caballus), cattle (Bos taurus), sheep (Ovis aries), goats (Capra hircus), llamas (Lama glama), pigs (Sus scrofa), geese (Anser sp.), ducks (Anas sp.), turkeys (Meleagris gallopavo), chickens (Gallus sp.), pheasants (Phasianus colchicus), dogs (Canis domesticus), and cats (Felis catus). Since 1987, wolves in the northern Rocky Mountains of Montana, Idaho, and Wyoming have also killed domestic animals, including llamas, horses, cattle, sheep, and dogs (68 FR 15804). Gray wolves hunt in packs during nighttime/crepuscular hours, and wolf density is positively correlated to the amount of ungulate biomass available and the vulnerability of ungulates to predation (68 FR 15804). Young wolves achieve near-adult size at between 8 and 10 months of age (Mech 1974). Wolves are social animals, typically living and hunting in packs of two to 12 wolves—primarily family groups consisting of a breeding pair, their pups from the current year, offspring from the previous year, and occasionally an unrelated wolf (68 FR 15804).

**Reproduction Narrative**

Adult: Gray wolves are monogamous, breeding once per year, with an average of six to seven (and up to ten) pups per season. Courtship begins between January and April. After a gestation period of 63 days, the young are born blind in a den, typically a hole in the ground, or in a rock crevice, hollow log, or an overturned stump. Pups are weaned in about 5 weeks, and young leave the den at about 3 months old. Some offspring remain with the pack; others disperse as they mature. Adults reach sexual maturity during their second or third year, and live for up to 10 to 16 years of age in the wild. Gray wolves have a high fitness, with an average reproductive capacity of 35 offspring in a lifetime. Only the dominant male and dominant female mate and rear offspring. Lone wolves generally do not successfully rear young, but they may if food is abundant (NatureServe 2015; Mech 1974; 68 FR 15804).

**Geographic or Habitat Restraints or Barriers**

Adult: Gray wolves occur only where human population density and persecution level are low and prey densities are high (NatureServe 2015).

**Spatial Arrangements of the Population**

Adult: Clumped

**Environmental Specificity**

Adult: Broad/generalist where key requirements are present.

**Site Fidelity**

Adult: Moderate

**Dependency on Other Individuals or Species for Habitat**

Adult: Abundance of ungulate prey (NatureServe 2015).

**Habitat Narrative**

Adult: Gray wolves show no particular habitat preferences, and can be found in such vegetation types as alpine, desert, conifer forest, hardwood forest, mixed forest, grassland/herbaceous, savanna, shrubland/chaparral, tundra, conifer woodland, hardwood woodland, and mixed woodland (NatureServe 2015). However, they are generally found only where human population density and persecution level are low and prey densities of ungulates are high (NatureServe 2015).

***Dispersal/Migration***

**Motility/Mobility**

Adult: High

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: Nonmigratory

**Dispersal**

Adult: Gray wolves have an annual home range (territory) of up to several hundred square kilometers (km2) (hundred square miles [sq. mi.]). Young gray wolves disperse from natal to new territories between the ages of 1 and 2 years, typically between February-April and October-November (NatureServe 2015).

**Immigration/Emigration**

Adult: Immigration/emigration.

**Dependency on Other Individuals or Species for Dispersal**

Adult: No

**Dispersal/Migration Narrative**

Adult: Gray wolves are highly mobile and readily disperse or migrate hundreds of kilometers (hundred or more miles). Gray wolves have an annual home range (territory) of up to several hundred km2. Young gray wolves disperse from natal to new territories (hundreds of kilometers [hundred or more miles]) between the ages of 1 and 2 years, typically between February-April and October-November; 35 percent of known-age wolves remained in their natal territory for more than 2 years (NatureServe 2015).

***Population Information and Trends***

**Population Trends:**

Northern Rocky Mountain DPS (western) Idaho – increasing (IDFG 2015); Montana -decreasing (Bradley et al. 2015); Wyoming – increasing (WGFD et al. 2015); Washington – increasing (Becker et al. 2015); and Oregon – increasing (ODFW 2015). Western Great Lakes DPS (eastern) Minnesota – declining-to-stable due to hunting and depredation control; Wisconsin – declining due to human-caused mortality; Michigan – declining for unstated reasons.

**Species Trends:**

Increasing to stable to declining, depending on location.

**Resiliency:**

The current availability of the gray wolf's individual and population needs (i.e., current availability of suitable habitat, current availability of prey, current population size and trends, and current levels of genetic diversity and connectivity) in the Western United States characterizes the current resiliency of wolves in the Western United States. In Chapter 3, we summarized our evaluation of potential stressors and conservation efforts that influence the condition of wolves in the Western United States. Human-caused mortality is the primary stressor that currently influences the resiliency of wolves in the Western United States. According to the best available science, disease also causes episodic, yet short-term and localized population decreases. Below, we discuss the current condition of the resource and demographic factors that gray wolves require and examine whether these stressors are compromising the gray wolf's current viability in the Western United States (USFWS, 2023).

**Representation:**

In addition to the attributes from Thurman et al. (2020, p. 522), we also analyzed current distribution on the landscape throughout different ecoregional provinces as an additional proxy for representation. A metapopulation structure, with subpopulations connected by some level of gene flow, can facilitate increased adaptive capacity because selective pressures may vary among subpopulations (Razgour et al. 2019, p. 10421; Carroll et al. 2021, p. 74); different environmental conditions or ecological factors can create these varied selective pressures. Within a subpopulation, adaptive variants that might be masked in the larger population can be expressed and selected for, increasing their prevalence in the overall metapopulation and contributing to adaptive capacity (Funk et al. 2019, p. 120; Razgour et al. 2019, p. 10421; Carroll et al. 2021, p. 74). For wolves in the Western United States, that phenomenon may be especially true as the population expands into unoccupied habitat and smaller founding subpopulations are established, which can sometimes diverge rapidly under strong selection (Carroll et al. 2021, pp. 76–77). To assess this potential, we examined wolves' current distribution across different ecoregional provinces, which incorporate temperature, precipitation, and vegetation data, as defined by Bailey (2016, map). As shown in Figure 10, wolves in the Western United States are currently found in five ecoregional provinces: (1) Southern Rocky Mountain Steppe—Open Woodland—Coniferous Forest—Alpine Meadow; (2) Rocky Mountain Steppe—Open Woodland—Coniferous Forest—Alpine Meadow; (3) Northern Rocky Mountain Steppe—Open Woodland—Coniferous Forest—Alpine Meadow; (4) Cascade Mixed Forest—Coniferous Forest—Alpine Meadow; and (5) Sierran Steppe—Mixed Forest—Coniferous Forest—Alpine Meadow. Occurrence in these different ecoregional provinces not only demonstrates the ecological flexibility of the species, which has become established in two new provinces (i.e., Cascade Mixed Forest and Sierran Steppe) since the NRM DPS (without Wyoming) was delisted in 2011, but also that the evolutionary processes that result from different selection regimes in these differing provinces are likely to positively contribute to the adaptive capacity of the species (USFWS, 2023).

**Redundancy:**

Wolves in the Western United States currently occur in one metapopulation, structured in a constellation of subpopulations spread across six states (and one known pack in Colorado); this metapopulation is also connected demographically to a larger population of wolves in Canada. At the end of 2022, there were at least 286 packs distributed between: California, Colorado, Montana, Oregon, Washington, and Wyoming,1F 14 further contributing to redundancy of the species. The best available scientific information does not provide a minimum number of wolf packs in Idaho for the end of 2022. Disease is the prevailing causal factor of high mortality events in carnivore species (Chapron et al. 2012, p. 14). Therefore, to assess catastrophic risk, we evaluate the frequency and impact of disease on wolf populations, and the current and future ability of wolf populations to rebound from high mortality disease events (see Chapters 5 and 6). While outbreaks of several diseases have occurred in the wolf population in the Western United States in the recent past, population decreases have been localized to specific regions, with the overall metapopulation continuing to expand to new areas (see Disease and Parasites in Wolves in Chapter 3). Although it is possible a novel disease may arise, given the wolf's wide distribution in the Western United States (i.e., redundancy) and our understanding of current wolf disease ecology, it is unlikely that a disease outbreak would cause the wolf metapopulation in the entire Western United States to crash, even given current management objectives to reduce wolf abundance in some states (USFWS, 2023).

**Population Growth Rate:**

Dependent on DPS, state, and localized conditions.

**Number of Populations:**

As of the end of 2022, states estimated that there were 2,797 wolves distributed between at least 286 packs in seven states (USFWS, 2023)

**Population Size:**

10,000 to >1,000,000 individuals (worldwide) (NatureServe 2015). Northern Rocky Mountain DPS (western) As of the end of 2022, states estimated that there were 2,797 wolves distributed between at least 286 packs in seven states (USFWS, 2023). Western Great Lakes DPS (eastern)

The minimum year-end wolf population in the Western Great Lakes DPS totaled 3,722 individuals, with a state-by-state breakdown as follows: Michigan (Upper Peninsula – late winter 2013-14) – 636 individuals; Isle Royale (January 2015) – 3 individuals; Minnesota (2013-2014) – 2,423 individuals; and Wisconsin (late winter 2013-14) – 660 individuals (USFWS 2014).

**Resistance to Disease:**

High

**Adaptability:**

High

**Additional Population-level Information:**

Because the species is wide-ranging, it is difficult to estimate the number of distinct occurrences (NatureServe 2015).

**Population Narrative:**

There are two populations of the gray wolf in the conterminous United States, not including the Mexican gray wolf: northern Rocky Mountains and Western Great Lakes (USFWS 2012). There are anywhere between 81 and more than 300 occurrences; however, because the species is wide-ranging, it is difficult to estimate the number of distinct occurrences (NatureServe 2015). The gray wolf has rebounded from the brink of extinction to exceed population targets by as much as 300 percent. Today, there are at least 5,521 gray wolves in the contiguous United States. Wolf numbers continue to be robust, stable, and self-sustaining (USFWS 2015).Outside the Northern Rocky Mountain DPS, there are 20 individuals in Washington. Population numbers and trends for each DPS are provided below (USFWS et al. 2015).Northern Rocky Mountain DPS (western)As of December 2014, the minimum year-end wolf population in the Northern Rocky Mountain DPS totaled 1,782 individuals, with a state-by-state breakdown as follows: Idaho – 770 individuals; Montana – 554 individuals; Oregon – 77 individuals; Washington – 48 individuals; and Wyoming – 333 individuals (USFWS et al. 2015).In the Northern Rocky Mountains DPS, state population trends are as follows: Idaho – increasing (IDFG 2015); Montana -decreasing (Bradley et al. 2015); Wyoming – increasing (WGFD et al. 2015); Washington – increasing (Becker et al. 2015); and Oregon – increasing (ODFW 2015).Western Great Lakes DPS (eastern)The minimum year-end wolf population in the Western Great Lakes DPS totaled 3,722 individuals, with a state-by-state breakdown as follows: Michigan (Upper Peninsula – late winter 2013-14) – 636 individuals; Isle Royale (January 2015) – 3 individuals; Minnesota (2013-2014) – 2,423 individuals; and Wisconsin (late winter 2013-14) – 660 individuals (USFWS 2014).In the Western Great Lakes DPS, state population trends are as follows: Minnesota – declining-to-stable due to hunting and depredation control; Wisconsin – declining due to human-caused mortality; Michigan – declining for unstated reasons.Mexican Gray Wolf-Experimental PopulationAs of December 2014, there were 109 individuals in Arizona and New Mexico (USFWS et al. 2015). Habitat and prey for wolves are abundant and well distributed in the Western United States. This, in conjunction with the high reproductive potential of wolves and their innate behavior to disperse and locate social openings or vacant suitable habitats, has allowed wolf populations to withstand relatively high rates of human-caused mortality (Service 2020, pp. 8–9). Our analysis of the current condition of gray wolves in the Western United States demonstrates that, despite current levels of regulated harvest, lethal control, and episodic disease outbreaks, wolf abundance in the Western United States has generally continued to increase and occupied range has continued to expand since reintroduction in the 1990s, with the exception of three years during which wolf abundance in the Western metapopulation decreased slightly (i.e., a decrease of approximately 50 to 100 wolves in one year) (Table 5). As of the end of 2022, states estimated that there were 2,797 wolves distributed between at least 286 packs in seven states12F. This large population size and broad distribution contributes to the resiliency and redundancy of wolves in the Western United States. Moreover, wolves in the Western United States currently have high levels of genetic diversity and connectivity, further supporting the resiliency of wolves throughout the West. Finally, based on several metrics for assessing adaptive capacity, wolves in the Western United States currently retain the ability to adapt to changes in their environment (USFWS, 2023). Habitat and prey for wolves are abundant and well distributed in the Western United States. This, in conjunction with the high reproductive potential of wolves and their innate behavior to disperse and locate social openings or vacant suitable habitats, has allowed wolf populations to withstand relatively high rates of human-caused mortality (Service 2020, pp. 8–9). Our analysis of the current condition of gray wolves in the Western United States demonstrates that, despite current levels of regulated harvest, lethal control, and episodic disease outbreaks, wolf abundance in the Western United States has generally continued to increase and occupied range has continued to expand since reintroduction in the 1990s, with the exception of three years during which wolf abundance in the Western metapopulation decreased slightly (i.e., a decrease of approximately 50 to 100 wolves in one year) (Table 5). As of the end of 2022, states estimated that there were 2,797 wolves distributed between at least 286 packs in seven states12F. This large population size and broad distribution contributes to the resiliency and redundancy of wolves in the Western United States. Moreover, wolves in the Western United States currently have high levels of genetic diversity and connectivity, further supporting the resiliency of wolves throughout the West. Finally, based on several metrics for assessing adaptive capacity, wolves in the Western United States currently retain the ability to adapt to changes in their environment (USFWS, 2023).

***Threats and Stressors***

**Stressor:** See narrative.
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Recent analysis of the current threats and stressors to the species are not available. In an effort to identify the factors that may affect the species, the threats and stressors identified in the Revised Recovery Plan for the Eastern Timber Wolf and Northern Rocky Mountain Recovery Plan are summarized below (USFWS 1987; USFWS 1992).Five main factors are critical to the long-term survival of the eastern timber wolf: (1) large tracts of wild land with low human densities and minimal accessibility by humans; (2) ecologically sound management; (3) availability of adequate wild prey; (4) adequate understanding of wolf ecology and management; and (5) maintenance of populations that are either free of, or resistant to, parasites and diseases new to wolves, or are large enough to successfully contend with their adverse effects (USFWS 1987).

**Stressor:** Development
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Development has multiple effects on wolves: (1) increased human presence increases the chance of direct killing of wolves; (2) although undocumented, unnatural structures, sounds,

and smells might deter wolves from inhabiting an area; (3) artificial corridors such as paved roads, powerlines, fences along interstate highways, and railroads may prevent or minimize dispersal; (4) increased human presence increases chances of introducing new diseases and parasites to wolves via pets; and (5) reduced prey species abundance and diversity reduce wolf food supply (USFWS 1987).

**Stressor:** Human density and accessibility
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Nowhere in the United States is there an area where the eastern timber wolf will not be affected by human activity. Wherever people reside in wolf county, they will have domestic livestock and/or pets that may be subject to wolf attack. Public education about the wolf, and the preservation of large tracts of wild land with low human densities and minimal accessibility, will help preserve the wolf. Human activity and exploitation of wildlife increase with accessibility. This is especially true for wolves, which are strongly affected by roads in the following ways: (1) direct mortality via vehicles; (2) roads allow access by hunters and trappers, some of whom deliberately and/or accidentally kill wolves; and (3) major highways are barriers to dispersal (USFWS 1992).

**Stressor:** Ecological sound management
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Ecologically sound management includes: (1) protection where needed to help restore the eastern timber wolf to areas of its original range and to preserve a naturally functioning population that can serve as a living museum, as a scientific subject, and as a reservoir to repopulate adjacent areas; (2) depredation control where wolves are killing domestic animals; (3) restocking of wolves into suitable areas of their former range, when feasible; (4) continued research and monitoring of wolf populations; and (5) provision of adequate prey diversity and numbers through habitat and population management and reintroductions where appropriate (USFWS 1992).The USFWS recommends that in Michigan and Wisconsin, and in Zone 1, 2, 3, and 4 of Minnesota, strict protection should be afforded the wolf. Legal protection, however, is only as effective as the public acceptance of laws and regulations needed for wolf management, and the degree of law enforcement devoted to it. Law enforcement is especially needed during fall and winter hunting and trapping seasons, generally September through March. Besides more rigorous and timely enforcement of the laws actually protecting the wolf, additional enforcement is also necessary to ensure that vehicles, including off-road vehicles, be kept off roads restricted against their use. Even the regular presence of law enforcement agents in wolf areas is a valuable deterrent to violations (USFWS 1992).

**Stressor:** Wild prey
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The wolf is dependent on a continual supply of deer, moose, and beaver. Therefore, one of the most important aspects of this plan is to maintain habitat in a high carrying capacity for prey. The most feasible method of doing this is through commercial and noncommercial

timber sales and habitat improvement projects for these species. Such programs require temporary roads, but these can later be obliterated or gated. In protected areas such as Voyageurs National Park or the Boundary Waters Canoe Area where timber sales are prohibited or restricted, the prescribed use of fire may produce the mosaic of habitats necessary for a diversity of prey species (USFWS 1992).

**Stressor:** Public education
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Because of the degree of misunderstanding about wolf ecology, population dynamics, and management, concerted efforts aimed at providing public information and education have been implemented. Nevertheless, considerable misinformation still exists among several segments of the Minnesota and Michigan population. Therefore, concerted information and education are still strongly needed (USFWS 1987).

**Stressor:** Disease and parasites
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In recent years, a number of new diseases and parasites have been clearly documented as occurring in wolf populations in Minnesota, Wisconsin, and Michigan. Heartworm, canine parvovirus (CPV), and Lyme disease each have the potential to become limiting factors acting on survival, reproduction, and dispersal of large numbers of wolves, and thus may determine the fate of isolated wolf populations. Wolf populations will be able to survive only if they are somehow able to contend with these new threats (USFWS 1987). Recent studies have shown that gray wolves, especially juveniles, are susceptible to CPV and distemper. Because survival of juvenile wolves is critical to successful recovery, developing a comprehensive health monitoring program for translocated and naturally reestablishing wolves is essential to minimize the risk of disease (USFWS 1992).

***Recovery***

**Reclassification Criteria:**
Consistent with assurances provided in the 1978 reclassification of the gray wolf in the conterminous United States (43 FR 9607, March 9, 1978), three gray wolf recovery programs in the following regions of the country were implemented: the Western Great Lakes (Minnesota, Michigan, and Wisconsin, administered by USFWS' Great Lakes, Big Rivers Region), the Northern Rocky Mountains (Idaho, Montana, and Wyoming, administered by USFWS' Mountain-Prairie Region and Pacific Region), and the Southwest (Arizona, New Mexico, Texas, Oklahoma, Mexico, administered by USFWS' Southwest Region). Recovery plans were developed in each of these areas to organize and prioritize recovery criteria and actions appropriate to the unique local circumstances of the gray wolf. Thus, the three gray wolf recovery programs have functioned independently from one another since their inceptions (USFWS 2012).

Western Great Lakes/Eastern Timber Wolf

The primary objective of the Recovery Plan for the Eastern Timber Wolf is to maintain and reestablish viable populations of the eastern timber wolf in as much of its former range as is feasible (USFWS 1992).

When condition 1 of the Delisting Criteria is met and there are 80 wolves (based on late winter counts) in Wisconsin for a minimum of 3 consecutive years, the eastern timber wolf should be downlisted to threatened in Wisconsin. At that time, consideration may also be given to the downlisting of the Michigan wolf population (USFWS 1992).

Northern Rocky Mountain

To reclassify the Northern Rocky Mountain wolf to threatened status over its entire range by securing and maintaining a minimum of 10 breeding pairs in each of two recovery areas for a minimum of 3 successive years (USFWS 1987).

To reclassify the Northern Rocky Mountain wolf to threatened status in an individual recovery area by securing and maintaining a minimum of 10 breeding pairs in the recovery area for a minimum of 3 successive years. Consideration will also be given to reclassifying such a population to threatened under similarity of appearance after this objective for the population has been achieved and verified, special regulations are established, and a state management plan is in place for that population (USFWS 1987).

Southwest/Mexican

Need to develop reclassification criteria.

**Delisting Criteria:**
Consistent with assurances provided in the 1978 reclassification of the gray wolf in the conterminous United States (43 FR 9607, March 9, 1978), three gray wolf recovery programs in the following regions of the country were implemented: the Western Great Lakes (Minnesota, Michigan, and Wisconsin, administered by USFWS' Great Lakes, Big Rivers Region), the Northern Rocky Mountains (Idaho, Montana, and Wyoming, administered by USFWS' Mountain-Prairie Region and Pacific Region), and the Southwest (Arizona, New Mexico, Texas, Oklahoma, Mexico, administered by USFWS' Southwest Region). Recovery plans were developed in each of these areas to organize and prioritize recovery criteria and actions appropriate to the unique local circumstances of the gray wolf. Thus, the three gray wolf recovery programs have functioned independently from one another since their inceptions (USFWS 2012).

Western Great Lakes/Eastern Timber Wolf

The Revised Recovery Plan for the Eastern Timber Wolf identified the following two recovery criteria necessary to delist the species.

1) the survival of the wolf in Minnesota is ensured (USFWS 1992); and

2) at least one viable population of eastern timber wolves outside Minnesota and Isle Royale in the contiguous 48 states of the United States is reestablished (USFWS 1992).

A viable population of eastern timber wolves outside of Minnesota must meet one of the following two descriptions, based on late winter counts: 1. An isolated eastern timber wolf population in the United States must average at least one wolf per 50 sq. mi. (a self-sustaining population of at least 200 wolves) distributed in a minimum area of at least 25,600 contiguous km2 (10,000 sq. mi.) of suitable habitat over a period of 5 successive years; or 2. An eastern timber wolf population in the United States, located within 160 kilometers (100 miles [mi.]) of a self-sustaining wolf population (as described in item 1), must average at least one wolf per 128 km2 (50 sq. mi.) or consist of 100 wolves distributed in an area of at least 12,800 contiguous km2 (5,000 sq. mi.) of suitable habitat over a period of 5 consecutive years. These 100 wolves do not have to be evenly distributed (USFWS 1992).

Northern Rocky Mountain

To remove the Northern Rocky Mountain wolf from the endangered and threatened species list by securing and maintaining a minimum of 10 breeding pairs in each of the three recovery areas for a minimum of 3 successive years (USFWS 1987).

Southwest/Mexican

Need to develop delisting criteria.

**Recovery Actions:**

- Consistent with assurances provided in the 1978 reclassification of the gray wolf in the conterminous United States (43 FR 9607, March 9, 1978), three gray wolf recovery programs in the following regions of the country were implemented: the Western Great Lakes (Minnesota, Michigan, and Wisconsin, administered by USFWS' Great Lakes, Big Rivers Region), the Northern Rocky Mountains (Idaho, Montana, and Wyoming, administered by USFWS' Mountain-Prairie Region and Pacific Region), and the Southwest (Arizona, New Mexico, Texas, Oklahoma, Mexico, administered by USFWS' Southwest Region). Recovery plans were developed in each of these areas to organize and prioritize recovery criteria and actions appropriate to the unique local circumstances of the gray wolf. Thus, the three gray wolf recovery programs have functioned independently from one another since their inceptions (USFWS 2012).
- Western Great Lakes/Eastern Timber Wolf
- The Revised Recovery Plan for the Eastern Timber Wolf provided the following recovery actions.
- Ensure perpetuation of the eastern timber wolf population at levels optimal to the various parts of its present Minnesota range (optimum level includes biological carrying capacity and compatibility with humans): Zone 1, to fluctuate naturally; Zones 2 and 3, one wolf per 10 sq. mi., Zone 4, one wolf per 50 sq. mi., Zone 5, no wolves (USFWS 1992).
- Enhance and reestablish a viable wolf population in Michigan (excluding Isle Royale) and Wisconsin (USFWS 1992).
- Continue management to perpetuate natural conditions for the eastern timber wolf on Isle Royale National Park, Michigan (USFWS 1992).
- Reestablish the wolf population in Adirondack Mountains (New York), northwestern Main/adjacent New Hampshire, and/or northeastern Maine (USFWS 1992).

- Create a Coordination Committee of state and federal representatives to implement the Eastern Timber Wolf Recovery Plan (USFWS 1992).
- Northern Rocky Mountain
- The Northern Rocky Mountain Wolf Recovery Plan provided the following recovery actions.
- Determine the present status and distribution of gray wolves in the Northern Rocky Mountains, and devise a systematic approach for compiling observations and other data on the Northern Rocky Mountain wolf (USFWS 1987).
- Evaluate and verify the population goals for a threatened and fully recovered population established in the current objectives (USFWS 1987).
- Delineate recovery areas and identify and develop conservations strategies and management plan(s) to ensure perpetuation of the Northern Rocky Mountain wolf (USFWS 1987).
- Monitor gray wolf populations, habitat, and prey (USFWS 1987).
- Develop and initiate information and education programs (USFWS 1987).
- Southwest/Mexican
- Inventory and evaluate remaining gene pool (USFWS 1982).
- Protect remaining gene pool (USFWS 1982).
- Reestablish and maintain viable wild populations of Mexican wolves in at least two areas in Mexico and/or adjoining areas of southwestern United States (USFWS 1982).
- If efforts fail to establish and maintain viable wild populations of Mexican wolves anywhere in Mexico or the United States, declare the subspecies extinct in the wild and maintain remaining captive Mexican wolves in captivity, managing captive populations so as to prevent extinction of the subspecies and, if possible, genetic degeneration. For this task, the exact mechanisms and assignment of responsibilities are to be determined at the time by agreement between USFWS and Dirección General de la Fauna Silverstre after recommendations are obtained from the Mexican Wolf Recovery Team, American Association of Zoological Parks and Aquariums, and International Species Inventory Systems (USFWS 1982).
- Monitor progress of agencies, groups, and individuals with assigned responsibilities to ensure that tasks are accomplished in the recommended order of priorities and by the target dates (USFWS 1982).
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***Additional Threshold Information:***

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# SPECIES ACCOUNT: *Canis lupus* (Gray wolf (all ssp. within U.S.))

***Species Taxonomic and Listing Information***

**Commonly-used Acronym:** None

**Listing Status:** Endangered/Experimental Population; 04/28/1976, 01/24/1998; Southwest Region (R2) (USFWS, 2016)

**Physical Description**

The gray wolf is the largest wild member of the Canidae, or dog family, with adults ranging from 18 to 80 kilograms (40 to 175 pounds), depending on sex and subspecies (68 FR 15804). The total length of the gray wolf is about 205 centimeters (cm) (80 inches [in.], with a tail of up to 50 cm (20 in.) in length, and a nose pad averaging 3.1 cm (1.2 in.) or more in diameter. The upper canine is more than 1.2 cm (0.5 in.) in anteroposterior diameter at the base, not extending below the level of the anterior mental foramen when the lower jaw is in place. The condylobasal length of the skull is 20.3 to 26.9 cm (8 to 10.6 in.) (NatureServe 2015). The wolves' fur color is frequently a grizzled gray, but it can vary from pure white to coal black. Wolves may appear similar to coyotes (Canis latrans) and some domestic dog breeds (such as the German shepherd or Siberian husky) (C. familiaris). However, wolves' longer legs, larger feet, wider head and snout, and straight tail distinguish them from both coyotes and dogs (68 FR 15804).

**Taxonomy**

Gray wolf taxonomy has undergone substantial revisions in recent years, including a major taxonomic revision in which the number of recognized gray wolf subspecies in North America was reduced from 24 to five: eastern wolf (C. l. lycaon), Mexican wolf (C. l. baileyi), Arctic wolf (C. l. arctos), northern timber wolf (C. l. occidentalis), and plains wolf (C. l. nubilus) (Chambers et al. 2012). The Mexican wolf is considered a morphologically distinct and valid subspecies, based on skull morphometrics and unique genetic markers, and is listed—and therefore treated separately—from the remaining gray wolves in North America (80 FR 2488). The gray wolf differs from the coyote in its larger nose pad, more rounded ears, larger anteroposterior diameter of upper canine at gum level, larger heel pad on the forefoot, longer skull, and relatively shorter canines. Also, the gray wolf holds the tail high when running, while the coyote holds it low. In some parts of central and eastern North America, the coyote approaches the wolf in certain characteristics, due to interbreeding. The gray wolf differs from the red wolf in its larger size, longer skull, and in certain features of the molars; however, the red wolf actually may be a coyote-gray wolf hybrid. The gray wolf differs from the domestic dog in its generally larger size, broader nose pad, more massive skull with heavier teeth, relatively longer rostrum, supraoccipital shield which is larger and projects farther posteriorly, and longer and narrower front foot track (NatureServe 2015).

**Historical Range**

Until the molecular genetics studies of the last few years, the range of the gray wolf prior to European settlement was generally believed to include most of North America. The only areas that were believed to have lacked gray wolf populations are southern and interior Greenland, the coastal regions of Mexico, all of Central America south of Mexico, coastal and parts of California, the extremely arid deserts and the mountaintops of the western United States, and parts of the eastern and southeastern United States. However, some authorities question the reported historical absence of gray wolves from parts of California. Authors are inconsistent in their views of the precise boundary of historical gray wolf ranges in the eastern and southeastern United States (68 FR 15804). The U.S. Fish and Wildlife Service (USFWS) views the historical range of the gray wolf as the central and western United States, including portions of the Western Great Lakes region, the Great Plains, portions of the Rocky Mountains, the Intermountain West, the Pacific Northwest, and portions of the Southwest. All or parts of 29 southern and eastern states (Maine, Massachusetts, Connecticut, New Hampshire, Rhode Island, Vermont, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, Florida, Ohio [the part outside the Western Great Lakes DPS], West Virginia, Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Texas [east of Interstate Highway 35], Oklahoma [east of Interstate Highway 35 and southeast of Interstate Highway 44 north of Oklahoma City], Arkansas, Missouri [southeast of Interstate Highway 44 and southeast of Interstate Highway 70 east of St. Louis], Indiana [the part outside the Western Great Lakes DPS], and Illinois [the part outside the Western Great Lakes DPS]) were not within the gray wolf's historical range (76 FR 26086).

**Current Range**

The present-day geographical area of the eastern (aka Minnesota)/Western Great Lakes DPS is described as all of Minnesota, Wisconsin, and Michigan; the portion of North Dakota north and east of the Missouri River upstream to Lake Sakakawea and east of the centerline of Highway 83 from Lake Sakakawea to the Canadian border; the portion of South Dakota north and east of the Missouri River; the portions of Iowa, Illinois, and Indiana north of the centerline of Interstate Highway 80; and the portion of Ohio north of the centerline of Interstate Highway 80 and west of the Maumee River at Toledo (50 FR 81666). The present-day geographical area of the western (aka Wyoming)/northern Rocky Mountains DPS includes California, northern Colorado, Idaho, Montana, Oregon, northern Utah, Washington, and Wyoming (77 FR 55530).

**Distinct Population Segments Defined**

Yes: Gray Wolf includes all subspecies and areas outside of DPSs identified below): (AL, AR, AZ, CA, CO, CT, DE, FL, GA, KS, KY, LA, MA, MD, ME, MO, MS, NC, NE, NH, NJ, NM, NV, NY, OK, PA, RI, SC, TN, TX, VA, VT, and WV, and portions of IA, IN, IL, ND, OH, OR, SD, UT, and WA), March 9, 1978 (43 FR 9607) Northern Rocky Mountain DPS (western): (excluding Wyoming), April 2, 2009 (74 FR 15123); (Wyoming), April 2, 2009 (74 FR 15123) Western Great Lakes DPS: (eastern) (Minnesota), March 9, 1978 (43 FR 9607); (excluding Minnesota), April 2, 2009 (74 FR 15070)

**Critical Habitat Designated**

Yes; 6/9/1977.

**Legal Description**

On March 9, 1978, the Service issued a final rulemaking which provides for the reclassification of the may wolf in the United States and Mexico, and for the determination of critical habitat for species of gray wolf in Michigan and Minnesota. The reclassification is considered to accurately express the current status of the gray wolf, based solely on an evaluation of the best available biological data. The special regulations being established in Minnesota are deemed necessary and advisable to provide for the future well-being of the species.

**Critical Habitat Designation**

Michigan. Isle Royale National Park. Minnesota. Areas of land, water, and airspace in Beltrami. Cook, Itasca, Koochiching, Lake, Lake of the Woods, Roseau, and St. Louis Counties, with boundaries (4th and 5th Principal meridians) identical to those of zones 1, 2, and 3, as delineated in 50 CFR 17.40(d)(1).

Zone 1 - 4,488 square miles. Beginning at the point of intersection of United States and Canadian boundaries in Section 22, Township 71 North, Range 22 West, in Rainy Lake, then proceeding along the west side of Sections 22, 21, and 34 in said Township and Sections 3, 10, 15, 22, 27 and 24 in Township 70 North, Range 22 West and Sections 3 and 10 in Township 69 North, Range 22 West; then east along the south boundaries of Sections 10, 11, and 12 in said Township; then south along the Koochiching and St. Louis counties line to Highway 53; thence southeasterly along State Highway 53 to the junction with County Route 765; thence easterly along County Route 765 to the junction with Kabetogama Lake in Ash River Bay; thence along the south boundary of Section 33 in Township 69 North, Range 19 West, to the junction with the Moose River; thence southeasterly along the Moose River to Moose Lake; thence along the western shore of Moose Lake to the river between Moose Lake and Long Lake; thence along the said river to Long Lake; thence along the east shore of Long Lake to the drainage on the southeast side of Long Lake in NE1/4. Section 16, Township 67 North, Range la West; thence along the said drainage southeast side and subsequently northeasterly to Marion Lake, the drainage being in Section 17 and 16, Township 67 North, Range 16 West; thence along the west shoreline of Marion Lake proceeding southeasterly to the Moose Creek: thence along Moose Creek to Flap Creek: thence southeasterly along Flap Creek to the Vermilion River: thence southerly along the Vermilion River to Vermilion Lake: thence along the Superior National Forest boundary in a southeasterly direction through Vermilion Lake passing these points: Oak Narrows, Muskrat Ghannel, South of Pine Island, to Hoodo Point and the junction with County Route 697; thence southeasterly on County Route 697 to the junction with State Highway 169: thence easterly along State Highway 169 to the junction with State Highway 1: thence easterly along State Hlghway 1 to the junction with the Erie Railroad tracks at Murphy City: thence easterly along the Erie Raikcmd tracks to the junction with Lake Superior at Taconite Harbor; thence northeasterly along the North Shore of Lake Superior to the Canadian Border; thence westerly along the Canadian Border to the point of beginning in Rainy Lake.

Zone 2 - 1,856 square miles. Beginning at the intersection of the Erie Mining Co. Railroad and State Highway 1 (Murphy City); thence southeasterly on State Highway 1 to the junction with County Road 4: thence southwesterly on County Road 4 to the State Snowmobile Trail (formerly the Alger-Smith Railroad); thence southwesterly to the intersection of the Old Railroad Grade and Reserve Mining Co. Railroad in Section 33 of Township 56 North, Range 9 West; thence northwesterly along the Railroad to Forest Road 107; thence westerly along Forest Road 107 to Forest Road 203; thence westerly along Forest Road 203 to the junction with County Route 2; thence in a northerly direction on County Route 2 to the junction with Forest Road 122; thence in a westerly direction along Forest Road 122 to the Junction with the Duluth, Missable and Iron Range Railroad; thence in a southwesterly direction along the said railroad tracks to the junction with County Route 14; thence in a northwesterly direction along County Route 14 to the junction with County Route 55; thence in a westerly direction along County Route 55 to the junction with County Route 44; thence in a southerly direction along County Route 44 to the junction with County Route 266; thence in a southeasterly direction along County Route 266 and subsequently in a westerly direction to the junction with County Road 44; thence in a northerly direction on County Road 44 to the junction with Township Road 2615; thence westerly along Township Road

2615 to Alden Lake; thence northwesterly across Alden Lake to the Inlet of the Cloquet River; thence northerly along the Cloquet River to the junction with Carrol Trail-State Forestry Road; thence west along the Carrol Trail to the junction with County Route 4 and County Route 49; thence west along County Route 49 to the junction with the Duluth, Winnipeg and Pacific Railroad: thence in a northerly direction along said Railroad to the junction with the Whiteface River; thence In a northeasterly direction along the Whiteface River to the Whiteface Reservoir; thence along the western shore of the Whiteface Reservoir to the junction with County Route 340; thence north along County Route 340 to the junction with County Route 16; thence east along County Route 16 to the junction with County Route 346; thence in a northerly direction along County Route 346 to the junction with County Route 569; thence along County Route 569 to the junction with County Route 565; thence in a westerly direction along County Route 565 to the junction with County Route 110; thence in a westerly direction along County Route 110 to the junction with County Route 100; thence in a north and subsequent west direction along County Route 100 to the junction with State Highway 135; thence in a northerly direction along State Highway 135 to the junction with State Highway 169 at Tower; thence in an easterly direction along the southern boundary of Zone 1 to the point of beginning of Zone 2 at the junction of the Erie Railroad Tracks and State Highway 1.

Zone 3 - 3,501 square miles. Beginning at the junction of State Highway 11 and State Highway 65; thence southeasterly along State Highway 65 to the junction with State Highway 1; thence westerly along State Highway 1 to the junction with State Highway 72; thence north along State Highway 72 to the junction with an un-numbered township road beginning in the northeast corner of Section 25, Township 155 North, Range 31 West; thence westerly along the said road for approximately seven (7) miles to the junction with SFR 95; thence westerly along SFR 95 and continuing west through the southern boundary of Sections 36 through 31, Township 155 North, Range 33 West, through Sections 36 through 31, Township 155 North, Range 34 West, through Sections 36 through 31, Township 155 North, Range 35 West, through Sections 36 and 35, Township 155 North, Range 36 West to the junction with State Highway 69, thence northwesterly along State Highway 69 to the junction with County Route 44; thence northerly along County Route 44 to the junction with County Route 704; thence northerly along County 704 to the junction with SFR 49; thence northerly along SFR 49 to the junction with SFR 57; thence easterly along SFR 57 to the junction with SFR 63: thence south along SFR 63 to the junction with SFR 70; thence easterly along SFR 70 to the junction with County Route 87; thence easterly along County Route 87 to the junction with County Route 1; thence south along County Route 1 to the junction with County Route 16; thence easterly along County Route 16 to the junction with State Highway 72; thence south on State Highway 72 to the junction with a gravel road tunnumbered County District Road) on the north side of Section 31, Township 158 North, Range 30 West; thence east on said District Road to the junction with SFR 62; thence easterly on SFR 62 to the junction with SFR 175; thence south on SFR 175 to the junction with County Route 101; thence easterly on County Route 101 to the junction with County Route 11; thence easterly on County Route 11 to the junction with State Highway 11; thence easterly on State Highway 11 to the junction with State Highway 65, the point of beginning.

**Primary Constituent Elements/Physical or Biological Features**

The Minnesota population represents the last significant element of a species that once occupied a vastly larger range in the lower 48 States, and long-term trends may be working against the wolf. To quote the Recovery Plan. “Future circumstances are unpredictable and those that now exist could change drastically. For example, widespread industrialization, mineral exploitation, and general development could threaten much of the wolf's remaining range, making regulation increasingly significant to the populations left. Additional roads, railroads, power lines, mines and tourist facilities could further carve up much of northern Minnesota. This would disrupt the natural repopulation of depleted areas by wolves and promote higher human densities which would compete with wolves for their wild prey." Moreover, in recent years there has been a decline in deer, the main prey species, in parts of the primary range of the wolf.

PCEs are not described. Based on the text above, it can be inferred that (1) undeveloped lands in Minnesota and (2) deer are major consituent elements for this species.

**Special Management Considerations or Protections**

The provisions for predator control state that wolves may be taken by authorized Federal or State employees in zones 2, 3, 4, and 5, if such wolves commit significant depredations on lawfully present domestic animals. Few, if any, of these wolves will be taken in zones 2 and 3 which have practically no livestock, and nearly all will be taken in zone 4. Essentially then, the wolf population in zones 1, 2, and 3 will not be affected by the depredation control activity. The population in zone 4 might be held below biological potential, but would continue to exist in reasonable numbers. The control of depredating wolves inzone 4 will reduce conflicts with human interests and should create a more favorable public attitude that would be of overall benefit to the wolf.

***Life History***

**Feeding Narrative**

Adult: Wolves primarily are predators of medium and large mammals. Wild prey species in North America include white-tailed deer (Odocoileus virginianus), mule deer (O. hemionus), moose (Alces alces), elk (Cervus canadensis), woodland caribou (Rangifer caribou), barren ground caribou (R. arcticus), bison (Bison bison), muskox (Ovibos moschatus), bighorn sheep (Ovis canadensis), Dall sheep (O. dalli), mountain goat (Oreamnos americanus), beaver (Castor canadensis), and snowshoe hare (Lepus americanus), with small mammals, birds, and large invertebrates sometimes being taken. In the Midwest, during the last 22 years, wolves have also killed domestic animals, including horses (Equus caballus), cattle (Bos taurus), sheep (Ovis aries), goats (Capra hircus), llamas (Lama glama), pigs (Sus scrofa), geese (Anser sp.), ducks (Anas sp.), turkeys (Meleagris gallopavo), chickens (Gallus sp.), pheasants (Phasianus colchicus), dogs (Canis domesticus), and cats (Felis catus). Since 1987, wolves in the northern Rocky Mountains of Montana, Idaho, and Wyoming have also killed domestic animals, including llamas, horses, cattle, sheep, and dogs (68 FR 15804). Gray wolves hunt in packs during nighttime/crepuscular hours, and wolf density is positively correlated to the amount of ungulate biomass available and the vulnerability of ungulates to predation (68 FR 15804). Young wolves achieve near-adult size at between 8 and 10 months of age (Mech 1974). Wolves are social animals, typically living and hunting in packs of two to 12 wolves—primarily family groups consisting of a breeding pair, their pups from the current year, offspring from the previous year, and occasionally an unrelated wolf (68 FR 15804).

**Reproduction Narrative**

Adult: Gray wolves are monogamous, breeding once per year, with an average of six to seven (and up to ten) pups per season. Courtship begins between January and April. After a gestation period of 63 days, the young are born blind in a den, typically a hole in the ground, or in a rock crevice, hollow log, or an overturned stump. Pups are weaned in about 5 weeks, and young leave the den at about 3 months old. Some offspring remain with the pack; others disperse as they mature. Adults reach sexual maturity during their second or third year, and live for up to 10 to 16 years of age in the wild. Gray wolves have a high fitness, with an average reproductive capacity of 35 offspring in a lifetime. Only the dominant male and dominant female mate and rear offspring. Lone wolves generally do not successfully rear young, but they may if food is abundant (NatureServe 2015; Mech 1974; 68 FR 15804).

**Geographic or Habitat Restraints or Barriers**

Adult: Gray wolves occur only where human population density and persecution level are low and prey densities are high (NatureServe 2015).

**Spatial Arrangements of the Population**

Adult: Clumped

**Environmental Specificity**

Adult: Broad/generalist where key requirements are present.

**Site Fidelity**

Adult: Moderate

**Dependency on Other Individuals or Species for Habitat**

Adult: Abundance of ungulate prey (NatureServe 2015).

**Habitat Narrative**

Adult: Gray wolves show no particular habitat preferences, and can be found in such vegetation types as alpine, desert, conifer forest, hardwood forest, mixed forest, grassland/herbaceous, savanna, shrubland/chaparral, tundra, conifer woodland, hardwood woodland, and mixed woodland (NatureServe 2015). However, they are generally found only where human population density and persecution level are low and prey densities of ungulates are high (NatureServe 2015).

***Dispersal/Migration***

**Motility/Mobility**

Adult: High

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: Nonmigratory

**Dispersal**

Adult: Gray wolves have an annual home range (territory) of up to several hundred square kilometers (km2) (hundred square miles [sq. mi.]). Young gray wolves disperse from natal to new territories between the ages of 1 and 2 years, typically between February-April and October-November (NatureServe 2015).

**Immigration/Emigration**

Adult: Immigration/emigration.

**Dependency on Other Individuals or Species for Dispersal**

Adult: No

**Dispersal/Migration Narrative**

Adult: Gray wolves are highly mobile and readily disperse or migrate hundreds of kilometers (hundred or more miles). Gray wolves have an annual home range (territory) of up to several hundred km2. Young gray wolves disperse from natal to new territories (hundreds of kilometers [hundred or more miles]) between the ages of 1 and 2 years, typically between February-April and October-November; 35 percent of known-age wolves remained in their natal territory for more than 2 years (NatureServe 2015).

***Population Information and Trends***

**Population Trends:**

Northern Rocky Mountain DPS (western) Idaho – increasing (IDFG 2015); Montana -decreasing (Bradley et al. 2015); Wyoming – increasing (WGFD et al. 2015); Washington – increasing (Becker et al. 2015); and Oregon – increasing (ODFW 2015). Western Great Lakes DPS (eastern) Minnesota – declining-to-stable due to hunting and depredation control; Wisconsin – declining due to human-caused mortality; Michigan – declining for unstated reasons.

**Species Trends:**

Increasing to stable to declining, depending on location.

**Resiliency:**

The current availability of the gray wolf's individual and population needs (i.e., current availability of suitable habitat, current availability of prey, current population size and trends, and current levels of genetic diversity and connectivity) in the Western United States characterizes the current resiliency of wolves in the Western United States. In Chapter 3, we summarized our evaluation of potential stressors and conservation efforts that influence the condition of wolves in the Western United States. Human-caused mortality is the primary stressor that currently influences the resiliency of wolves in the Western United States. According to the best available science, disease also causes episodic, yet short-term and localized population decreases. Below, we discuss the current condition of the resource and demographic factors that gray wolves require and examine whether these stressors are compromising the gray wolf's current viability in the Western United States (USFWS, 2023).

**Representation:**

In addition to the attributes from Thurman et al. (2020, p. 522), we also analyzed current distribution on the landscape throughout different ecoregional provinces as an additional proxy for representation. A metapopulation structure, with subpopulations connected by some level of gene flow, can facilitate increased adaptive capacity because selective pressures may vary among subpopulations (Razgour et al. 2019, p. 10421; Carroll et al. 2021, p. 74); different environmental conditions or ecological factors can create these varied selective pressures. Within a subpopulation, adaptive variants that might be masked in the larger population can be expressed and selected for, increasing their prevalence in the overall metapopulation and contributing to adaptive capacity (Funk et al. 2019, p. 120; Razgour et al. 2019, p. 10421; Carroll et al. 2021, p. 74). For wolves in the Western United States, that phenomenon may be especially true as the population expands into unoccupied habitat and smaller founding subpopulations are established, which can sometimes diverge rapidly under strong selection (Carroll et al. 2021, pp. 76–77). To assess this potential, we examined wolves' current distribution across different ecoregional provinces, which incorporate temperature, precipitation, and vegetation data, as defined by Bailey (2016, map). As shown in Figure 10, wolves in the Western United States are currently found in five ecoregional provinces: (1) Southern Rocky Mountain Steppe—Open Woodland—Coniferous Forest—Alpine Meadow; (2) Rocky Mountain Steppe—Open Woodland—Coniferous Forest—Alpine Meadow; (3) Northern Rocky Mountain Steppe—Open Woodland—Coniferous Forest—Alpine Meadow; (4) Cascade Mixed Forest—Coniferous Forest—Alpine Meadow; and (5) Sierran Steppe—Mixed Forest—Coniferous Forest—Alpine Meadow. Occurrence in these different ecoregional provinces not only demonstrates the ecological flexibility of the species, which has become established in two new provinces (i.e., Cascade Mixed Forest and Sierran Steppe) since the NRM DPS (without Wyoming) was delisted in 2011, but also that the evolutionary processes that result from different selection regimes in these differing provinces are likely to positively contribute to the adaptive capacity of the species (USFWS, 2023).

**Redundancy:**

Wolves in the Western United States currently occur in one metapopulation, structured in a constellation of subpopulations spread across six states (and one known pack in Colorado); this metapopulation is also connected demographically to a larger population of wolves in Canada. At the end of 2022, there were at least 286 packs distributed between: California, Colorado, Montana, Oregon, Washington, and Wyoming,1F 14 further contributing to redundancy of the species. The best available scientific information does not provide a minimum number of wolf packs in Idaho for the end of 2022. Disease is the prevailing causal factor of high mortality events in carnivore species (Chapron et al. 2012, p. 14). Therefore, to assess catastrophic risk, we evaluate the frequency and impact of disease on wolf populations, and the current and future ability of wolf populations to rebound from high mortality disease events (see Chapters 5 and 6). While outbreaks of several diseases have occurred in the wolf population in the Western United States in the recent past, population decreases have been localized to specific regions, with the overall metapopulation continuing to expand to new areas (see Disease and Parasites in Wolves in Chapter 3). Although it is possible a novel disease may arise, given the wolf's wide distribution in the Western United States (i.e., redundancy) and our understanding of current wolf disease ecology, it is unlikely that a disease outbreak would cause the wolf metapopulation in the entire Western United States to crash, even given current management objectives to reduce wolf abundance in some states (USFWS, 2023).

**Population Growth Rate:**

Dependent on DPS, state, and localized conditions.

**Number of Populations:**

As of the end of 2022, states estimated that there were 2,797 wolves distributed between at least 286 packs in seven states (USFWS, 2023)

**Population Size:**

10,000 to >1,000,000 individuals (worldwide) (NatureServe 2015). Northern Rocky Mountain DPS (western) As of the end of 2022, states estimated that there were 2,797 wolves distributed between at least 286 packs in seven states (USFWS, 2023). Western Great Lakes DPS (eastern)

The minimum year-end wolf population in the Western Great Lakes DPS totaled 3,722 individuals, with a state-by-state breakdown as follows: Michigan (Upper Peninsula – late winter 2013-14) – 636 individuals; Isle Royale (January 2015) – 3 individuals; Minnesota (2013-2014) – 2,423 individuals; and Wisconsin (late winter 2013-14) – 660 individuals (USFWS 2014).

**Resistance to Disease:**

High

**Adaptability:**

High

**Additional Population-level Information:**

Because the species is wide-ranging, it is difficult to estimate the number of distinct occurrences (NatureServe 2015).

**Population Narrative:**

There are two populations of the gray wolf in the conterminous United States, not including the Mexican gray wolf: northern Rocky Mountains and Western Great Lakes (USFWS 2012). There are anywhere between 81 and more than 300 occurrences; however, because the species is wide-ranging, it is difficult to estimate the number of distinct occurrences (NatureServe 2015). The gray wolf has rebounded from the brink of extinction to exceed population targets by as much as 300 percent. Today, there are at least 5,521 gray wolves in the contiguous United States. Wolf numbers continue to be robust, stable, and self-sustaining (USFWS 2015).Outside the Northern Rocky Mountain DPS, there are 20 individuals in Washington. Population numbers and trends for each DPS are provided below (USFWS et al. 2015).Northern Rocky Mountain DPS (western)As of December 2014, the minimum year-end wolf population in the Northern Rocky Mountain DPS totaled 1,782 individuals, with a state-by-state breakdown as follows: Idaho – 770 individuals; Montana – 554 individuals; Oregon – 77 individuals; Washington – 48 individuals; and Wyoming – 333 individuals (USFWS et al. 2015).In the Northern Rocky Mountains DPS, state population trends are as follows: Idaho – increasing (IDFG 2015); Montana -decreasing (Bradley et al. 2015); Wyoming – increasing (WGFD et al. 2015); Washington – increasing (Becker et al. 2015); and Oregon – increasing (ODFW 2015).Western Great Lakes DPS (eastern)The minimum year-end wolf population in the Western Great Lakes DPS totaled 3,722 individuals, with a state-by-state breakdown as follows: Michigan (Upper Peninsula – late winter 2013-14) – 636 individuals; Isle Royale (January 2015) – 3 individuals; Minnesota (2013-2014) – 2,423 individuals; and Wisconsin (late winter 2013-14) – 660 individuals (USFWS 2014).In the Western Great Lakes DPS, state population trends are as follows: Minnesota – declining-to-stable due to hunting and depredation control; Wisconsin – declining due to human-caused mortality; Michigan – declining for unstated reasons.Mexican Gray Wolf-Experimental PopulationAs of December 2014, there were 109 individuals in Arizona and New Mexico (USFWS et al. 2015). Habitat and prey for wolves are abundant and well distributed in the Western United States. This, in conjunction with the high reproductive potential of wolves and their innate behavior to disperse and locate social openings or vacant suitable habitats, has allowed wolf populations to withstand relatively high rates of human-caused mortality (Service 2020, pp. 8–9). Our analysis of the current condition of gray wolves in the Western United States demonstrates that, despite current levels of regulated harvest, lethal control, and episodic disease outbreaks, wolf abundance in the Western United States has generally continued to increase and occupied range has continued to expand since reintroduction in the 1990s, with the exception of three years during which wolf abundance in the Western metapopulation decreased slightly (i.e., a decrease of approximately 50 to 100 wolves in one year) (Table 5). As of the end of 2022, states estimated that there were 2,797 wolves distributed between at least 286 packs in seven states12F. This large population size and broad distribution contributes to the resiliency and redundancy of wolves in the Western United States. Moreover, wolves in the Western United States currently have high levels of genetic diversity and connectivity, further supporting the resiliency of wolves throughout the West. Finally, based on several metrics for assessing adaptive capacity, wolves in the Western United States currently retain the ability to adapt to changes in their environment (USFWS, 2023). Habitat and prey for wolves are abundant and well distributed in the Western United States. This, in conjunction with the high reproductive potential of wolves and their innate behavior to disperse and locate social openings or vacant suitable habitats, has allowed wolf populations to withstand relatively high rates of human-caused mortality (Service 2020, pp. 8–9). Our analysis of the current condition of gray wolves in the Western United States demonstrates that, despite current levels of regulated harvest, lethal control, and episodic disease outbreaks, wolf abundance in the Western United States has generally continued to increase and occupied range has continued to expand since reintroduction in the 1990s, with the exception of three years during which wolf abundance in the Western metapopulation decreased slightly (i.e., a decrease of approximately 50 to 100 wolves in one year) (Table 5). As of the end of 2022, states estimated that there were 2,797 wolves distributed between at least 286 packs in seven states12F. This large population size and broad distribution contributes to the resiliency and redundancy of wolves in the Western United States. Moreover, wolves in the Western United States currently have high levels of genetic diversity and connectivity, further supporting the resiliency of wolves throughout the West. Finally, based on several metrics for assessing adaptive capacity, wolves in the Western United States currently retain the ability to adapt to changes in their environment (USFWS, 2023).

### *Threats and Stressors*

**Stressor:** See narrative.
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Recent analysis of the current threats and stressors to the species are not available. In an effort to identify the factors that may affect the species, the threats and stressors identified in the Revised Recovery Plan for the Eastern Timber Wolf and Northern Rocky Mountain Recovery Plan are summarized below (USFWS 1987; USFWS 1992).Five main factors are critical to the long-term survival of the eastern timber wolf: (1) large tracts of wild land with low human densities and minimal accessibility by humans; (2) ecologically sound management; (3) availability of adequate wild prey; (4) adequate understanding of wolf ecology and management; and (5) maintenance of populations that are either free of, or resistant to, parasites and diseases new to wolves, or are large enough to successfully contend with their adverse effects (USFWS 1987).

**Stressor:** Development
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Development has multiple effects on wolves: (1) increased human presence increases the chance of direct killing of wolves; (2) although undocumented, unnatural structures, sounds,

and smells might deter wolves from inhabiting an area; (3) artificial corridors such as paved roads, powerlines, fences along interstate highways, and railroads may prevent or minimize dispersal; (4) increased human presence increases chances of introducing new diseases and parasites to wolves via pets; and (5) reduced prey species abundance and diversity reduce wolf food supply (USFWS 1987).

**Stressor:** Human density and accessibility
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Nowhere in the United States is there an area where the eastern timber wolf will not be affected by human activity. Wherever people reside in wolf county, they will have domestic livestock and/or pets that may be subject to wolf attack. Public education about the wolf, and the preservation of large tracts of wild land with low human densities and minimal accessibility, will help preserve the wolf. Human activity and exploitation of wildlife increase with accessibility. This is especially true for wolves, which are strongly affected by roads in the following ways: (1) direct mortality via vehicles; (2) roads allow access by hunters and trappers, some of whom deliberately and/or accidentally kill wolves; and (3) major highways are barriers to dispersal (USFWS 1992).

**Stressor:** Ecological sound management
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Ecologically sound management includes: (1) protection where needed to help restore the eastern timber wolf to areas of its original range and to preserve a naturally functioning population that can serve as a living museum, as a scientific subject, and as a reservoir to repopulate adjacent areas; (2) depredation control where wolves are killing domestic animals; (3) restocking of wolves into suitable areas of their former range, when feasible; (4) continued research and monitoring of wolf populations; and (5) provision of adequate prey diversity and numbers through habitat and population management and reintroductions where appropriate (USFWS 1992).The USFWS recommends that in Michigan and Wisconsin, and in Zone 1, 2, 3, and 4 of Minnesota, strict protection should be afforded the wolf. Legal protection, however, is only as effective as the public acceptance of laws and regulations needed for wolf management, and the degree of law enforcement devoted to it. Law enforcement is especially needed during fall and winter hunting and trapping seasons, generally September through March. Besides more rigorous and timely enforcement of the laws actually protecting the wolf, additional enforcement is also necessary to ensure that vehicles, including off-road vehicles, be kept off roads restricted against their use. Even the regular presence of law enforcement agents in wolf areas is a valuable deterrent to violations (USFWS 1992).

**Stressor:** Wild prey
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The wolf is dependent on a continual supply of deer, moose, and beaver. Therefore, one of the most important aspects of this plan is to maintain habitat in a high carrying capacity for prey. The most feasible method of doing this is through commercial and noncommercial

timber sales and habitat improvement projects for these species. Such programs require temporary roads, but these can later be obliterated or gated. In protected areas such as Voyageurs National Park or the Boundary Waters Canoe Area where timber sales are prohibited or restricted, the prescribed use of fire may produce the mosaic of habitats necessary for a diversity of prey species (USFWS 1992).

**Stressor:** Public education
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Because of the degree of misunderstanding about wolf ecology, population dynamics, and management, concerted efforts aimed at providing public information and education have been implemented. Nevertheless, considerable misinformation still exists among several segments of the Minnesota and Michigan population. Therefore, concerted information and education are still strongly needed (USFWS 1987).

**Stressor:** Disease and parasites
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** In recent years, a number of new diseases and parasites have been clearly documented as occurring in wolf populations in Minnesota, Wisconsin, and Michigan. Heartworm, canine parvovirus (CPV), and Lyme disease each have the potential to become limiting factors acting on survival, reproduction, and dispersal of large numbers of wolves, and thus may determine the fate of isolated wolf populations. Wolf populations will be able to survive only if they are somehow able to contend with these new threats (USFWS 1987). Recent studies have shown that gray wolves, especially juveniles, are susceptible to CPV and distemper. Because survival of juvenile wolves is critical to successful recovery, developing a comprehensive health monitoring program for translocated and naturally reestablishing wolves is essential to minimize the risk of disease (USFWS 1992).

***Recovery***

**Reclassification Criteria:**
Consistent with assurances provided in the 1978 reclassification of the gray wolf in the conterminous United States (43 FR 9607, March 9, 1978), three gray wolf recovery programs in the following regions of the country were implemented: the Western Great Lakes (Minnesota, Michigan, and Wisconsin, administered by USFWS' Great Lakes, Big Rivers Region), the Northern Rocky Mountains (Idaho, Montana, and Wyoming, administered by USFWS' Mountain-Prairie Region and Pacific Region), and the Southwest (Arizona, New Mexico, Texas, Oklahoma, Mexico, administered by USFWS' Southwest Region). Recovery plans were developed in each of these areas to organize and prioritize recovery criteria and actions appropriate to the unique local circumstances of the gray wolf. Thus, the three gray wolf recovery programs have functioned independently from one another since their inceptions (USFWS 2012).

Western Great Lakes/Eastern Timber Wolf

The primary objective of the Recovery Plan for the Eastern Timber Wolf is to maintain and reestablish viable populations of the eastern timber wolf in as much of its former range as is feasible (USFWS 1992).

When condition 1 of the Delisting Criteria is met and there are 80 wolves (based on late winter counts) in Wisconsin for a minimum of 3 consecutive years, the eastern timber wolf should be downlisted to threatened in Wisconsin. At that time, consideration may also be given to the downlisting of the Michigan wolf population (USFWS 1992).

Northern Rocky Mountain

To reclassify the Northern Rocky Mountain wolf to threatened status over its entire range by securing and maintaining a minimum of 10 breeding pairs in each of two recovery areas for a minimum of 3 successive years (USFWS 1987).

To reclassify the Northern Rocky Mountain wolf to threatened status in an individual recovery area by securing and maintaining a minimum of 10 breeding pairs in the recovery area for a minimum of 3 successive years. Consideration will also be given to reclassifying such a population to threatened under similarity of appearance after this objective for the population has been achieved and verified, special regulations are established, and a state management plan is in place for that population (USFWS 1987).

Southwest/Mexican

Need to develop reclassification criteria.

**Delisting Criteria:**
Consistent with assurances provided in the 1978 reclassification of the gray wolf in the conterminous United States (43 FR 9607, March 9, 1978), three gray wolf recovery programs in the following regions of the country were implemented: the Western Great Lakes (Minnesota, Michigan, and Wisconsin, administered by USFWS' Great Lakes, Big Rivers Region), the Northern Rocky Mountains (Idaho, Montana, and Wyoming, administered by USFWS' Mountain-Prairie Region and Pacific Region), and the Southwest (Arizona, New Mexico, Texas, Oklahoma, Mexico, administered by USFWS' Southwest Region). Recovery plans were developed in each of these areas to organize and prioritize recovery criteria and actions appropriate to the unique local circumstances of the gray wolf. Thus, the three gray wolf recovery programs have functioned independently from one another since their inceptions (USFWS 2012).

Western Great Lakes/Eastern Timber Wolf

The Revised Recovery Plan for the Eastern Timber Wolf identified the following two recovery criteria necessary to delist the species.

1) the survival of the wolf in Minnesota is ensured (USFWS 1992); and

2) at least one viable population of eastern timber wolves outside Minnesota and Isle Royale in the contiguous 48 states of the United States is reestablished (USFWS 1992).

A viable population of eastern timber wolves outside of Minnesota must meet one of the following two descriptions, based on late winter counts: 1. An isolated eastern timber wolf population in the United States must average at least one wolf per 50 sq. mi. (a self-sustaining population of at least 200 wolves) distributed in a minimum area of at least 25,600 contiguous km2 (10,000 sq. mi.) of suitable habitat over a period of 5 successive years; or 2. An eastern timber wolf population in the United States, located within 160 kilometers (100 miles [mi.]) of a self-sustaining wolf population (as described in item 1), must average at least one wolf per 128 km2 (50 sq. mi.) or consist of 100 wolves distributed in an area of at least 12,800 contiguous km2 (5,000 sq. mi.) of suitable habitat over a period of 5 consecutive years. These 100 wolves do not have to be evenly distributed (USFWS 1992).

Northern Rocky Mountain

To remove the Northern Rocky Mountain wolf from the endangered and threatened species list by securing and maintaining a minimum of 10 breeding pairs in each of the three recovery areas for a minimum of 3 successive years (USFWS 1987).

Southwest/Mexican

Need to develop delisting criteria.

**Recovery Actions:**

- Consistent with assurances provided in the 1978 reclassification of the gray wolf in the conterminous United States (43 FR 9607, March 9, 1978), three gray wolf recovery programs in the following regions of the country were implemented: the Western Great Lakes (Minnesota, Michigan, and Wisconsin, administered by USFWS' Great Lakes, Big Rivers Region), the Northern Rocky Mountains (Idaho, Montana, and Wyoming, administered by USFWS' Mountain-Prairie Region and Pacific Region), and the Southwest (Arizona, New Mexico, Texas, Oklahoma, Mexico, administered by USFWS' Southwest Region). Recovery plans were developed in each of these areas to organize and prioritize recovery criteria and actions appropriate to the unique local circumstances of the gray wolf. Thus, the three gray wolf recovery programs have functioned independently from one another since their inceptions (USFWS 2012).
- Western Great Lakes/Eastern Timber Wolf
- The Revised Recovery Plan for the Eastern Timber Wolf provided the following recovery actions.
- Ensure perpetuation of the eastern timber wolf population at levels optimal to the various parts of its present Minnesota range (optimum level includes biological carrying capacity and compatibility with humans): Zone 1, to fluctuate naturally; Zones 2 and 3, one wolf per 10 sq. mi., Zone 4, one wolf per 50 sq. mi., Zone 5, no wolves (USFWS 1992).
- Enhance and reestablish a viable wolf population in Michigan (excluding Isle Royale) and Wisconsin (USFWS 1992).
- Continue management to perpetuate natural conditions for the eastern timber wolf on Isle Royale National Park, Michigan (USFWS 1992).
- Reestablish the wolf population in Adirondack Mountains (New York), northwestern Main/adjacent New Hampshire, and/or northeastern Maine (USFWS 1992).

- Create a Coordination Committee of state and federal representatives to implement the Eastern Timber Wolf Recovery Plan (USFWS 1992).
- Northern Rocky Mountain
- The Northern Rocky Mountain Wolf Recovery Plan provided the following recovery actions.
- Determine the present status and distribution of gray wolves in the Northern Rocky Mountains, and devise a systematic approach for compiling observations and other data on the Northern Rocky Mountain wolf (USFWS 1987).
- Evaluate and verify the population goals for a threatened and fully recovered population established in the current objectives (USFWS 1987).
- Delineate recovery areas and identify and develop conservations strategies and management plan(s) to ensure perpetuation of the Northern Rocky Mountain wolf (USFWS 1987).
- Monitor gray wolf populations, habitat, and prey (USFWS 1987).
- Develop and initiate information and education programs (USFWS 1987).
- Southwest/Mexican
- Inventory and evaluate remaining gene pool (USFWS 1982).
- Protect remaining gene pool (USFWS 1982).
- Reestablish and maintain viable wild populations of Mexican wolves in at least two areas in Mexico and/or adjoining areas of southwestern United States (USFWS 1982).
- If efforts fail to establish and maintain viable wild populations of Mexican wolves anywhere in Mexico or the United States, declare the subspecies extinct in the wild and maintain remaining captive Mexican wolves in captivity, managing captive populations so as to prevent extinction of the subspecies and, if possible, genetic degeneration. For this task, the exact mechanisms and assignment of responsibilities are to be determined at the time by agreement between USFWS and Dirección General de la Fauna Silverstre after recommendations are obtained from the Mexican Wolf Recovery Team, American Association of Zoological Parks and Aquariums, and International Species Inventory Systems (USFWS 1982).
- Monitor progress of agencies, groups, and individuals with assigned responsibilities to ensure that tasks are accomplished in the recommended order of priorities and by the target dates (USFWS 1982).
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***Additional Threshold Information:***

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# SPECIES ACCOUNT: *Canis rufus* (Red wolf)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered/Experimental Population, Non-Essential; 03/11/1967, 11/19/1986; Southeast Region (R4) (USFWS, 2016)

**Physical Description**

The dorsal pelage is mainly gray with interspersed blackish hairs and sometimes yellowish or reddish hairs, especially on the legs and underparts. Nose pad is more than 25 mm wide. Total length 136-165 cm (Whitaker 1996, Whitaker and Hamilton 1998). LENGTH:165 cm. WEIGHT: 40900 g (NatureServe, 2015).

**Taxonomy**

Based on recent genetic studies, Wilson et al. (2000) concluded that the eastern timber wolf (Canis lupus lycaon) and the red wolf (Canis rufus) are sister taxa and are best considered to be conspecific. Additionally, Wilson et al. found that these two taxa form a North American lineage with the coyote (Canis latrans) that is distinct from that of the gray wolf (Canis lupus), which is Eurasian in origin. Wilson et al. (2000, 2003) proposed that the eastern timber wolf (Canis lycaon) be recognized as a species distinct from the gray wolf (C. lupus). In contrast, Nowak (2002) presented an analysis of cranial morphology of recent and Pleistocene Canis and concluded that Canis rufus is a valid species and that lycaon may be a hybrid between Canis rufus and western Canis lupus (NatureServe, 2015).

**Historical Range**

Delineation of the range of this wolf is hampered by a paucity of specimens and debate over the taxonomic status of the species (see Nowak 2002). Data presented by Nowak (2002) indicate a range extending from Maine to Florida and eastward (south of the Great Lakes) to Illinois, Oklahoma, and Texas, based on pre-1918 complete skulls (fragmentary archaeological and paleontological material dating back 10,000 years do not change this much). Basically, if the red would is regarded as a valid species, its range historically was essentially confined to the southeastern United States. Assuming the traditional view that the red wolf is a valid species and that it still exists in unhybridized form, the species was, until recent reintroductions, extinct in the wild since early 1980s (or mid-1970s, Rennie 1991). Formerly it was believed to have occurred from central Texas eastward to the coasts of Florida and Georgia and north to North Carolina, and along the Mississippi River Valley north to southern Illinois, and occasionally in Mexico. The last remnant population along Texas/Louisiana coast was rendered functionally extinct due to hybridization with coyote. A reintroduced population now occurs in an area of roughly 6,900 square kilometers in northeastern North Carolina (reintroduction in Great Smoky Mountains National Park failed and has been terminated; Federal Register, 8 October 1998) (NatureServe, 2015).

**Current Range**

Propagation populations currently exist on two islands: Bulls Island, Cape Romain National Wildlife Refuge, South Carolina; and St. Vincent National Wildlife Refuge, Florida. Other red wolves exist in many captive-breeding facilities (NatureServe, 2015). The only population of red wolves known to exist in the wild on the Albemarle Peninsula of northeastern North Carolina (USFWS, 2007).

**Distinct Population Segments Defined**

No

**Critical Habitat Designated**

No;

***Life History***

**Feeding Narrative**

Adult: Opportunistic. Diet consists of a variety of invertebrates and vertebrates (rabbits, rodents, deer, birds, etc.). Particularly favors marsh rabbits (SYLVILAGUS AQUATICUS), nutria (MYOCASTOR COYPUS), and carrion. Not considered a threat to livestock (does not hunt in packs), but may prey on unattended young calves, pigs, and barnyard fowl (Matthews and Moseley 1990). Adults and immatures and carnivorous, piscivorous, and invertivorous. It is pimarily nocturnal (NatureServe, 2015).

**Reproduction Narrative**

Adult: Mates in January-February. Gestation lasts 60-63 days. Litter of 3-12 (average 6-7) is born in March-May. One litter per year. Young are born in a den in a hollow log, in a burrow, or in similar secluded sites (NatureServe, 2015). Age of breeding can be 2 years and up (USFWS, 2007). The sex ratio is biased, currently showing 14 percent more females than males. Red wolves are monestrous and typically persist as monogamous pairs (USFWS, 1989).

**Spatial Arrangements of the Population**

Adult: Small groups, scattered individuals (NatureServe, 2015)

**Environmental Specificity**

Adult: Broad (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Suitable habitat for this habitat generalist includes upland and lowland forests, shrublands, and coastal prairies and marshes; areas with heavy vegetative cover. More social than coyote but less so than gray wolf; typically travels and forages in small family groups or alone. Formerly density probably not more than 1 per 2 sq. miles (NatureServe, 2015).

***Dispersal/Migration***

**Motility/Mobility**

Adult: High (NatureServe, 2015))

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: Non-migratory (NatureServe, 2015)

**Dispersal**

Adult: High (NatureServe, 2015)

**Dispersal/Migration Narrative**

Adult: Home ranges variously reported as 65 to 130 square kilometers (Riley and McBride 1975), 117 (males) and 78 square kilometers (females, Carley 1979); 100-200 sq. km mentioned by Lowman 1975; varies with conditions. Wolves are highly mobile and readily disperse hundreds of kilometers. This species is non-migratory (NatureServe, 2015). Large areas of habitat of at least 170,000 acres in size are required by this species (USFWS, 1989).

***Population Information and Trends***

**Population Trends:**

Decline of >90% (NatureServe, 2015)

**Species Trends:**

Decreasing (USFWS, 2007)

**Resiliency:**

Given the very low numbers in the NEP (3 breeding pairs; N approximately 44), without substantial intervention (e.g., releases and management of coyote introgression), extirpation will likely occur within as few as eight years (Faust et al. 2016, p. 15). Faust et al. (2016, p. 3) suggested that the NEP could avoid extirpation and be viable (<10% chance of extirpation in 125 years) as a population with intervention, which might include reduction of the NEP mortality rate, increase in breeding rates (which would require reducing breeding season mortality), and releases from the Species Survival Plan (SSP) captive population for approximately 15 years followed by releases to maintain genetic health after that. However, the starting value (i.e., number of animals) for the population is now lower (44 wolves) than was initially modeled, and there is now an increased risk of stochastically-driven dynamics given the smaller population size (i.e., variability in the environment could have a stronger effect on the remaining population, than initially projected). All in all, without significant intervention, wild red wolves in the NEP could be extirpated in the near-term. If interventions described in Faust et al. (2016) are carried out, which could produce a viable population on the Albemarle Peninsula, substantial additional efforts and financial resources will be needed to facilitate population expansion in North Carolina. Modelling indicates landscape-level factors that affect habitat (e.g., particularly sea-level rise and increased flooding) will result in substantial changes to the habitat on the peninsula in the next 125 years, which could push wolves further west from where they currently occur. If this happens, they would encounter more development (e.g., Greenville area), as indicated by the urban development model results. Whether their natural mobility as a species will allow the red wolf to locate suitable habitat in a changing landscape is still unclear, but coyotes will likely use the same habitats and are more adaptable with regard to human development and infrastructure. Without sufficient wolf mates on the landscape, hybridization would likely continue to occur and coyotes already vastly outnumber wolves on both the peninsula and areas west of the current NEP so, intensive management and significant additional resources would be necessary. With regard to the SSP captive population, current gene diversity for the managed population is 88.87% and is equivalent to the genetic diversity of a population descended from only approximately five founders. This is one of the biggest challenges with this species because the current gene diversity is very low. The main objective for the captive population is to maintain this diversity in the long term. Faust et al. (2016, p. 3) discussed that "[w]hile the SSP [captive population] has been maintained at a relatively large population size of more than 150 animals for over 20 years, it needs to increase breeding and increase its population size/space to ensure long-term viability and its ability to serve as a strong source for animals to release to the wild (USFWS 2018)."

**Representation:**

The SSP captive population represents the genetic fail-safe for the entire population and any future recovery potential for the species. However, only twelve of the original fourteen lines are still represented and Faust et al. (2016) provide several scenarios through which the SSP captive population could be expanded, genetic diversity (of the remaining 12 lines) maintained, and future release efforts supported. While any future reintroductions would require a consideration of SSP capacity to support these efforts, it is clear that the SSP captive population has maintained a genetically-diverse stock, within the limits of the remaining 12 founder lines, from which to grow the population and release into the wild. This report presents the best available scientific information to date on the status and management of the red wolf. This report is expected to be a living document that can be edited and peer-reviewed regularly to keep it current with the best available science. We expect to use this report for future recovery planning activities, management efforts, species status review (i.e., 5-year reviews), and other conservation activities that depend on the most current science (USFWS 2018).

**Redundancy:**

Redundancy is having sufficient numbers of resilient populations for the species to withstand catastrophic events. The single NEP of red wolves could be extirpated in approximately 8 to 37 years (Faust et al. 2016, p. 15). Without new reintroduction sites the species is unlikely to have significant redundancy in the wild. Some level of redundancy is present in captivity because the species is held at multiple facilities throughout the U.S. However, this does not constitute a viable wild population. Therefore, at present and into the future, there is no redundancy of red wolves in the wild (USFWS 2018).

**Population Growth Rate:**

8% per year (USFWS, 1989)

**Number of Populations:**

1 (USFWS, 2007)

**Population Size:**

20-22 in the wild, non-essential population and 263 in the SAFE population (USFWS, 2024)

**Minimum Viable Population Size:**

2,000 (USFWS, 1989)

**Resistance to Disease:**

Low (inferred from USFWS, 2007; see threats)

**Adaptability:**

Low (inferred from NatureServe, 2015)

**Population Narrative:**

Assuming an historical range throughout southeastern North America (e.g., Nowak 2002), the extent of occurrence, area of occupancy, and abundance of this species have undergone a drastic decline over the long term. This species has experienced a long-term decline of >90%. As of 2005, there were about 100 red wolves in the wild on 6,900 square kilometers in northeastern North Carolina. The number of reproductive individuals probably is not greater than 50. The captive population included around 165 wolves. This species occurs in the wild in one major location (plus two islands that serve as propagation areas). Genetic data (see Wayne and Jenks 1991, Wayne 1992, Wayne et al. 1998, Reich et al. 1999) indicate that existing populations of what have been called red wolves have no unique genetic characteristics and most likely are a product of hybridization between Canis lupus and C. latrans. A reintroduced population now occurs in an area of roughly 6,900 square kilometers in northeastern North Carolina. Attempted reintroduction in Great Smoky Mountains National Park failed, probably due to parvovirus and other common canine diseases, internal and external parasites, poor nutrition caused by low food availability, and predation (Federal Register, 8 October 1998) (NatureServe, 2015). There is only one population currently existing in the wild. The species status is declining based on the 2006 and 2007 Recovery Data Calls. Recent calendar year counts for red wolves in the wild population fluctuate between approximately 100 to 130 red wolves (USFWS, 2007). If the genetic models prescribe an Ne of 500 to achieve some set of genetic objectives, the MVP might have to be 2,000. While over the history of the population the average growth rate has been about 8 percent per year (i.e., lambda = 1.08), it is expected that the potential for increase could be expanded to 20 percent per year (USFWS, 1989). The Red Wolf is a species of wolf once common throughout the Eastern and South-Central United States. A nonessential experimental population located in eastern North Carolina has approximately 20-22 wild wolves. The SAFE (captive) population has 263 individuals. The species continues to be threatened by hybridization with coyotes, human-caused mortalities including poaching, poisoning, vehicle strikes, habitat modification from development and loss from future sea level rise. Only 12 animals were used to found the SAFE propagation program for Red Wolves and introductions. Since the number of founders are limited, inbreeding depression, reduced genetic variability, significant declines by stochastic events, and potential Allee effects are all of concern for the species. Considering the full analysis described in the Species Status Assessment report, the Red Wolf continues to have virtually no resiliency, no redundancy, and very low representation. (USFWS, 2024)

***Threats and Stressors***

**Stressor:** Habitat loss and fragmentation (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** For centuries, fragmentation in red wolf historic range has come in the form of habitat conversion and land development by humans. Proposed development projects on the Albemarle Peninsula will have short-term and long-term effects on red wolves in the NEP unless potential effects are addressed early via planning, designs, and project implementation. Barriers to dispersal that fragment habitat (e.g., highways, airports, or large fenced areas) can have long-term effects upon genetic diversity. For restored populations of small size, such as the red wolf NEP, fragmenting barriers can magnify these genetic effects and potentially dampen or reverse population growth to a greater degree. Fragmentation contributed to the initial decline of the red wolf species. Now, fragmentation threatens red wolves in the North Carolina NEP via proposed barriers and habitat conversion on both public and private land (USFWS, 2007).

**Stressor:** Disease (USFWS, 2007)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Because canid diseases can spread quickly, they can cause serious setbacks in red wolf recovery. Canid diseases remain a serious threat to the red wolf NEP and to captive red wolves. Acton and colleagues found that titers against parvovirus are not detectable in a large portion of vaccinated red wolves, indicating the NEP is still very much at risk to CPV2 parvovirus. This is important because poor pup survival from parvovirus caused the Service in 1998 to discontinue the Great Smoky Mountains red wolf NEP (Henry 1998). Numerous diseases and other ailments have been documented during the past thirty years in individual red wolves. During 2007, the Service observed eye entropia in three young captive program red wolves being held at Alligator River NWR. Other physical anomalies were observed in captive red wolves in recent years, such as progressive retinal atrophy, malocclusion and undescended testicles (Waddell, Pers. Comm. 2007). Heartworms, hookworms (Ancylostoma caninum), and sarcoptic mange, are serious concerns, but heartworms and hookworms have so far not been identified as a significant source of mortality in the NEP (USFWS 1990; Phillips and Scheck 1991). Tick paralysis was reported by Beyer and Grossman (1997), while Rothschild et al. (2001) reported arthritis, and Harrenstein et al. (1997) reported antibody responses to canine distemper and canine parvovirus indicating prior exposure. Penrose et al. (2000) reported the lyme disease causing bacteria Borrelia burgdoferi in a red wolf. Neiffer et al. (1999) reported abdominal disease involving cecal inversion and colocolic intussusception. Kearns et al. (2000) reported dermatosis. Acton et al. (2000) surveyed necropsy results in 62 captive program red wolves for the period of 1992 to 1996. They documented numerous ailments in individual red wolves of many different ages. Of 22 neonatal deaths, major causes included parental trauma, parasitic pneumonia, and septicemia (systemic bacteria often found in the blood). Two juvenile red wolves died of cardiovascular anomalies or systemic parasitism. Of 38 adult red wolf deaths, causes included neoplasia and gastrointestinal diseases. Of the fatal neoplasm conditions, 50% were lymphosarcoma (USFWS, 2007).

**Stressor:** Gunshot and vehicle mortality (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Gunshot mortality is a serious threat to red wolves in the North Carolina NEP. Preliminary figures generated in 2006 and 2007 (D. Murray unpublished data) showed that a wild red wolf is 7.2 times more likely to be killed by gunshot during the hunting season than during the nonhunting season. Whether accidental by licensed hunters, or illegal, gunshot mortality since 2004 is hampering the ability of the red wolf NEP to continue its upward trend in growth. Since 2004, gunshot mortality has reduced the number of breeding pairs and pups in the NEP and otherwise removed growth potential. Vehicle strike mortality significantly impacts the red wolf NEP in North Carolina. From 270 known red wolf mortalities recorded for the NEP between 1987 and 2006, vehicle mortality was calculated to be 17.4 percent (D. Murray 2007, unpublished data) (USFWS, 2007).

**Stressor:** Hybridization (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Introgression of coyote genes continues to be a threat to the red wolf across its historic range (USFWS, 2007).

**Stressor:** Climate change (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Natural weather events and global climate change will play growing roles in long-term survival and recovery of red wolves. The red wolf NEP in North Carolina is subject to annual tropical storm activity. In fact, Hurricane Isabel resulted in the deaths of two captive red wolves during September of 2003, with no noticeable long-term impacts observed in the NEP. However, the NEP and associated prey species remain vulnerable to sea level rise and flooding related to climate change and hurricanes. Additional long-term changes in habitat availability, prey abundance, and other ecological or landscape factors will occur with climate change (Parry et al. 2007) (USFWS, 2007).

***Recovery***

**Reclassification Criteria:**
Not available

Recovery Priority Number: 5C

**Delisting Criteria:**
Criterion 1: Three viable wild populations occur within the Red Wolf historic range and are distributed to maximize species redundancy. • Populations occur in suitable habitats of sufficient quantity and quality to support natural demographic processes (e.g., survival, reproduction, dispersal, and mortality) that lead to viable populations, as described in Criterion 2. (USFWS, 2024)

Criterion 2: Each Red Wolf population meets the following criteria for viability: • One of the three populations consists of at least 180 individuals, the other 2 populations consists of a minimum of 280 individuals each, based on an estimate of the number of individuals 1 year and older; • At least 80% of current and future founder gene diversity has been maintained; • Once the population meets minimum abundance, the population is stable or growing for a period of 10 years without extensive human interventions (mean population growth rate for those 10 years is ≥1.0); and • Each population has a 95% probability of persistence for 100 years.(USFWS, 2024)

Criterion 3: Adequate mechanisms or long-term commitments are in place that provide a high level of certainty that Criterion 2 for each population will be maintained into the foreseeable future without the protections of the Act. At this time none of these criteria have been met. (USFWS, 2024)

**Recovery Actions:**
- Maintain and evaluate existing wild populations (USFWS, 1989).
- Establish new populations in the wild (USFWS, 1989).
- Expand captive-breeding capabilities (USFWS, 1989).

- Expand cryopreservation capabilities (USFWS, 1989).
- Develop an effective disease prevention and management plan for red wolves and other canid species in northeastern North Carolina (USFWS, 2007).
- Expand the number of facilities participating in the Red Wolf Species Survival Plan to continue to meet genetic diversity objectives and to aid in establishing any future additional red wolf populations. Support Tacoma Metroparks and the Point Defiance Zoo and Aquarium in Washington with relocation and reconstruction of the flagship red wolf captive breeding facility located there. Enhance partnerships in the Red Wolf Species Survival Plan with staff at facilities across North America to enhance red wolf captive breeding (USFWS, 2007).
- Identify and evaluate land areas in red wolf historic range that could be considered for potential establishment of second and third wild red wolf populations. Examine biological and human factors important in identifying new restoration locations. Evaluate site selection concepts offered by states, scientists, and partners (Knowlton 2007 in litt.; Kyle et al. 2007; Van Manen et al. 2000; Defenders of Wildlife 2005 in litt.; Scott et al. 2005; Stoskopf 2007 in litt.; Murray 2007 in litt.; among others). Biologists have known since the first wolf was released in North Carolina and based on the recovery plan for the red wolf, that the species cannot be recovered by restoring it only to the Albemarle Peninsula. Before release of red wolves in North Carolina, the Service recognized the impacts this action would have and cooperated extensively with the State and local communities in order to be able to initiate an important recovery action while maintaining flexibility to ensure human safety and activities would be considered. One of the objectives to attain the red wolf's recovery is to restore and expand the red wolf into other suitable habitats within its historic range. The Service's immediate focus is on its recovery efforts for the red wolf NEP. The Service would like to explore the feasibility of restoration of other populations and intends to work in cooperation with States, partners, and local communities (USFWS, 2007).
- Work collaboratively with the U.S. Department of Agriculture Wildlife Services in support of efforts by the NCWRC to develop a cooperative statewide canid management plan or policy. With NCWRC leadership, develop a plan or policy concurrent with developing new state and federal regulations which address the most pressing canid issues in the State of North Carolina. Include the issues of landowner needs, hunter stewardship, trapping opportunities, wolf management areas, and canid disease management. Focus on the illegal import, illegal release, and fox pen hunting of invasive eastern coyotes, with safeguards ensuring wolves are not hunted in fox pens. Focus on elimination of eastern coyotes from the Albemarle Peninsula to the extent feasible. Include in the cooperative plan provisions to effectively manage wolves, coyotes, wolf-dog hybrids, foxes and exotic variations of these animals (USFWS, 2007).
- Develop cooperative actions which result in significant reduction of the portion of red wolf mortality attributed indirectly or directly to people. Work with the North Carolina Wildlife Resources Commission and the North Carolina Department of Transportation to develop cooperative measures which reduce the loss of red wolves caused by gunshot and vehicles strikes. Develop and implement educational outreach measures to highlight to people and local communities we need their assistance in reducing red wolf mortality. Encourage managers of large development projects and partners on the Peninsula to work with us in incorporating red wolf recovery concerns. Develop mutually beneficial landowner incentive measures. Explore potential joint state and federal law enforcement measures (USFWS, 2007).

- Draft a new recovery plan and species survival plan for the red wolf. These plans should incorporate significant advances in science and information developed since approval of the 1990 Red Wolf Recovery/Species Survival Plan. The 1982, 1984 and 1990 plans were written to identify measures which ensure immediate survival of red wolves in captivity and in the red wolf NEP. Many tasks in these early plans associated with captive rearing and restoration into the wild are completed or ongoing with significant gains in survival pulling the red wolf away from the brink of extinction. After 20 years of restoration and management of red wolves in the wild and in captivity, we must set new recovery goals, objectives, criteria, tasks and research needs. These should focus on population management, restoration in historic range, expanded captive breeding, reduction of new threats, long-term conservation, delisting, and down-listing (USFWS, 2007).
- Establish a human dimensions sub-team and a community stakeholder group to advise the Service and Red Wolf Recovery Implementation Team scientists on human factors and issues important in successful red wolf recovery (USFWS, 2007).
- Maintain at least two locations which fulfill the vital restoration roles of island propagation sites that contribute directly to both wild red wolf population(s) and captive breeding. The two sites currently with such capabilities are St. Vincent NWR in Florida and Cape Romain NWR in South Carolina (USFWS, 2007).
- Launch studies of wolf/coyote interaction and monitoring to identify additional long-term strategies for wolf and coyote management, with focus on the western end of the red wolf NEP (USFWS, 2007).
- Consider updating the red wolf 4(d) rule in cooperation with the State to reflect additional strength and flexibility needed for landowners, land managers, hunters, trappers, communities, red wolves and law enforcement officers. Another option is to identify alternate conservation incentive agreements with land owners and land managers (USFWS, 2007).
- Engage further science in the discussion of relationships between red wolves and Algonquin wolves and whether or not they should be managed together across a broader geographic continuum (USFWS, 2007).
- Launch enhanced, expanded and new efforts to educate local communities and visitors about red wolf conservation and ecosystem values. Share red wolf conservation values with children, families, other stakeholders and the general public. Enhance partnerships developing ecotourism values for local communities proximal to the wild red wolf population(s). Assist partners in their efforts to promote ecotourism and establish an education center emphasizing red wolf, refuge, farming, hunting and other natural resource community values (USFWS, 2007).
- Evaluate how the effects of climate change will influence red wolf recovery. Develop plans which address the effects of climate change via strategies in long-term conservation (USFWS, 2007).
- Continue to implement and further develop the red wolf adaptive management plan for wild red wolf population(s), based on regular evaluations and recommendations by scientists from the Red Wolf Recovery Implementation Team (USFWS, 2007).

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# SPECIES ACCOUNT: *Corynorhinus (=Plecotus) townsendii virginianus* (Virginia big-eared bat)

***Species Taxonomic and Listing Information***

**Commonly-used Acronym:** VBEB

**Listing Status:** Endangered; Northeast Region (R5) (USFWS, 2015)

**Physical Description**

Plecotus townsendii is a medium-sized bat with forearms measuring 39 to 48 millimeters (mm) long and weighing 7 to 12 grams. Total body length is 98 mm, the tail is 46 mm, and the hind foot is 11 mm long. This bat's long ears (over 2.5 centimeters) and facial glands on either side of the snout are quite distinctive. Fur is light to dark brown depending upon the age of the individual and the subspecies (USFWS, 2015).

**Taxonomy**

Formerly included in the genus Plecotus (see taxonomic comments for C. townsendii). (NatureServe, 2015)

**Historical Range**

Historically known from Appalachian Mountains in Virginia, West Virginia, North Carolina, and eastern Kentucky. (NatureServe, 2015)

**Current Range**

Presently occurs in decreased numbers throughout much of the historic range. Largest colonies are in several caves in Pendleton County, West Virginia; some caves serve as both hibernation and maternity sites, others are primarily maternity caves Colonies occur also in Lee County and surrounding counties, Kentucky (the best known site being Stillhouse Cave); in Bath, Highland, Rockingham, Bland, and Tazewell counties, Virginia (Dalton 1987); and in Avery and Watauga counties, North Carolina (including Black Rock Cliffs Cave) See Matthews and Moseley (1990) and Handley (1991). (NatureServe, 2015). Since the 2008 status review, there are new county records for: Watauga, North Carolinawhere a new maternity cave has been documented (Weberet al. 2016); Carter and Johnson Counties, Tennessee where VBEBs were tracked to day roost sites from known caves in adjacent counties (Weber et al. 2016); Bath County, Virginia where 4 VBEBs were found hibernating in 2 caves (VDGIF 2017 data);and Pulaski County, Kentucky where one male VBEB was found hibernating. This site is located 32.8 miles from the closest known VBEB site (Kiser 2016) (USFWS 2019).

**Distinct Population Segments Defined**

No

**Critical Habitat Designated**

Yes; 11/30/1979.

**Legal Description**

On November 30, 1979, the Service determined the Virginia big-eared bat to be an endangered species and determined five caves in West Virginia to be critical habitat.

**Critical Habitat Designation**

The critical habitat designation for Corynorhinus (=Plecotus) townsendii virginianus includes five caves in Pendleton and Tucker Counties, West Virginia.

Pendleton County: Cave mountain Cave, Hellhole Cave, Hoffman School Cave, Sinnit Cave.

Tucker county: Cave Hollow Cave.

**Primary Constituent Elements/Physical or Biological Features**

Not specified. The Virginia big-eared bat depends on the maintenance of precise conditions in these caves which it must use for hibernating sites in the winter and for nurseries in the summer.

**Special Management Considerations or Protections**

Activities that may adversely modify critical habitat include: 1. Any action which would sustantially alter the physical structure, temperature, humidity, or air flow of the designated caves culd adversely modify critical habitat since the virginia big-eared bat depends on the maintenance of precise conditions in these caves which it must use for hibernating sites in the winter and for nurseries in the summer. 2. any action which would result in disturbance of the bats in their hibernating or nursery caves would adversely affect critical habitat since the species is highly tolerant of human disturbance. Such activity might inlude blasting or construction in or near the dsignated caves, or increasing human access to the caves.

***Life History***

**Feeding Narrative**

Adult: Feeds principally on moths. Forages over fields and woods, with individuals routinely traveling 3-5 miles from roost cave to foraging area (End. Sp. Tech. Bull., Sept./Dec. 1991). In eastern West Virginia, Lepidoptera was the most important insect order in the diet, followed by Coleoptera, Diptera, and Hymenoptera; compared to availability, selectively consumed Lepidotera and avoided Coleoptera; forest insect comprised a substantial part of the diet (Sample and Whitmore 1993).; Food Habits: Invertivore (Adult, Immature). Activity usually begins well into the night, late relative to other bats. After an initial feeding period, roosts and rests during the night, presumably before a later feeding bout. Commonly arouses in winter, changing position within a hibernaculum or moving to a nearby cave or mine.; (NatureServe, 2015). Townsend's big-eared bat feeds principally on small moths (Microlepidoptera), averaging 6mm in length (range 3 to 10 mm), and also may take other insects, including representatives of Neuroptera, Coleoptera, Diptera, and Hymenoptera (Hamilton, 1943; Ross, 1967; Whitaker et al, 1977). Howell (1920) noted that Townsend's big-eared bat captured insects from leaves and other places. However, Bell (in Kunz and Martin, 1982) noted that big-eared bats feed mostly in the air along forested edges and should not be regarded as foliage gleaners (USFWS, 1984).

**Reproduction Narrative**

Adult: Maximum longevity reported for this species is 16 years 5 months, based on recoveries of banded bats in California (Paradiso and Greenha11, 1967). The following is a summary by Kunz and Martin (1982) of Pearson's work: Estrus and subsequent copulation begin in autumn and the peak of copulations occurs from November through February, although some females apparently mate before arriving at hibernacula. Young females are reproductively active and mate in the"ir first autumn. Spermatozoa are stored in the reproductive tracts of females until spring, when ovulation, fertilization, and gestation occur. Ovulation may occur either before or after females leave hibernation. Development of a single embryo takes place in the right uterine horn. The length of gestation varies from 56 to 100 days, depending on spring temperatures and the varying amounts of torpor experienced by different individuals. Parturition occurs in late spring and early summer, followed by an anestrous period. In adult males, spermatogenesis occurs during the summer, reaching maximum activity in September. By late September and early October, the testes of adults begin to atrophy, coinciding with the appearance of sperm in the enlarging eipididymides. The accessory glands reach full size in late October. Copulation is preceded by a ritualized precopulatory behavior characterized by the production of audible vocalizations, followed by head nuzzling which may be directed at either torpid or active individuals. Young males fail to reach sexual maturity in their first autumn. As in other bats, baby Townsend's big-eared bats are large at birth, weighing nearly 25% of their mother's post-partum mass. Newborn bats are naked and their large ears lie over their unopened eyes for the first few days. Within a few hours after birth they can produce audible 'chirps' which may play an important role in mother-infant recognition. At the age of one week, young bats are capable of producing adult-like audible 'squawks'. Young bats grow rapidly, nearly reaching adult forearm size in one month. They are capable of flight at 2.5 to 3 weeks and are fully weaned by 6 weeks (USFWS, 1984).

**Spatial Arrangements of the Population**

Adult: Clumped (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (NatureServe, 2015)

**Site Fidelity**

Adult: High (NatureServe, 2015)

**Habitat Narrative**

Adult: Species inhabits caves typically in limestone karst regions dominated by mature hardwood forests of hickory, beech, maple, and hemlock (Matthews and Moseley 1990). Prefers cool, well-ventilated caves for hibernation (Matthews and Moseley 1990); roost sites are often near cave entrances or in places where there is considerable air movement (Handley 1991). Males and females hibernate together. In summer, males occur singly or in groups in caves (Handley 1991). In eastern Kentucky, feeding roosts were in cliffs adjacent to two maternity roosts and one bachelor roost (Burford and Lacki 1998). Individuals may move from one roost to another at any season. Maternity colonies settle deep within caves, far from entrance (Matthews and Moseley 1990); these caves are warmer than those used for hibernation. In Kentucky, used limestone caves, except in one instance in which a sandstone rock shelter was used (Lacki et al. 1994). In Kentucky, often detected in old fields and above cliffs (Burford and Lacki 1995) (NatureServe, 2015). High eclogical integrity of the population and site fidelity as well as low tolerance ranges are inferred based on the species need to inhabits caves that are not disturbed.

***Dispersal/Migration***

**Motility/Mobility**

Adult: High (NatureServe, 2015)

**Dispersal/Migration Narrative**

Adult: Fairly sedentary; not known to migrate more than about 64 km between hibernation and maternity caves (Matthews and Moseley 1990) (NatureServe, 2015).

***Population Information and Trends***

**Number of Populations:**

6 - 20 (NatureServe, 2015)

**Population Size:**

The current total population of the species is approximately 19,574 bats in hibernacula and 11,778 within the known maternity sites (USFWS, 2019). The large majority of these bats are currently concentrated in 10 hibernacula and 18 maternity sites distributed among 4 genetically distinct populations located in geographically distinct regions (USFWS, 2019).

**Population Narrative:**

Total known population was 3,866 bats (ll colonies) in 1984 (Bagley and Jacobs 1985), about 10,000 in the late 1980s (Dalton 1987). In 1987, the total West Virginia population was 8000, based on a count of about 3500 females, up almost one-third since 1983 (Matthews and Moseley 1990). A 1991 count of the 9 summer colonies in West Virginia yielded 4455 individuals, a 15 percent increase from the 1990 count and a 20 percent increase from 1984 (End. Sp. Tech. Bull., Sept./Dec. 1991); the count was basically unchanged in early 1992, but in May 1992 the largest known maternity colony (1300 individuals) of this subspecies was discovered (1992 End. Sp. Tech. Bull. 17(12):18). The largest known concentration of this species is in Hellhole Cave, West Virginia; the count for the 1994-1995 season was 6378 individuals (End. Sp. Bull. 20(4):21). As of the mid-1990s, West Virginia/North Carolina population was more than 13,000 (1994 End. Sp. Tech. Bull. 19(5):14). In Kentucky, the hibernating population in Stillhouse Cave increased from 1700 in 1982 to 2600 in 1987 (Matthews and Moseley 1990). Virginia population in the 1980s was about 2000 and stable (Dalton 1987, Handley 1991). Total population in 1997 probably was less than 20,000 (Pupek 1997). Known from about 15 caves in 4 states (Kentucky-1, Virginia-2, West Virginia-11, North Carolina-1). Other colonies have either declined or disappeared (NatureServe, 2015). Moderate resiliency, representation and redundancy are inferred based on the number of known population and their relatively disperesed geography.

***Threats and Stressors***

**Stressor:** Development (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat

**Narrative:** Foraging habitat in some areas have been lost to development (USFWS, 2008).

**Stressor:** Mining activities (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Mining activities could potentially impact some of the caves that support this species (USFWS, 2008).

**Stressor:** Protection of cave habitat (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Most caves are protected (gated). However, some privately owned caves are not (USFWS, 2008).

**Stressor:** Rock climbing (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Rock climbing activity has increased in an area of Kentucky which has potential habitat. Inadvertent disturbance could occur (USFWS, 2008).

**Stressor:** White nosed syndrome (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals/loss of populations
**Narrative:** Although not known to occur in VBEB habitats this species is susceptible to possible infestation (USFWS, 2008).

**Stressor:** Predation (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Predation by house cats and black rat snakes has been documented (USFWS, 2008).

**Stressor:** Wind turbines (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** The anticipated development of wind turbines near hibernacula maternity colony caves is a threat to this species (USFWS, 2008).

**Stressor:** Vandalism (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Even when gates are locked, cave vandalism can be a problem (USFWS, 2008).

**Stressor:** Road mortalities (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** VBEB has become more susceptible to road mortalities as areas around their habitat become more developed (USFWS, 2008).

**Stressor:** Oil and brine separation plants (USFWS, 2008)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Oil and brine separation plants are a threat to this species (USFWS, 2008).

***Recovery***

**Reclassification Criteria:**
A minimum number of maternity, hibernation, and bachelor sites and total abundance for each MU are attained as described in table 1 of the Recovery Plan Draft Amendment 1 (USFWS, 2019)

For each MU, total population numbers for both hibernacula and maternity sites are stable or increasing for a timeframe approximately equal to the lifespan of a VBEB, (approximately 16 years), which encompasses multiple VBEB generations, and meet or exceed the minimum population numbers listed in table 1 for the most recent half of that timeframe. Numbers shall be based on biennial monitoring of hibernation sites and annual monitoring of maternity sites using Service-approved protocols (USFWS, 2019).

For all sites needed to support the minimum population numbers and distribution specified in table 1, long-termt management agreements are in place (finalized and fully implemented) with responsible land and resource management entities. Long-term protection is defined to include: a) The site is located on state or Federal lands with an established long-term management plan, or it is located on private lands with a signed enforceable management agreement that will transfer to new owners; and b) The management plan or agreement specifies that the area will be maintained for the benefit of the VBEB and ensures that habitat (including both the surface and subsurface features) sufficient to support all life functions at all life stages of the populations that utilize the area will be conserved; and c) Human access to the site is controlled by the installation of gates or fences, unless the site is located in a sufficiently remote location such that access violations are not expected. In addition, the site must be closed to access during all periods VBEBs are expected to be present (except for access needed to manage or monitor the bats or the site). Signs are placed at the site to indicate access is prohibited (USFWS, 2019).

Long-term management agreements are in place to protect features essential to all identified key foraging areas (USFWS, 2019).

1. Documentation of long-term protection of 95 percent of all known active colony sites (USFWS, 2024).

2. Documentation of stable or increasing populations at 95 percent of the known active maternity sites and hibernacula for a period of 5 years (USFWS, 2024).

3. Foraging habitat for both subspecies must be identified and restored as much as possible. However, a given amount of foraging habitat cannot be required in the objective at this time due to lack of information on colony needs (USFWS, 2024).

4. Finally, a periodic monitoring program must be established to ensure a continued awareness of the status of these animals (USFWS, 2024).

Recovery Priority Number: 9C

**Delisting Criteria:**
Delisting for the VBEB may be considered when criteria 1 through 4 above are maintained and when all of the following additional criteria are met: Within each MU, all sites needed to support the minimum population numbers and distribution as specified in table 1 are connected by habitats that support travel between sites (USFWS, 2019).

Long-term mechanisms are in place to deter, monitor, detect, and enforce access violations; maintain any gates, fences, and other access controls; and ameliorate adverse effects (including predation) for all sites required to meet criterion 1. Effective monitoring programs are in place to detect access violations and damage to any gates or other access controls in a timely manner. Responsible management entities are identified and accountable for maintaining and repairing access controls, and for regulating and controlling threats from predation (USFWS, 2019).

Delisting for the VBEB may be considered when criteria 1 through 4 above are maintained7 and when all of the following additional criteria are met: 5. Within each RU, all sites needed to support the minimum population numbers and distribution as specified in table 1 are connected by habitats that support travel between sites and that are free from major barriers to movement (USFWS, 2024). Justification: This criterion addresses Factor A and Factor E (other natural and manmade factors). Barriers to movement (e.g., wind turbines, major highways) that could fragment habitats, impede migration between sites within each RU, or cause direct mortality have been identified as an increasing threat (Service 2019). Mating, hibernation, and reproduction are key life history phases for the VBEB. The bats use different sites for each of these phases. In addition, bats may shift between different maternity or hibernation sites. Therefore, the ability to move between sites within an RU is required to complete their life cycle and to ensure population resiliency.

6. Lasting mechanisms are in place to deter, monitor, detect, and enforce access violations; maintain any gates, fences, and other access controls; and ameliorate adverse effects (including predation) for all sites required to meet criterion 1. Effective monitoring programs are in place to detect access violations and damage to any gates or other access controls in a timely manner. Responsible management entities are identified and accountable for maintaining and repairing access controls, and for regulating and controlling threats from predation. Justification: This criterion addresses Factors A, E, D (inadequacy of existing regulatory mechanisms), and C (predation). This criterion would ensure that the protections needed to maintain recovery are continued absent the ESA. Because the VBEB is subject to threats that can be managed but not eliminated, it is considered a conservation-reliant species, (i.e., their long-term viability depends

on continued management). Therefore, alternative mechanisms are needed after delisting to ensure that threats are adequately managed into the future. VBEB populations are concentrated in a small number of sites in the winter and summer. Disturbance to bats in roosts is one of the primary threats that resulted in the listing of the species. Protection of these sites is reliant upon gates, fences, and other structures that must be maintained to remain effective. Ongoing management and protection to prevent development, conversion, or degradation of surrounding foraging and migratory habitats is also required (USFWS, 2024).

**Recovery Actions:**

- Review of the existing list of recovery actions as well as the 2008 and 2019 status reviews indicates that some recovery actions have been completed (USFWS, 2019).
- Continue Monitoring Population Trends at All Essential Sites: One recovery criterion for downlisting in the 1995 recovery plan requires maintenance of a stable or increasing OBEB population at all known essential caves over a 10-year period. Results from a recent genetic study (Weyandt et al. 2005) corroborate the importance of monitoring the population trends at each colony. The research suggests very strong site fidelity and limited dispersal by females, and high natal philopatry. These results suggest that failure to protect a maternity site may result in the loss of genetic variation. Each essential site should continue to be monitored over the next 10 years to determine population trends. The hibernacula that are difficult to monitor without disturbing the bats should be monitored every three years (USFWS, 2008).
- Acquire Essential Caves and Important Foraging Habitat for Additions to the Ozark Plateau NWR: The Ozark Plateau NWR was approved, in 2005, to expand up to 15,000 acres in Adair, Delaware, Ottawa, Sequoyah, Craig, Mayes, and Cherokee counties, Oklahoma. The Environmental Assessment for the approved Expansion of the Ozark Plateau NWR (Service 2002) includes a land protection plan that identifies: 1) important known habitat for the OBEB in need of long-term protection, 2) the preferred type of protection for each tract, 3) the minimum type of protection deemed necessary, and 4) a protection priority classification for each site. Protecting additional OBEB caves and foraging areas through fee title acquisition and conservation easements would help minimize future destruction and modification of cave and foraging habitats. Adding cave sites to the refuge also would facilitate monitoring of the sites and help regulate human entry for scientific, recreational, and educational purposes. Additional OBEB essential and limited-use caves and surrounding foraging areas need protection through acquisition and/or other measures such as cave gating. Important sites that currently are not afforded protection include essential caves AD-17, AD-24, AD-25, AD-T1, and WA-5202, as well as numerous limited-use caves. These sites could be acquired by the Service as additions to the refuge or by other natural resource agencies and conservation groups through fee title acquisition or through conservation easements when sellers or donors are willing. The development of voluntary cooperative agreements and cave management plans to protect forested foraging habitat and caves also are potential conservation measures that can be pursued to prevent habitat loss and modification (USFWS, 2008).
- Increase Staff and Funding Levels at the Ozark Plateau NWR: Refuge responsibilities are extensive and include developing and maintaining positive landowner relations, developing and implementing cooperative agreements with landowners, working with state and federal agencies, universities, and non-profit organizations, constructing cave gates and fences, repair and maintenance of cave gates and fences, habitat enhancement and restoration (e.g., timber thinning, planting, prescribed burns, etc.), maintenance of roads and buildings,

annual monitoring of bat populations, cavefish and cave crayfish monitoring, identifying important tracts for future acquisition, placement and maintenance of interpretative and warning signs at cave entrances, law enforcement, mapping essential caves, facilitating important research, developing and implementing plans for scientific, educational, and other public use, actively preparing proposals for funding from the Service and other agency and private sources for management and acquisition, and preparing important planning documents. Inadequate funding and insufficient staffing at the Ozark Plateau NWR would only continue to make refuge management, and, hence, meeting an OBEB recovery criterion difficult. The Southwest Region's "National Wildlife Refuge System Work Plan" for FY 2007 – 2009 identifies the Ozark Plateau NWR as a Tier 1 focus refuge for the Region. This classification implies that staff and funding from refuges classified as Tier 2 (Targeted Reduction Refuges) and Tier 3 (Satellite Refuges) would be shifted to the Ozark Plateau NWR. Increasing staffing and funding levels would help ensure sufficient operation of the refuge and facilitate recovery of the OBEB. Filling the following positions would facilitate more efficient operation of the Refuge: 1) Refuge Manager, 2) Fish and Wildlife Biologist, and 3) Administrative Assistant (USFWS, 2008).

- Develop Voluntary Cooperative Agreements with Private Landowners: The OBEB is known to forage up to 5 miles from cave sites. Efforts to protect foraging habitat should focus on areas within a 5-mile radius from known caves (Harvey 1992, Clark et al. 1993, Wethington et al. 1996). Most surface foraging habitat occurs on private land. Although acquisition in fee title is the most secure and long-term means of protecting OBEB caves and foraging habitat, purchase of all areas necessary for the recovery of the OBEB likely would not be possible due to the large area used by OBEBs. Therefore, working with private landowners has and will continue to be an important recovery tool. The Service's Partners for Fish and Wildlife Program is designed to work cooperatively with private landowners to protect and enhance fish and wildlife resources. The Partner's Program has provided financial assistance for the construction of cave gates in Oklahoma. Where possible, the Partner's Program should continue to be used to protect cave sites from human disturbance through financial and technical assistance. In addition, a number of important caves on private land have been gated with funds from Section 6 of the Endangered Species Act in cooperation with Oklahoma Department of Wildlife Conservation and Rogers State University. This program is popular with private landowners and has been very successful and should continue. Establishing relationships with private landowners also could facilitate the development of voluntary cooperative agreements to protect forested foraging habitat. Potential avenues for these voluntary agreements include the development of Safe Harbor Agreements and TNC's Natural Area Registry Program (USFWS, 2008).
- Facilitate Management by Other Agencies and Groups: The Service has worked closely with several state and federal agencies, tribes, universities, and non-profit organizations to protect and manage OBEB habitats, including the ODWC, ANHC, AGFC, the Cherokee Nation, Ozark National Forest, the Oklahoma and Arkansas Chapters of TNC, City of Tulsa, Land Legacy, and the local chapter of the NSS (Tulsa Regional Oklahoma Grotto). Universities involved include Rogers State University, Oklahoma State University, University of Oklahoma, Northeastern State University, Southeastern Oklahoma State University, University of Central Oklahoma, University of Arkansas, and Arkansas State University. The Service should continue to coordinate management efforts with other agencies and organizations. Essential foraging habitat that is available from willing sellers should be identified for future purchase by the States of Oklahoma and Arkansas through the Recovery Land Acquisition Program and other mechanisms. Landowners of important tracts that are

not for sale should be approached regarding conservation easements and possible voluntary cooperative agreements, such as The Nature Conservancy's Natural Area Registry Program (USFWS, 2008).

- Fine-Tune and Standardize Annual Monitoring at Maternity Colonies: The population trend analysis at all known essential caves revealed a statistically significant trend at only four of the 15 sites analyzed. The inability to determine whether the population was increasing, decreasing, or stable at most of the essential sites is likely attributable to several possible factors, including movements of bats among the caves and other life history traits that make monitoring more difficult. Additionally, surveyors conducting exit counts in mid-June could unknowingly count only adult females in some years and females plus newly volant young in others. As the climate warms the bats may be reproducing earlier in the year and the young flying earlier. Fine-tuning and standardizing the monitoring approach likely will facilitate collection of more comparable data and enhance efforts to determine population trends at known sites (USFWS, 2008).
- Investigate the Feasibility of Gating AD-24 and/or -25 to Minimize Human Disturbance: Apparent declines of the AD-13/24/25 colony may be attributable to movement among caves, as discussed above. Human disturbance could be a contributing factor to the potential movement. Although AD-13 is gated to prevent unnecessary human disturbance and vandalism, neither AD-24 nor -25 are afforded such protection. The landowner of these sites should be contacted regarding implementation of this conservation measure (USFWS, 2008).
- Assess the Ownership and Protective Status of All Known Limited-Use Sites: Limited-use sites should be afforded protection. These sites provide important habitat for small groups of bats and solitary males during the summer. An assessment of the ownership and protective status (e.g., gated, cooperative landowner agreement, etc.) for each site should be determined. Conservation easements, fee title acquisitions, and cooperative landowner agreements should be sought on all unprotected sites (USFWS, 2008).
- Re-Visit Historic and Possible OBEB Caves in Missouri: An OBEB survey was conducted at 34 sites in Missouri during the summer and fall of 1999 (Elliott et al. 1999). During this survey, evidence of OBEB use, in the form of neatly clipped moth wings, was discovered at two cave sites. A list of the sites from the survey effort is available from the MDC. At a minimum, the two sites with evidence of use should be re-visited periodically. The Oklahoma Ecological Services Field Office currently is working with the Missouri Ecological Services Field Office to investigate possible funding sources and the availability of qualified biologists to conduct an OBEB survey in Missouri within the next few years (USFWS, 2008).
- Continue to Search for Caves of Importance: The possibility of finding new essential and limited-use OBEB sites in the Ozarks still exists. For example, in the summer of 2006, a cluster of 15 OBEBs was discovered in a sandstone talus crack on a private in-holding within the Ozark National Forest. Additionally, annual monitoring efforts at maternity sites and hibernacula present a disparity between summer and winter population estimates. Numbers of OBEBs estimated from summer maternity counts are larger than those found during winter hibernacula counts. This indicates there are likely major hibernacula being used by OBEB that have not yet been located. Therefore, searches for unknown maternity sites, limited-use sites, and hibernacula should continue throughout the Ozarks in Oklahoma and Arkansas. Additionally, evidence of possible OBEB occurrence in the form of neatly clipped moth wings and guano has been found in many caves in Oklahoma, Arkansas, and Missouri. These sites should be revisited to determine whether they are caves of importance. Equipment, such as the Anabat detector that can be placed near cave entrances

to record and help identify echolocating bats, may prove valuable in this effort. Should re-visitation of historic or possible sites in Missouri find OBEBs, search efforts should be intensified in Missouri (USFWS, 2008).

- ADDITIONAL SITE-SPECIFIC RECOVERY ACTIONS AND PRIORITY CHANGES Review of the existing list of recovery actions, as well as the 2008 and 2019 status reviews, indicates that some recovery actions have been completed and that there are new threats or recovery needs that have developed since that time, as described below. In addition, some minor modifications to the priority number or wording of the actions would be more reflective of current recovery needs, as described in table 2. Cave Gates: When the 1984 recovery plan was written, it was recognized that cave gates could control or limit human disturbance at sites. However, the response of VBEBs to cave gates was not well studied, and there were concerns that gates could alter VBEB behavior and increase predation rates. Therefore, the original plan included recovery actions to study the effects of these gates and then determine if gates should be recommended and, if so, what designs and specifications should be used (recovery actions 3.3.1 – 3.3.7). Many years of monitoring and testing have documented that VBEBs readily adapt to properly designed angle-iron bat gates that are constructed to avoid altering the entrance or airflow of the site. Therefore, recovery actions 3.3.1 – 3.3.7 are obsolete and the following new recovery actions have been developed: 3.3: Install and maintain cave gates. 3.3.1: VBEB sites that are threatened by human entrance and disturbance should be gated in accordance with gate designs, criteria, and specifications that have been shown to not adversely affect the VBEB. Currently these are described in Fant et al. (2009). Updated information and future revisions shall be reviewed and approved by the Service's VBEB Recovery Coordinator prior to implementation. Alternative gate designs should be used only in special cases where previously tested designs are not feasible and should be tested and monitored (in consultation with the Service) in order to determine whether they are safe and effective for the VBEB. 3.3.2: All gates and fences installed around VBEB sites should be monitored, maintained, repaired, or replaced as needed to ensure their continued effectiveness. Recovery Action 3.3 is considered a priority 1 recovery need. Prevent Adverse Modifications to Essential Habitat When the 1984 recovery plan was written, it was understood that appropriate subsurface and surface habitats must be maintained to ensure continued survival and recovery of VBEB. As detailed in the Rationale for Amended Recovery Criteria Northeastern RU section above, VBEB population numbers during the 2018-2019 winter counts at Hellhole and 2019 summer maternity counts were likely affected by substantially higher-than-normal rainfall during 2018. This rainfall impacted internal cave temperatures and humidity levels in Hellhole, which the data suggest are the likely cause for bats vacating Hellhole for other hibernacula and maternity areas currently unknown. Due to these events, an amendment to this recovery action has been developed: 5.1.1: Monitor internal cave conditions to better detect and promptly address potential modifications of internal cave habitats, monitoring of internal cave conditions (temperature, humidity, water depth (where applicable), etc.) and cave surface influences (streams) should occur. These data will assist biologists and land managers in their understanding of potential causes for changes to bat populations and alert them to changes in these conditions that may not be otherwise apparent. Barriers to Movement and Sources of Direct Mortality Barriers to movement (i.e., roads) and sources of direct mortality (e.g., roads, direct disturbance to caves) were not known to be of concern when the 1984 recovery plan was written. However, the 2008 and 2019 status reviews identified these as increasing threats. Therefore, an additional recovery action has been identified. 9.0 Within each RU, avoid and/or minimize barriers to movement and sources of direct mortality to

VBEB (e.g., roads, wind turbines, brine pits). 9.1 Conduct research to better understand the effects of barriers to movement and sources of direct mortality to the VBEB and develop methods to reduce adverse effects. 9.2 Implement measures to reduce effects from existing and proposed barriers to movement and sources of direct mortality to VBEB. Avoid and/or minimize placement of new barriers to movement and sources of direct mortality within foraging areas, or within commuting and migration distances from VBEB sites. Where avoidance is infeasible, postconstruction mortality monitoring for large road projects and wind turbines constructed within the species' range should be implemented to document effectiveness of avoidance and minimization measures applied within project development, operation, and maintenance. Recovery Action 9.0 is considered a priority 1 recovery need. (USFWS, 2024)

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# SPECIES ACCOUNT: *Dipodomys elator* (Texas kangaroo rat)

***Species Taxonomic and Listing Information***

**Listing Status:** Proposed Endangered

**Physical Description**

The Texas kangaroo rat is a nocturnal rodent with long hind feet, long tail and external cheek pouches (Dalquest and Horner 1984, p. 118). Hind feet have four toes and its laterally white-striped, thick tail has a conspicuous white tuft of hair on the tip and is about 160 percent of the length of the body (Merriam 1894, p. 110) (Figure 2.1). Ord?s kangaroo rat, (Dipodomys ordii), the only other kangaroo rat in the TKR range, is smaller, lacks the long white hairs at the tip of the tail, has five toes on the hind feet, and lives in sandy soil uncharacteristic of TKR habitat (Dalquest and Collier 1964, p. 148; Martin 2002, p. 2). Like other Dipodomys spp., both male and female TKR possess skin glands dorsally between the shoulders, which communicate sexual receptivity (Stangl et al. 2006, p. 466). The body is relatively large averaging 120 millimeters (mm) (4.7 inches (in)) in length. The upper body is a pale yellow-brown color with blackish guard hairs and the underside of the animal is white. The nearly hairless ears are small and the eyes relatively large. The sexes are superficially indistinguishable (Strassman 2004, p. 2); however, males may be generally larger than females, especially on the eastern and western margins of their range (Best 1987, p. 57). External measurements average: total length, 317 mm (12.5 in); tail, 196 mm (7.7 in); hind foot, 46 mm (1.8 in) (Schmidly 2004, p. 366). TKR use their long hind feet for saltatorial (jumping) locomotion and escaping predators (USFWS, 2021)

**Historical Range**

The species historical range included Oklahoma, Texas. (USFWS, 2021)

**Current Range**

Extirpated from Oklahoma. The most current survey information in Texas comes from two rangewide presence/absence surveys by Ott et al. (2019) and Stuhler et al. (2019), and a survey of a portion of the historical range by Veech et al. (2018). In 2016 and 2017 Ott et al. (2019, p. 621) surveyed all 11 counties in Texas by spotlighting from unpaved roads and using motion-detecting cameras. Ott et al. (2019, p. 623) found 96 TKR at 75 locations in 5 of 11 counties surveyed (Childress, Cottle, Hardeman, Wichita, and Wilbarger); 4 additional captures were reported in unpublished data from this survey effort (Veech 2020, pers. comm.). In 2017, Ott et al. (2019, p. 623) found 78 TKR at 63 locations, reconfirming 19 locations from 2016 were still occupied. Despite surveying new routes, the 2017 survey confirmations came from the same 5 counties where TKR was detected in the 2016 survey (Ott et al. 2019, p. 623). Between June 2015 and August 2017, Stuhler et al. (2019, p. 56) live trapped and conducted roadside surveys at 811 locations along dirt roads across TKR's 11-county range and at an additional 60 locations in neighboring Hall County to investigate the possibility of a westward shift in distribution. From the 871 sites surveyed and trapped, Stuhler et al. (2019, p. 58) documented 35 TKR at 26 sites in 5 counties (Childress, Cottle, Hardeman, Wichita and Wilbarger) and none in Hall County. Stuhler et al. (2019, p. 29) also conducted a live trap study on 50 sites on state and private land across the historical range of TKR; 35 sites were trapped in 2016 and an additional 15 sites were trapped in 2018. In their 2016 survey of 35 sites, Stuhler et al. (2019, p. 31) encountered 30 TKR across six sites in 2 counties (i.e., Cottle and Wichita) (Stuhler et al. 2019, p. 48). In their 2018 survey of 15 sites on private land, Stuhler et al. (2019, p. 32) did not encounter any TKR even though soil and vegetation was similar to previously surveyed sites where TKR were detected; location information is not available for these sites. An additional survey of a portion of the TKR range in Texas detected 42 individuals at 34 locations (from Childress, Hardeman, Wichita, and Wilbarger Counties) in 2018 (Veech et al. 2018). It should be noted that, while some interior rangeland was surveyed, the majority of these survey efforts occurred from public roadsides across the historical range. Additionally, a large landholding (approx. 500,000 acres) within a portion of the historical range has limited public road area and has not been surveyed in decades (USFWS, 2021).

**Critical Habitat Designated**

No;

***Life History***

**Food/Nutrient Resources**

**Food Source**

Adult: largely grass seeds (69.5 %), including cultivated oats (Avena sativa and Sorghum halepense); fruits and flowers of forbs were also common (42.3 %) (Chapman 1972, pp. 878—879). Mesquite seeds were found in the cheek pouches of only one individual (USFWS, 2021)

**Food/Nutrient Narrative**

Adult: The TKR is an opportunistic seed gatherer (Martin 2002, p. 31). Cheek pouch contents of TKRs sampled in Hardeman County contained largely grass seeds (69.5 %), including cultivated oats (Avena sativa and Sorghum halepense); fruits and flowers of forbs were also common (42.3 %) (Chapman 1972, pp. 878—879). Mesquite seeds were found in the cheek pouches of only one individual (Chapman 1972, p. 879). TKR forage for seeds from 2.5 to 20 m (8 to 65 ft) from burrow entrances (Goetze et al. 2008, pp. 311—315) though they have been observed searching ≥ 50 m (164 ft) from burrows (Ott 2020, pers. comm.). Food items are not consumed immediately, but instead are placed in cheek pouches and later cached near burrow entrances or within chambers of their tunnel (Goetze et al. 2008, pp. 311—315). TKR are not known to hibernate but utilize food caches in burrows that serve as reserves when above ground food is unavailable during winter or inclement weather (Dalquest and Collier 1964, p. 148; Lewis 1970, p. 8; Chapman 1972, p. 879). Green vegetation (stems, leaves) gathered along with seeds may be a source of moisture (Chapman 1972, p. 879). TKR do not use planted wheat fields as a food source (Goetze et al. 2008, pp. 311—315). Recent radio-telemetry research shows TKR utilizing dirt road shoulders within their home range and intermittent activity in adjacent crop fields (Veech et al. 2018, p. 6) presumably foraging for seeds collecting on the ground (USFWS, 2021)

**Reproductive Strategy**

Adult: Vivaparity (USFWS, 2021)

**Lifespan**

Adult: 2 years (USFWS, 2021)

**Breeding Season**

Adult: The TKR appears capable of breeding throughout the calendar year, with peak times in February and August (USFWS, 2021)

**Reproduction Narrative**

Adult: Little research exists on the reproduction and brood rearing of TKR. Most of the information published is data recorded secondarily to primary study objectives. The TKR appears capable of breeding throughout the calendar year, with peak times in February and August. Females give birth early in the calendar year and young-of-year are able to birth their first litter in the late summer or early fall of the same year (Packard 1976, p.3; Carter et al. 1985, p. 1). Average litter size is 2.7 ± 0.8 pups (Martin 2002, p. 29). Sub-adults molt in the fall, while adults molt annually at any time throughout the year. This suggests a prolonged reproductive cycle and that more than a single reproductive cycle occurs annually (Webster and Jones 1985, pp. 55—60; Martin 2002, pp. 28—29). Life span of the TKR in the wild is approximately two years (Martin 2002, p. 28). Individual male and female TKR require suitable breeding habitat to establish a territory, construct a burrow in an appropriate soil substrate, and forage for themselves and their offspring. Territories encompass an average of 0.8 ha (0.20 acre (ac)) (Roberts and Packard 1973, p. 960). Bare ground is important as males and females display sexual receptivity by dust bathing at bare ground sites within their territory and leaving their "scent" (an oily substance exuded by dorsal sebaceous glands) (USFWS, 2021).

**Habitat Type**

Adult: Terrestrial

**Habitat Vegetation or Surface Water Classification**

Adult: bare ground and short grasses (USFWS, 2021)

**Habitat Narrative**

Adult: Habitat that supports the TKR's life history generally includes an accumulation of loose, friable soil, usually associated with a minor topographic uplift (e.g., prairie mounds) or physical support, including woody vegetation (e.g., roots of shrubs and cacti) and other natural (e.g., rocks, upturned rootballs) or manmade structures. A common characteristic of TKR habitat is the presence of bare ground and short grasses, often expressed as a lack of dense vegetation. The TKR digs a subterranean burrow system within loam/clay-loam soils with multiple chambers branching from the main tunnel, which are , used for shelter, reproduction, and food storage. Resource needs for individual TKR generally include: • Friable, loam/clay-loam soil for burrowing • Predominately grasses and forbs for a food source • Short grass prairie with bare ground and limited woody cover • Topographic relief not prone to flooding events (USFWS, 2021).

***Dispersal/Migration***

***Population Information and Trends***

**Number of Populations:**

4 AUs (USFWS, 2021)

**Population Narrative:**

We determined the TKR currently exists within four groups, or analysis units, within its range in Texas (Figure ES-3). The total area of the four analysis units is approximately 111,000 hectares

(274,500 acres), ranging from the largest (East Unit) of approximately 46,673 hectares (115,332 acres) to the smallest (West Unit) of approximately 18,242 hectares (45,078 acres). 285 detections within the 4 AUs (USFWS, 2021).

***Threats and Stressors***

**Stressor:** Alteration of the Prairie Dog, Fire, and Bison Complex (USFWS 2021)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The role of bison, prairie dogs, and fire in supporting and enhancing the life history needs of the TKR, and conversely the negative impact of their absence or reduction since the late 1800s, has been suggested (Stangl et al. 1992, p. 33; Nelson et al. 2009, pp. 128—129; Ott et al. 2019, p.18). TKR rely upon grasslands with limited woody vegetation, composed largely of short grasses and areas of bare soil (Stasey et al. 2010, p. 11; Roberts and Packard 1973, p. 958). These habitat needs are most often associated over loam, clay-loam, and sandy-loam soils within the historical TKR distribution in the Central Great Plains and Southwestern Tablelands ecoregions of north Texas (Ott et al. 2019, p. 625) and limited areas in southern Oklahoma. The expansion of Euro-Americans beginning in the 1800s led directly to the decline of bison (Isenberg 2000, p. 12) and black-tailed prairie dogs. By the early 1900s, bison were near extinction and prairie dog control substantially reduced once large colonies across the Great Plains (Weltzin et al. 1997a, p. 251). Prairie dog control continued through the 1900s, along with increases in cropland and the onset of the oil industry in Texas (USFWS, 2021).

**Stressor:** Conversion to Cropland (USFWS, 2021)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The conversion of native rangeland to row crops is a direct loss of habitat because the TKR does not construct burrows in soils of agricultural crops (Martin and Matocha 1972, p. 874; Martin 2002, pp. 33–34; Goetze et al. 2007, p. 18; Goetze et al. 2008, p. 313; Nelson et al. 2009, pp. 119–120; Ott et al. 2019, p. 627). Ground disturbance caused by plowing and disking associated with cultivating cropland disturbs the soil substrate, resulting in a loss of burrowing habitat in areas that would have previously supported the species. Cropland also eliminates native foraging area; however, the use of cropland for TKR foraging is not fully understood. Cropland in the north central region of Texas is often planted as a monoculture. Some evidence suggests cropland has little use or is avoided by the TKR (Goetze et al. 2008, p. 313). A study of cheek pouch contents (Chapman 1972, pp. 878–879) indicated Texas kangaroo rats may have foraged in adjacent oat fields following harvest. Recent unpublished data using telemetry shows TKR utilizing cropland adjacent to road edge habitat (Veech et al. 2018, p. 6), presumably to forage. It appears some cropland edges may provide a forage base, at least opportunistically, depending on crop type, adjacent habitat conditions, time of season, and other unknown factors. For example, Stephen's kangaroo rat (D. stephensi), is reported to enter cultivated fields following plowing (Price and Endo 1989, p. 296). The conversion of rangeland to cropland also leads to increased habitat fragmentation; that is, it presents a barrier to movement and dispersal since it appears TKR do not traverse active croplands seeking food, shelter, or mates (USFWS, 2021).

**Stressor:** Development and Roads (USFWS, 2021)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** There is substantial evidence that saltatorial species such as kangaroo rats travel within areas of bare ground and sparse grasses because dense vegetation is restrictive to locomotion (Genoways and Brown 1993, p. 522). Because of limited access for surveys on private lands, unpaved road systems, which includes the road surface and the adjacent right-of-way, account for a substantial proportion of all published TKR detections. According to a study on the endangered Stephen's kangaroo rat in California, unpaved roads may function as a surrogate for historical areas of bare ground and sparse grass cover used for burrowing, foraging, dustbathing, and scent marking (Brock and Kelt 2004, p. 638). TKR have often been documented using burrows along unpaved road edge (Stangl et al. 1992, p. 26; Martin 2002, p. 19; Nelson et al. 2013, p. 8). While unpaved roads may function as non-traditional habitat and travel corridors, a paved road may have negative impacts on TKR. Some small mammals often avoid crossing paved or gravel roads (Oxley et al. 1974, p. 56; Merriam et al. 1989, pp. 231— 232) and are often killed by traffic (Adams and Geis 1983, p. 413). Paved and gravel roads substantially reduce or eliminate bare ground and provide a hard substrate assumed to be of limited use by TKR (Goetze et al. 2016, p. 229). Paved roads have a higher traffic volume, allow greater vehicle speed, and are generally wider than unpaved roads. For these reasons, it is likely paved roads have a negative impact on the TKR because they may restrict movement, increase mortality, and fragment habitat (USFWS, 2021).

**Stressor:** Woody Species Encroachment (USFWS, 2021)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Woody vegetation in grasslands and savannas has increased worldwide over the past 100–200 years (Archer et al. 2017, p. 25). In North America, the increase in woody cover within grasslands ranges from 0.5% to 2% per year, and is among the major land-cover changes occurring over the past 150 years (Sala and Maestre 2014, p. 1359). Mean annual precipitation sets an upper limit to woody plant cover, but local patterns of disturbance (fire, browsing) and soil properties (texture, depth) prevent the realization of this potential (Archer et al. 2017, p. 25). In the absence of these constraints, seasonality, inter-annual variation, and intensity of precipitation events determine the rate and extent of woody plant expansion. Although probably not a triggering factor, rising atmospheric CO2 levels may have favored woody plant growth (Archer et al. 2017, p. 25). Woody plant encroachment coincided with the global intensification of livestock grazing, triggering the reduction of fine fuels and altering fire frequency and intensity, which further perpetuated woody plant encroachment (Archer et al. 2017, p. 25). From a conservation perspective, woody plant encroachment threatens the maintenance of grassland and savanna ecosystems and their endemic biodiversity (USFWS, 2021).

**Stressor:** Effects from Oil and Gas Exploration (USFWS, 2021)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The TKR's association with disturbance (natural and anthropogenic) is well established (Stangl et al. 1992, pp. 29–34; Goetze et al. 2007, pp. 18–19). Among sources of manmade

disturbance, oil and gas infrastructure is common throughout the TKR range. As of June 2, 2020, there were 71,843 oil and natural gas well sites across the 11 Texas counties within the range (Table 3.2) (Railroad Commission of Texas, 2020). The majority of all wells within the current TKR range occur within Wichita and Wilbarger counties (USFWS, 2021).

**Stressor:** Climate Change (USFWS, 2021)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). "Climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements (IPCC 2014, pp. 119–120). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (e.g. temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity (e.g., greenhouse gas emissions), or both (USFWS, 2021)

***Recovery***

***Conservation Measures and Best Management Practices:***

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***Additional Threshold Information:***

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**References**

USFWS. 2021. Species Status Assessment Report for Texas Kangaroo Rat (Dipodomys elator). Version 1.1. Arlington, Texas Field Office, U.S. Fish and Wildlife Service, Arlington, TX. 94 pp + Appendices.

# SPECIES ACCOUNT: *Dipodomys merriami parvus* (San Bernardino Merriam's kangaroo rat)

***Species Taxonomic and Listing Information***

**Commonly-used Acronym:** SBKR

**Listing Status:** Endangered; 01/27/1998; California/Nevada Region (R8) (USFWS, 2016)

**Physical Description**

The San Bernardino kangaroo rat (Dipodomys merriami parvus; SBKR) is a small, dark-colored kangaroo rat. In coastal southern California, D. merriami is the only kangaroo rat with four toes on each of its hind feet. It has a body length of about 95 millimeters (mm) (3.7 inches [in.]) and a total length of 230 to 235 mm (9.0 to 9.3 in.). The hind foot measures less than 36 mm (1.4 in.) in length. The body color is pale yellow, with a heavy overwash of dusky brown. The tail stripes are medium to dark brown, and the foot pads and tail hairs are dark brown. The flanks and cheeks of the subspecies are dusky. The flanks and cheeks of the subspecies are dusky. The San Bernardino kangaroo rat, endemic to southern California, is one of the most highly differentiated subspecies of Merriam’s kangaroo rat (65 FR 77178; 67 FR 19812).

**Taxonomy**

The San Bernardino kangaroo rat is one of 19 recognized subspecies of Merriam's kangaroo rat (D. merriami), a widespread species distributed throughout arid regions of the western United States and northwestern Mexico. In coastal southern California, D. merriami is the only kangaroo rat with four toes on both of its hind feet. Additionally, it is considerably darker and much smaller than either of the other two subspecies of Merriam's kangaroo rat in southern California—Merriam's kangaroo rat (D. merriami merriami) and Earthquake Merriam's kangaroo rat (D. merriami collinus). It is also one of the most highly differentiated subspecies of Merriam's kangaroo rat, likely due to its apparent isolation from other members of D. merriami (63 FR 51005).

**Historical Range**

The historical range of the San Bernardino kangaroo rat extends from the San Bernardino Valley in San Bernardino County to the Menifee Valley in Riverside County. Prior to 1960, this subspecies was known from more than 25 localities within this range. From the early 1880s to the early 1930s, it was a common resident of the San Bernardino and San Jacinto valleys of southern California (67 FR 19812). Based on aerial photography, museum records, field surveys, and literature, the historical range is thought to have encompassed roughly 11,331 hectares (ha) (28,000 acres [ac.]) of alluvial floodplain habitat. This historical range of the San Bernardino kangaroo rat was thought to include the extensive alluvial fan terraces at the bases of the San Gabriel, San Bernardino, and San Jacinto mountain ranges in San Bernardino and Riverside counties, California. The northern extent of this subspecies range was likely the Cajon Pass in San Bernardino County, and the southernmost extent was in Menifee in Riverside County (USFWS 2009).

**Current Range**

The majority of the remaining San Bernardino kangaroo rat populations are primarily found in three areas: the Santa Ana Wash, the San Jacinto Wash, and Lytle Creek and Cajon Wash. Other smaller populations of the San Bernardino kangaroo rat are documented in washes and hills in the areas surrounding the three main population centers (67 FR 19812). The current range of the species encompasses at least 4,328 ha (10,696 ac.). Although this area does not encompass all habitat occupied by or suitable for the San Bernardino kangaroo rat, we believe that they do represent much of the remaining occupied habitat (USFWS 2009).

**Distinct Population Segments Defined**

No

**Critical Habitat Designated**

Yes; 10/17/2008.

**Legal Description**

On October 17, 2008, the U.S. Fish and Wildlife Service (Service), designated final revised critical habitat for the San Bernardino kangaroo rat (Dipodomys merriami parvus) under the Endangered Species Act of 1973, as amended (Act). Approximately 7,779 acres (ac) (3,148 hectares (ha)) of habitat in San Bernardino and Riverside Counties, California, were designated as critical habitat for the San Bernardino kangaroo rat. The final revised designation constitutes a reduction of approximately 25,516 ac (10,326 ha) from the 2002 designation of critical habitat for the San Bernardino kangaroo rat.

**Critical Habitat Designation**

Approximately 7,779 ac (3,148 ha) of land are desginated as critical habitat for the San Bernardino kangaroo rat in five units.

Unit 1: Santa Ana River Wash Unit 1 consists of approximately 3,258 ac (1,318 ha) and is located in San Bernardino County. This unit includes the Santa Ana River and portions of City, Plunge, and Mill Creeks. The area includes lands within the cities of San Bernardino, Redlands, and Highland. Although Seven Oaks Dam (northeast of Unit 1) impedes sediment transport and reduces the magnitude, frequency, and extent of flood events from the Santa Ana River, the system still retains partial fluvial dynamics because Mill Creek is not impeded by a dam or debris basin. This critical habitat unit was occupied at the time of listing, is currently occupied, and contains all of the features essential to the conservation of the San Bernardino kangaroo rat. Additionally, this unit contains the highest densities of San Bernardino kangaroo rats in the Santa Ana wash. The physical and biological features contained within this unit may require special management considerations or protection to minimize impacts associated with flood control operations, water conservation projects, sand and gravel mining, and urban development. Approximately 751 ac (304 ha) of revised proposed critical habitat Unit 1 occurred within the WSPA, a section of the floodplain downstream of Seven Oaks Dam that was preserved by the flood control districts of Orange, Riverside, and San Bernardino Counties. The WSPA was established in 1988 by the ACOE to minimize the effects of Seven Oaks Dam on the federally endangered plant, Eriastrum densifolium ssp. sanctorum (Santa Ana River woolly-star). This area of alluvial fan scrub in the wash near the low-flow channel of the river was identified for preservation because these sections of the wash were thought to have the highest potential to maintain the hydrology necessary for the periodic regeneration of early phases of alluvial fan sage scrub. A 1993 Management Plan for the Santa Ana River WSPA has been completed, and a draft MSHMP for

WSPA lands, which includes protection for the San Bernardino kangaroo rat, is to be completed as an additional conservation measure pursuant to our December 19, 2002, biological opinion on operations for Seven Oaks Dam (Service 2002b, p. 8). As a result of our partnership and development of approved management plans, we excluded the approximately 751 ac (304 ha) of WSPA lands from the final revised critical habitat designation (see ‘‘Exclusions Under Section 4(b)(2) of the Act’’ section for a detailed discussion). In 1994, the BLM designated three parcels in the Santa Ana River, a total of approximately 760 ac (308 ha), as an ACEC. One parcel is located south of the Seven Oaks borrow pit, another is farther west and south of Plunge Creek, and the third is located farther west between two large mining pits. The primary goal of this ACEC designation is to protect and enhance the habitat of federally listed plant species occurring in the area while providing for the administration of valid existing water conservation rights. Although the establishment of this ACEC is important in regard to conservation of sensitive species and vegetation communities in this area, the administration of existing water conservation rights conflicts with the BLM’s ability to manage their lands for the San Bernardino kangaroo rat. Existing rights include a withdrawal of Federal lands for water conservation through an act of Congress on February 20, 1909 (Public Law 248, 60th Cong., 2nd sess.). The entire ACEC is included in this withdrawn land and may be used for water conservation measures, such as the construction of percolation basins. Although the BLM is coordinating with the Service to conserve San Bernardino kangaroo rat habitat, at this time we do not consider these lands to be managed for the benefit of the San Bernardino kangaroo rat or its PCEs, and we are not excluding these lands from the final revised critical habitat designation. We are currently coordinating with the BLM, ACOE, San Bernardino Valley Conservation District, Cemex Construction Materials, Robertson’s Ready Mix, and other local interests on a proposed exchange of Federal and private lands and the development of the Upper Santa Ana River Habitat Conservation Plan (USAR HCP, also known as ‘‘Plan B’’). The goal of the USAR HCP is to consolidate a large block of alluvial fan scrub occupied by three federally endangered species (the San Bernardino kangaroo rat, Eriastrum densifolium ssp. sanctorum, and Dodecahema leptoceras (slender-horned spineflower)) and one federally threatened species (the coastal California gnatcatcher (Polioptila californica californica)). The area under consideration includes the majority of the Santa Ana wash from just downstream of the confluence of Mill Creek with the Santa Ana River to Alabama Street. While the goal of this effort is to benefit the San Bernardino kangaroo rat through the establishment of preserve lands that will be managed for this subspecies and other listed species, we are still in the development phase of this HCP, and we are not excluding lands within the proposed Santa Ana River Wash Conservation Area from the final revised critical habitat designation. Approximately 267 ac (108 ha) of occupied habitat in the Santa Ana River wash is set aside for conservation in perpetuity by the U.S. Air Force as part of on-base site remediation efforts at the former Norton Air Force Base in San Bernardino, California. These areas are managed specifically for the San Bernardino kangaroo rat and Eriastrum densifolium spp. sanctorum pursuant to the Former Norton Air Force Base CMP completed in March 2002. We excluded these 267 ac (109 ha) from the final revised critical habitat designation based on benefits provided to San Bernardino kangaroo rat habitat through our partnership and the approved CMP

Unit 2: Lytle/Cajon Creek Wash Unit 2 encompasses approximately 3,421 ac (1,384 ha) in San Bernardino County and includes the northern extent of this subspecies’ remaining distribution. This unit contains habitat along and between Lytle and Cajon Creeks from the Interstate 15 Bridge in Lytle Creek and the Kenwood Avenue/ Cajon Boulevard junction in Cajon Creek, downstream to Highland Avenue. Unit 2 was occupied at the time of listing, is currently occupied, and contains all of the features essential to the conservation of the San Bernardino kangaroo rat. This unit includes some of the last remaining alluvial fans, floodplain terraces, historical braided river channels, and associated alluvial sage scrub and upland vegetation that provides habitat for the San Bernardino kangaroo rat in the Lytle/Cajon Creek wash. This unit also contains the highest densities of San Bernardino kangaroo rat in the Lytle/Cajon wash. The physical and biological features within this unit may require special management considerations or protection to minimize impacts associated with flood control operations, water conservation projects, sand and gravel mining, and urban development. The hydro-geomorphological processes that apparently rejuvenate and maintain the dynamic mosaic of alluvial fan sage scrub are still largely intact in Lytle and Cajon Creeks (i.e., stream flows are not impeded by dams or debris basins), and the remaining habitat allows dispersal between these two drainages, which is important for genetic exchange between populations (67 FR 19812, April 23, 2002). This unit is adjacent to large tracts of undeveloped land and contains upland areas occupied by the subspecies (PCEs 1, 2, and 3). Several areas that were proposed in Unit 2 will be or are protected and managed to some extent for the San Bernardino kangaroo rat. The Cajon Creek Habitat Conservation Management Area (HCMA) includes approximately 1,265 ac (512 ha) to offset approximately 2,270 ac (919 ha) of sand and gravel mining proposed within and adjacent to Cajon Creek. Of the 1,265 ac (512 ha) Cajon Creek HCMA, approximately 567 ac (229 ha) is the Cajon Creek Conservation Bank established to help conserve populations of 24 species associated with alluvial fan scrub, including the San Bernardino kangaroo rat. Furthermore, the remaining 698 ac (282 ha) are set aside as permanent conservation lands. These conservation lands will be managed in perpetuity for alluvial fan scrub habitat and associated listed species (including the San Bernardino kangaroo rat) pursuant to the HEMP (M. Blane and Associates 1996) and associated Memorandum of Understanding and Implementation Agreement for the Cajon Creek Habitat Management Area (MOU) (CalMat Company 1996). We excluded 1,265 ac (512 ha) of HCMA lands from the final revised critical habitat designation based on our partnership and benefits provided by the HEMP and MOU (see ‘‘Exclusions Under Section 4(b)(2) of the Act’’ for a detailed discussion). In 2003, the Service issued a biological opinion for the Lytle Creek North Master Planned Community, which falls within the boundary of existing San Bernardino kangaroo rat habitat (Service 2003a, FWS–SB– 1640.11). The project includes an approximately 677 ac (274 ha) master planned community with over 2,400 residential units. Construction activities are proposed to be phased over an estimated 5 to 10 years. As an off-site measure for this project, the Lytle Creek Development Company will dedicate approximately 213 ac (86 ha) of largely undeveloped habitat within Lytle Creek (Unit 2) as a conservation area for the San Bernardino kangaroo rat. Habitat that provides primary foraging, sheltering, and breeding habitat for the San Bernardino kangaroo rat within this area will be conserved and managed in perpetuity (Service 2003a, p. 45). Forty acres (16 ha) of this area is upland island habitat that lies within the floodplain and will receive additional management through restoration or enhancement for the benefit of the San Bernardino kangaroo rat (Service 2003a, p. 42). A long-term management plan will be completed at the end of an initial management period allowing for lessons learned during that time to be incorporated into the long-term management plan. However, to date, no conservation easements or endowments have been secured for the lands proposed as conservation areas, nor has the long-term management plan been completed, and we are not excluding the 213 ac (86 ha) of proposed future conservation lands that will be established as a result of this project from the final revised critical habitat designation. On June 15, 1999, we issued our biological opinion on the construction and extension of the north levee at Sunwest Materials’ (now CEMEX) Lytle Creek Quarry (Service 1999, 1–6–99–F– 42). The armored, engineered levee (over 10,000 feet (3,048 meters) in length) protects mining operations from flooding and replaces a shorter, earthen embankment (Service 1999, p. 3). As a conservation measure for this project, Sunwest Materials delivered to the California Department of Fish and Game a conservation easement deed to approximately 26 ac (11 ha) delineated as Conservation Area 1 to protect biological resources in perpetuity (Service 1999, p. 7). Additionally, Sunwest Materials is to record a biological resource deed restriction on approximately 12 ac (5 ha) of land to permanently preclude activities that would interfere with habitat value (Service 1999, p. 8). However, a management plan benefiting the San Bernardino kangaroo rat is not yet developed for these lands, and we are not excluding these 38 ac (16 ha) from the final revised critical habitat designation.

Unit 3: San Jacinto River Wash Unit 3 encompasses approximately 506 ac (205 ha) in Riverside County and includes areas along the San Jacinto River in the vicinity of San Jacinto, Hemet, and Valle Vista. This unit encompasses the San Jacinto River wash from the Blackburn Road/Lake Hemet Main Canal area, downstream to the East Main Street Bridge. This unit includes all of the features essential to the conservation of the San Bernardino kangaroo rat, was occupied at the time of listing, and is currently occupied. Additionally, this unit contains one of only three large extant core populations of the San Bernardino kangaroo rat and is the only core population in Riverside County. Historically, the San Bernardino kangaroo rat occurred along the San Jacinto River from the upper reach of habitat in the river downstream past State Route 79. The physical and biological features within this unit may require special management considerations or protection to minimize impacts associated with flood control operations, channelization, water conservation projects (groundwater recharge ponds), off-road vehicle activity, and urban development. Lands within Unit 3 are adjacent to lands of the Soboba Band of Luisen˜ o Indians Reservation, which were included in the 2002 final critical habitat designation (see 50 CFR 17.95(a); 67 FR 19812, April 23, 2002). We are not designating these Tribal lands as critical habitat for the San Bernardino kangaroo rat in this final revised critical habitat designation (see ‘‘Governmentto-Government Relationship with Tribes’’ section for a detailed discussion). All private lands proposed as critical habitat in the San Jacinto River wash fall within the boundaries of the Western Riverside County MSHCP. We excluded private lands under the jurisdiction of permittees to the MSHCP and all lands owned and managed by permittees to the MSHCP within this area (263 ac (106 ha)) based on our partnership and the benefits provided to the San Bernardino kangaroo rat by the Western Riverside County MSHCP. We are also excluding 39 ac (16 ha) of land owned by the Eastern Municipal Water District related to The Soboba Band of Luisen˜ o Indians Settlement Act and implementation of its associated settlement agreement.

Unit 4: Cable Creek Wash Unit 4 consists of approximately 483 ac (195 ha) and is located in San Bernardino County. This unit encompasses the Cable Creek alluvial floodplain from the mouth of Cable Canyon to I–215 where the creek becomes channelized. Because Cable Creek is not impeded by a dam or debris basin, the fluvial dynamics necessary to maintain the PCEs of San Bernardino kangaroo rat habitat remain in this unchannelized portion of Cable Creek. This critical habitat unit was occupied at the time of listing, is currently occupied, and contains all of the features essential to the conservation of the San Bernardino kangaroo rat. Additionally, this unit contains a likely self-sustaining population of San Bernardino kangaroo rats that may be important for the long-term conservation of the subspecies. This unit is demographically isolated from the core population of the subspecies in the Lytle/Cajon wash (Unit 2). A stochastic event causing dramatic population decline or local extirpation in Unit 2 may have little effect on Unit 4. In such a case, the population in Unit 4 could serve as a source of individuals for repopulating Unit 2. The physical and biological features contained within this unit may require special management considerations or protection to minimize impacts associated with flood control operations, water conservation projects, sand and gravel mining, and urban development.

Unit 5: Bautista Creek Unit 5 consists of approximately 111 ac (45 ha) and is located in Riverside County. This unit includes occupied habitat from the unchannelized reach of Bautista Creek (i.e., from the existing instream mining operation to upstream areas where the grade of the creek precludes the formation of alluvial terraces or braids). This unit represents the southernmost extent of the San Bernardino kangaroo rat's current range. The wash system in upper Bautista Creek retains fluvial dynamics because it is not impeded by a dam, debris basin, or concrete channelization. This critical habitat unit was occupied at the time of listing, is currently occupied, and contains all of the features essential to the conservation of the San Bernardino kangaroo rat. Historically, the subspecies occurred upstream of the Bautista flood control basin until the topography of the canyon becomes too steep. This unit contains agricultural areas that could be occupied at low densities by this subspecies (PCE 3). Additionally, this unit contains a likely self-sustaining population of San Bernardino kangaroo rats that may be important for the long-term conservation of the subspecies. This unit is demographically isolated from the core population of the subspecies in the San Jacinto wash (Unit 3) by a concrete-lined channel. This channel directs flows from upper Bautista Creek downstream to the San Jacinto River. Given the current status of the San Bernardino kangaroo rat and ongoing threats to its habitat, it is important for the conservation of the San Bernardino kangaroo rat that natural fluvial processes in occupied habitat are maintained. A stochastic event could cause a dramatic population decline or local extirpation in either Units 3 or 5. In such a case, through relocation for the purposes of recovery, the population in Unit 5 could serve as a source of individuals for repopulating Unit 3, and vice versa. The physical and biological features contained within this unit may require special management considerations or protection to minimize impacts associated with agricultural activities, sand and gravel mining, and urban development. All private lands proposed as critical habitat in Bautista Creek fall within the boundaries of the Western Riverside County MSHCP. We excluded private lands under the jurisdiction of permittees to the MSHCP and all lands owned and managed by permittees to the MSHCP within this area (332 ac) based on our partnership and the benefits provided to the San Bernardino kangaroo rat by the Western Riverside County MSHCP.

**Primary Constituent Elements/Physical or Biological Features**

Critical habitat units are designated for San Bernardino and Riverside Counties, California. The PCEs of critical habitat for the San Bernardino kangaroo rat are the habitat components that provide:

(i) Alluvial fans, washes, and associated floodplain areas containing soils consisting predominately of sand, loamy sand, sandy loam, and loam, which provide burrowing habitat necessary for sheltering and rearing offspring, storing food in surface caches, and movement between occupied patches;

(ii) Upland areas adjacent to alluvial fans, washes, and associated floodplain areas containing alluvial sage scrub habitat and associated vegetation, such as coastal sage scrub and chamise chaparral, with up to approximately 50 percent canopy cover providing protection from predators, while leaving bare ground and open areas necessary for foraging and movement of this subspecies; and

(iii) Upland areas adjacent to alluvial fans, washes, and associated floodplain areas, which may include marginal habitat such as alluvial sage scrub with greater than 50 percent canopy cover with patches of suitable soils that support individuals for re-population of wash areas following flood events. These areas may include agricultural lands, areas of inactive aggregate mining activities, and urban/wildland interfaces.

**Special Management Considerations or Protections**

Critical habitat does not include manmade structures (such as buildings, aqueducts, airports, roads, other paved areas, and the land on which such structures are located) existing on the effective date of this rule and not containing one or more of the PCEs.

Special management considerations or protection may be required to minimize effects of mining activities on alluvial sage scrub habitat and the natural hydrological processes that maintain proper alluvial sage scrub conditions for the San Bernardino kangaroo rat.

Special management considerations or protection may be required to minimize effects of flood control and water conservation activities on alluvial sage scrub habitat and the natural hydrological processes that maintain proper alluvial sage scrub conditions for the San Bernardino kangaroo rat.

Special management considerations or protection may be required to minimize the impacts of development within the alluvial wash and adjacent upland areas. Areas of the alluvial washes and floodplains adjacent to development may require exclusionary fencing and signage to minimize human and domestic animal disturbance of San Bernardino kangaroo rat habitat. Because this subspecies is active at night, lights from adjacent developed areas should be minimized and directed away from San Bernardino kangaroo rat habitat.

Special management considerations or protection may be required to minimize effects of agricultural activities on alluvial sage scrub habitat.

Special management considerations or protection, such as exclusionary fencing, additional enforcement, and signage placed around areas of the wash, may be needed to minimize impacts from unauthorized off-road vehicle use.

***Life History***

**Feeding Narrative**

Adult: Typical of kangaroo rats, Merriam's kangaroo rats are primarily nocturnal, granivorous, and often store large quantities of seeds in surface caches. Seed caching may enable them to endure temporary shortages of food. Water is obtained metabolically from moisture in food. Although seeds are the primary food source, green vegetation (primarily filaree [Erodium sp.]) and insects appear to be important seasonal food and water sources for the San Bernardino kangaroo rat (USFWS 2009; Zeiner et al. 1990). Insects, when available, have been documented to constitute as much as 50 percent of a kangaroo rat's diet (67 FR 19812). Because the distribution of the San Bernardino kangaroo rat appears to be driven by soils type (sandy loam substrains) that are characteristic of alluvial fans and floodplains, the hydrologic regime in the alluvial fans supporting the subspecies is of critical importance. Maintaining habitat connectivity between upland terrace habitat and the channel for the movement of animals between upland

and instream habitat is critical to support animals in both locations (USFWS 2009). The San Bernardino kangaroo rat is active year-round; and the species has a rapid growth rate, because females are capable of breeding shortly after weaning (as soon as 2 to 3 months of age) (Ceballos 2014; Zeiner et al. 1990).

**Reproduction Narrative**

Adult: Although reproductive activities peak in June and July, the San Bernardino kangaroo rat appears to have a prolonged breeding season. Pregnant or lactating females have been captured between January and November, while males in reproductive condition have been captured between January and August (USFWS 2009). This subspecies may breed several times a year, typically once to twice, with the ability to confine reproduction to periods of favorable conditions (Ceballos 2014; Zeiner et al. 1990). The San Bernardino kangaroo rat has a gestation period of 33 days, and typically birth between two and three young per litter (USFWS 2009). Weaning occurs 24 to 33 days after birth, and females are capable of breeding shortly after weaning. Merriam's kangaroo rat (D. merriami) exhibit an average lifespan of 3.5 years (Ceballos 2014). Kangaroo rat populations typically exhibit large fluctuations in density in response to temporal variability in plant productivity. Reproduction appears to be timed to coincide with high food-availability, but the rate of population growth is limited by the relatively small size of litters and long intervals between litters (USFWS 2009).

**Geographic or Habitat Restraints or Barriers**

Adult: Habitat fragmentation due to development and related activities in the San Bernardino and San Jacinto valleys act as a habitat restraint (67 FR 19812).

**Spatial Arrangements of the Population**

Adult: Clumped

**Environmental Specificity**

Adult: Narrow/specialist

**Tolerance Ranges/Thresholds**

Adult: Moderate

**Site Fidelity**

Adult: High

**Dependency on Other Individuals or Species for Habitat**

Adult: No

**Habitat Narrative**

Adult: San Bernardino kangaroo rats are typically found on alluvial fans (relatively flat or gently sloping masses of loose rock, gravel, and sand deposited by a stream as it flows into a valley or upon a plain); floodplains; along washes; in adjacent upland areas containing appropriate physical and vegetative characteristics; and in areas with historic braided channels. These areas consist of sand, loam, sandy loam, or gravelly soils that are associated with alluvial processes. San Bernardino kangaroo rat also occupy areas where winds contribute to the deposition of sandy soils. The soils deposited by alluvial or wind-driven processes typically support alluvial sage scrub and chaparral vegetation, and allow kangaroo rats to dig simple, shallow burrow systems. The burrow systems of adults are often clustered in a given area, and adults actively defend small core areas near their burrows (USFWS 2009). Alluvial sage scrub is a relatively open vegetation type that is adapted to periodic flooding and erosion, and is composed of an assortment of drought-deciduous shrubs and larger evergreen woody shrubs characteristic of both coastal sage scrub and chaparral communities (73 FR 61936). Habitat fragmentation due to development and related activities in the San Bernardino and San Jacinto valleys act as a habitat restraint (67 FR 19812).

***Dispersal/Migration***

**Motility/Mobility**

Adult: Moderate

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: Nonmigratory

**Dispersal**

Adult: Moderate; in a mark-recapture study conducted between 1978 and 1984, it was found that 75 percent of adult male and 59 percent of adult female Merriam’s kangaroo rats dispersed more than 60 meters (m) (197 feet [ft.]) from their initial capture sites, and that some individuals of both sexes moved more than 240 m (787 ft.) before they were no longer found by researchers. In a similar study, male San Bernardino kangaroo rats of reproductive age routinely moved as much as 40 m (131 ft.)—a conservative estimate based on distance between locations where they were trapped, which is not necessarily the total distance an animal may have actually travelled. Long-range dispersal and population expansion by the San Bernardino kangaroo rat is likely hampered by the presence of other rodents (USFWS 2009).

**Immigration/Emigration**

Adult: No

**Dependency on Other Individuals or Species for Dispersal**

Adult: No

**Dispersal/Migration Narrative**

Adult: The San Bernardino kangaroo rat has moderate motility and is nonmigratory. Habitat connectivity and sufficient food resources are needed for dispersal. Little is known about home range size, dispersal distances, or other spatial requirements of the San Bernardino kangaroo rat. In a mark-recapture study conducted between 1978 and 1984, it was found that 75 percent of adult male and 59 percent of adult female Merriam’s kangaroo rats dispersed more than 60 m (197 ft.) from their initial capture sites, and that some individuals of both sexes moved more than 240 m (787 ft.) before they were no longer found by researchers. In a similar study, male San Bernardino kangaroo rats of reproductive age routinely moved as much as 40 m (131 ft.)—a conservative estimate based on distance between locations where they were trapped, which is not necessarily the total distance an animal may have actually travelled. Long-range dispersal and population expansion by the San Bernardino kangaroo rat is likely hampered by the presence of other rodents (USFWS 2009). Home ranges for the Merriam's kangaroo rat in the Palm Springs, California, area averaged 0.33 ha (0.82 ac.) for males and 0.31 ha (0.77 ac.) for females. Much larger home ranges have been reported for Merriam's kangaroo rats in New

Mexico, where home ranges averaged 1.7 ha (4.1 ac.) for males and 1.6 ha (3.9 ac.) for females. Space requirements for the San Bernardino kangaroo rat likely vary according to season, age and sex of animal, food availability, and other factors. Although outlying areas of their home ranges may overlap, Dipodomys adults actively defend small core areas near their burrows (73 FR 61936). Juveniles exhibit high fidelity to natal areas (Ceballos 2014).

**Additional Life History Information**

Adult: Little is known about home range size, dispersal distances, or other spatial requirements of the San Bernardino kangaroo rat. However, home ranges for the Merriam's kangaroo rat in the Palm Springs, California, area averaged 0.82 ac. (0.33 ha) for males and 0.77 ac. (0.31 ha) for females. Much larger home ranges have been reported for Merriam's kangaroo rats in New Mexico, where home ranges averaged 4.1 ac. (1.7 ha) for males and 3.9 ac. (1.6 ha) for females. Space requirements for the San Bernardino kangaroo rat likely vary according to season, age and sex of animal, food availability, and other factors. Although outlying areas of their home ranges may overlap, Dipodomys adults actively defend small core areas near their burrows (73 FR 61936).

***Population Information and Trends***

**Population Trends:**

Decreasing; population has declined dramatically. Historic range has been reduced by about 96 percent; reduced from 25 historic locations to 7 (8 identified by others) currently occupied sites. Habitat loss and fragmentation is continuing (NatureServe 2015).

**Species Trends:**

Decreasing (NatureServe 2015)

**Number of Populations:**

Three (USFWS, 2024)

**Population Size:**

Unknown; the highest densities occur in the Santa Ana River Wash and Cajon Wash (NatureServe 2015). Actual densities not known; female home ranges (which overlap only slightly) for this species in other regions range from 0.31 to 1.6 ha (0.76 to 3.95 ac.) (NatureServe 2015). In 1997, San Bernardino kangaroo rat occupied about 6,576 ha (16,250 ac.) of habitat (NatureServe 2015). Population size is highly variable, and is correlated with percent vegetation cover and vegetation type as well as variations in substrate (percent sand, gravel, and cobble) (USFWS 2009). San Bernardino kangaroo rats are currently distributed among three isolated populations. These core areas make up the majority of the modeled habitat thought to be suitable for the subspecies within the historical range. There is some evidence of inbreeding that could have negative impacts in the future, especially in the smallest and most genetically distinct population (San Jacinto population) (USFWS, 2024).

**Resistance to Disease:**

Moderate

**Adaptability:**

Low

**Additional Population-level Information:**

Population density studies have documented substantial annual variation. There appear to be several reasons for these greatly disparate values, including: 1) a low population density observed in an area at one point in time does not mean that the area is occupied at the same low density in any other month, season, or year; 2) a low population density is not an indicator of low habitat quality or low overall value of the land for the conservation of the species; 3) an abundance of San Bernardino kangaroo rat can decrease rapidly; and 4) one or more factors (e.g., food availability, fecundity, disease, predation, genetics, and environment) are strongly influencing the species' population dynamics in one or more areas (67 FR 19812).

**Population Narrative:**

Populations of San Bernardino kangaroo rats are decreasing and have declined dramatically. The historic range of the species has been reduced by about 96 percent; reduced from 25 historic locations to 7 (8 identified by others) currently occupied sites. Habitat loss and fragmentation is continuing (NatureServe 2015). The San Bernardino kangaroo rat occurs at eight localities. Four localities (Santa Ana River, Lytle and Cajon washes, and Etiwanda Creek) contain moderately large populations and four (Badlands, Bautista Canyon, San Timoteo Creek, and San Jacinto River near Hemet) have small populations in fragmented and isolated habitat patches (Bolster 1998). Population size is highly variable, and is correlated with percent vegetation cover and vegetation type as well as variations in substrate (percent sand, gravel, and cobble) (USFWS 2009). Population density studies have documented substantial annual variation. There appear to be several reasons for these greatly disparate values, including: 1) a low population density observed in an area at one point in time does not mean that the area is occupied at the same low density in any other month, season, or year; 2) a low population density is not an indicator of low habitat quality or low overall value of the land for the conservation of the species; 3) an abundance of San Bernardino kangaroo rats can decrease rapidly; and 4) one or more factors (e.g., food availability, fecundity, disease, predation, genetics, and environment) are strongly influencing the species' population dynamics in one or more areas (67 FR 19812).

***Threats and Stressors***

**Stressor:** Habitat fragmentation and loss
**Exposure:** Flood control structures and operations, aggregate mining, agricultural activities, urban and industrial development, and off-highway vehicles.
**Response:** Habitat loss, degradation, and fragmentation, and vulnerability to catastrophic events such as flooding.
**Consequence:** Mortality, population decline.
**Narrative:** Development in the floodplain habitat continues to increase with population growth. As a result of the combined pressures of agriculture, flood control structures, aggregate mining, and urbanization, it is anticipated that there will be new construction of roads, expansion of existing roads and bridges, and additional construction of pipelines, reservoirs, and pumping stations, primarily in the Santa Ana and San Jacinto River floodplains. This will result in an overall reduction in the amount of available habitat to the San Bernardino kangaroo rat. Because the limited amount of remaining habitat is in the floodplain and in close proximity to active channels, with little upland refugia, the subspecies remains vulnerable to catastrophic events such as flooding. Additionally, the highly fragmented landscape, reduced habitat patch size, and isolation will exacerbate the effect of habitat loss on a species' persistence (USFWS 2009).

**Stressor:** Inadequacy of existing regulatory mechanisms.
**Exposure:** The majority of known populations of the San Bernardino kangaroo rat occur on nonfederal land.
**Response:** Inadequate state and federal protections on private land.
**Consequence:** Mortality, population decline.
**Narrative:** Although state and other federal regulations may provide some discretionary conservation benefit to the San Bernardino kangaroo rat, the Federal Endangered Species Act (ESA) is the primary regulatory mechanism mandating San Bernardino kangaroo rat conservation and ensuring that the San Bernardino kangaroo rat is addressed during planning efforts that may impact the subspecies or its habitat. Section 10 of the ESA is the primary federal process for addressing both the economic development needs and the conservation needs of the species on private lands in Riverside County. Management and coordination with federal, state, and local government agencies and mining operations will be needed to protect San Bernardino kangaroo rat from further habitat fragmentation and loss (USFWS 2009).

**Stressor:** Small population size
**Exposure:** Remaining populations of the San Bernardino kangaroo rat continue to be at risk due to their small size.
**Response:** Susceptible to inbreeding, loss of genetic variation, and stochastic events.
**Consequence:** Potential extirpation of populations.
**Narrative:** Small populations have a higher probability of extinction than larger populations, because their low abundance renders them susceptible to inbreeding; the loss of genetic variation; demographic problems like skewed variability in age and sex ratios; and stochastic events such as floods, droughts, or disease epidemics (USFWS 2009).

**Stressor:** Predation
**Exposure:** Fragmentation of habitat and urbanization.
**Response:** Could promote higher levels of predation by urban-associated animals, particularly domestic cats.
**Consequence:** Could threaten remnant populations of San Bernardino kangaroo rat.
**Narrative:** Fragmentation of habitat and urbanization likely promotes higher levels of predation by urban-associated animals, specifically domestic cats. As the interface between occupied habitat to developed areas is increased, predation could become a larger threat to the San Bernardino kangaroo rat (USFWS 2009).

**Stressor:** Isolation
**Exposure:** Habitat fragmentation of the San Bernardino kangaroo rat’s historical range.
**Response:** Remaining blocks of isolated habitat may now function independently of each other.
**Consequence:** Higher susceptibility to extirpation by accidental or natural catastrophes.
**Narrative:** Altered fluvial processes, urbanization, and land conversion have fragmented the historical range of the San Bernardino kangaroo rat in such a way that remaining extant populations are isolated from and function independently of one another. Therefore, the extirpation of remnant populations during local catastrophes will continue to become more probable with increased habitat fragmentation and isolation (USFWS 2009).

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 6C

1. Sufficient habitat is conserved to maintain connectivity between upland and wash habitat in each of the three systems and management is implemented to restore sediment transport and maintain appropriate soils: • Lytle/Cajon Creeks – 3,500 acres (1,416 hectares). • Santa Ana River – 3,000 acres (1,214 hectares). • San Jacinto River – 1,500 acres (607 hectares). (USFWS, 2024a)

2. Monitoring shows that each population has a stable or increasing effective population size of at least 100 adults for 10 years that includes at least one drought cycle. (USFWS, 2024a)

**Delisting Criteria:**
1. At least 8,500 acres (3,440 hectares) of suitable San Bernardino kangaroo rat habitat are conserved among the three populations, and we have assurance that management will continue for the next 60 years. (USFWS, 2024a)

2. Effective management will be implemented to control nonnative grasses and ensure that impacts to habitat due to recreational activity are avoided or minimized (this includes OHV activities and other recreational trail use). (USFWS, 2024a)

3. Effective management will ensure that the threat of predation is minimized such that there are not population-level impacts. (USFWS, 2024a)

4. Management for all three populations is assured over the next 60 years through the implementation of a genetic management plan such that we believe genetic diversity, including Ne, will be stable or increasing during this time. There is connectivity within each population and all three populations are large enough to ensure representation is retained long-term to maintain evolutionary potential into the future. (USFWS, 2024a)

**Recovery Actions:**
- Need to develop an approved Recovery Plan containing recovery actions.
- Work with partners and identify opportunities through USFWS' Partners for Fish and Wildlife Program to seek habitat management, restoration, and enhancement opportunities for San Bernardino kangaroo rat. A goal of habitat restoration projects and management actions should be to determine more specific habitat requirements for this species (USFWS 2009).
- Work with partners to protect additional San Bernardino kangaroo rat habitat, including upland refugia habitat to support San Bernardino kangaroo rat during flood events. Occupied floodplains and adjacent upland habitat should be conserved to ensure protection of populations large enough to remain viable in the long term (USFWS 2009).
- Monitor San Bernardino kangaroo rat populations throughout known and potentially occupied sites to track their recovery. Systematic sampling efforts for a minimum of 5 years at each occupied site would provide basic data to estimate occupancy and relative abundance through time. Standard survey protocols for San Bernardino kangaroo rat population abundance or density trends need to be developed (USFWS 2009).
- Develop a recovery plan for the San Bernardino kangaroo rat (USFWS 2009).

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***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Since listing, efforts have been made to conserve habitat in the three remaining alluvial system populations (Santa Ana River, San Jacinto River, Lytle/Cajon Creeks) since habitat loss continues to be the primary threat. Conserving high quality habitat and studying San Bernardino kangaroo rat behavior and genetics has helped conserve the subspecies. Recovery will require stabilizing the three remaining populations. The biggest hurdle in recovery is conserving and managing large tracts of suitable habitat (both upland refugia and lowland areas), so all populations are self-sustaining and can withstand stochastic events associated with alluvial habitat (flooding). To be self-sustaining, each population will need to be able to recolonize suitable lowland habitat after flooding, minimize impacts from inbreeding, and maintain genetic diversity within the population. We have identified these recommendations to aid recovery of the San Bernardino kangaroo rat: 1. Create and implement a protocol for rangewide surveys and monitoring. 2. Conduct PVA to enhance our understanding of population dynamics and provide probabilities of persistence to aid in recovery planning. 3. Conserve and restore occupied habitat throughout the range of the species. 4. Create a genetic management plan to prevent loss of genetic variation and maintain or improve adaptive potential over time. 5. Restore and protect other potentially suitable habitat including upland refugia habitat throughout the range of the species. 6. Use management tools to improve connectivity and maintain/restore small populations. 7. Utilize outreach and other techniques to limit reactional threats and improve public awareness and support. 8. Continue to investigate reestablishment and augmentation as tools to increase abundance and expand distribution in the wild. (USFWS, 2020)
- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be initiated over the next 5 years. Successful implementation of these actions will reduce threats to the San Bernardino kangaroo rat and provide information to better understand the biological and physical factors limiting the population growth and distribution. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid with future restoration efforts. 1. Conduct research to inform management actions and successfully implement habitat restoration techniques restore habitat where appropriate throughout the range of the subspecies. 2. Create and implement a protocol for range wide surveys and monitoring. 3. Restore and protect other potentially suitable habitat including upland refugia habitat throughout the range of the subspecies. 4. Increase population abundance at extant occurrences and expand distribution in the wild using reestablishment and augmentation as recovery tools. 5. Use management tools to improve connectivity and maintain/restore populations (USFWS, 2024).

***Additional Threshold Information:***

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# SPECIES ACCOUNT: *Dipodomys stephensi (incl. D. cascus)* (Stephens' kangaroo rat)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 02/17/2022; Pacific Southwest Region (R8)

**Physical Description**

A medium-sized, long-tailed, nocturnal, hopping rodent.A chunky, large-headed, long-tailed, five-toed rat with a dusky cinnamon buff dorsum, white belly, external fur-lined cheek pouches, and large hind legs; white tail stripe is about half as wide as the dorsal tail stripe at mid-tail; total length 277-300 mm; tail 164-180 mm, about 145% of head and body length; hind foot 39-43 mm; length of ear from notch 13-16 mm; skull length 38.3-40.6 mm; width of maxillary arch 5.1-6 mm; adults averages about 67 g (Ingles 1965, Bleich 1977). LENGTH:32 WEIGHT: 75 (NatureServe, 2015)

**Current Range**

The range encompasses approximately 2,870 square kilometers in the San Jacinto Valley and adjacent areas of western Riverside County, southwestern San Bernardino County (at least formerly), and northwestern and north-central San Diego County, California (Bleich 1977, Williams et al. 1993), at elevations of 55-1,250 meters (USFWS 1997). As of the late 1980s, most extant populations were in western Riverside County, but the largest known population was on the Warner Ranch near Lake Henshaw, San Diego County (see Burke et al. 1991). See also USFWS (1987). The Stephens' kangaroo rat is currently found in a patchy distribution in Riverside and San Diego Counties, California. (USFWS, 2021)

**Critical Habitat Designated**

No;

***Life History***

**Feeding Narrative**

Adult: Probably similar to D. HEERMANNI and D. PANAMINTIMUS which feed primarily on seeds but also eat insects and herbaceous vegetation in the spring. Sagebrush may provide much of the food (Biosystems Analysis 1989). More likely to forage in open, lit spaces than is sympatric D. AGILIS (Burke et al. 1991).; Food Habits: Granivore (Adult, Immature) (NatureServe, 2015)

**Reproduction Narrative**

Adult: Probably produces 1 litter per year, 2 litters/year under high rainfall conditions, perhaps none under drought conditions. Average litter size is about 2.5. In Riverside County, a peak in recruitment occurred in spring (McClenaghan and Taylor 1993). In some areas, young are born in late spring or early summer, and at least sometimes as late as July. In some years, young-of-the-year may reproduce. Life span appear to be relatively short, generally less than a few years.; Population density estimates vary with location and season, range from about 5 to 58 per ha; perhaps about 20-40/ha would be typical (USFWS 1987, Bleich 1977, McClenaghan and Taylor 1993). Population densities can vary more than 10-fold in response to rainfall patterns (Price and Endo 1989). In Riverside County, peak numbers occurred in late spring-early summer;

populations declined from late summer through winter; minimum monthly survival rates for adults was 0.79-0.87 (McClenaghan and Taylor 1993). Mean home range size for 2 populations in Riverside County: 570 sq m and 970 sq m (Bleich 1977). Price et al. (1994) found that the median of the maximum distances moved between captures was about 29 m for 557 individuals; home ranges were stable over time. Predators include owls and various Carnivora.; (NatureServe, 2015)

**Habitat Narrative**

Adult: Habitats include annual grassland and coastal sage scrub with sparse shrub cover, the former more favorable than the latter, commonly in association with Eriogonum fasciculatum, Artemisia californica, and Erodium cicutarium (USFWS 1997). Typical habitat includes sparsely vegetated areas (perennial cover less than 30%) with loose, friable, well-drained soil (generally at least 0.5 m deep) and flat or gently rolling terrain. This species may recolonize abandoned agricultural land. It is most abundant where stands of native vegetation remain (Matthews and Moseley 1990) but deceases as bunchgrass density increases (see Burke et al. 1991). In western Riverside County, shrub removal resulted in increased kangaroo rat densities (Price et al. 1994). Periods of inactivity are spent in underground burrows. Individuals may construct their own burrows or may nest in old burrows of the California ground squirrel or in abandoned burrows of pocket gophers (see Burke et al. 1991, USFWS 1997). In captivity, females construct elaborate nests (Bleich 1977) (NatureServe, 2015).

***Dispersal/Migration***

**Motility/Mobility**

Adult: High (inferred from NatureServe, 2015)

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: Non-migratory (NatureServe, 2015)

**Dispersal**

Adult: Low: Adults maintained a home range center within 30 meters (100 ft) of where they were first observed. Maximum distances between captures varied between 170 and 350 meters. However, the researchers felt they were underestimating the frequency of long-ditance disperal (USFWS, 1997).

**Dispersal/Migration Narrative**

Adult: Adults maintained a home range center within 30 meters (100 ft) of where they were first observed. Maximum distances between captures varied between 170 and 350 meters. However, the researchers felt they were underestimating the frequency of long-ditance disperal (USFWS, 1997).

***Population Information and Trends***

**Population Trends:**

Price and Endo (1988) estimated that the historical habitat had been reduced by about 60 percent by 1984. USFWS (1990) categorized the status as "declining." Decline of 50-70% (NatureServe, 2015)

**Population Growth Rate:**

Price and Endo (1988) estimated that the historical habitat had been reduced by about 60 percent by 1984. USFWS (1990) categorized the status as "declining." Decline of 50-70% (NatureServe, 2015)

**Number of Populations:**

6 - 80 (NatureServe, 2015)

**Population Size:**

10,000 to >1,000,000 individuals (NatureServe, 2015)

**Population Narrative:**

Price and Endo (1988) estimated that the historical habitat had been reduced by about 60 percent by 1984. USFWS (1990) categorized the status as "declining." Decline of 50-70% Total adult population size is unknown but exceeds 10,000. As of the late 1980s, the largest known population included about 14,000 individuals (Burke et al. 1991). Local population density may vary 10-fold with variations in rainfall (populations decline with drought). As in most small mammals, abundance is a misleading index to degree of jeopardy. As of the late 1980s, there were 79 known extant populations (O'Farrell and Uptain 1989; see also Burke et al. 1991). Some of these populations no longer exist whereas subsequent surveys have revealed previously undocumented populations (see USFWS 1997). USFWS (1997) mapped a dozen "significant populations," noting that additonal small fragmented populations also exist. (NatureServe, 2015). The Stephens' kangaroo rat is currently found in a patchy distribution in Riverside and San Diego Counties, California. The distribution and density of populations of the Stephens' kangaroo rat can vary temporally, within and between years, and spatially, depending on natural changes in habitat conditions and succession of plant communities. Comprehensive, rangewide surveys to estimate abundance and distribution for this species have not been conducted since 1988, so we are unable to estimate population trends for the species at this time. There has been no formal assessment of the population structure for the Stephens' kangaroo rat such as the minimum habitat patch size required to support a stable population or an estimate of the minimum number of interconnected patches needed to support a potential metapopulation of this species. Researchers believe that the species' population structure in southern California follows a metapopulation dynamic in which the availability of suitable habitat patches is both spatially and temporally dynamic and is based on the equilibrium between colonization and extinction of local populations. Populations of the Stephens' kangaroo rat reach their highest densities in grassland communities dominated by forbs and characterized by moderate to high amounts of bare ground, moderate slopes, and well-drained, sandy loam soils. Forb cover is important as a food resource while areas with high levels of shrub cover are avoided. The Stephens' kangaroo rat constructs burrow systems that are used as shelter, protection from predators, food storage (caching), and nesting. Areas of occupied (patchy) habitat consist of burrow entrances connected by a network of welldefined surface runways in which the size of a patch and the distance between occupied patches varies depending on topography and soil characteristics, and broader features such as biotic variables (e.g., vegetation cover, predation) and behavioral factors (e.g., immigration and emigration). (USFWS, 2021). Based on habitat predictors from field studies, we used spatial analyses to model habitat for the Stephens' kangaroo rat. We estimated that there are approximately 131,343 ac (53,153 ha) and 51,737 ac (20,937 ha) of modeled habitat in Riverside and San Diego Counties, respectively. (USFWS, 2021)

***Threats and Stressors***

**Stressor:** Climate change (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Although it is uncertain how climate change will affect Stephens' kangaroo rat or its habitat, modeling predictions suggest more extreme weather events, which could impact the extent of suitable habitat or induce stresses on the species (USFWS, 2010).

**Stressor:** Habitat destruction or modification (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Stephens' kangaroo rat habitat continues to be threatened by habitat degradation from urban development, conversion of native vegetation to nonnative annual grassland, and off-highway vehicles (which directly damage plant communities, as well as the soil crust and the burrow systems) now and in the foreseeable future throughout the Stephens' kangaroo rat's range. Grazing by ungulates is no longer considered to be a rangewide threat, assuming grazing is adequately managed (USFWS, 2010).

**Stressor:** Predation (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Predation by feral and domestic cats is considered to be a threat to the Stephens' kangaroo rat rangewide, and in particular in western Riverside County, now and in the foreseeable future (USFWS, 2010).

**Stressor:** Rodenticides (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Anticoagulant rodenticides, used to control nuisance species, may be consumed by nontarget species, including Stephens' kangaroo rat, even when elevated bait stations are used. Poison bait that falls to the ground or that is cached at ground level by targeted species poses a threat to Stephens' kangaroo rat if ingested during nocturnal foraging or encountered in use of abandoned burrows (USFWS, 2010).

**Stressor:** Small population size (USFWS, 2010)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Small population size continues to affect this species throughout its range and exacerbates the effects of other threats, making Stephens' kangaroo rat susceptible to stochastic events (USFWS, 2010).

**Stressor:** List of Stressors (USFWS, 2021)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Habitat Fragmentation. Habitat Loss Due To Urban and Agricultural Development. Habitat Modification— Conversion of Native Vegetation (wildfires, nonnative grasses, invasive species). Habitat Destruction or Modification—Other (nonnative ungulates, OHVs, fire suppression) . Predation. Use of Rodenticides. Wildfire. Climate Change Effects. (USFWS, 2021)

***Recovery***

**Reclassification Criteria:**
1. Establishement of four reserves, which encompass at least 6,070 hectares (15,000 acres) of occupied habitat and are permanently protected, funded, and managed, and are located in western Riverside County (inside or outside the Habitat Conservation Plan planning area) (USFWS, 1997).

2. Establishment of one ecosystem based reserve in either western or central San Diego County that is permanently protected, funded, and managed (USFWS, 1997).

Recovery Priority Number: 11

**Delisting Criteria:**
1. A minimum of five reserves in western Riverside County, of which one is ecosystem based, and that encompass at least 6,675 hectares (16,500 acres) of occupied habitat that is permanently protected, funded, and managed (USFWS, 1997).

2. Two ecosystem based reserves in San Diego County. One reserve needs to be established in the Western conservation Planning Area and one reserve needs to be established in the Central Conservation Planning Area. These reserves must be permanently protected, funded, and managed (USFWS, 1997).

**Recovery Actions:**
- Preserve and protect populations of the Stephen's Kangaroo rat throughout representative portions of its range (USFWS, 1997).
- Protect conserved populations of the Stephen's Kangaroo rat and their habitat (USFWS, 1997).
- Eliminate unnatural mortality factors (USFWS, 1997).
- Establish research program (USFWS, 1997).
- Develop outreach program (USFWS, 1997).
- Secure and conserve remaining large contiguous blocks of habitat and Stephens' kangaroo rat populations in southern portions of this species' range (i.e., San Diego County) that will lower the extirpation risks associated with lower genetic variability and smaller, fragmented populations (USFWS, 2011).
- Develop and adopt a systematic survey program for monitoring species status and trends across the range of Stephens' kangaroo rat. This objective will include standardization of habitat assessment methodologies across reserves and will require rigorous, detailed, and

consistent surveys at appropriate regularity necessary to reliably determine an accurate population status and trend for the species (USFWS, 2011).

- Develop and adopt a centrally organized management plan which employs appropriate management techniques for maintaining suitable habitat quality for Stephens' kangaroo rat. The management plan will prevent habitat loss and degradation and restore degraded habitats through practices directed at increasing occupied habitat, including reduction of nonnative grass density and thatch buildup that inhibits species movement (USFWS, 2011).
- Revise the draft recovery plan to include threats-based and demographic criteria that objectively address current threats. Recovery criteria should be modified and updated to incorporate new information regarding current threats to the species and the quality and maintenance of remaining habitat (Service 2010, p. 51204) (USFWS, 2011).
- Increase funding and support for investigations, which support translocation activities. Encourage hypothesis-driven studies that investigate effects of grazing, controlled burns, vegetation mowing, tilling and scraping as habitat management tools and which test their efficacy in site-specific locations (USFWS, 2011).
- Conduct genetic studies to examine gene flow over a more recent period that will help to clarify impacts of recent habitat fragmentation on Stephens' kangaroo rat genetics, and provide information on the frequency with which genetic exchange occurs between existing populations (USFWS, 2011).

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# SPECIES ACCOUNT: *Eumops floridanus* (Florida bonneted bat)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; Southeast Region (R4) (USFWS, 2015)

**Physical Description**

The taxon was originally listed as endangered in the State of Florida as the Florida mastiff bat (Eumops glaucinus floridanus) (Florida Administrative Code, Chapter 68). A biological status review recognized the taxon as the Florida bonneted bat, and the State's current threatened and endangered list uses both names, Florida bonneted (mastiff) bat, Eumops (=glaucinus) floridanus. The dorsum is black or brownish-gray to cinnamon-brown, slightly paler grayish below; fur is short and glossy; hairs are bicolored, lighter at the base; distal half of tail projects beyond interfemoral membrane; the largest bat in Florida, where total length is 126-165 mm; forearm length 57.9-69.2 mm; hind foot 10.8-15.0 mm; leathery rounded ears are joined at the midline and project forward, ear length 19.9-31.0 mm; tragus broad and truncate distally; mass 30.2 g to at least 55.4 g in pregnant females (Belwood 1992, Hall 1981). Males and females are not significantly different in size (Timm and Genoways 2004). Timm and Genoways (2004) found no pattern of size related geographic variation in this species.

**Taxonomy**

The taxon differs from Tadarida brasiliensis in being larger (maximum total length of brasiliensis is about 105 mm) and having the ears joined at the midline. No other Florida bats have a tail that extends far beyond the interfemoral membrane.

**Historical Range**

Records indicating historical range are limited. Morgan (1991) indicated that E. glaucinus had been identified from four late Pleistocene (approximately 11,700 years ago) and Holocene (time period beginning 10,000 years ago) fossil sites in the southern half of the Florida peninsula. Late Pleistocene remains are known from Melbourne, Brevard County, and Monkey Jungle Hammock in Miami-Dade County (Allen 1932; Martin 1977, as cited in Belwood 1981 and Timm and Genoways 2004; Morgan 1991). Holocene remains are known from Vero Beach, Indian River County (Ray 1958; Martin1977; and Morgan 1985, 2002 as cited in Timm and Genoways 2004; Morgan 1991), and also Monkey Jungle Hammock (Morgan1991). The largest fossil sample (9 specimens) was reported from the Holocene stratum at Vero Beach (Morgan 1985 as cited in Morgan 1991). The fossil records from Brevard County and Indian River County are considerably farther north than where living individuals have typically been recorded (Timm and Genoways 2004; Marks and Marks 2008b). Most of the historical records and sightings for this species are several decades old from the cities of Coral Gables and Miami in extreme southeastern Florida, where the species was once believed to be common (Belwood 1992; Timm and Genoways 2004; Timm and Arroyo-Cabrales 2008). G.T. Hubbell also reported a female with young from Fort Lauderdale in Broward County; all of his sightings of Florida bonneted bats were near human dwellings (Belwood 1992). Prior to 1967, G.T. Hubbell regularly heard loud, distinctive calls at night as the bats foraged above buildings and he routinely obtained several individuals per year that were collected during the winter months from people's houses (Belwood 1992). Other early literature also mentioned Fort Lauderdale as an area where the species occurred (Barbour and Davis1969; Belwood 1992). However, in their comprehensive review, none of the specimens examined by Timm and Genoways (2004) were from Broward County. Belwood

(1981) found a colony in Punta Gorda; however, the longleaf pine in which the bats roosted was felled during highway construction. Recent specimens are only known from extreme southern and southwestern Florida, including Miami-Dade County on the east coast and Charlotte, Collier, and Lee Counties on the Gulf coast (Timm and Genoways 2004).

**Current Range**

Based upon available information, the Florida bonneted bat appears to be restricted to south and southwest Florida. The core range may primarily consist of habitat within Charlotte, Lee, Collier, Monroe, and Miami-Dade Counties. Recent data also suggest use of portions of Okeechobee and Polk Counties and possible use of areas within Glades County. However, given available data, it is not clear to what extent areas outside of the core range may be used. It is possible that areas outside of the south and southwest Florida are used only seasonally or sporadically. Alternatively, these areas may be used consistently, but the species was not regularly detected due to the limitations of available data, survey methods, and search efforts.

**Critical Habitat Designated**

Yes; 4/8/2024.

**Legal Description**

: We, the U.S. Fish and Wildlife Service (Service), designate critical habitat for the Florida bonneted bat (Eumops floridanus) under the Endangered Species Act of 1973 (Act), as amended. In total, approximately 1,160,625 acres (469,688 hectares) in 13 Florida counties fall within the boundaries of the critical habitat designation. This rule extends the Act's protections to this species' critical habitat.

**Critical Habitat Designation**

Critical habitat units are depicted for Charlotte, Collier, DeSoto, Glades, Hardee, Hendry, Highlands, Lee, MiamiDade, Monroe, Okeechobee, Osceola, and Polk Counties, Florida

**Primary Constituent Elements/Physical or Biological Features**

Within these areas, the physical or biological features essential to the conservation of Florida bonneted bat consist of the following components:

(i) Habitats with sufficient darkness that provide for roosting and rearing of offspring. Such habitat provides structural features for rest, digestion of food, social interaction, mating, rearing of young, protection from sunlight and adverse weather conditions, and cover to reduce predation risks for adults and young, and is generally characterized by: (A) Live or dead trees and tree snags, especially longleaf pine, slash pine, bald cypress, and royal palm, that are sufficiently large (in diameter) and tall and have cavities of a sufficient size for roosts; and (B) Live or dead trees and tree snags with sufficient cavity height, spacing from adjacent trees, and relative canopy height to provide unobstructed space for Florida bonneted bats to emerge from roost trees; this may include open or semi-open canopy and canopy gaps.

(ii) Habitats that provide adequate prey and space for foraging, which may vary widely across the Florida bonneted bat's range, in accordance with ecological conditions, seasons, and disturbance regimes that influence vegetation structure and prey species' distributions. Foraging habitat may be separate and relatively far from roosting habitat. Essential foraging habitat consists of sufficiently dark open areas in or near areas of high insect production or congregation, commonly including, but not limited to: (A) Freshwater edges, and freshwater herbaceous wetlands (permanent or seasonal); (B) Prairies; (C) Wetland and upland shrub; and/ or (D) Wetland and upland forests.

(iii) A dynamic disturbance regime (e.g., fire, hurricanes, forest management) that maintains and regenerates forested habitat, including plant communities, open habitat structure, and temporary gaps, which is conducive to promoting a continual supply of roosting sites, prey items, and suitable foraging conditions.

(iv) A sufficient quantity and diversity of habitats to enable the species to be resilient to short-term impacts associated with disturbance over time (e.g., drought, forest disease). The ecological communities the Florida bonneted bat inhabits differ in hydrology, fire frequency/intensity, climate, prey species, roosting sites, and threats, and include, but are not limited to: (A) Pine rocklands; (B) Cypress communities (cypress swamps, strand swamps, domes, sloughs, ponds); (C) Hydric pine flatwoods (wet flatwoods); (D) Mesic pine flatwoods; and (E) High pine.

(v) Habitats that provide structural connectivity where needed to allow for dispersal, gene flow, and natural and adaptive movements, including those that may be necessitated by climate change. These connections may include linear corridors such as vegetated, riverine, or open-water habitat with opportunities for roosting and/or foraging, or patches (i.e., stepping stones) such as tree islands or other isolated natural areas within a matrix of otherwise low-quality habitat.

(vi) A subtropical climate that provides tolerable conditions for the species such that normal behavior, successful reproduction, and rearing of offspring are possible.

**Special Management Considerations or Protections**

Habitat Loss Habitat loss, degradation, and modification from human population growth and associated development (including infrastructure and energy development) and agriculture have impacted the Florida bonneted bat and are expected to further curtail its limited range (see the Factor A discussion in the final listing rule (78 FR 61004, October 2, 2013, pp. 61026–61030); Bailey et al. 2017a, entire). Based on the expected rates of human population growth and urbanization in southern Florida, nearly all agricultural and private natural lands are predicted to be converted to developed land by 2060 (Zwick and Carr 2006, pp. 15, 18). Of this, approximately 2.6 percent of designated critical habitat (30,716 ac (12,430 ha)) is predicted to be converted to developed land by 2070 (Carr and Zwick 2016, entire). The species occurs, in part, on publicly owned lands that are managed for conservation, ameliorating some of these threats (see Conservation Lands Within Florida Bonneted Bat Final Critical Habitat Designation under Supporting and Related Material in Docket No. FWS–R4–ES–2019–0106 on https://www.regulations.gov). However, any unknown extant populations of the bat or suitable habitat on private lands or non-conservation public lands are vulnerable to habitat loss and fragmentation. Retaining a habitat network of large and diverse natural areas for conservation purposes in a spatial configuration throughout the Florida bonneted bat's range and actively managing those lands will likely be essential to conservation. In addition, conservation efforts on private lands can help reduce the threats of habitat loss, increasing the potential for long-term survival. Natural roosting habitat appears to be limiting, and competition for tree cavities is high (see Competition for Tree Cavities under the Factor E discussion in the final listing rule (78 FR 61004, October 2, 2013, p. 61034)). To help conserve the Florida bonneted bat, efforts should be made to retain tall trees, cavity trees, trees with hollows or other decay, and snags wherever possible to protect habitat, reduce competition for suitable roosts, and bolster or expand populations within the species' known range (Angell and Thompson 2015, p. 187; Braun de Torrez et al. 2016, pp. 235, 240; Ober et al. 2016, p. 7). The use of artificial structures for the Florida bonneted bat may also be beneficial in some locations, especially where roosting structures are lacking or deficient (see Use of Artificial Structures (Bat Houses) in the final listing rule (78 FR 61004, October 2, 2013, p. 61010)). Substantial losses in suitable foraging habitats are expected to occur in the coming decades as natural and agricultural areas are converted to other uses and as areas become urbanized (Carr and Zwick 2016, entire; Bailey et al. 2017a, p. 1591). Conservation of natural and semi-natural habitats and restoration with native plants is imperative to help maintain sufficient prey base. Natural habitats conducive to insect diversity should be protected and any pesticides should be used with caution (for more information, see the final listing rule (78 FR 61004; October 2, 2013) under Life History (pp. 61005– 61006), and Pesticides and Contaminants in the Factor E discussion (pp. 61035–61036). Climate Change and Sea Level Rise The effects resulting from climate change, including sea level rise, saltwater intrusion, and coastal squeeze, are expected to become severe in the future and result in additional habitat losses, including the loss of roost sites and foraging habitat (see the Factor A discussion in the final listing rule (78 FR 61004, October 2, 2013, pp. 61026– 61030)). Within the species' range, lowlying areas along the coast are most vulnerable to inundation, and additional areas are likely to experience changes in plant species composition (decline in forested habitat such as cabbage palm forests, pine rockland, and coastal hardwood hammocks). Occupied Florida bonneted bat habitat located near the coast in south Florida (e.g., Collier, Lee, Miami-Dade, Monroe, Charlotte, Desoto, and Sarasota Counties) will be vulnerable to inundation and/or saltwater intrusion as sea levels rise. Based on source data used by the National Oceanic and Atmospheric Administration (NOAA) Sea Level Rise map viewer, an estimated 8.7 percent (100,840 ac (40,809 ha)) of the designated occupied habitat area is projected to be inundated by 6 feet of salt water around 2070 (sea level rise plus tidal flooding; Sweet et al. 2017, entire; Sweet et al. 2018, entire; Sweet et al. 2019, entire; Sweet et al. 2022, entire). In addition, data from Florida's statewide digital elevation model (University of Florida (UF) GeoPlan Center 2017, entire) indicate that an additional 14.3 percent (166,257 ac (67,282 ha)) of designated occupied habitat outside of the areas mapped by NOAA are at or below 6 feet in elevation and may also be affected by sea level rise (this does not include area in Unit 1 due to the unlikelihood of sea level rise impacts). Although we are unable to accurately estimate the extent of other climate change-related effects, we expect additional occupied habitat will be impacted by saltwater intrusion, drier conditions, and increased variability in precipitation, likely resulting in changes to vegetation composition and prey availability, decreased forest regeneration, and potential increases in wildfire frequency, severity, and scale (for more information, see the final listing rule (78 FR 61004; October 2, 2013) under the discussion of Factor A in Land Use Changes and Human Population Growth (pp. 61026–61027) and Climate Change and Sea Level Rise (pp. 61028–61029)). The trend toward higher temperatures and lower rainfall (or shifts in rainfall patterns) could result in the degradation of wetlands and other important open water habitats, or complete loss of affected foraging areas if drought-like conditions persist. Actual impacts may be greater or less than anticipated based upon high variability of factors involved (e.g., sea level rise, human population growth) and assumptions made. As a result of these impacts and other causes of habitat loss and degradation, the essential physical or biological features for the Florida bonneted bat may no longer be available in some areas, and the amount of suitable occupied Florida bonneted bat habitat is likely to shrink dramatically in the future. Habitat loss from sea level rise and saltwater intrusion will be greatest in areas closer to the coast and is likely to result in the loss of some bonneted bat populations, such as those in eastern Miami-Dade County, reducing the species' ability to withstand catastrophic events (i.e., redundancy). We anticipate additional populations near the coast will be reduced in size, such as those in Charlotte, Lee, Collier, Monroe, and remaining areas in MiamiDade Counties, resulting in decreased overall health and fitness (i.e., resiliency) of those populations. Further, most of the remaining bat populations face similar threats and pressures (e.g., development pressure, effects of climate change, coastal squeeze, droughts, hurricanes) that are expected to reduce their resiliency. This limits the species' ability to recover from population declines when many populations are similarly affected. However, we lack certainty as to the severity of impacts the effects of sea level rise may have on the Florida bonneted bat's critical habitat. Directly addressing sea level rise is beyond the control of landowners or managers. However, while landowners or land managers may not be able prevent these events, they may be able to respond with management or protection. Management actions or activities that could ameliorate the effects of sea level rise on the Florida bonneted bat (i.e., loss and degradation of habitats that provide for roosting or foraging, especially those areas closer to the coast) include providing protection of inland or higher elevation suitable habitats (e.g., in the northern portion of the bat's range) that are predicted to be unaffected or less affected by sea level rise, or habitat restoration or enhancement of these areas. Environmental Stochasticity Hurricanes, storm surges, and other catastrophic and stochastic events are of significant concern (for more information, see final listing rule (78 FR 61004; October 2, 2013) under the discussion of Factor E in Environmental Stochasticity (pp. 61037–61039) and Aspects of the Species' Life History and Climate Change Implications (p. 61039)). In 2017 alone, at least four known roost trees were impacted by Hurricane Irma. While landowners or land managers cannot prevent these events, they may be able to respond with protection or management that can help reduce some effects or facilitate recovery from these events. Retention of large trees and snags wherever possible in multiple locations can help provide valuable roosting habitat throughout the species' range (Braun de Torrez et al. 2016, pp. 235, 240; Ober et al. 2016, p. 7). Management actions or activities that could enhance forest recovery following storms may include hand or mechanical removal of damaged vegetation or prescribed fire, if or when conditions are suitable. If large trees, cavity trees, trees with hollows or other decay, or snags need to be removed due to safety issues, visual or other inspection should occur to ensure that active roosts are not removed in this process. Artificial structures could potentially help provide roosting opportunities in areas impacted by stochastic events or where suitable natural roosts are lacking or deficient. More research on the role of bat houses in bonneted bat conservation is needed, especially given the bat's social structure (FWC 2013, pp. 11–12; Ober et al. 2016, p. 7). If used, bat houses should be appropriately designed, placed, maintained, and monitored; such structures may also need to be reinforced and duplicated to prevent loss. If an occupied area is severely impacted, causing major losses of suitable natural roosts, the use of artificial structures could be explored as one possible option to help regain lost roosting capacity. Pesticides and Contaminants More study is needed to fully assess the risk that pesticides (particularly insecticides) and contaminants pose to the Florida bonneted bat (see Pesticides and Contaminants under the Factor E discussion in the final listing rule (78 FR 61004, October 2, 2013, pp. 61035– 61036)). Although data are lacking, the species may be exposed to a variety of compounds through multiple routes of exposure. Areas with intensive pesticide activity may not support an adequate food base. Foraging habitat can be enhanced, in part, by limiting the use of pesticides, including agrochemicals (chemicals used in agriculture) (Russo and Jones 2003, pp. 206–207; Wickramasinghe et al. 2003, pp. 991– 992; Wickramasinghe et al. 2004, entire). While exposure to some contaminants (e.g., mercury) may be beyond the realm of what individuals or agencies can rectify, risks from pesticides can be partially reduced at the local level. For example, landowners and land managers can help reduce some risks of exposure and improve foraging conditions for the Florida bonneted bat by avoiding or limiting use of insecticides (e.g., mosquito control, agricultural), wherever possible, and especially in areas known to be occupied by the Florida bonneted bat. An increased occurrence of bonneted bats was found in agricultural areas and was attributed to a combination of insect abundance in these areas and the species' ability to forage in open spaces (Bailey et al. 2017a, pp. 1589, 1591). It is reasonable to assume that prey base (i.e., availability, abundance, and diversity of insects) would be more plentiful with reduction of insecticides, where possible. If pesticides cannot be avoided, ways to reduce impacts should be explored. Protecting natural and semi-natural habitats that support insect diversity can also improve foraging conditions and contribute to conservation. Ecological Light Pollution The Florida bonneted bat's behavioral response to ecological light pollution has not specifically been examined (see Ecological Light Pollution under the Factor E discussion in the final listing rule (78 FR 61004, October 2, 2013, p. 61036)); however, there is evidence of closely related and other open space foraging bat species avoiding artificial lighting and of the Florida bonneted bat preferring darker landscapes within an urban matrix (Jung and Kalko 2010, pp. 147–148; Bat Conservation International 2022, p. 18; Mena et al. 2022, pp. 568– 571). Artificial lighting can impact roosting habitat quality as light at emergence can disrupt emergence cues and may increase predation risk (or perceived predation risk) for other open space foraging and insectivorous bats (Rydell et al. 1996, pp. 249, 251; Mariton et al. 2022, p. 8). Similarly, lighting can restrict habitat connectivity and fragment foraging areas (Voigt et al. 2020, pp. 197–199). Artificial lighting can also affect the abundance and availability of insects (van Grunsven et al. 2020, entire; Boyes et al. 2021, entire; Pennisi 2021, entire; Mariton et al. 2022, pp. 2, 7), thereby reducing the quality of foraging habitat for Florida bonneted bats. Thus, at this time, we consider ecological light pollution a potential threat to the Florida bonneted bat and its habitat. Management actions or activities that could ameliorate ecological light pollution include avoiding and minimizing the use of artificial lighting, retaining natural light conditions, and promoting the use of environmentally friendly lighting practices to minimize impacts to wildlife (e.g., Voigt et al. 2018, entire). Inadvertent Impacts From Land Management Practices Forest management can help maintain and improve the Florida bonneted bat's roosting and foraging habitat (see Use of Forests and Other Natural Areas in the final listing rule (78 FR 61004, October 2, 2013, pp. 61007–61010)), and a lack of forest management, including a lack of prescribed fire or invasive plant control, can be detrimental to the species. For example, prescribed burns may benefit Florida bonneted bats by improving habitat structure, enhancing the prey base, and creating openings; restoration of fire to fire-dependent forests may improve foraging habitat for this species and create snags (Carter et al. 2000, p. 139; Boyles and Aubrey 2006, pp. 111–113; Lacki et al. 2009, entire; Armitage and Ober 2012, pp. 107–109; FWC 2013, pp. 9–11; Ober and McCleery 2014, pp. 1–3; Braun de Torrez et al. 2018a–b, entire). Fire is a vital component in maintaining suitable Florida bonneted bat habitat (Braun de Torrez et al. 2018b, entire), and while many prescribed fire and other land management practices mimic natural processes and benefit native species on broad spatial and temporal scales, these activities can result in inadvertent negative impacts in the near term. For example, extensive removal of trees with cavities or hollows during activities associated with forest management, fuel reduction, vista management, off-road vehicle trail maintenance, prescribed fire, or habitat restoration may inadvertently remove roost sites or reduce the availability of roost sites (see Land Management Practices in the final listing rule (78 FR 61004, October 2, 2013, p. 61027)). The features essential to the conservation of the Florida bonneted bat may require special management considerations or protection to reduce threats and conserve these features. Actions that could ameliorate threats include, but are not limited to: (1)

Retaining and actively managing a habitat network of large and diverse conservation lands throughout the Florida bonneted bat's range; (2) Protecting, restoring, or enhancing inland or higher elevation habitats that are predicted to be unaffected or less affected by sea level rise; (3) Protecting habitats that support high insect diversity and abundance, and avoiding the excessive use of pesticides wherever possible; (4) Retaining potential roost trees and snags (see Cover or Shelter, above); and (5) Developing and implementing specific guidelines (see the Florida Bonneted Bat Consultation Guidelines under Supporting and Related Material in Docket No. FWS–R4–ES–2019–0106 on https://www.regulations.gov) to minimize impacts of activities associated with hurricane clean-up, prescribed fire, invasive species management, forest management, and development.

***Life History***

**Feeding Narrative**

Adult: Foraging behavior – Precise foraging and roosting habits and long-term requirements are unknown (Belwood 1992). Active year-round, the species is likely dependent upon a constant and sufficient food supply, consisting of insects, to maintain its generally high metabolism. Based upon limited information, Florida bonneted bats feed on flying insects of the following orders: Coleoptera (beetles), Diptera (true flies), and Hemiptera (true bugs) (Belwood 1981; Belwood 1992; FBC 2005). An analysis of bat guano (droppings) from the colony using the pine flatwoods in Punta Gorda indicated the sample (by volume) contained coleopterans (55 percent), dipterans (15 percent), and hemipterans (10 percent) (Belwood 1981; Belwood 1992). Molossids, in general, seem adapted to fast flight in open areas (Vaughan 1966). Various morphological characteristics (e.g., narrow wings, high wing-aspect ratios (ratio of wing length to its breadth) make Eumops well-adapted for efficient, rapid, and prolonged flight in open areas (Findley et al. 1972; Freeman 1981; Norberg and Rayner 1987; Vaughan, 1959 as cited in Best et al. 1997). Barbour and Davis (1969) noted that the species flies faster than smaller bats, but cannot maneuver as well in small spaces. Belwood (1992) stated E. glaucinus is ''capable of long, straight, and sustained flight,'' which should allow individuals to travel large distances. Norberg and Rayner (1987) attributed long distance flights of Brazilian free-tailed bats to their high wing-aspect ratios, with that species capable of traveling 65 km (40 miles) from its roosting site to its foraging areas (Barbour and Davis 1969). Nonetheless, average foraging distances for the Florida bonneted bat are not known (G. Marks, personal communication 2012). Although the species can fly long distances, it likely does not travel farther than necessary to acquire food needed for survival (G. Marks, personal communication 2012). Bonneted bats are ''fast hawking'' bats that rely on speed and agility to catch target insects in the absence of background clutter, such as dense vegetation (Simmons et al. 1979; Belwood 1992; Best et al. 1997). Foraging in open spaces, these bats use echolocation to detect prey at relatively long range, roughly 3 to 5 m (10 to 16 ft) (Belwood 1992). Based upon information from G.T. Hubbell, Belwood (1992) indicated that individuals leave roosts to forage after dark, seldom occur below 10 m (33 ft) in the air, and produce loud, audible calls when flying; calls are easily recognized by some humans (Belwood 1992; Best et al. 1997; Marks and Marks 2008a).

**Reproduction Narrative**

Adult: The Florida bonneted bat has a fairly extensive breeding season during summer months (Timm and Genoways 2004). The maternity season for most bat species in Florida occurs from mid-April through mid-August (Marks and Marks 2008a). During the early portion of this period, females give birth and leave young in the roost while they make multiple foraging excursions to support lactation (Marks and Marks 2008a). During the latter portion of the season, young and females forage together until the young become sufficiently skilled to forage and survive on their own (Marks and Marks 2008a). The Florida bonneted bat is a subtropical species, and pregnant females have been found in April through September (FBC 2005; Marks and Marks 2008a; J. Myers, personal communication, 2015). Examination of limited data suggests this species may be polyestrous (having more than one period of estrous in a year), with a second birthing season possibly in January–February (Timm and Genoways 2004; FBC 2005). Information on reproduction and demography is sparse. The Florida bonneted bat has low fecundity; litter size is one (FBC 2005; Timm and Arroyo-Cabrales 2008). Lifespan – Relatively little is known about the Florida bonneted bat's life history. Lifespan is not known. Based upon the work of Wilkinson and South (2002), Gore et al. (2010) inferred a lifespan of 10 to 20 years for the Florida bonneted bat, with an average generation time of 5 to 10 years.

**Habitat Narrative**

Adult: Habitat – Relatively little is known of the ecology of the Florida bonneted bat, and long-term habitat requirements are poorly understood (Robson 1989; Robson et al. 1989; Belwood 1992; Timm and Genoways 2004). Habitat for the Florida bonneted bat mainly consists of foraging areas and roosting sites, including artificial structures. At present, only two active, natural roost sites are known, and only limited information on historical sites is available. Recent information on foraging habitat has been obtained largely through acoustical surveys, designed to detect and record bat echolocation calls (Marks and Marks 2008a). Acoustical methods have generally been selected over mist netting as the primary survey methodology because this species flies and primarily forages at heights of 9 m (30 ft) or more (Marks and Marks 2008a). The Florida bonneted bat has a unique and easily identifiable call. While most North American bats vocalize echolocation calls in the ultrasonic range that are inaudible to humans, the Florida bonneted bat echolocates at the higher end of the audible range, which can be heard by some humans as high-pitched calls (Marks and Marks 2008a). Most surveys conducted using acoustical equipment can detect echolocation calls within a range of 30 m (100 ft); call sequences are analyzed using software that compares calls to a library of signature calls (Marks and Marks 2008a). Florida bonneted bat calls are relatively easy to identify because calls are issued at frequencies well below that of other Florida bat species (Marks and Marks 2008a). In general, open, fresh water and wetlands provide prime foraging areas for bats (Marks and Marks 2008c). Bats will forage over ponds, streams, and wetlands and drink when flying over open water (Marks and Marks 2008c). During dry seasons, bats become more dependent on remaining ponds, streams, and wetland areas for foraging purposes (Marks and Marks 2008c). The presence of roosting habitat is critical for day roosts, protection from predators, and the rearing of young (Marks and Marks 2008c). For most bats, the availability of suitable roosts is an important, limiting factor (Humphrey 1975). Bats in south Florida roost primarily in trees and manmade structures (Marks and Marks 2008a). Available information on roosting sites for the Florida bonneted bat is extremely limited. Roosting and foraging areas appear varied, with the species occurring in forested, suburban, and urban areas (Timm and Arroyo-Cabrales 2008). Data from acoustical surveys and other methods suggests the species uses a wide variety of habitats (Marks and Marks 2008a; 2008b; 2008c; 2012; R. Arwood, Inside-Out Photography, Incorporated, personal communication 2008a, 2008b, 2012; Smith 2010; S. Snow, personal communication 2011a, 2011b, 2012).

***Dispersal/Migration***

**Motility/Mobility**

Adult: High

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: Non-migratory

**Dispersal/Migration Narrative**

Adult: The Florida bonneted bat is active year-round and does not have periods of hibernation or torpor. The species is not migratory, but there might have been seasonal shifts in roosting sites (Timm and Genoways 2004).

***Population Information and Trends***

**Population Trends:**

Unknown

**Number of Populations:**

~26 colonys

**Population Size:**

Unknown. Estimate 286

**Population Narrative:**

Little information exists on historical population levels. The Florida bonneted bat was considered common in the Miami-Coral Gables area because of regular collection of specimens from 1951 to 1965 (Robson 1989; Belwood 1992). Jennings (1958) indicated the species was not abundant, noting a total of 20 individuals had been taken from 1936 to 1958. Prior to 1967, G.T. Hubbell regularly heard loud, distinctive calls at R. Timm, personal communication 2012). night as the bats foraged above buildings in the Miami area, and he routinely obtained several individuals per year that were collected from people's houses (Belwood 1992). Barbour and Davis (1969) indicated that, on average, about two individuals per year are brought to the Crandon Park Zoo in Miami, due to injuries, but no time period was specified. Unpublished data from a survey of 100 pest control companies in 1982 on the southeastern coast of Florida showed that requests to remove ''nuisance'' bats from this area all but ceased beginning in the 1960s (Belwood 1992), indicating a sharp decline in bats in general. Timm and Genoways (2004) found only three records of Florida bonneted bats in the greater Miami area after 1965. The colony found near Punta Gorda in 1979 appeared to be the only recorded occurrence since 1967 (Belwood 1981). A 6-week field trip in 1980 to locate other occurrences was unsuccessful and led to the belief this species was ''probably extinct in Florida'' (Belwood 1992). No new evidence of this species was found from 1979 until 1988 when Robson et al. (1989) found a pregnant female in Coral Gables (Robson 1989). Timm and Genoways (2004) surmised the Florida bonneted bat may have been uncommon for several decades, based upon the work of previous researchers (Barbour 1945 as cited in Timm and Genoways 2004; Jennings 1958; Layne 1974), who noted the scarcity of bats in southern Florida. Owre (1978) observed fewer than a dozen individuals in roughly 25 years and noted few mammalogists had success in finding the species. Robson (1989) indicated the decline of specimens and sightings in the mid-1960s is reflected in the museum record and noted the 1950s and 1960s was a period of rapid growth in the Miami area. Robson (1989) suggested the resulting disturbance and destruction of native habitat may have flushed a large number of specimens out of established roosts, resulting in a high collection rate. A status survey conducted in 1989, encompassing 25 sites within natural areas within a nine county area, found no new evidence of this species (Robson 1989). Based upon available data and information, the Florida bonneted bat occurs within a restricted range and in low abundance (Marks and Marks 2008a; 2012; Timm and Arroyo-Cabrales 2008; FWC 2011a, 2011b; Actual population size is not known, and no population viability analyses are available (FWC 2011b). However, population size is thought to be less than that needed for optimum viability (Timm and Arroyo-Cabrales 2008). As part of their evaluation of listing criteria for the species, Gore et al. (2010) found the extent of occurrence appears to have declined on the east coast, but trends on the west coast could not be inferred due to limited information. Results of the 2006-2007 range-wide survey suggested that the Florida bonneted bat is a rare species with limited range and low abundance (Marks and Marks 2008a). Based upon results of both the range-wide study and survey of select public lands, the species was found at 12 locations (Marks and Marks 2008b), but the number and status of the bat at each location are unknown. Based upon the small number of locations where calls were recorded, the low numbers of calls recorded at each location, and the fact that the species forms small colonies, Marks and Marks (2008a) stated that it is possible that the entire population of Florida bonneted bats may number less than a few hundred individuals. Results of the 2010 to 2012 surveys and additional surveys by other researchers identified new occurrences within the established range (i.e., within Miami area, areas of ENP and Big Cypress National Preserve [BCNP]) (S. Snow, personal communication 2011a, 2011b, 2012; R. Arwood, personal communication 2012; Marks and Marks 2012), however, not in sufficient numbers to alter previous population estimates. In their 2012 report on the status of the species, Marks and Marks (2012) provided an updated estimation of population size, based upon 120 nights of surveys at 96 locations within peninsular Florida, results of other known surveys, and personal communications with others involved in Florida bonneted bat work. Based upon an average colony size of 11and an estimated 26 colonies within the species' range, researchers estimated the total Florida bonneted bat population at 286 bats (Marks and Marks 2012).

***Threats and Stressors***

**Stressor:**
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This bat is vulnerable to habitat loss (in urban and forested areas), habitat alteration (removal of old trees with cavities, or buildings with spaces suitable for roosting), and detrimental effects of pesticide spraying for mosquitoes. The last may be responsible for the species' decline in the Miami area, as roosting sites are still abundant. Severe hurricanes may cause loss of older trees with roosting cavities. Hurricane Andrew, an intense Category 5 hurricane that struck southeastern Florida in 1992, may have had a significant impact upon the already low population of bonneted bats (Timm and Genoways 2004).USFWS (2013) summarized threats as follows: Habitat loss, degradation, and modification from human population growth and associated development and agriculture have impacted the Florida bonneted bat and are expected to further curtail its limited range. The effects resulting from climate change, including sea-level rise and coastal squeeze, are expected to become severe in the future and result in additional habitat losses, including the loss of roost sites and foraging habitat. The species is also facing threats from a wide array of natural and manmade factors, including small population size,

restricted range, few colonies, slow reproduction, low fecundity, and relative isolation. Existing regulatory mechanisms are inadequate to reduce these threats. Overall, impacts from increasing threats, operating singly or in combination, place the species at risk of extinction. White-nose syndrome (WNS) is not currently known to be a threat to this species, but it is possible that disease will have a greater impact on the Florida bonneted bat in the future. The extent to which predation (e.g., by non-native species) may be impacting the Florida bonneted bat is unknown, but given the species' apparent small population size and overall vulnerability, it is reasonable to assume that predation is a potential threat, which may increase in the future. Further study is required to more fully assess the risk that pesticides and contaminants pose to the Florida bonneted bat. (NatureServe, 2015)

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 2C

**Recovery Actions:**

- Determine the distribution and status of the Florida bonneted bat; Protect and enhance known existing populations through regulatory mechanisms, education, and outreach; Minimize disturbance or mortality to the Florida bonneted bat through communication to utility and construction workers, nuisance animal companies, and the public; Continue to collaborate with state and federal agencies, other institutions and organizations to conduct research on the ecology and life history of the Florida bonneted bat, including foraging and roosting habitat associations, food habits, predators, parasites and disease, and the potential effects of pesticides; Develop standard methods to monitor the status of the Florida bonneted bat that allow for spatial and temporal comparisons; Develope a mechanism for sharing information; Protect and manage Florida bonneted bat habitat through land acquisitions and conservation easements, and by developing management plans with partners; Examine ecological processes in Florida bonneted bat habitat including fire, hydrology, and other factors that increase the likelihood of supporting foraging and roosting (USFWS, 2018).
- Management Recommendations 1. Discontinue pesticide spraying for any area known to be used by species (USFWS, 2016).
- 2. Educate public about bats, especially this very rare species (USFWS, 2016).
- Conducting acoustic surveys within the species' historic range to better understand movements, threats, and delineate range; Locating natural roosts and identifying factors influencing roost selection; Evaluating impacts to individuals living in urban areas; Using various techniques to accurately and safely monitor extant populations (USFWS, 2018).

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# SPECIES ACCOUNT: *Glaucomys sabrinus coloratus* (Carolina northern flying squirrel)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 7/1/1985; Southeast Region (R4) (USFWS, 2015)

**Physical Description**

A small squirrel. The length is 37 cm. (NatureServe, 2015). They possess a long, broad, flattened tail (80% of head and body length), prominent eyes, and dense, silky fur. The distinctive patagia (folds of skin between the wrists and ankles) are fully furred and supported by slender cartilages extending from the wrist bones; these plus the broad tail create a large gliding surface area and are the structural basis for the squirrel's characteristic gliding locomotion (Thorington and Heaney, 1981). Adults are dorsally gray with a brownish, tan, or reddish wash, and grayish white or buffy white ventrally (USFWS, 1990). It is distinguished from the West Virginia (WV) northern flying squirrel (Glaucomys sabrinus fuscus) by its larger size, longer tail length, and brighter coloration (Handley 1980) (USFWS, 2013).

**Taxonomy**

Closely related to subspecies coloratus. The population of Glaucomys sabrinus in the Mount Rogers and Whitetop area of Virginia may be intergrades between subspecies coloratus and fuscus (Handley 1991). One of 25 currently recognized subspecies (NatureServe, 2015).

**Historical Range**

The Carolina northern flying squirrel is a Pleistocene relict in the Southern Appalachians that is confirmed to a handful of isolated high-elevation peaks and ridges that support spruce-fir and northern hardwood forests. Fossil remains indicate a much larger range during the Pleistocene and early Holocene (Service 1990). At the time it was added to the Federal List of Endangered and Threatened Wildlife and Plants, the Carolina northern flying squirrel was known from only four areas--Roan Mountain (TN and NC), Great Smoky Mountains National Park (TN and NC), Mt. Mitchell (NC), and Whitetop Mountain (southwestern VA) (USFWS, 2013).

**Current Range**

Occurs in the Southern Appalachian Mountains, Tennessee and North Carolina as well as isolated localities in Virginia. Subspecies identity is uncertain in the Mount Rogers and Whitetop area, Virginia; this may be an area of intergradation between subspecies coloratus and fuscus (Handley 1991) (NatureServe, 2015).

**Distinct Population Segments Defined**

No

**Critical Habitat Designated**

No;

***Life History***

**Feeding Narrative**

Adult: Diet consists of both plant and animal material. Eats insects, nuts, lichens, fungi, buds, seeds, fruit during season; apparently can subsist on lichens and fungi for extended periods. Spends considerable time foraging on ground. It is active at night and throughout the year. Peak activity occurs from sunset to 2 hours after and 1 hour before sunrise (NatureServe, 2015).

**Reproduction Narrative**

Adult: Gestation lasts 37 - 42 days. Apparently produces 1 litter/year, in spring or summer. Young are weaned at about 2 months. Sexually mature within one year. Highly social, especially in winter when nests may be shared. Apparently lives in family groups of adults and juveniles. (NatureServe, 2015). The northern flying squirrel can be relatively long-lived (4 to 7 years) and has a low reproductive rate (generally a single litter annually, with two to five young) (Weigl et al. 1999, Weigl 2007, Kelly 2008) (USFWS, 2013).

**Geographic or Habitat Restraints or Barriers**

Adult: Typically occurs > 4,500 ft. elevation (USFWS, 2013)

**Environmental Specificity**

Adult: Narrow (inferred from USFWS, 2013)

**Habitat Narrative**

Adult: Prefers coniferous and mixed forest, but will utilize deciduous woods; riparian woods; optimal conditions: cool, moist, mature forest with abundant standing and down snags. Occupies tree cavities, leaf nests, and underground burrows. See Payne et al. (1989) for specific habitat characteristics in the southern Appalachians. Prefers cavities in mature trees as den sites. Small outside twig nests sometimes used for den sites. Will use nest box (NatureServe, 2015). The Carolina northern flying squirrel occupies high-elevation forests and is most often encountered at the ecotone between northern hardwood and spruce or spruce/fir forests. Habitat features important to the Carolina northern flying squirrel include old trees and abundant woody debris (habitat characteristics associated with old-growth forests), cool and moist conditions, substantial ground cover, and some degree of openness under the canopy (Weigl et al. 1999). This habitat exists at high elevations, typically above 1,372 meters (4,500 feet) and is most often found on north-facing mountainsides and drainages (USFWS, 2013). While the Carolina northern flying squirrel is thought to primarily inhabit forests above 4,500 ft (1,372 m) in elevation, it has been found at lower elevations. As previously mentioned, areas in the 4,000-4,500 ft (1,219-1,372 m) elevation band were under-sampled in the past, and NCWRC has focused on surveying these areas in recent years. In 2011, NCWRC captured a squirrel at 4,073 ft (1,241 m) in the Unicoi Mountains, marking the lowest elevation on record for North Carolina. Suitable habitat at lower elevations tends to occur on north-facing slopes and likely in cold air drainages. These areas may be important at lower elevations because they tend to be dominated by mesic northern hardwoods utilized by Carolina northern flying squirrels. Drier sites at these elevations, tend to be dominated by high-elevation red oak (Quercus rubra), which may not provide suitable habitat and is often inhabited by southern flying squirrels (USFWS, 2022).

***Dispersal/Migration***

**Motility/Mobility**

Adult: Moderate (inferred from NatureServe, 2015)

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: Non-migratory (NatureServe, 2015)

**Dispersal**

Adult: Low (inferred from NatureServe, 2015); moderate (inferred from USFWS, 2013)

**Dispersal/Migration Narrative**

Adult: This species is non-migratory. Summer home range was estimated at 2-3 ha in North Carolina (Austin et al., no date) (NatureServe, 2015). A study in the Unicoi Mountains revealed larger home range sizes (3 .3 to 51.4 hectares, with an average of 15.9 hectares). It is known that squirrels are capable of going on long forays (especially males) of over 1.5 kilometers (Weigl et al. 1999, Weigl et al. 2002, Hughes 2006) (USFWS, 2013).

***Population Information and Trends***

**Population Trends:**

Not available

**Species Trends:**

Unknown (USFWS, 2013)

**Number of Populations:**

3 (USFWS, 2022)

**Population Size:**

Unknown (USFWS, 2013)

**Population Narrative:**

The species status is stable given continued presence at sites. Because of variability in detections, it is difficult to establish current population levels or trends for the NC population of the squirrel. Considerably less is known about northern flying squirrel populations in TN and VA (USFWS, 2013). Recent modeling has led to estimates of habitat and suggest that the majority of high-quality habitat (nearly 90%) exists in just three GRAs: Great Smoky Mountains (63%), Black Mountains (15%), and Great Balsams (12%). Most of the other GRAs appear to have small amounts of habitat with three (Unaka, Long Hope, and Unicoi Mountain) predicted to each have less than 600 ac (~250 ha) of high-quality habitat. With the exception of the Great Smoky Mountains and Plott Balsams, GRAs appear to be isolated with no current gene flow between them. It is probably safe to assume that populations in some of these GRAs are small and vulnerable to threats associated with small, isolated populations (e.g., reduced genetic fitness, vulnerable to catastrophic events, etc.). (USFWS, 2022)

***Threats and Stressors***

**Stressor:** Habitat destruction and fragmentation (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** There has been an increase in residential development in the Southern Appalachians, and the human population is expected to continue to grow. Actual and potential loss and fragmentation of habitat to residential development threatens two GRAs (the Plott Balsams and Long Hope Valley). The loss of habitat in the Plott Balsams would break up connectivity with neighboring GRAs, and the loss of habitat in Long Hope Valley could result in the loss of an entire recovery area (Kelly 2008). In addition to habitat loss due to residential development, activities to accommodate an increasing demand for recreation at high elevations are also a significant threat (e.g., construction of parking areas and roads; vista management). For example, the construction of a high-elevation highway (Cherohala Skyway) in the Unicoi Mountains GRA resulted in a barrier to squirrel movement. This barrier has effectively cut the population into two isolated segments (Weigl et al. 2002, Hughes 2006). Forest pests and diseases are significant indirect threats to the existence and recovery of the Carolina northern flying squirrel, with the balsam woolly adelgid, hemlock woolly adelgid, and beech bark disease threatening the habitat this species occupies. The loss of fir and hemlock trees and declines in spruce trees may result in serious degradation of squirrel habitat since conifers are an important component of their habitat (USFWS, 2013).

**Stressor:** Pet trade (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Flying squirrels are highly desirable as pets; thus, collection for the pet trade is at least a potential threat (USFWS, 2013).

**Stressor:** Strongyloides robustus parasite (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The internal nematode parasite Strongyloides robustus has been identified as a potential problem for Carolina northern flying squirrels (Weigl et al. 1999). While it apparently does not have significant adverse effects on this species, it can be lethal or seriously debilitating to Carolina northern flying squirrels (Weigl1968, Weigl et al. 1999). The prevalence of this parasite in Carolina northern flying squirrel populations has increased in recent years, and the role it plays in the viability of squirrel populations is poorly understood (Weigl et al. 1999, Weigl 2007) (USFWS, 2013).

**Stressor:** Interspecific competition (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Southern flying squirrels not only act as potential vectors for disease, but they also are generally more aggressive than the northern squirrels and have the potential to displace them (Weigl 1978, Weigl et al. 1999). Differences in habitat preferences, diets, and climatic tolerances have largely kept these species separate in the past (Weigl 2007), but this could change in human-altered landscapes. Southern flying squirrels are expanding into higher elevations in more southern latitudes (Odom et al. 2001, Weigl et al. 1999 in Smith 2007). While direct interspecific competition has not been widely reported, similarities in behavior and shared vital resources (e.g., tree cavities) coupled with expanding oak and hickory forests and warming climate could

lead to more interactions (Weigl et al. 1999 in Smith 2007, Weigl 2007) (USFWS, 2013).

**Stressor:** Climate change (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Climate change could, if it results in appreciable increases in temperatures, threaten the Carolina northern flying squirrel. The squirrel is restricted to small areas with suitable habitat in the Southern Appalachians. These areas form small islands at high elevations and have reduced connectivity between them. If temperatures in the Southern Appalachians increase and precipitation decreases, it is anticipated that the areal extent of boreal forests will decrease. Warming at high elevations could allow for further invasion by southern flying squirrels and increase the viability of parasites such as Strongyloides as mentioned previously. Further, climate change may increase the susceptibility of associated forests to exotic and native forest pests and pathogens (USFWS, 2013).

**Stressor:** Pollution (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Pollution (in the form of acid rain and inputs of heavy metals) adversely impacts forest health and productivity, including that of the red spruce (Kelly 2008). Furthermore, high levels of mercury, lead, and other heavy metals found in the soils and fungi within the squirrel's habitat may threaten this mycophagous squirrel. Fungi, which form an important component of the flying squirrel's diet, can bioaccumulate heavy metals; this potential threat needs further evaluation (USFWS, 2013).

***Recovery***

**Reclassification Criteria:**
1. Squirrel populations are stable or expanding (based upon biennial sampling over a 10-year period) in a minimum of 80 percent of all Geographic Recovery Areas (GRAs) (USFWS, 2013).

2. Sufficient ecological data and timber management data have been accumulated to assure future protection and management (USFWS, 2013).

3. GRAs are managed in perpetuity to ensure: (a) Sufficient habitat for population maintenance/expansion and (b) habitat corridors, where appropriate elevations exist, to permit migration among GRAs (USFWS, 2013).

Recovery Priority Number: 6C

**Delisting Criteria:**
In addition to the downlisting criteria, the existence of the high-elevation forests on which the squirrels depend is not itself threatened by introduced pests, such as the balsam wooly adelgid, or by environmental pollutants, such as acid precipitation or toxic substance contamination (USFWS, 2013).

**Recovery Actions:**

- Survey for new populations and monitor known populations (USFWS, 1990).
- Study habitat requirements (USFWS, 1990).
- Study diet, interactions with other squirrels and genetics (USFWS, 1990).
- Study effects of various land use practices (mining, logging, recreation) (USFWS, 1990).
- Ensure implementation of appropriate habitat management guidelines, based on results of 1 -3. (This would include periodic monitoring, even following de-listing.) (USFWS, 1990).
- Develop and institute improved survey methods that reliably assess the status, population levels, and population trends of the species throughout its range (USFWS, 2013).
- Determine the distribution and status of populations of northern flying squirrels in TN and southwestern VA using reliable and more intensive surveys of the areas that are currently known to support the species as well as additional sites that appear to provide suitable habitat (USFWS, 2013).
- Determine the taxonomic status of the southwestern VA population of the northern flying squirrel (USFWS, 2013).
- Develop predictive models of habitat utilized by the Carolina northern flying squirrel throughout its range in order to provide managers with an additional tool to manage and protect the species as well as provide insight into additional areas that may support the squirrel (USFWS, 2013).
- Restore spruce where appropriate, and use spruce restoration as a tool to create and maintain corridors to connect GRAs. Concurrently, remaining stands of northern hardwood need to be protected (USFWS, 2013).
- Establish a group of federal and state biologists and land managers familiar with the species and its requirements who will coordinate activities related to the assessment, protection, and management of the Carolina northern flying squirrel. This group could, if properly constituted, form the core of a team to develop a revised recovery plan (USFWS, 2013).
- Revise the recovery plan to reflect current knowledge of the Carolina northern flying squirrel, including objective and measurable recovery criteria and updated actions needed to recover the species (USFWS, 2013).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIVITIES The 2013 5-year review included a list of recommendations to improve recovery of the species (Service 2013). Significant progress has been made on several of those actions as outlined in this review, but work remains to be done on others. The following recommendations were developed in light of new information and primarily expand upon previous recommendations. Several of these actions have been initiated. • Continue and expand upon efforts to restore red spruce by working with SASRI to implement the Southern Appalachian Spruce Restoration Plan. Also explore activities to increase resiliency of Fraser fir (e.g., improve stand structure/age in regenerated fir, collect seeds from old fir that appear to have survived adelgid to use in future propagation/planting efforts). • The Appalachian Northern Flying Squirrel Working Group was formed in 2016 with the goals of: 1) identifying research and management priorities, 2) facilitating collaborative research, monitoring and management efforts, and 3) improving outreach and communication for Carolina and Virginia northern flying squirrels. Continue working with this group to improve coordination of recovery efforts. • Focus research efforts on priorities identified by Appalachian Northern Flying Squirrel Working Group. These priorities are as follows: o Mapping efforts to help plan for expanding populations and/or connecting populations o Additional acoustic data to learn more about local dialects to further inform this survey technique o Acoustic monitoring details including number of detectors and detector configuration needed. o Success of different spruce restoration treatments o Reference conditions for high-elevation forests (i.e., conifer and yellow birch) o Wildlife responses to spruce restoration activities o Information on spodosols in the Southern Appalachians to inform spruce restoration o Hybridization between Carolina northern flying squirrel and southern flying squirrel and what factors are causing hybridization o Strongyloides in the wild (e.g., prevalence loads based on habitat type and presence of southern flying squirrels) o Accumulation of heavy metals in habitat and potential effects on Carolina northern flying squirrels • Update the preliminary occupancy analysis to include nest box, acoustic and telemetry data collected since 2011 and examine occupancy over time in individual GRAs. • Upon completion of a long-term monitoring plan for North Carolina, work to implement consistent monitoring across the range of the Carolina northern flying squirrel. • As staff time and office resources allow, reevaluate the recovery criteria to include specific metrics to help assess achievement and amend the recovery plan. If deemed necessary, work with the Regional Office to include recovery plan updates and/or amendments into the regional workplan (USFWS, 2022).

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# SPECIES ACCOUNT: *Leptonycteris nivalis* (Mexican long-nosed bat)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered

**Physical Description**

A leaf-nosed bat. This grayish brown bat has a leaflike nose projection and no tail; forearm 55-60 mm (Whitaker 1996). LENGTH:9 WEIGHT: 21 (NatureServe, 2015)

**Taxonomy**

The Mexican long-nosed bat is a member of the family Phyllostomidae (New World leaf—nosed bats) and is grouped in the subfamily, Glossophaginae, with several other pollen—, fruit-, and nectar-eating bats. The genus Leptonycteris is characterized by two dental features, lack of the third molar and presence of lower incisors (Walker 1975). Leptonycteris means “slender bat” (leptos - slender, nycteris — bat), and the specific name nivalis refers to the fact that the type specimen was caught near snow line on the 17,816 feet (5,747 m) extinguished volcano, Mt. Orizaba, in Veracruz, Mexico. The original description by Saussure (1860), named these bats Ischnoglossa nivalis. Many changes in nomenclature have characterized these bats, and only recently the situation seems to have been settled by Arita and Humphrey (1988, see their paper for a review of classification and nomenclature). Arita and Humphrey (1988) analyzed measurements from 1,951 long—nosed bat specimens in the genus Leptonycteris and determined that L. nivalis is a monotypic species. Some studies prior to 1988 may have referred to L. nivalis, but because of Arita and Humphrey’s determination those individuals were actually found to be L. curasoae. Thus, literature prior to this time should be carefully scrutinized before conclusions about L. nivalis are made (USFWS, 1994).

**Current Range**

Range includes northern and central Mexico, southwestern Texas, and southwestern New Mexico, generally at elevations of about 500 to 3,000+ meters. Most occurrences in Mexico are at elevations of 1,000-2,200 meters, but this bat been captured at an elevation of 3,780 meters (see Arita 1991), and the type specimen reportedly was caught near snow line at 17,816 feet (5,747 meters) on Mt. Orizaba, in Veracruz, Mexico (USFWS 1994). In Texas, the species has been captured in Big Bend National Park (Brewster County) and the Chinati Mountains (Presidio County); Emory Peak Cave in the Chisos Mountains (elevation 2,290 meters) hosts the only known roosting population in Texas (Ammerman et al. 2012). Two specimens of Leptonycteris taken in Hidalgo County, New Mexico (in 1963 and 1967), were determined to be L. nivalis. The presence of this species in New Mexico was reconfirmed in Hidalgo County in 1992 (Hoyt et al. 1994). Populations exist in the Animas and Big Hatchet mountain in New Mexico (P. Cryan, pers. comm., cited by Ammerman et al. 2012). The range has been described as extending into Guatemala and adjacent southern Mexico (Hensley and Wilkins 1988; Simmons, in Wilson and Reeder 2005), but specimens collected from those areas were assigned to L. yerbabuenae by Arita and Humphrey (1988) and Arita (1991). Simmons (in Wilson and Reeder 2005) described the range of L. nivalis as including southeastern Arizona, but no actual records for Arizona are known.á

**Critical Habitat Designated**

Yes;

***Life History***

**Feeding Narrative**

Juvenile: Diet includes mainly nectar and pollen of at least 21 plant species representing 10 plant families (Sánchez and Medellín 2007). In the northern part of the range, the bats often feed at the flowers of cacti and paniculate agaves. In Texas; nectar of mescal and Chisos agave flowers probably are the main food (Schmidly 1977). The diet may include insects associated with flowers, and probably some fruits, especially in the southern part of the range.; Food Habits: Nectarivore (Adult, Immature), Frugivore (Adult, Immature). Activity occurs throughout the year. Emergence to feed occurs relatively late in the evening.; (NatureServe, 2015)

Adult: Diet includes mainly nectar and pollen of at least 21 plant species representing 10 plant families (Sánchez and Medellín 2007). In the northern part of the range, the bats often feed at the flowers of cacti and paniculate agaves. In Texas; nectar of mescal and Chisos agave flowers probably are the main food (Schmidly 1977). The diet may include insects associated with flowers, and probably some fruits, especially in the southern part of the range.; Food Habits: Nectarivore (Adult, Immature), Frugivore (Adult, Immature). Activity occurs throughout the year. Emergence to feed occurs relatively late in the evening.; (NatureServe, 2015). Mexican long-nosed bats are known to consume the nectar or pollen from at least 49 different species of flowering plants across their range. They are thought to specialize in feeding on species from the families Agavaceae and Convolvulaceae, specifically those in the genus Agave and Ipomoea in the US portion of the range (USFWS 2018). In Mexico, the diet may be more diverse and columnar cacti may dominate the diet in some areas. The Mexican long-nosed bat requires healthy populations of these flowering plants near roosting sites and along migratory routes. Valiente-Banuet (1997) reports the bat as the main pollinator of Neobuxbaumia species, a dominant columnar cactus genus in central Mexico. Mexican long-nosed bats in New Mexico were found to travel 20–30 kilometers (km) (12–19 miles [mi]) one-way each night to forage on agave (Bogan et al., 2017). In Texas, they have been found to make foraging trips ranging from 13–30 km (8–19 mi) round-trip and twice as much agave habitat overlapped with the home ranges used by adults compared to juveniles (England, 2012). Generally, adequate foraging resources within 50 km (30 miles) of roosting sites are considered crucial, especially for maternity colonies (USFWS, 2024).

**Reproduction Narrative**

Adult: Litter size normally is 1. Young are born apparently in spring (April-June), primarily in Mexico before females arrive in Texas, though pregnant females have been captured in Texas in late April (Brown 2008, Ammerman et al. 2012). In Texas, lactating females have been observed in June-July, flying juveniles in late June. Young are weaned in July or August. These bats are highly colonial.; These bats are effective pollinators of cacti and agave; the plants are dependent on bats for sexual reproduction.; (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped roosting/Uniform feeding (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Moderate (Feeding areas), Low (Roosting areas) (NatureServe, 2015)

**Site Fidelity**

Adult: High (NatureServe, 2015)

**Habitat Narrative**

Adult: Habitats include desert scrub, open conifer-oak woodlands, and pine forests in the Upper Sonoran and Transition Life Zones; generally arid areas where agave plants are present (USFWS 1994). Colonies roost in caves (or similar mines and tunnels), sometimes in culverts, hollow trees, or unused buildings. Roosting habitat requirements are not well known. (NatureServe, 2015). Moderate ecological integrity of the population and tolerance ranges for feeding areas are based on the fact that this is a mobile species and can cover large areas in search of food. High ecological integrity of the population and low tolerance ranges for roosting/maternity caves is based on the fact that these caves are limited in number and need to be relatively undisturbed for the species to thrive. High site fidelity is based on the species reliance on caves for roosting and maternity sites.

***Dispersal/Migration***

**Motility/Mobility**

Adult: High (NatureServe, 2015)

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: Migratory (NatureServe, 2015)

**Dispersal**

Adult: Moderate (NatureServe, 2015)

**Immigration/Emigration**

Adult: Unlikely (NatureServe, 2015)

**Dispersal/Migration Narrative**

Adult: This species is migratory in the northern portion of its range (Wilson et al. 1985, Schmidly 1991, Ammerman et al. 2012), but movements are not well-known. Seasonal movements likely correspond with food availability. It has been recorded in the United States from June to August (Ammerman et al. 2012). Most northward migrants in Texas are females, but in New Mexico the sex ratio is more balanced (Hoyt et al. 2004; P. Cryan, pers. comm., cited by Ammerman et al. 2012).;This species is highly mobile and is capable of traveling great distances, including its migration from Mexico to the southern U.S. Dispersal is listed as moederate because of the species liklihood of using the same caves year after year. Unlikely immigration/emigration is based on the lack of information concerning this species leaving areas it has been known to occur or inhabiting new territory. (NatureServe, 2015)

***Population Information and Trends***

**Resiliency:**

Resiliency - Overall northeastern Mexico and southwestern United States have resilient roosts mainly due to the isolation of the roosts and subsequently less disturbance to their foraging grounds. These two regions are most vulnerable from a lack of floral diversity. Central and east Mexico are less isolated and therefore have greater disruption to flowering ability of floral resources. These two regions are also vulnerable to human disturbance of the caves with lower resilience in terms of barriers to cave disturbance and level of protection (USFWS, 2018).

**Representation:**

Representation - Currently, central Mexico has the greatest representation with 5 extant roosts, one that has high resiliency, three of which are moderately resilient, and one that has low resiliency. East Mexico has the lowest representation with one moderately resilient roost. Northeastern Mexico and the southwestern United States each have one moderately resilient roost and one highly resilient roost (USFWS, 2018).

**Redundancy:**

Redundancy - Using the best information available, the bat has a low to moderate redundancy in terms of total number of roosts because of the lack of resilient roosts across its broad range. However, if the roost type is considered, redundancy is even lower. There are three known maternity roosts, one that is moderately resilient and two that are highly resilient. More importantly, there is only one known mating roost (Cueva Del Diablo) in central Mexico that is moderately resilient. Disturbance of Cueva Del Diablo could have significant effects on the entire species regardless of the number of other roosts, making the Mexican long-nosed bat vulnerable in terms of redundancy (USFWS, 2018).

**Population Growth Rate:**

Long-term trend is unclear. Extent of occurrence and area of occupancy probably have not changed much, but the number of occurrences or subpopulations and population size may have dramatically decreased in some locations during the last three decades. Wilson (1985) found that this species was either completely absent or present in reduced numbers in known roosts. The number of bats found represented only a fraction of the total reported in previous studies. For example, in an abandoned mine in Nuevo Leon, Mexico, where an estimated population of 10,000 was observed in 1938, no individuals of L. nivalis were found in 1983 (Wilson 1985). Another mine in Nuevo Leon had a ceiling covered with newborn bats in 1967, but only one bat was found in 1983. A few other roosts had reduced numbers of bats compared to findings during previous surveys. These changes could indicate a decline in the overall population, but they might reflect movement of bats among different roosting sites in different years, or they could result from seasonal changes in bat distribution (survey dates varied).A colony of L. nivalis in Morelos, Mexico, increased from an estimated 5,000 in 1996 to 8,000-10,000 in 2001-2002 (Medellín 2003).Abundance at Emory Peak Cave in Texas fluctuates widely from year to year (0 to 10,000+ individuals). Reasons for the fluctuations are not completely understood, but they apparently reflect annual variations in regional food resources (number of flowering agave plants) (USFWS 1994, Ammerman and Tabor 2008); a similar pattern has been observed at a cave in Nuevo Leon, Mexico (Moreno-Valdez et al. 2004). Historical count data for Emory Peak Cave may not be completely reliable; bats present in the cave may go undetected (Ammerman et al. 2009, 2012).Ammerman et al. (2012) noted a lack of consistency among various trend estimates or indications for this species (Wilson 1985, Arita and Humphrey 1988, Cockrum and Petryszyn 1991, USFWS 1994, Medellín 2003, Ammerman and Tabor 2008, Ammerman et al. 2009) Despite some inconsistency, most authors have concluded that the species is declining in abundance, though the degree of decline is highly uncertain. However, better population data based on improved monitoring methods are needed before a reliable trend determination can be made (Ammerman et al. 2012). Decline of 30-70% (NatureServe, 2015)

**Number of Populations:**

~30, 2 in the U.S. (USFWS, 2019)

**Population Narrative:**

Based on genetic evidence, the Mexican long-nosed bat consists of a single population comprised of multiple subpopulations corresponding to major, seasonally used roost sites (Service 2018, p. 50). Mexican long-nosed bats are known from approximately 30 roost sites, with 28 of these roosts in Mexico (Service 2018, pp. 12-32). Two roost sites are in the United States at Mount Emory Cave, Big Bend National Park, Brewster County, Texas and Romney Cave, Big Hatchet Mountains Wilderness Study Area, Hidalgo County, New Mexico. Eleven roost sites have been studied or monitored in the last 20 years while little information exists for the remaining 19 roosts (Service 2018, pp. 14-15). (USFWS, 2019). A recent publication summarized size observations at Emory Cave in Big Bend National Park, Brewster County, Texas from 2008–2023 (Ammerman et al., 2024, entire). Despite observations being conducted in the first week of July each year, the maximum colony size fluctuated widely (Ammerman et al., 2024, p. 31). Further, there was no significant positive or negative population trend (Ammerman et al., 2024, p. 13). The lowest colony size was 294 individuals, recorded on 3 July 2008, while the highest was 3,360 individuals recorded on July 2021 (Ammerman et al., 2024, p. 13). In 2009 and 2021, the colony size exceeded 3,000 bats (Ammerman et al., 2024, p. 13). Mean MLNB colony size over the 14 census years was 2,156 individuals (SD = 796) (Ammerman et al., 2024, p. 13). Previous estimates of colony size at Emory Cave have also featured wide fluctuations, ranging from 5,000 bats to 13,650 (Easterla, 1972, p. 288). Future work is needed to identify variables that best explain the fluctuations in colony size and how that relates to the rangewide population status for MLNB (USFWS, 2024).

***Threats and Stressors***

**Stressor:** Disturbance and destruction of roost sites (USFWS, 1994)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Modification or destruction of roost sites is listed as a threat to this species (USFWS, 1994).

**Stressor:** Modification of foraging habitat (USFWS, 1994)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Foraging habitat disruption and destruction has also been identified as a threat to L. nival is. Foraging habitat can be modified or destroyed by the harvesting of agave for mescal and pulque, the expansion of agriculture, and other land uses. The main threat to food plants is from “moonshining” not from government regulated liquor industries (D. Howell and G. Nabhan, pers. comm.). The large fields of planted agaves like those around Jalisco probably supplanted few natural agaves prior to the tequila industry. Public relations people from Jos6 Cuervo tequila

have investigated the advisability of letting a few rows in each cultivated field go to flower to provide a food source for bats (Howell, pers. comm.). Nabhan and Fleming (1993) have estimated that bootleg mescal makers are eliminating between 500,000 and 1,200,000 wild paniculate agaves a year in Sonora alone. Nabhan (pers. comm.) indicated that in no place were agaves completely wiped out but that the agaves left to bloom in the Sonora study area are often widely dispersed or in inaccessible areas which make harvesting unproductive (USFWS, 1994). Although it is not known how far L. nivalis will fly to forage or how clumped the resource must be to be energetically productive, at some point widely spaced flowering stalks and distance to clumps become inefficient and affects reproduction and survival. Nabhan and Fleming (1993) suggest that the “tequila connection” is not as important as was once thought. “There are few places in Sonora or elsewhere in Mexico where wild Agave harvesting has eliminated a significant percentage of nectar—producing genets... because indigenous harvesters know how to disrupt apical dominance.., to encourage vegetative offshooting... before removing the ‘mother plant’ for mescal production.” However, by removing the flowering stalk “head” thus encouraging vegetative offshooting, they delay flowering (until the vegetatively produced plants mature) and eliminate the possibility of the flowering stalk becoming available to the bats that year. The impact of alcoholic beverage production on Mexican long—nosed bat foraging and survival is far from clear (USFWS, 1994).

**Stressor:** Pesticides (USFWS, 1994)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat/loss of individuals
**Narrative:** The use of pesticides may also negatively affect L. nival is. Because long—nosed bats are nectarivorous, they are probably not as susceptible to pesticide effects as insectivorous bats. However, pesticides may be applied in a way that covers everything that is exposed, and thus, might fall on the bat’s food plants. When bats feed on the nectar, soft fruits, or incidentally on insects, pesticides might be consumed by the bats. Reidinger (1976) found lesser long-nosed bats in Arizona and Sonora, Mexico contained the least amount of organochlorine residues of all bats sampled. Reidinger (1976) did not speculate on the possible effects of the pesticide level he did find in Leptonycteris (USFWS, 1994).

**Stressor:** Competition (USFWS, 1994)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Interspecific competition may occur between L. nivalis and L. curasoae and Choeronycterls mexicana (USFWS, 1994). Competition for roost space may also occur with other bat species, particularly where caves are not abundant and cattle ranching and livestock production have artificially increased vampire bat populations by providing easy and abundant prey. Vampire bats commonly occupy the highest, darkest, warmest places in caves (Medellin, pers. obs.; Turner 1975). On several occasions, vampire bats have been found to replace non—vampire species (Medellin, pers. obs.). Turner (1975) also noted a similar trend; when the number of vampire bats increased, the number of non—vampire bats in the roost decreased or remained constant, but rarely increased (USFWS, 1994).

**Stressor:** Disease (USFWS, 1994)
**Exposure:**

**Response:**
**Consequence:** Loss of individuals
**Narrative:** One study has suggested that rabies may be present in Mexican long-nosed bats (Villa-R and Jim6nez 1962). However, there is some doubt regarding the specific identification of the bats in that report. Additionally, the incidence of rabies is very low in non-sanguivorous (non-blood eating) bats, less than half of 1 percent (no higher than that seen in many other animals) (Tuttle 1988). No real threat is apparently posed by other diseases for this species, although this factor can not be completely discounted (USFWS, 1994).

**Stressor:** Predation (USFWS, 1994)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Although there are no documented cases of predation of L. nivalis, they probably experience predation from owls, hawks, snakes, and mammals (including raccoons, cats, and ringtails) similar to other bat species (Tuttle and Stevenson 1982). In the case of L. nivalis, predation does not seem to be a particularly important limiting factor. However, the impact of predation is likely much greater than generally realized and low reproductive rates of most bats greatly increase the importance of even low predation rates (Tuttle and Stevenson 1982). Anthropogenicallycaused increased populations of domestic or feral cats and other predators may affect survival of bat colonies, particularly maternity colonies near human habitations (USFWS, 1994).

**Stressor:** Natural catastrophes/climate (USFWS, 1994)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Other natural events that may impact Mexican long—nosed bats are climate and natural catastrophes. Some particularly severe winters may have an effect on the amount of food availability. For example, in mid—elevation areas a late— or early—season freeze may dramatically reduce the number of live flowers, particularly since these flowers are open at night when the coldest temperatures occur. Such conditions could cause starvation or migration of bat colonies. Additionally, roost destruction due to earthquakes, floods, or other natural causes may destroy entire bat colonies. These factors would not pose a serious threat to the species if populations were at their original numbers. However, if the species is receiving additional pressure from human activities, natural disasters may play a critical role in the species' survival (USFWS, 1994).

**Stressor:** Climate Change (USFWS, 2019a)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Recent work does suggest that climate change may impact Mexican long-nosed bat habitat, particularly Agave species. While the predicted effects of climate change are highly dependent on the modeling efforts being used, a study by Zamora-Gutierrez et al. (2018, table S1) looking at the effect of climate and land use change predicts that even under an optimistic scenario, 59 percent of the Mexican long-noses bat's range will be unsuitable by 2050. The driving climatic variables in this model were mean temperature of the warmest quarter, mean

temperature of the coldest quarter, annual precipitation, and precipitation seasonality (Zamora-Gutierrez et. al. 2018, p. 365). (USFWS, 2019a)

**Stressor:** Parasites (USFWS, 2024)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** A new parasitic mite (Periglischrus calcariflexus ) was described in association with MLNB in Mexico. The presence of P. calcariflexus on MLNB in different studied localities suggests a monoxenous species, meaning a parasite that lives on only one kind of host throughout its life cycle (Morales-Malacara and LópezOrtega, 2023, p. 85). This specificity implies the existence of close links from the origin of the host–parasite association, which in turn has led to reproductive success and the dispersion of these mites in the host population throughout its distribution (Morales-Malacara and López-Ortega, 2023, p. 85). At present, we do not know the impact this parasite has on the MLNB (USFWS, 2024).

***Recovery***

**Reclassification Criteria:**
The Mexican long-nosed bat will be considered for reclassification from endangered to threatened when: Downlisting Criterion 1: The threat of disturbance, mainly in the form of recreational human disturbance and urban development, is eliminated from Cueva del Diablo, along with at least two more of the five major roosts for the Mexican long-nosed bat: Aguacatitla Tunnel, El Infierno Cave, El Rosillo Cave, and Mount Emory Cave. This criterion is met at a cave when there is no evidence of illegal entry/human disturbance for five consecutive years (USFWS, 2024). Downlisting Criterion 2: Cueva del Diablo maintains a colony size of at least 10,000 bats over a 10-year period (USFWS, 2024).

Downlisting Criterion 2: Cueva del Diablo maintains a colony size of at least 10,000 bats over a 10-year period (USFWS, 2024).

Downlisting Criterion 3: An annual monitoring program of both the bat and its food sources should be implemented. Bats should be monitored once annually at each of the five major roosts, along with monitoring of food sources around at least one roost per region annually. If the region has a major roost, a major roost should be selected as the survey location. In addition, agave availability should be surveyed annually within 50 km (31 mi) of all five major roosts with confirmed nectar availability of at least 200 Agave spp. plants for five consecutive years (USFWS, 2024).

Recovery Priority Number: 5

**Delisting Criteria:**
Delisting Criterion 1: The threat of disturbance, mainly in the form of recreational human disturbance and urban development, is mitigated at all five major roosts for the species: Cueva del Diablo, Aguacatitla Tunnel, El Infierno Cave, El Rosillo Cave, and Mount Emory Cave by prohibiting all recreational caving through the natural entrance via fencing and video monitoring, or by requiring all cavers to obtain permits, which can streamline what activities are permitted in the caves and lead to accountability for those who visit them. This criterion is met

when no evidence of illegal entry/unpermitted human disturbance is recorded for five consecutive years (USFWS, 2024).

Delisting Criterion 2: In addition to the five major roosts, at least five additional roosts (a total of a 10-roost minimum) that maintain a minimum colony size of 500 Mexican longnosed bats over a 10-year period (USFWS, 2024).

Delisting Criterion 3: Cueva del Diablo maintains a colony size of at least 12,000 bats over a 25-year period (USFWS, 2024).

Delisting Criterion 4: Five consecutive years of data showing that at least a 4:1 ratio of bats to host plants within 50 km (31 mi) of 50% of roosts in each region. This corresponds to at least 5 roosts in central Mexico, 4 roosts in eastern Mexico, 3 roosts in northeastern Mexico, and one roost in the southwest US (USFWS, 2024)

**Recovery Actions:**

- Recovery Action 1. Conserve, Restore, and Protect Habitat: This action includes the successful conservation, restoration, and protection of foraging habitat. This means securing land rights and protection status for all caves, enforcing existing laws, and creating action protocols for monitoring, reporting, and resolving threats covered by laws and regulations (chain of command, jurisdictions, enforcement mechanisms, coordination among institutions, etc.). It also includes defining a strategy for land acquisition, protecting critical roosting habitat, management, and promoting sustainable practices that minimize disturbance. (USFWS, 2024).
- Recovery Action 2. Establish Agave Restoration Program: This action includes agave replanting, along with teaching and supporting bat-friendly management practices (limit harvest and/or support current practices that maintain agave populations, allow development of flowering stalks, reduce or eliminate cattle foraging to induce recruitment of young agave) in areas agave (wild and cultivated) are harvested for human consumption across the range (USFWS, 2024).
- Recovery Action 3. Identify Effective Management Strategies: Project and adapt restoration and management plans according to climate change projections for all roosts and along the migratory pathway (USFWS, 2024).
- Recovery Action 4. Research including but not limited to: • Conducting a study and design a strategy to preserve the structural integrity of the Aguacatitla roosting tunnel in the long-term; • Identifying potential roost locations using a habitat model; • Researching the location of migratory pathways, foraging grounds, and associated roosts; • Tracking bat movements to identify alternate roosts near known roosts; • Determining the diet of the bat across the range to identify Agave species that are part of the diet as well as food resources other than Agave spp.; and • Researching the threat and effect of fire on Agave spp. (USFWS, 2024).
- Recovery Action 5. Education & Outreach: Promote and enforce cave-friendly conservation and management practices through environmental education and public outreach programs for all roosts. Develop environmental awareness programs to support bat-friendly agave management (wild and cultivated) and land restoration programs using Agave spp. for all roosts (USFWS, 2024).

- Recovery Action 6. Effective Planning and Coordination: Host a workshop with Nivalis Conservation Network and the government of Mexico (Commission on Natural Protected Areas (CONANP)) to design and approve the PACE (Action Program for the Conservation of Species) and link it to management plans for protected areas in Mexico. Partner with other protected lands in the vicinity of each roost and conduct meetings with landowners, stakeholders, and authorities to raise awareness of laws and regulations that protect the species and its habitat for all roosts. Develop a fire management plan for Big Bend National Park that addresses the protection of Emory Cave. Work with Bureau of Land Management to create a management plan for Romney Roost (USFWS, 2024).
- Recovery Action 7. Expand Monitoring: Design a standardized monitoring program for roosts and foraging habitat across the species' range. This may include but is not limited to: • Monitoring the phenology of Agave spp. across the species' range; • Monitoring nightly behaviors of the Mexican long-nosed bats near roosts between May and August to identify important foraging areas; • Monitoring poorly known roosts or potential roosts for demographics, seasonality, stability, etc.; and • Evaluating the conservation status of historical roosts and determine their contribution to the viability of the species (USFWS, 2024).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS • Revise and update the Mexican Long-nosed Bat Recovery Plan in light of a recent, comprehensive species status assessment. • New protective measures at unprotected roosts and enhanced measures at currently protected roosts should be instituted in Mexico and the United States to eliminate or substantially reduce disturbance of these sites by human activities. • Continue population monitoring of key Mexican long-nosed bat roosts in Mexico and the United States. • Monitor Mexican long-nosed bat roosts for the presence of the white-nosed syndrome pathogen, Pseudogymnoascus destructans. • Survey to assess the potential for undiscovered Mexican long-nosed bat roosts in Mexico and the United States to facilitate a better understanding of the bat's migratory path. • Further investigate and refine understanding of how climate change will affect Mexican long-nosed bat roosts and the availability of floral foraging resources across the species' migratory path. • Implement a long-term monitoring program to obtain information on Agave phenology to aid in identification of mismatches in Agave flowering and presence of Mexican longnosed bats. • Assess species richness and abundance of Agave species near Mexican long-nosed bat roosts, especially in light of potential land-use and climatic changes. • Explore the potential and feasibility of augmenting or restoring Agave resources near Mexican long-nosed bat roosts. (USFWS, 2019)
- RECOMMENDATIONS FOR FUTURE ACTIONS • Enforce existing laws in Mexico to halt further development and construction of buildings on land directly on top of the Cueva del Diablo maternity roost (as described in the 2024 recovery plan). • Grant state and federal protection status in Mexico to the Todos Santos roost and habitat buffer (as described in the 2024 recovery plan). • Protect any additional roosts identified across the species range. • Conduct Agave replanting and bat-friendly management practices in areas where cultivated and wild Agave species are harvested for human consumption. • Project and adapt restoration and management plans in response to climate change projections for all roosts and along the migratory pathway. • Develop a fire management plan for Emory Cave in Big Bend National Park (as described in the 2024 recovery plan). • Conduct surveys for MLNB in Arizona to identify the potential for additional populations in that state. • Conduct further surveys of La Cueva de los Coyotes in Mexico, in addition to the recommendations previously made in the species' recovery plan (USFWS, 2024)

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# SPECIES ACCOUNT: *Myotis septentrionalis* (Northern long-eared bat)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 05/04/2015; Great Lakes-Big Rivers Region (R3) (USFWS, 2016)

**Physical Description**

The northern long-eared bat is a medium-sized bat about 3 to 3.7 inches in length but with a wingspan of 9 to 10 inches. As its name suggests, this bat is distinguished by its long ears, particularly as compared to other bats in its genus, Myotis, which are actually bats noted for their small ears (Myotis means mouse-eared) (USFWS, 2016). Pelage (fur) colors include medium to dark brown on its back; dark brown, but not black, ears and wing membranes; and tawny to pale-brown fur on the ventral side (Nagorsen and Brigham 1993, p. 87; Whitaker and Mumford 2009, p. 207) (USFWS, 2015).

**Taxonomy**

Myotis septentrionalis formerly was regarded as conspecific with Myotis keenii; van Zyll de Jong (1979, 1985) and Jones et al. (1992) regarded Myotis keenii and M. septentrionalis as separate species; Koopman (in Wilson and Reeder 1993) included septentrionalis in Myotis keenii, noting that they may be separate species. Baker et al. (2003) and Simmons (in Wilson and Reeder 2005) recognized M. septentrionalis and M. keenii as distinct species. Most older literature using the name Myotis keenii actually pertains to Myotis septentrionalis. No subspecies are recognized. No genetically distinctive subpopulations have been identified (Johnson et al. 2014) (NatureServe, 2015).

**Historical Range**

Prior to the incidence of white-nose syndrome, this species was regarded as more common in the northern part of the range than in the south (Harvey 1992), and it was rare in the northwestern portion of the range (Nagorsen and Brigham 1993, Caceres and Barclay 2000). It was reported as very rare in Alabama (Best, pers. comm.), uncommon in Indiana, Kentucky, Tennessee, and Wisconsin (Mumford and Cope 1964, Harvey 1991, Jackson 1961), more common in northern Michigan than in southern Michigan (Kurta 1982), and quite common in New York (Hamilton and Whitaker 1979). (NatureServe, 2015). Historically, the northern long-eared bat was widely distributed in the eastern part of its range (Caceres and Barclay 2000, p. 2) (USFWS, 2015).

**Current Range**

This bat is widely but patchily distributed in the eastern and northcentral United States and adjacent southern Canada, from eastern British Columbia and southern Yukon eastward across southern Canada to eastern Quebec, Prince Edward Island, and Newfoundland, and southward to southern Texas (one old record), Louisiana, Alabama, Georgia, and Florida (one old record from panhandle), and westward in the United States generally to the eastern margin of the Great Plains region (Barbour and Davis 1969, Harvey 1992, van Zyll de Jong 1985, Hall 1981, Crnkovic 2003, Wilson and Reeder 2005, Amelon and Burhans 2006, Marks and Marks 2006, Henderson et al. 2009, Ammerman et al. 2012, Park and Broders 2012). The overall summer and winter ranges are essentially the same (Barbour and Davis 1969) (NatureServe, 2015).

**Distinct Population Segments Defined**

No

**Critical Habitat Designated**

No;

***Life History***

**Feeding Narrative**

Adult: This species evidently is an opportunistic insectivore (Kunz 1973); prey composition varies widely among sites and seasons; diet includes Lepidoptera, Coleoptera, Neuroptera, Diptera, Hymenoptera, Homoptera, and Hemiptera (Whitaker 1972, LaVal and LaVal 1980, Griffith and Gates 1985, Dodd et al. 2012; see also Ammerman et al. 2012r for a review of other recent information). These bats capture flying insects and also glean prey from plants or the forest floor. Foraging occurs within forests, along forest edges, over forest clearings, and occasionally over ponds (Ammerman et al. 2012). Hibernation occurs from late summer/early fall to spring. In summer, an activity peak generally occurs 1 - 2 hours after sunset, with a secondary peak 7 - 8 hours after sunset (NatureServe, 2015). Arachnids are also being a common prey item (Feldhamer et al. 2009, p. 45) (USFWS, 2015).

**Reproduction Narrative**

Adult: Copulation occurs in the late summer and early fall, during the swarming period when large numbers of bats congregate in and near certain caves (Baker 1983, Kurta 1980). Females store sperm during hibernation, though some may copulate again at spring emergence (Guthrie 1933, Racey 1982). Females ovulate at the time of emergence and parturition occurs 50 - 60 days later (Baker 1983). Females bear a single young. Young-of-the-year may reproduce in their first fall, but the proportion of the cohort doing so is unknown (Kurta, pers. comm.). Most nursery colonies are in cavities or beneath loose bark in trees or snags in upland forests, with roost entrances generally below or within the tree canopy (Mumford and Cope 1964, Sasse and Perkins 1996, Lacki and Schwierjohann 2001, Menzel et al. 2002, Owen et al. 2002, Carter and Feldhamer 2005, Perry and Thill 2007, Lacki et al. 2009, Timpone et al. 2010, Silvis et al. 2012). The disparity in the sex ratio (male-biased) appears to be quite consistent among studies, seasons, and sites. Although age structure is not known for any population, potential longevity is at least two decades (NatureServe, 2015).

**Spatial Arrangements of the Population**

Adult: Solitary (NatureServe, 2015); colonial, small groups (USFWS, 2015)

**Site Fidelity**

Adult: High (NatureServe, 2015)

**Habitat Narrative**

Adult: Individuals usually roost solitarily. This bat generally is associated with old-growth forests composed of trees 100 years old or older. It relies on intact interior forest habitat, with low edge-to-interior ratios. Relevant late-successional forest features include a high percentage of old trees, uneven forest structure (resulting in multilayered vertical structure), single and multiple tree-fall gaps, standing snags, and woody debris. However, recent studies indicate that these bats can exploit relatively isolated and small forest fragments (Caceres and Barclay 2000, Henderson et al. 2008, Johnson et al. 2008). Hibernation occurs primarily in caves, mines, and tunnels, typically those with large passages and entrances, relatively constant and cool temperatures, high humidity, and no air currents (Griffin 1940, Jackson 1961, Mumford and Cope 1964, Kurta 1982, Raesly and Gates 1987, Caceres and Pybus 1997, USFWS 2013). A lack of suitable hibernacula may prevent occupancy of areas that otherwise have adequate habitat (Kurta 1982). There appears to be a high degree of philopatry in hibernaculum use. Caves, mines, and quarry tunnels are used as night roosts, typically by males, but also by non-reproductive females (Clark et al. 1987, Jones et al. 1967) (NatureServe, 2015). Northern long-eared bats actively form colonies in the summer (Foster and Kurta 1999, p. 667) and exhibit fission-fusion behavior (Garroway and Broders 2007, p. 961), where members frequently coalesce to form a group (fusion), but composition of the group is in flux, with individuals frequently departing to be solitary or to form smaller groups (fission) before returning to the main unit (Barclay and Kurta 2007, p. 44) (USFWS, 2015).

***Dispersal/Migration***

**Motility/Mobility**

Adult: High (NatureServe, 2015)

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: Seasonal movements between winter and summer sites (USFWS, 2015)

**Dispersal**

Adult: Moderate (USFWS, 2015)

**Dispersal/Migration Narrative**

Adult: In West Virginia, foraging home ranges of seven females averaged 61.1 hectares (Menzel et al. 1999) (NatureServe, 2015). While the northern long-eared bat is not considered a long-distance migratory species, short regional migratory movements between seasonal habitats (summer roosts and winter hibernacula) have been documented between 56 km (35 mi) and 89 km (55 mi) (Nagorsen and Brigham 1993 p. 88; Griffin 1940b, pp. 235, 236; Caire et al. 1979, p. 404) (USFWS, 2015).

***Population Information and Trends***

**Population Trends:**

Declining (FR 87. No. 229. Pages 73488-73504)

**Species Trends:**

Declining (FR 87. No. 229. Pages 73488-73504)

**Number of Populations:**

Unknown (NatureServe, 2015)

**Population Size:**

10,000 - 100,000 individuals (NatureServe, 2015)

**Resistance to Disease:**

Low (inferred from NatureServe, 2015; see threats)

**Population Narrative:**

Recent genetic data indicate that movements and genetic interchanges among populations may be considerable. The range-wide trend over the long term is uncertain, but the number of subpopulations as well as the overall population size clearly have declined (>70%). Range-wide trend over the past 10 years or three generations is uncertain, but the number of subpopulations as well as the overall population size clearly have declined to a large degree (>70%). Total adult population size is unknown but presumably at least 10,000 and perhaps greater than 100,000. Although there are hundreds of hibernating colonies rangewide, these colonies rarely comprise even as many as 50 individuals (very exceptionally 300), suggesting that the overall population (even before the incidence of white-nose syndrome) was relatively small. The number of distinct occurrences has not been determined using standardized criteria. More than 780 hibernacula have been identified throughout the species' range in the United States, although many hibernacula contain only a few (1 to 3) individuals (Barbour and Davis 1969, Whitaker and Hamilton 1998, USFWS 2013). Missouri, Pennsylvania, and West Virginia each have greater than 100 known hibernacula (USFWS 2013) (NatureServe, 2015). The species' range includes 37 states (USFWS, 2016). NLEB, a wide-ranging bat species, found in 37 states and 8 provinces in North America, typically overwinters in caves or mines and spends the remainder of the year in forested habitat (USFWS, 2022). Current Condition In evaluating current conditions of the northern long-eared bat, we used the best available data. Winter hibernacula counts provide the most consistent, long-term, reliable trend data and provide the most direct measure of WNS impacts. We also used summer data in evaluating population trends, although the availability and quality of summer data varies temporally and spatially. Available evidence, including both winter and summer data, indicates northern long-eared bat abundance has and will continue to decline substantially under current demographic and stressor conditions, primarily driven by the effects of WNS. As part of our assessment of the current condition of northern long-eared bat's representation, we identified and delineated the variation across the northern long-eared bat's range into geographical representation units (RPUs) using the following proxies: variation in biological traits, genetic diversity, peripheral populations, habitat niche diversity, and steep environmental gradients. Winter abundance (from known hibernacula) has declined rangewide (49 percent) and declined across all but one RPU (declines range from no decline to 90 percent). The number of extant winter colonies also declined rangewide (by 81 percent) and across all RPUs (40– 88 percent). There has also been a noticeable shift towards smaller colony sizes, with a 96–100 percent decline in the number of large hibernacula (≥100 individuals) across the RPUs (see figure 2, below). Continued declines are anticipated, with projections indicating rangewide abundance declining by 95 percent and the spatial extent declining by 75 percent from historical conditions (under current threat conditions), by 2030 (Service 2022, Chapter 5). Declines continue to be driven by the catastrophic effects of WNS (FR 87. No. 229. Pages 73488-73504).

***Threats and Stressors***

**Stressor:** White nose syndrome (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The most serious threat is white-nose syndrome (WNS), an often (but not always) lethal condition caused by a fungal pathogen (Pseudogymnoascus destructans). WNS was first

noticed in 2006 in New York. Since its initial discovery, WNS has spread rapidly (confirmed in more than 100 bat hibernacula) and now has been documented throughout northeastern North America and as far west as Missouri and Arkansas, and south to northern Alabama and northern Georgia (as of May 2014; www.whitenosesyndrome.org). WNS affects Myotis septentrionalis and several other bat species (Gargas et al. 2009) and has resulted in several million bat deaths in the northeastern United States in recent years. Though M. septentrionalis was not common in surveys in the northeastern United States before the recognition of WNS, counts of this species subsequently have declined to zero in many caves since the advent of the disease (Hicks et al. 2008). As of 2013, WNS was still spreading and was documented in 22 of the 39 states in which the species occurs). As of early 2015, WNS was still spreading but was confined primarily to areas east of the Mississippi River (plus several locations in Arkansas and Missouri, with suspected instances in Iowa and Minnesota). The vast majority of known hibernacula are in regions where WNS has been confirmed. USFWS (2013) found no information to indicate that there are areas within the species' range that will not be impacted by the disease or that similar rates of decline (to what has been observed in the East, where the disease had been present for at most 8 years) will not occur throughout the species' range (NatureServe, 2015).

**Stressor:** Habitat modification and degradation (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Loss, degradation, and fragmentation of mature forest habitat (associated with various kinds of human activities, such as logging; oil, gas, and mineral development; and wind energy development) also may be a significant threat (Center for Biological Diversity 2010, USFWS 2011). However, the general lack of genetic structure at both watershed and regional scales indicates that forest disturbances such as prescribed fire or timber harvest at watershed scales do not appear to disrupt northern myotis gene flow across the landscape (Johnson et al. 2014). Mortality caused directly by wind turbines may pose a significant threat in some areas (USFWS 2011). Closures of mines used for hibernation are a potential threat, but there is no evidence that mine closures are currently affecting Myotis septentrionalis populations (USFWS 2011; NatureServe, 2015). Anthropogenic modifications to cave and mine entrances, such as the addition of restrictive gates or other structures intended to exclude humans, may not only alter flight characteristics and access (Spanjer and Fenton 2005, p. 1110), but may change airflow and alter internal microclimates of the caves and mines, eliminating their utility as hibernacula (Service 2007, p. 71). Northern long-eared bats likely evolved with fire in their habitat, and thus may benefit from fire-created habitat. However, there are potential negative effects from prescribed burning, including direct mortality (USFWS, 2015).

**Stressor:** Human disturbance (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** This species is sensitive to disturbance during hibernation (Garner, pers. comm., Thomas 1995); frequently aroused bats may deplete their energy reserves. Nursery colonies are very sensitive to disturbance by humans; bats may move to an alternate roost after a single disturbance, even if no attempt is made to capture the bats (Layne 1978) (NatureServe, 2015).

**Stressor:** Climate change (USFWS, 2015)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Climate change may also affect this species, as northern long-eared bats are particularly sensitive to changes in temperature, humidity, and precipitation. Impacts from climate change may also indirectly affect the northern long-eared bat due to changes in food availability, timing of hibernation, and reproductive cycles, along with other factors, all of which may contribute to a shift in suitable habitat (USFWS, 2015).

**Stressor:** Contaminants (USFWS, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Environmental contaminants, in particular insecticides, pesticides, and inorganic contaminants, such as mercury and lead, may also have detrimental effects on northern long-eared bats. Contaminants may bioaccumulate (become concentrated) in the tissues of bats, potentially leading to a myriad of sublethal and lethal effects (USFWS, 2015).

***Recovery***

**Reclassification Criteria:**
Not available - this species does not have a recovery plan.

Recovery Priority Number: 5

**Delisting Criteria:**
Not available - this species does not have a recovery plan.

**Recovery Actions:**
- Not available - this species does not have a recovery plan.
- Direct protection of caves and mines can be accomplished through installation of bat-friendly gates that allow passage of bats while reducing disturbance from human entry as well as changes to the cave microclimate from air restrictions. The NPS has proactively taken steps to minimize effects to underground bat habitat resulting from vandalism, recreational activities, and abandoned mine closures (Plumb and Budde 2011, unpublished data). In addition, the NPS is properly gating abandoned coal mine entrances, using a ‘‘bat-friendly’’ design, as funding permits (Graham 2011, unpublished data). All known hibernacula within national grasslands and forestlands of the Rocky Mountain Region of the USFS are closed during the winter hibernation period, primarily due to the threat of WNS, although this will reduce disturbance to bats in general inhabiting these hibernacula (USFS 2013, unpaginated). Many States are also taking a proactive stance to conserve and restore forest and riparian habitats with specific focus on maintaining forest patches and connectivity. Many States are undertaking research and monitoring efforts to gain more information about habitat needs of and use by northern long-eared bat (USFWS, 2015).
- In 2011, the Service, in partnership with several other State, Federal, and Tribal agencies, finalized a national response plan for WNS to provide a common framework for the investigation and management of WNS (Service 2011, p. 1). In 2012, a sister plan was finalized for the national response to WNS in Canada, allowing for a broader coordinated

response to the disease throughout the two countries. The multi-agency, multiorganization WNS response team, under the U.S. National Plan and in coordination with Canadian partners, has and continues to develop recommendations, tools, and strategies to slow the spread of WNS, minimize disturbance to hibernating bats, and improve conservation strategies for affected bat species. In 2009, the Service also issued a recommendation for a voluntary moratorium on all caving activity in States known to have hibernacula affected by WNS, and all adjoining States, unless conducted as part of an agency-sanctioned research or monitoring project (Service 2009, entire). The NPS is currently updating their cave management plans (for parks with caves) to include actions to minimize the risk of WNS spreading to uninfected caves. Research is also under way to develop control and treatment options for WNS-infected bats and environments (USFWS, 2015).

- Due to the known impacts from wind energy development, in particular to listed (and species currently being evaluated to determine if listing is warranted) bird and bat species in the Midwest, the Service, State natural resource agencies, and wind energy industry representatives are developing the MSHCP. The planning area includes the Midwest Region of the Service, which includes all of the following States: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin. The MSHCP would allow permit holders to proceed with wind energy development, which may result in ‘‘incidental’’ taking of a listed species under section 10 of the Act, through issuance of an incidental take permit (77 FR 52754; August 30, 2012). Currently, the northern long-eared bat is included as a covered species under the MSHCP. The MSHCP will address protection of covered species through avoidance, minimization of take, and mitigation to offset ‘‘take’’ (e.g., habitat preservation, habitat restoration, habitat enhancement) to help ameliorate the effect of wind development (77 FR 52754; August 30, 2012). In some cases, the USFS has agreed to limit or restrict burning in the central hardwoods from mid- to late April through summer to avoid periods when bats are active in forests (Dickinson et al. 2010, p. 2200) (USFWS, 2015).

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Threatened Species Status for the Northern Long-Eared Bat With 4(d) Rule

Final Rule and Interim Rule. April 2, 2015. Pages 17973 - 18033.

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# SPECIES ACCOUNT: *Myotis sodalis* (Indiana bat)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 03/11/1967; Great Lakes-Big Rivers Region (R3) (USFWS, 2015)

**Physical Description**

A medium-sized bat. Its forearm length is 35-41 mm (13 /8- 15 /8 in), and the head and body length ranges from 41-49 mm (15 /8-17 /8 in). The Indiana bat usually has a distinctly keeled calcar. The ears and wing membranes have a dull appearance and flat coloration that does not contrast with the fur, and the fur lacks luster compared with that of little brown bats (Barbour and Davis 1969, Hall 1981). The nose of an Indiana bat is lighter in color than that of a little brown bat. The skull of an Indiana bat has a small sagittal crest, and the braincase tends to be smaller, lower, and narrower than that of the little brown bat (Barbour and Davis 1969, Hall 1981) (USFWS, 2007).

**Taxonomy**

The Indiana bat was first described as a species by Miller and Allen (1928), based on museum specimens collected in 1904 from Wyandotte Cave in Crawford County, Indiana. Before that time, specimens of the Indiana bat often were confused with those of other Myotis, especially the little brown bat. The Indiana bat is monotypic, indicating there are no recognized subspecies. Alternative common names for the species are Indiana myotis, social bat, pink bat, and little sooty bat (Bailey 1933, Osgood 1938, Nason 1948, Mumford and Whitaker 1982) (USFWS, 2007).

**Historical Range**

Historically, the Indiana bat had a winter range restricted to areas of cavernous limestone in the karst regions of the east-central United States (Miller and Allen 1928, Hall 1962, Thomson 1982, Figure 1). Prior to and during much of the European settlement of the eastern United States, winter populations of Indiana bats likely occurred in karst regions of what would eventually become Alabama, Arkansas, Georgia, Illinois, Indiana, Iowa, Kentucky, Maryland, Massachusetts, Missouri, New Jersey, New York, North Carolina, Oklahoma, Pennsylvania, Tennessee, Vermont, Virginia, and West Virginia. The historic summer distribution and range for this species is poorly documented. The historic summer range almost certainly included areas where the bats have now been locally extirpated due to extensive loss and fragmentation of summer habitat (e.g., forests, woodlands, wetlands) (USFWS, 2007).

**Current Range**

The overall range extends west to the western Ozark region in eastern Oklahoma (Saugey et al. 1990) and Iowa (Clark et al. 1987), north and east to southern Wisconsin and Michigan (Evers 1992, Kurta and Teramino 1994, Kurta 1995), New York, New England, and northern New Jersey, and south to northern Alabama and Arkansas, with accidental or nonregular occurrences outside this range (e.g., Florida, Marks and Marks 2006). The species has disappeared from or greatly declined in most of its former range in the northeastern United States (e.g., Trombulak et al. 2001). Most capture records of reproductively active females and juveniles have occurred in glaciated portions of the Midwest including southern Iowa, northern Missouri, much of Illinois, most of Indiana, southern Michigan, and western Ohio, and in Kentucky, with a growing number of maternity records documented in New York, New Jersey, and Vermont in recent years (USFWS 2009). Maternity colonies also exist to the south in Arkansas (Brandebura et al. 2011) and in heavily forested regions to at least eastern Tennessee and western North Carolina (Britzke et al. 2003). However, the geographic locations of the majority of Indiana bat maternity colonies remain unknown (USFWS 2009). Northern populations migrate south to Alabama, Tennessee, Kentucky, Indiana, Missouri, and West Virginia for winter. In winter, the species is apparently absent from Michigan, Ohio, and northern Indiana where suitable caves and mines are unknown. About 42 percent of the total population hibernates in southern Indiana (USFWS 2013). (NatureServe, 2015). In general, the spatial distribution of winter habitat/hibernacula has changed little since the Indiana bat was first listed. However, in at least three known cases, the species has expanded its current winter range beyond its historic winter limits as a result of occupying man-made hibernacula (e.g., mines, tunnels, a dam) in relatively recent times (USFWS, 2009). Since the last review was completed in 2009, a very large previously unknown Indiana bat hibernaculum was discovered near Hannibal, Missouri. (USFWS, 2021)

**Distinct Population Segments Defined**

No

**Critical Habitat Designated**

Yes; 9/24/1976.

**Legal Description**

On September 24, 1976, the U.S. Fish and Wildlife Service designated critical habitat for the Indiana Bat (Myotis sodalis) pursuant to Section 7 of the Endangered- Species Act of 1973 (41 FR 41914 - 41916). This Final Rule was corrected and augmented on September 22, 1977 (42 FR 47840 - 47845).

**Critical Habitat Designation**

Approximately 75 percent of the known population hibernates at the sites designated below. The bats are entirely dependent on the shelter provided by there caves and mines during the winter. Their loss or subjection to excessive disturbance or modification would lead to the near or t3tal extinction of the species.

The Following areas (exclusive of those existing man-made structures or settlements which are not necessary to the normal needs or survival of the species) are critical habitat for the Indiana bat (Myotis sodalis):

(1) Illinois. The Blackball Mine, La Salle County.

(2) Indiana. Big Wyandotte Cave, Crawford County; Bay's Cave, Greene County.

(3) Kentucky. Bat Cave, Carter County; Coach Cave, Edmonson County.

(4) Missouri. Cave 021, Crawford County; Cave 009, Franklin County; Cave 017, Franklin County; Pilot Knob Mine, Iron County; Bat Cave, Shannon County; Cave 029, Washington County (numbers assigned by Division of Ecological Services, U.S. Fish and Wildlife Service, Region 6).

(5) Tennessee. White Oak Blowhole Cave, Blount County.

(6) West Virginia. Hellhole Cave, Pendleton County.

**Primary Constituent Elements/Physical or Biological Features**

Not described. From the critical habitat designation, it can be inferred that shelter provided by caves and mines during the winter is a primary constituent element for this species.

***Life History***

**Feeding Narrative**

Adult: Flying insects are the typical prey items; diet reflects prey present in available foraging habitat. Foraging habitats include riparian areas, upland forests, ponds, and fields (Menzel et al. 2001), but forested landscapes are the most important habitat in agricultural landscapes (Menzel et al. 2005). Females begin hibernation soon after mating, whereas males often remain active through mid-October to November (Cope and Humphrey 1977). Most individuals are in hibernation by late November although some are still active until December (Barbour and Davis 1969). Activity is resumed generally in April, with few bats still in the hibernation caves by mid-May (NatureServe, 2015). Consistent use of moths, flies, beetles, and caddisflies throughout the year at various colonies suggests that Indiana bats are selective predators to a certain degree, but incorporation of ants into the diet also indicates that these bats can be opportunistic (Murray and Kurta 2002). The Indiana bat is a nocturnal insectivore (USFWS, 2007).

**Reproduction Narrative**

Adult: Females give birth to a single young in June or early July (Easterla and Watkins 1969, Humphrey et al. 1977, Kurta and Rice 2002) while in their maternity roosts. As previously discussed, maternity colonies reduce thermoregulatory costs, which, in turn, increases the energy available for birthing and raising young (Barclay and Harder 2003). There are no documented occurrences in which a female Indiana bat has successfully given birth and raised a pup alone without communal benefits of a maternity colony. A study by Belwood (2002) shows asynchronous births extending over two weeks within one colony. This asynchrony results in great variation in size of juveniles (newborn to almost adult size young) in the same colony. In Indiana, lactating females have been recorded from June 10 to July 29 (Whitaker and Brack 2002). Lactation begins at birth and continues through early volancy of young. Young Indiana bats are volant within 3-5 weeks of birth (Mumford and Cope 1958, Easterla and Watkins 1969, Cope et al. 1974, Humphrey et al. 1977, Clark et al. 1987, Gardner et al. 1991a, Kurta and Rice 2002, Whitaker and Brack 2002). Young born in early June may fly as early as the first week of July (Clark et al. 1987), others from mid-to-late July. Once the young Indiana bats are volant, the maternity colony begins to disperse. The use of primary maternity roosts diminishes, although the bats may stay in the maternity roost area until migrating to their respective hibernacula. Bats become less gregarious and the colony uses more alternate roosts (Kurta et al. 1996), possibly because there is no longer the need for the adult females to cluster for thermoregulation and to nurture their young. However, as many as 69 bats have been observed exiting a primary roost tree in central Indiana in late September (D. Sparks, Indiana State University, pers. comm., 2006) (USFWS, 2007).

**Geographic or Habitat Restraints or Barriers**

Adult: Large open areas (USFWS, 2007)

**Spatial Arrangements of the Population**

Adult: Forms hibernation clusters of 500 - 1,000 (NatureServe, 2015); females colonial year round (USFWS, 2007)

**Environmental Specificity**

Adult: Narrow (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low - specific thermoregulatory requirements (NatureServe, 2015)

**Site Fidelity**

Adult: High (NatureServe, 2015)

**Habitat Narrative**

Adult: Myotis sodalis hibernates primarily in caves (about 70 percent of population), also in mines and in one dam and one tunnel (USFWS 2009). Maternity sites generally are behind loose bark of dead or dying trees or in tree cavities (Menzel et al. 2001). In hibernation, limestone caves with pools are preferred. Roosts usually are in the coldest part of the cave. Preferred sites have a mean midwinter air temperature of 4 - 8°C (tolerates much broader range) (Hall 1962, Henshaw and Folk 1966), well below that of caves that are not chosen (Clawson et al. 1980). Hibernation in the coldest parts of the cave ensures a sufficiently low metabolic rate so that the fat reserves last through the six-month hibernation period (Henshaw and Folk 1966, Humphrey 1978). Relative humidity in occupied caves ranges from 66 to 95% and averages 87% throughout the year (Barbour and Davis 1969, Clawson et al. 1980). Because of these requirements, M. sodalis is highly selective of hibernacula. During the fall, when these bats swarm and mate at their hibernacula, males roost in trees nearby during the day and fly to the cave during the night. In summer, habitat consists of wooded or semi-wooded areas, often but not always along streams. Humphrey et al. (1977) determined that dead trees are preferred roost sites and that trees standing in sunny openings are attractive because the air spaces and crevices under the bark are warmer. Hibernating individuals characteristically form large, compact clusters of as many as 5,000 individuals (averaging 500 to 1,000 bats per cluster; Hall 1962); the clusters may average 300 individuals per square foot (LaVal and LaVal 1980). Clusters form in the same area in a cave each year, with more than one cluster possible in a particular cave (Hall 1962, Engel et al. 1976). Clustering may perform certain functions, such as protecting the central individuals from temperature changes (Twente 1955), reducing the sensitivity of most bats to external disturbance (Hall 1962), or rapid arousal and escape from predators (Humphrey 1978). Strong homing tendencies are reflected in fidelity to hibernacula (NatureServe, 2015). In order to meet their energy, thermoregulation, and social needs, adult females are colonial year-round. As a rule, Indiana bats do not cross large open areas and will follow tree lines or fencerows to reach foraging areas despite increased energy expenditures and commuting distances (Murray and Kurta 2004, Winhold et al. 2005), although exceptions to this have been noted. Adequate habitat connectivity is needed to allow for movement of bats (USFWS, 2007).

***Dispersal/Migration***

**Motility/Mobility**

Adult: High (inferred from NatureServe, 2015)

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: Migratory or seasonal movements (NatureServe, 2015)

**Dispersal**

Adult: High (inferred from NatureServe, 2015)

**Dispersal/Migration Narrative**

Adult: Once the young Indiana bats are volant, the maternity colony begins to disperse. The use of primary maternity roosts diminishes, although the bats may stay in the maternity roost area until migrating to their respective hibernacula. Reproductive female bats may disperse from the primary maternity roost and use alternate roosts after young are capable of flight, although they remain in the established maternity area until migration. Even though hibernating Indiana bats were dispersed across 16 states in 2005, over 90 percent of the estimated rangewide population hibernated in just five states, including: Indiana (45.2%), Missouri (14.2%), Kentucky (13.6%), Illinois (9.7%), and New York (9.1%) (USFWS, unpublished data, 2006). (USFWS, 2007)

**Additional Life History Information**

Adult: Migration occurs in late summer (NatureServe, 2015)

***Population Information and Trends***

**Population Trends:**

Decline from 1965 to 2001 (USFWS, 2007); increase from 2003 - 2007 (USFWS, 2009); 30 - 50% decline (NatureServe, 2015) Declining - 4% from 2017 to 2019 and 19% from 2007 to 2019 (USFWS, 2021)

**Species Trends:**

Declining - 4% from 2017 to 2019 and 19% from 2007 to 2019 (USFWS, 2021)

**Number of Populations:**

269 maternity colonies (USFWS, 2009)

**Population Size:**

468,184 (USFWS, 2009), 537,297 (USFWS, 2021)

**Resistance to Disease:**

Low (USFWS, 2009)

**Population Narrative:**

The range-wide population estimate in 2005, 2007, 2009, and 2013 was relatively stable (ranged from 534,239 in 2013 to 590,875 in 2007), though abundance declined significantly between 2005 and 2013 in some states (e.g., New York and West Virginia) (USFWS 2013). This species has experienced a long term population decline of 30 - 50%; the population estimate in 2013 was about 60 percent of the 1960s estimate (USFWS 2013) (NatureServe, 2015). When the 2007 Plan was released, the Service had records of extant winter populations at approximately 281 hibernacula in 19 states and 269 maternity colonies in 16 states and the rangewide. The revised 2007 overall population estimate is 468,184. Since the Indiana bat's original listing and since standardized winter surveys began in the early 1980's, the Indiana bat's overall population decreased precipitously until an increasing population trend began in 2003 and continued through 2007. WNS poses a significant new threat to the species' status and may quickly reverse recent population gains (USFWS, 2009).

***Threats and Stressors***

**Stressor:** Disease and parasites (NatureServe, 2015; USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** White-nose syndrome (WNS) has quickly and significantly raised the degree of threat against the species and has lowered the species overall recovery potential (USFWS 2009). A model developed by Thogmartin et al. (2013) projected that WNS will cause a severe range-wide decline (> 86 percent) in the M. sodalis population over the next decade, with few of the remaining wintering populations exceeding 250 females (NatureServe, 2015). Rabies can be fatal to bats, although antibody evidence suggests that some bats may recover from the disease (Messenger et al. 2003). Rabies has never been reported in Indiana bats (Thomson 1982, Whitaker and Douglas in press), although relative to many other species few have been tested. Butchkoski and Hassinger (2002) observed hair loss in a maternity colony of Indiana bats roosting in an abandoned church in Pennsylvania. Similar atypical loss of hair occurred in little brown bats using the same roost, suggesting that the hair loss was somehow environmentally induced or perhaps caused by an unknown parasite. Although they did not observe mortality related to the hair loss, they discussed thermoregulatory implications (USFWS, 2007). Since the last review, WNS and the fungus that causes it, Pseudogymnoascus destructans (Pd), has spread across the entire range of the Indiana bat and caused mortality of tens of thousands of Indiana batsand affected eleven other bat species (WNS 2019). Thus, WNS has led to regional and range-wide declines in Indiana bat abundance and triggered a decreasing population trend at most, but not all, affected hibernacula (Thogmartin et al. 2012a, Thogmartin 2012b, Thogmartin et al. 2013). Essentially, all Indiana bat hibernacula across the range were considered to be WNS-affected by 2017 (USFWS, unpublished data, 2019). While Indiana bat numbers have fared better than some of its congeners (i.e., M. lucifugus and M. septentrionalis) (Turner et al. 2011), researchers remain concerned that its apparent tolerance of Pd may not be indicative of reduced long-term extinction risk (Maslo et al. 2017, Thogmartin et al. 2013). By 2015, 99% of the range-wide Indiana bat population was hibernating in WNS-affected sites (USFWS 2019a). At present, all known Indiana bat hibernacula fall within the "endemic area" or zone of WNS in North America and are assumed to be WNS�affected(USFWS, 2021)

**Stressor:** Degradation of hibernation habitat (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** There are well-documented examples of modifications to Indiana bat hibernation caves that affected the thermal regime of the cave, and thus the ability of the cave to support hibernating Indiana bats. Reasons for modifications include (but are not limited to) alterations to accommodate tourists, erection of physical barriers (e.g., doors, gates) to control cave access, and mining (particularly saltpeter). Generally, threats to the integrity of hibernacula have decreased since the time that Indiana bats were listed as endangered. Increasing awareness of the importance of cave microclimates to hibernating bats and regulatory authorities under ESA have both helped to alleviate this threat. However, the threat of collapse in mines where Indiana

bats hibernate, and the threat of inadvertent modifications to caves or natural catastrophes that can impact hibernacula remain (USFWS, 2007).

**Stressor:** Loss and degradation of summer, migration, and swarming habitats (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Loss of forest cover and degradation of forested habitats have been cited as part of the decline of Indiana bats (U.S. Fish and Wildlife Service 1983, Gardner et al.1990, Garner and Gardner 1992, Drobney and Clawson 1995, Whitaker and Brack 2002). In some areas, such as northern Indiana, up to 97 percent of the landscape has been cleared of trees, and the absence of woodlands on the landscape certainly equates to less habitat than in prehistoric and early historic periods. It is reasonable to conclude that Indiana bat reproductive rates would be affected by alterations which lowered the quality of their maternity habitat or forced females to search for new habitat. In highly fragmented landscapes, the loss of connectivity among remaining forest patches may degrade the quality of the habitat for Indiana bats. Conversion to agriculture has been the largest single cause of forest loss. The conversion of floodplain and bottomland forests, recognized as high quality habitats for Indiana bats, has been a particular cause of concern (Humphrey 1978). Dredging and channelization of riverine habitats to provide for agricultural drainage and flood control has also been cited as a specific threat to Indiana bat summer habitat (Humphrey et al. 1977, Humphrey 1992, Drobney and Clawson 1995). Currently, the greatest single cause of conversion of forests within the range of the Indiana bat is urbanization and development (Wear and Greis 2002; U.S. Forest Service 2005, 2006). Indiana bats are known to use forest-agricultural interfaces for foraging. In contrast, Indiana bats appeared to avoid foraging in highly developed areas. Modifications of the surface habitat around the hibernacula can impact the integrity, and in turn the microclimate, of the hibernacula. Areas surrounding hibernacula also provide important summer habitat for those male Indiana bats that do not migrate, which is thought to be a large proportion of the male population. Loss or degradation of habitat within this area has the potential to impact a large proportion of the total population (USFWS, 2007).

**Stressor:** Disturbance during hibernation (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The primary forms of human disturbance to hibernating bats result from cave commercialization (cave tours and other commercial uses of caves), recreational caving, vandalism, and research-related activities. There are well-documented examples of disturbance resulting in declines in populations of hibernating bats (Barbour and Davis 1969). Disturbance causes the bats to arouse and use fat reserves essential for successful hibernation. Thomas et al. (1990) demonstrated that arousal from hibernation is metabolically expensive for bats; little brown bats used as much fat during a typical arousal from hibernation as would be used during 67 days of torpor. Few major hibernacula are still threatened by commercial use during the hibernation period. Impacts of recreational caving on hibernating bats are more difficult to assess and to control compared with commercial uses because commercial caves are generally gated, or have some effective means of controlling access. Increased awareness and voluntary cooperation of cavers who belonged to organized cave groups likely resulted in reduced levels of disturbance. However, it is more difficult to address visitors who are not associated with organized groups and

are less likely to appreciate the sensitive nature of the cave environment and cave fauna. Disturbance of hibernating bats by cavers remains a threat in many hibernacula. Direct killing of hibernating Indiana bats by vandals has been documented throughout the species' range (Greenhall 1973, Humphrey 1978, Murphy 1987). Since the early 1980s, biennial hibernacula surveys constitute the major research-related disturbance of hibernating Indiana bats throughout most of the species range. Efforts are made to minimize the disturbance associated with these surveys (USFWS, 2007).

**Stressor:** Disturbance of summering bats (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Research-related disturbance of summering Indiana bats has been observed. Marking-related injuries have also been reported, particularly injuries related to bat banding (Baker et al. 2001), but some researchers have concluded that the risk of banding injuries and associated mortality of Indiana bats is slight (LaVal and LaVal 1980). Several researchers have also reported that impacts related to radiotagging of bats are minor. Mohr (1972) noted that handling of pregnant female bats may cause abortion. Generally, current procedures being used by researchers to capture, mark, and track Indiana bats during summer appear to result in minimal mortality, but continued caution and evaluation are warranted (USFWS, 2007).

**Stressor:** Predation (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Munson and Keith (1984) conservatively estimated that an average of 1,150 bats per year were consumed by raccoons over the past 1,500 years based on raccoon feces collected in Wyandotte Cave, noting that the true predation rate is possibly several times that figure. Bat bones are routinely observed in raccoon feces in mines used as Indiana bat hibernacula in New York and the feces are often found far from the hibernacula entrance, suggesting that the raccoons may be penetrating into hibernacula specifically to seek hibernating bats (A. Hicks, pers. comm., 2006). Observations or evidence of predation by raccoons, mink (Mustela vison), snakes, owls, and feral and domestic cats in or at the entrance of hibernacula have been reported (Goodpaster and Hoffmeister 1950, Thomson 1982, Brack 1988, Butchkoski 2003). Evidence that hibernating Indiana bats were consumed by mice (Peromyscus sp.) has been observed on numerous occasions in Indiana caves, with one incident involving 13 dead Indiana bats (V. Brack, pers. comm., 2006). Indiana bats roosting under bark are susceptible to predation, both within the roost and when they depart at dusk. Humphrey et al. (1977) observed an unsuccessful attack on a foraging Indiana bat by a screech owl (Otus asio) near the bat's roost (USFWS, 2007).

**Stressor:** Competition (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Researchers have observed that the overlap in roosting niches between Indiana bats and northern long-eared bats could lead to interspecific competition, particularly in habitats where roosts are not abundant (Foster and Kurta 1999), but Carter et al. (2001) reported no evidence of competition for roosts between these two species on their study area. Butchkoski

and Hassinger (2002) noted no antagonistic behavior between Indiana bats and little brown bats that formed maternity roosts in the same abandoned church in Pennsylvania. Competition for roosts with other taxa has been noted. Kurta and Foster (1995) observed temporary takeover of an Indiana bat maternity roost by a pair of brown creepers (Certhia americana). Indiana bats temporarily abandoned a primary maternity roost tree that was being used by nesting pileated woodpeckers (Dryocopus pileatus) in Indiana. Competition for prey is more commonly cited than competition for roosts but is also not well documented. Whitaker (2004) studied food habits among eight species of bats in a single community and showed that main foods were most similar for the Indiana bat, little brown bat, and northern long-eared bat. The impact of the competition on populations will be exacerbated by habitat fragmentation. Loss and degradation of habitat will force more individuals of sympatric bat species (as well as other taxa with similar habitat requirements) into smaller and potentially lower quality patches of habitat (USFWS, 2007).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Generally, existing regulatory mechanisms are more effective at protecting Indiana bat hibernacula than summer habitat. Even in situations where a maternity colony is known to be present, it is seldom known what the range extent of the colony is. Further, the conservation value of protecting a hibernaculum is easier to demonstrate and quantify compared with the value of protecting summer habitat. ESA protection extends to hibernacula that are privately owned, but recovery options are often limited on private lands. The location of most Indiana bat maternity colonies is not known; the U.S. Fish and Wildlife Service estimates that the location of approximately 270 maternity colonies has been identified, representing perhaps 6 to 9 percent of all colonies. Monitoring and management of maternity colonies on private lands can only be achieved through effective outreach to private landowners. Current regulatory mechanisms, or the manner in which those mechanisms have been implemented, have thus far not been effective in providing for this type of outreach on a broad scale (USFWS, 2007). At present, 59% of Priority 1 hibernacula (n = 27) are considered protected and 38% of Priority 2 sites (n = 58) (see Appendix A, Tables 1 and 5, respectively). Among the currently protected high-priority hibernacula, there remains some degree of threat from potentially harmful developments and activities. Ownership of Indiana bat habitat is probably the primary factor that limits effectiveness of existing regulatory mechanisms. Of the 85 Priority 1 and 2 hibernacula, 16 (19%) are federally owned, 22 (26%) are state-owned, 45 (53%) are privately owned, 1 (1%) is city owned and 1 (1%) has an unknown ownership (USFWS 2019a). ESA protection extends to hibernacula that are privately owned, but recovery options are often limited on private lands. However, it should be noted that most private hibernacula owners are cooperative in efforts to protect Indiana bats. (USFWS, 2021)

**Stressor:** Natural factors (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Natural catastrophes in hibernacula have the potential to kill large numbers of Indiana bats. Flooding events that killed large numbers of hibernating Indiana bats were reported by DeBlase et al. (1965) in Wind Cave, Breckinridge County, Kentucky (thousands of bats killed in

1964); T. Hemberger (Kentucky Department of Fish and Wildlife Resources, pers. comm., 2006) in Bat Cave, Carter County, Kentucky (3,000 bats killed in 1997); Johnson et al. (2002) in Batwing Cave, Crawford County, Indiana (several hundred bats killed in 1996); and Hicks and Novak (2002) in Haile's Cave, Albany County, New York (several hundred bats killed in 1996). Indiana bats have also frozen to death in hibernacula (Humphrey 1978). Cool temperatures also reduce the food supply for Indiana bats (Humphrey et al. 1977, Belwood 1979). The extent to which temperatures inside maternity roosts impact productivity of Indiana bats is not known. However, cold spring temperatures could further stress pregnant females, already stressed by energy demands of hibernation and migration (USFWS, 2007).

**Stressor:** Environmental contaminants (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** By the late 1970s and early 1980s, bat mortalities caused by organochlorine pesticides (dieldrin, heptachlor epoxide) were documented in several Missouri caves (Clark et al. 1978, 1980, 1983). Although the historic studies of bat/organochlorine poisonings documented lethality, there is still no understanding of the long-term health effects of sub-lethal doses of organochlorine pesticides to individual longevity and reproductive fitness. More than 70 analytical data sets or subsets exist for analytical samples of bat carcasses, bat guano, and bat hair from caves throughout the range of the Indiana bat, including Missouri, Kentucky, New York, Indiana, Illinois, Ohio, Oklahoma, Tennessee, West Virginia, and Virginia (Martin 1992; Ryan et al. 1992; Hudgins 1993; McFarland 1998; New York State Department of Environmental Conservation et al. 2004; O'Shea and Clark 2002; BHE 2004, 2005; Adornato 2005; Sparks 2006; USFWS, Bloomington, Indiana Field Office, unpublished data, 1997-2006; USFWS, Cookeville, Tennessee Field Office, unpublished data, 1997-2001). From this incomplete literature review and data mining effort, it is clear that there are still potentially significant organochlorine contaminant problems in several Missouri caves. Other site specific organochlorine contaminant problems may be adversely impacting Indiana bats. For example, Stansley et al. (2001) documented recent bat mortalities in localized areas where chlordane had historically been used. In the limited studies of PCBs impacts to bats (Clark and Prouty 1976, Clark and Lamont 1976, Clark 1978, Clark and Krynitsky 1978) there is evidence of reproductive failures in bats. PCB transfer from the female to its young through nursing is the most important exposure route in prevolant bats. Juvenile bats typically contain the highest concentrations of PCBs in studied populations (Clark and Prouty 1976). Adult male bats may continue to bioaccumulate PCBs throughout their life and will generally have higher concentrations than adult females (Clark et al. 1975). Thousands of miles of rivers and streams throughout the range of the Indiana bat have fish consumption advisories due to PCB contamination. Many known maternity colonies are located in corn-producing areas. It is unknown whether or not this is cause for concern, yet, recent improvements in analytical chemistry techniques for monitoring the persistent organochlorine pesticides and PCBs have found low levels of chlorpyrifos in almost every recently analyzed Indiana bat carcass and guano sample (Sparks 2006). BHE (2004, 2005) also detected low levels of chlorpyrifos in several surrogate bat samples from Fort Leonard Wood and from nearby controls. This confirms that exposure to OP pesticides is routinely occurring in at least parts of the Indiana bat's range. In addition, several bats from Indiana that died under suspicious circumstances (i.e., cause of death unknown) were tested for contaminants. The following OP pesticides were detected in 3 of 9 submitted samples: diazinon, methyl parathion, and chlorpyrifos (Sparks 2006). In guano samples recently evaluated from several Indiana caves

(Coon, Grotto and Wyandotte Caves), the OP pesticide dichlorvos was detected (Sparks 2006). The greatest risk to bats from pyrethroids is indirect; the significant reduction or loss of the insect prey base near a maternity colony could have an adverse impact on survival. The residual contamination from lead mining in southwestern Missouri could be sufficient to cause adverse effects to Indiana bats on the western limits of its range. In 1992 and 1993, oil pits in the oil production well fields of southwestern Indiana were surveyed for dead animals. Hundreds of dead birds and bats were found in oil pits in counties with Indiana bat summer habitat (USFWS, Bloomington, Indiana, Field Office, unpublished data, 1993-1994). Identification of oiled bat carcasses was done by the Ashland, Oregon, Forensics Laboratory, but most bats were only identified to Myotis spp. Spills of petroleum and crude oil can have significant short-term impacts to occupied summer habitats and likely result in take of some individual Indiana bats (USFWS, 2007).

**Stressor:** Climate change (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Humphries et al. (2002) used climate change models to predict a northern expansion of the hibernation range of the little brown bat; such modeling would likely result in predictions of range shifts for Indiana bats as well. Potential impacts of climate change on hibernacula can be compounded by mismatched phenology in food chains (e.g., changes in insect availability relative to peak energy demands of bats) (V. Meretsky, pers. comm., 2006). Changes in maternity roost temperatures may also result from climate change, and such changes may have negative or positive effects on development of Indiana bats, depending on the location of the maternity colony. The effect of climate change on Indiana bat populations is a topic deserving additional consideration (USFWS, 2007). Mounting data on the impact of climate change, including extreme events such as drought and flooding, on bats are a cause for concern as recent increases in global temperature represent one fifth, or less, of those expected over the next century (Frick et al. 2019, O’Shea et al. 2016, Rebelo et al. 2010, Sherwin et al. 2013, USGCRP 2018). In combination with WNS, habitat destruction, and other sources of environmental degradation, climate change poses a serious and increasing threat to Indiana bats. Questions about the degree to which negative effects of climate change will be offset by positive effects on other life history features, whether population losses in one part of the species' range will be offset by gains in other regions, and the degree to which bats can adapt by adjusting their behavioral, ecological, and phenological characteristics remain largely unanswered. Further monitoring and research is needed to better understand the impacts of climate change on Indiana bats and their habitat. (USFWS, 2021)

**Stressor:** Collisions with man-made objects (USFWS, 2007)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Johnson (2005) reviewed bat mortality due to collisions with turbines at wind-energy developments in the United States. Eleven species of North American bats have been recorded among the mortalities; species within the genus Lasiurus form a large proportion of the bats killed. No documented mortality of Indiana bats at wind farms has occurred to date. However, there is growing concern regarding the potential for bat kills given the rapid proliferation of wind farming and the large-scale mortality that has occurred at some facilities. Wind-energy

developments, particularly near hibernacula or along potential migration routes where large numbers of Indiana bats could be impacted, should be evaluated as a potential threat. Bat collision mortalities have also been associated with communication towers and other manmade structures (Johnson 2005). Like collisions with wind turbines and communication towers, strikes with aircraft occur most often during the fall migration. Russell et al. (2002) verified that an Indiana bat was killed by collision with a vehicle on a Pennsylvania road. There is no implication to date that Indiana bats are particularly susceptible to such collisions, but they may represent a threat to local populations under certain conditions (USFWS, 2007). A total of 13 Indiana bat fatalities has been documented at wind energy facilities in six states (Illinois, Indiana, Iowa, Ohio, Pennsylvania, and West Virginia) since 2009 (Pruitt and Reed 2018). To put this number of fatalities in context, it is important to understand that monitoring of bat fatalities at wind facilities is expensive and difficult. Not all facilities conduct fatality monitoring, and even when monitoring is conducted only a small proportion of dead bats are found during ground searches. We assume that additional Indiana bat mortality has occurred at these facilities and at other wind facilities throughout the range of the species. Additional Indiana bat fatality information and Service guidance is available online (see Pruitt and Reed 2018, USFWS 2011b). (USFWS, 2021)

**Stressor:** Invasive Species (USFWS, 2021)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Biological invasions by non-native invasive species (NNIS) are one of the most significant environmental threats to the maintenance of natural forest ecosystems in North America and elsewhere (Liebhold et al. 1995). Invasive forest insect pests (and fungal diseases) have the ability to cause massive mortality events across vast areas. Apart from the staggering economic losses attributed to exotic insect pests such as the gypsy moth (Lymantria dispar L), emerald ash borer (EAB; Agrilus planipennis) and Asian long-horned beetle (Anoplophora glabripennis)(Wallner 1997, Aukema et al. 2011), these pests can have devastating adverse impacts on the health, productivity, species richness and overall biodiversity of eastern U.S. forests and the bat communities dependent on them. The impacts of NNIS to Indiana bats specifically are not well documented, but are presumed to be significant in some portions of the species' range. Other NNIS that negatively impact the quality of Indiana bat habitat include plants such as Asian bush honeysuckles (Lonicera spp.), Japanese honeysuckle (Lonicera japonica), Russian olive (Elaeagnus angustifolia), Oriental bittersweet (Celastrus orbiculatus), and Kudzu (Pueraria montana var. lobata), which can outcompete and choke out native trees and thereby alter the long-term succession of the forest. Non-native plants may also reduce the amount of insect biomass available to bats and other insectivores and disrupt terrestrial and aquatic food webs (Tallamy 2004, Tallamy et al. 2010, McNeish et al. 2017). Numerous other NNIS ranging from fungi to exotic earthworms impact forest dynamics within the Indiana bat range, but few are well studied or easily controlled at present (Brack et al. 2013, Welch and Leppanen 2017). Further research and strategic eradication and control efforts of NNIS are encouraged as they indirectly support the maintenance of quality habitat for Indiana bats. (USFWS, 2021)

**Stressor:** Artificial Lighting/Light Pollution (USFWS, 2021)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** The rapid global spread of artificial light at night is causing unprecedented disruption to ecosystems, but its biological impacts have only recently been recognized (Rowse et al. 2016). Artificial lighting attracts and repels animals in taxon-specific ways and may affect their physiological processes. Being nocturnal, bats are among the taxa most likely to be affected by light pollution. Bats may react to artificial lighting in a number of ways, including deserting roosts which are lit, delaying roost emergence thus shortening time available for foraging, and avoiding drinking, foraging or commuting in lit areas (Haddock et al. 2019, Russo et al. 2017, Stone et al. 2009, Stone et al. 2015). Artificial lighting, therefore, has potentially serious conservation consequences. It has been associated with lower colony size in some species suggesting continued use of artificial lighting could negatively impact local populations (Kurvers and Hölker. 2015, Stone et al. 2015). At present, very little information is available as to what impacts light pollution may be having on Indiana bat populations or to what degree. However, we can gain some insight from surrogate species of insectivorous bats and from anecdotal accounts of Indiana bat behavior. For example, from his study of radio-tagged Indiana bats near the Indianapolis Airport, Sparks (2003) concluded that the most heavily used foraging areas were in the middle of the darkest regions of his study area and that the effects of artificial light were in need of additional study. Others have noted that bat responses to lighting are species-specific and reflect differences in flight morphology and performance. For example, fast-flying aerial hawking species frequently feed around street lights, and relatively slow-flying bats (like the Indiana bat), that forage in more confined spaces tend to be more light-averse (Rydell and Baagøe 1996, Rowse et al 2016). Additional research on the potential impacts of artificial lighting on Indiana bats is needed particularly as lighting technologies are rapidly changing, with the increased use of light-emitting diode (LED) street lamps (Stone et al. 2012). (USFWS, 2021)

***Recovery***

**Reclassification Criteria:**

1. Permanent protection of 80% of all Priority 1 hibernacula in each Recovery Unit (USFWS, 2009).

2. A minimum overall population estimate equal to the 2005 population estimate of 457,000 bats (USFWS, 2009). Criteria Achieved (USFWS, 2021)

3. Predicted continued positive population growth rate at each of the most populous hibernacula in each RU (using a linear regression with 90% confidence interval through 5 most recent population estimates as a means of predicting trend over the next 10-year period) (USFWS, 2009).

Recovery Priority Number: 5

**Delisting Criteria:**

1. Protection of a minimum of 50% of Priority 2 hibernacula in each Recovery Unit (USFWS, 2009).

2. A minimum overall population estimate equal to the 2005 population estimate of 457,000 bats (USFWS, 2009). Criteria Provisionally Achieved (USFWS, 2021)

3. Positive population growth rates at a minimum of 80% of all Priority 1A hibernacula/ complexes as evidenced by a positive slope of a linear regression through the 5 most recent population estimates post-reclassification (USFWS, 2009).

**Recovery Actions:**

- Develop and implement public information and outreach program (USFWS, 2007).
- Conserve and manage hibernacula and their winter populations (USFWS, 2007).
- Conserve and manage summer habitat to maximize survival and fecundity (USFWS, 2007).
- Plan and conduct research essential for recovery (USFWS, 2007).
- Within the next year (and prior to the next 5-year review), the Service plans to approve and finalize a revision to the Indiana Bat Recovery Plan. The revised plan will certainly need to address the newly emerging threat of WNS at whatever level is possible given the knowledge base at that time. Although WNS was not identified/addressed as a threat in the 2007 Plan, the population-based recovery criteria in the 2007 Plan are likely to remain as one of the most effective means of assessing the WNS-related mortality and recovery from WNS in the future. While we have a successful means of monitoring WNS in Indiana bat hibernacula, additional actions are necessary to help minimize the impacts of WNS on Indiana bats if possible. Additional research to understand the causes and potential spread of WNS should be initiated immediately. Research of potential management actions aimed at minimizing the potential spread of WNS must continue to be supported and effective actions implemented and adapted as we learn more about the cause(s) of WNS-related mortalities. As we understand more about the cause(s) and vectors of WNS, management actions to help minimize mortalities should be investigated and implemented (i.e., an adaptive management approach will be taken). Public education/outreach efforts about WNS must also continue (USFWS, 2009).
- It is also apparent from this Review that additional attention should be placed on securing permanent/long-term protection of both Priority 1 and Priority 2 hibernacula. Several Priority 1 hibernacula would satisfy Reclassification Criterion 1 if their cave/mine entrances were gated or if appropriate buffer zones were delineated and protected (USFWS, 2009).
- We also recommend that the Service pursue some of the highest priority recovery actions identified within the 2007 Plan that would improve our understanding of the Indiana bat's population status and progress towards recovery. In particular, actions 2.4.1, 3.1.2 - 3.1.6, and 3.2.2.1 should ideally be completed prior to the next 5-year review (USFWS 2007). These specific actions involve estimating population biology parameters and demographics such as juvenile and adult survivorship, reproductive success, and developing population models for the Indiana bat. We recommend a population viability analysis be conducted that would model the population impacts of discrete catastrophes and/or variable WNS mortality scenarios across the species' range. The Service is currently planning such a population analysis to be conducted in 2009-2010 (USFWS, 2009).
- Finally, it is apparent from conducting this Review that the Service will need to continue to improve and maintain a significant, ongoing level of coordination with bat surveyors, the caving community, and other conservation and research partners in order to maintain the Service's hibernacula and population databases and in order to successfully coordinate and implement the recovery actions outlined in the 2007 Plan across the species' wide range (USFWS, 2009).

***Conservation Measures and Best Management Practices:***

- Future revisions to the Indiana Bat Recovery Plan should addresses WNS and other longstanding and emerging threats. Although WNS was not identified/addressed as a threat in the 2007 Plan, the population-based recovery criteria in the 2007 Plan are likely to remain as one of the most effective means of assessing the WNS-related mortality and potential recovery from WNS in the future.
- The Service has a long and successful record of collaborating with many state and federal partners to survey and monitor Indiana bat populations at their hibernacula and these should continue. Additional efforts to monitor known maternity colonies and to discover additional ones on the summer landscape is needed particularly in regions hardest-hit by WNS. In some areas, aerial tracking of radio-tagged females during the spring migration is likely to be the most efficient means of locating and subsequently conserving new maternity colonies (see Roby et al. 2019). We also recommend that the Service and our partners support and take actions to implement the North American Bat Monitoring Program (NABat; https://www.nabatmonitoring.org/). Finally, to ensure we are obtaining reliable information about Indiana bat summer occurrences, the Service will need to continue to 1) update and improve our range-wide presence/probable absence survey protocols, 2) work with others to test and approve the accuracy of new automated acoustic ID software versions and 3) provide training on proper survey techniques and interpretation and reporting of survey results.
- Additional research to better understand the impacts of WNS on the species and the larger bat community is warranted as well as research, funding and strategic implementation of practicable management actions should they prove successful at improving Indiana bat survival and reproduction. In the interim, we should continue to pursue tried and true management approaches of fostering high reproductive success and survival, such as providing for the continual recruitment of large-diameter snags in landscapes with a variety of well-connected forested habitat types and protecting hibernating bats from indiscriminate alterations to hibernacula, unauthorized human disturbance, and excessive research-related activities (see Boyles 2017). We concur with Ingersoll et al. (2016) who stated… "Although research on bat responses to WNS must proceed apace in hopes of mitigating the most severe effects of this disease, renewed management attention to other threats may hold more immediate promise for reducing further declines. Reducing such threats 35 could alleviate synergistic or interacting effects that may be compounding threats to bats, ameliorate other stressors to make bats more resilient to WNS, and enable immediate intervention on threats more amenable to management than WNS." In other words, effective Indiana bat conservation will require further research to mitigate impacts of WNS, and renewed attention to other threats to the species. To be most effective at alleviating threats, we will also need to continue public education/outreach efforts about WNS, wind turbine conflicts, climate change, NNIS, light pollution and other threats to bats and pursue opportunities to share how others can help bats (e.g., Johnson and King 2018)
- The Service also needs to make a more concerted effort to reach out to public and private stakeholders to improve understanding of our legal responsibilities (e.g., ESA) and mutual natural resource goals (see D'Acunto and Zollner 2019). It is also apparent from this review that additional attention should be placed on securing permanent/long-term protection of additional Priority 1 and Priority 2 hibernacula. Several Priority 1 hibernacula would satisfy Reclassification Criterion 1 if their cave/mine entrances were gated or if appropriate buffer zones were delineated and protected.
- We also recommend that the Service continue to pursue some of the highest priority recovery actions identified within the 2007 Plan that have yet to be completed in an effort to improve or refine our current understanding of the Indiana bat's population status and progress towards recovery (e.g., develop site‐specific hibernacula management plans at high priority hibernacula, develop standardized methods for characterizing and monitoring hibernacula microclimates, and

determine beneficial land management practices for maternity colonies). In order to successfully implement the recovery actions outlined in the 2007 Plan across the species' range, the Service will need to continue to improve and maintain a significant, ongoing level of coordination with state, federal and private agencies, bat surveyors, the caving and academic communities, and other conservation and research partners to further develop and maintain the Service's existing hibernacula and maternity colony databases.

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# SPECIES ACCOUNT: *Odocoileus virginianus clavium* (Key deer)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; Southeast Region (R4) (USFWS, 2015)

**Physical Description**

The Key deer is the smallest subspecies of the North American white-tailed deer. Adult males average 80 pounds (lbs), adult females 63 lbs, and fawns weigh about 32 lbs at birth. Height at the shoulder averages 27 inches for adult bucks and 25 inches for adult does (Hardin et al. 1984). The body appears stockier than that of other deer (Klimstra et al. 1978a); the legs are shorter, and the skull is shorter and relatively wider (Klimstra et al. 1991). Pelage varies from deep reddish-brown to grizzled gray, and a distinct black cross or mask is often present between the eyes and across the brow (Klimstra 1992). Antler size and number of points for male Key deer are less than for other whitetails (Folk and Klimstra 1991a). Bucks typically grow spikes until their second year, when they produce forked antlers. They usually attain 8 points by the fourth year. Besides their size, Key deer possess a number of characteristics unique from other white-tailed deer, including high salt-water tolerance (Jacobson 1974), low birth rate, low productivity (Folk and Klimstra 1991b), more solitary nature, and weak family bonds (Hardin 1974). According to Ellsworth et al. (1994), the Key deer population is the most genetically divergent deer population in the southeastern United States

**Taxonomy**

The Key deer is a member of the Cervidae family of the order Artiodactyla class Mammalia. It was first recognized as a subspecies distinct from the races of O. v. osceola and O. v. virginianus when Barbour and Allen (1922) described it. The population has been geographically and reproductively isolated in the Lower Keys since the last glacier melted at least 4,000 years ago.

**Historical Range**

Formerly most of Florida Keys. (NatureServe, 2015)

**Current Range**

The current range includes approximately 26 islands extending from Big Pine Key to Sugarloaf Key (Folk 1991, Lopez et al. 2005, Parker et al. 2008a; Figure 2). Although, not part of the official range, Key deer have been recently (2016) sighted on Boca Chica Key. These are likely temporary visits from Key deer on Sugarloaf Key. The National Key Deer Refuge and Great White Heron National Wildlife Refuge encompass much of this range and this area is managed for the Key deer and other imperiled species by the Service. The principal factor influencing the distribution and movement of Key deer in the Keys is the location and availability of fresh surface water. Key deer swim easily between Keys and use all islands during the wet season (May to October), but during the dry season (November to April), suitable freshwater is available on only 13 islands (Folk 1991). Big Pine Key, the largest of the Lower Keys (2,500 hectares [ha]), contains the most high-quality habitat (upland) and freshwater resources (Lopez 2001, Harveson et al. 2006a,b), and as a result, is the center of the Key deer's range and supports about two-thirds of the entire population (core population; Klimstra et al. 1974, Lopez et al. 2004a, Roberts 2005, Roberts et al. 2006, Harveson et al. 2006a,b, Parker et al. 2008, Watts et al. 2008). No Name Key, also providing a large proportion of available freshwater, is the second most populated Key. The range of the Key deer in 2006 was estimated to encompass

9,986 ha. Similarly, Lopez (2001) estimated it to be 9,836 ha in 2000. We added Lower Sugarloaf Key (1,017 ha) to the range of Key deer due to anecdotal sightings for a total range of 11,218 ha. Big Pine and No Name keys encompass approximately 2,900 of those hectares (Hobgood 2006). According to Hanski and Gilpin (1991), a metapopulation is comprised of local subpopulations that connect with each other though individual dispersal. For the Key deer metapopulation, we define subpopulations as tiers (island groups) with the largest number of Key deer on Big Pine and No Name keys (Tier I). Other islands are secondary or transitional in terms of population numbers due to resource availability (e.g., upland habitat, freshwater resources; Tier II and III). We expand upon the tier systems later in this document. (USFWS, 2019)

**Distinct Population Segments Defined**

No. (USFWS, 2015)

**Critical Habitat Designated**

No;

***Life History***

**Feeding Narrative**

Adult: The Key deer is capable of exploiting a variety of foods over a range of habitat conditions. Diet varies seasonally with resource availability and changes in nutritional requirements of deer (Klimstra and Dooley 1990; Carlson et al. 1993). Key deer forage on over 160 plant species including red mangrove (Rhizophora mangle), blackbead (Pithecellobium keyense), acacia (Acacia pinetorum), Indian mulberry (Morinda royoc), and pencil flower (Stylosanthes hamata). Red and black mangroves (Avicennia germinans) constitute 24 percent by volume of the diet of the Key deer (Klimstra and Dooley 1990). Key deer require a freshwater source for survival (Folk et al. 1991).

**Reproduction Narrative**

Adult: The social structure of the Key deer varies throughout the year with the reproductive cycle. Bucks associate with females only during the breeding season and will tolerate other males when feeding and bedding only during the non-breeding season. Does may form loose matriarchal groups consisting of an adult female with several generations of her female offspring, but these associations are not stable (Hardin et al. 1976). Key deer produce fewer young per female than any other white-tailed deer population in North America. Fecundity (number of fetuses per female) and productivity (percent of females reproducing) are low, mean age of first breeding is high, and twinning is infrequent, resulting in relatively low reproductive potential. The sex ratio of Key deer favors males at birth, with a 1.75 to 1 fetal ratio and 2 to 1 fawn ratio. However, significantly higher male mortality at maturity serves to balance adult sex ratios more evenly. Annual deer mortality is a function of deer density and population size (Lopez et al. 2003).

**Environmental Specificity**

Adult: Broad (based on habitat).

**Habitat Narrative**

Adult: Key deer use all habitat types including pine rocklands, hardwood hammocks, buttonwood salt marshes, mangrove wetlands, freshwater wetlands, and disturbed/developed areas (Lopez 2001). The deer use uplands more than wetlands (Lopez et al. 2004b). Key deer use these habitats for foraging, cover, shelter, fawning, and bedding. Pine rocklands hold freshwater year round and are especially important to Key deer survival. About 34 percent of the range is pine rocklands and hardwood hammocks (Lopez et al. 2004c). Over 85 percent of fawning occurs in pine rocklands and hardwood hammocks (Hardin 1974). Five of 26 islands occupied by Key deer have significant pine rocklands. Key deer also use residential and commercial areas extensively where they feed on ornamental plants and grasses and can seek refuge from biting insects. Behavior: Key deer have well-defined patterns of activity and habitat use, and established trails from years of daily use are visible in many areas within Key deer habitat (Klimstra et al. 1974). Roadkill hotspots are evident from the Service's long-term mortality database, further illustrating the habitual movement patterns of Key deer. The social structure of the Key deer varies throughout the year with the reproductive cycle. Bucks associate with females only during the breeding season and will tolerate other males when feeding and bedding only during the non-breeding season. Does may form loose matriarchal groups consisting of an adult female with several generations of her female offspring, but these associations are not stable (Hardin et al. 1976). Home ranges of Key deer are variable (Lopez 2001). On Big Pine Key and No Name Key, average annual home range size (95 percent probability area; ages combined) for males and females was estimated to be 546 acres and 104 acres, respectively, during the period 1998 to 2000. Home range sizes were significantly larger from 1968 to 1972 (males, 959 acre, females 250 acres) (Silvy 1975; Lopez 2001). Males tend to disperse from their natal (birth) range as fawns or yearlings. Adult males range over larger areas during the breeding season and may shift to an entirely new area (Silvy 1975; Drummond 1989; Lopez 2001). Territorial behavior is limited to a buck's defense of a receptive doe from other bucks, rather than the defense of a specific territory (Klimstra et al. 1974). Aggressive male behaviors (combat) between rutting males are common in Key deer, especially during the fall breeding season or rut. Key deer home ranges have become smaller and tolerance for other deer has increased because of development and feeding (Lopez et al. 2005). Urbanization: Key deer have urbanized over the last 45 years, a trend reported in Folk and Klimstra (1991c). Key deer are regularly fed at several private locations on Big Pine Key, which has resulted in increased tameness (Folk and Klimstra 1991c; Lopez et al. 2005). Peterson et al. (2004) assessed the effects of residential feeding and watering on Key deer behavior on Big Pine Key. Peterson documented deer aggregations around homes that provided food and water, and the deer exhibited increased levels of tameness. Past research has shown that the Key deer on Big Pine Key habituate to human noises, lights, and vehicular traffic (Folk and Klimstra 1991c). Folk and Klimstra (1991c) observed that Key deer "often bedded in open sites within 7 feet of a road and were not disturbed by cars, pedestrians, or cyclists. Loud noises from within 131 feet, such as circular saws, lawn leafblowers, and wood chippers brought little response." Several studies have documented that deer in general quickly habituate to noise and lights. Bashore and Bellis (1982) found that deer quickly became accustomed to noise and lights on Pennsylvania airfields. It has been suggested that less than 10 percent of Key deer on Big Pine Key exhibit "wild," or natural, characteristics (Frank 2005, personal communication). A study conducted by Harveson et al. (2007) concluded that Key deer have adapted to an urban environment.

***Dispersal/Migration***

**Motility/Mobility**

Adult: High

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: Non-migratory

**Dispersal/Migration Narrative**

Adult: Home ranges of Key deer are variable (Lopez 2001). On Big Pine Key and No Name Key, average annual home range size (95 percent probability area; ages combined) for males and females was estimated to be 546 acres and 104 acres, respectively, during the period 1998 to 2000. Home range sizes were significantly larger from 1968 to 1972 (males, 959 acre, females 250 acres) (Silvy 1975; Lopez 2001). Males tend to disperse from their natal (birth) range as fawns or yearlings. Adult males range over larger areas during the breeding season and may shift to an entirely new area (Silvy 1975; Drummond 1989; Lopez 2001). Territorial behavior is limited to a buck's defense of a receptive doe from other bucks, rather than the defense of a specific territory (Klimstra et al. 1974). Aggressive male behaviors (combat) between rutting males are common in Key deer, especially during the fall breeding season or rut. Key deer home ranges have become smaller and tolerance for other deer has increased because of development and feeding (Lopez et al. 2005).

***Population Information and Trends***

**Population Trends:**

Stable

**Resiliency:**

In summary, Key deer habitat is categorized into 3 tiers with overall resilience ranks of high (Tier I and II), moderate, and low (Tier III), as defined by compartment model outputs (described in Future Conditions section, Table 8). Tier I islands have a large abundance of Key deer mainly due to relatively high amounts of preferred vegetation and freshwater sources. Tier II islands have significantly fewer Key deer, although the presence of preferred vegetation and freshwater sources results in population growth potential, as they are currently under carrying capacity. Tier I and II islands, when calculated at carrying capacity, are currently designated as high resilence (Table 7). Tier III islands have low Key deer abundance due to the small size of the islands (i.e., low habitat availability and freshwater sources) and generally do not support permanent populations. Tier III islands are have low resilience. Evidence indicates that a 30% population reduction due to Hurricane Irma does not immediately impact the quasi- and terminal extinction thresholds (Appendix). Current estimates of preferred vegetation (pineland + hammock) and freshwater sources include (Tier I: Veg. = 1,009 ha, 142 freshwater sources; Tier II: Veg. = 760 ha, 78 freshwater sources; Tier III: Veg. = 407 ha, 56 freshwater sources). (USFWS, 2019)

**Representation:**

The Key deer metapopulation is an interconnected group of Key deer inhabiting an area of limited extent. Historically, the Key deer occupied a much broader range that included far more islands resulting in a more robust representation. The decline in Key deer range left only a small area of occupation that precludes application of the traditional Service definition of representation as there are no representative units. We also lack comprehensive genetic diversity data across the Key deer range. Like much of the available data, genetic data are limited to the Tier I islands. Genetic analyses in the core habitat indicated subspecies genetic diversity was lower than mainland white-tailed deer subspecies; however, there was little comprehensive data supporting inbreeding depression or loss of diversity (Villanova et al. 2017). Previous research indicated that dispersal between Tier I islands and the other major Key deer habitat (Sugarloaf and Cudjoe keys) is limited (Harveson et al. 2006a,b). Without external intervention, this may have eventually raised concerns about population persistence and genetic diversity in these areas. In 2003 to 2005, translocation of 39 Key deer from Tier I islands to these Tier II islands (Sugarloaf and Cudjoe keys) acted as a large-scale dispersal event both boosting the population and likely alleviating issues related to genetic diversity. Future translocations may be required to build upon these gains. (USFWS, 2019)

**Redundancy:**

The Key deer are spread across 15 to 25 total islands (Lopez 2001); however, many of these islands only support marginal habitat for Key deer. The majority of the population (~98 percent) occurs on 8 islands: Tier 1 (2 islands) and Tier II (6 islands) spread over 20 to 25 linear km (Tables 6, 8). As such, overall redundancy is relatively low due to restricted number and distribution of islands. Large scale catastrophes (e.g., hurricanes, disease/infestation) are likely to impact the entire population due to the few islands spread over a narrow range (Lopez et al. 2003a). For instance, hurricanes are generally hundreds of kilometers in diameter and when moving through the Lower Florida Keys they affect all islands in the Key deer range (e.g., Hurricane Irma). The majority of the available forage and freshwater for the entire Key deer population in this scenario would be impacted (Lopez et al. 2003a, Parker et al. 2017b). This presents complications for the Key deer population as whole; highlighting the low redundancy. • Tier I: Includes 2 islands consisting of 1,009 ha of preferred upland vegetation. Tier I has high resiliency based upon low terminal and quasi-extinction risk. • Tier II: Includes 6 islands consisting of 760 ha of preferred upland vegetation. Tier II has moderate resiliency based upon moderate levels of terminal and quasi-extinction risk. • Tier III: Includes other islands in the Key deer range (variable, but approximately 5–10) consisting of 407 ha of preferred upland vegetation. Tier III has low resiliency based upon high levels of terminal and quasi-extinction risk. (USFWS, 2019)

**Population Size:**

~5,000 (USFWS, 2019)

**Population Narrative:**

. Current Big Pine and No Name Key human population is estimated to be approximately 5,000 individuals with some fluctuation around that number expected. (USFWS, 2019)

***Threats and Stressors***

**Stressor:** Habitat loss
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Loss of habitat resulting from development is the most significant and obvious threat to Key deer (Klimstra et al., 1974). The human population on Big Pine Key more than doubled from 1980 to 2000. An estimated 116 acres per year of Key deer habitat was cleared on Big Pine Key in the early 1970s. A building moratorium, new County ROGO requirements and Habitat Conservation Plan (HCP) for Big Pine and No Name Keys reduced development in recent years, but habitat loss from development is still a threat.

**Stressor:** Fencing
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fencing associated with development may cause direct Key deer habitat loss by preventing access to areas used for breeding, feeding, and sheltering. Native habitat that is fenced is no longer available for use by the Key deer and the fencing may block access to other areas. This loss of habitat has reduced the availability of food, water, and shelter as well as fawning areas needed by deer to survive and reproduce. Large networks of fencing have fragmented Key deer habitat and restricted movement, which reduces the availability and value of these areas to Key deer. Although the Monroe County Comprehensive Land Use Plan regulates fencing, many areas important to Key deer continue to be impacted by fences. An additional concern is the injury or death that occurs when deer become entangled when attempting to jump fences.

**Stressor:** Fire suppression
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fire suppression promotes ecological succession in pine rockland communities, resulting in increased hardwood cover, dense brush, decreased herbaceous cover, reduced light penetration, and a general deterioration of habitat quality for Key deer (Klimstra, 1986; Carlson et al., 1993).

**Stressor:** Exotics
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Exotic vegetation is believed to restrict Key deer and concentrate their movements along established trails. This results in more Key deer crossing roads at fewer access routes or walking along roads, increasing their vulnerability to traffic. Exotic plant species such as Australian pine (Casuarina equisetifolia), Brazilian pepper (Schinus terebinthifolius), and latherleaf (Colubrina asiatica) are invading Key deer habitat, out competing native vegetation, and reducing habitat quality.

**Stressor:** Disease
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** As the population density nears carrying capacity, density dependent disease becomes an increasing problem (Lopez 2001). Service biologists necropsy mortalities and test for infectious diseases. Several diseases are documented, but only haemonchosis (anemia attributable to blood loss from blood-sucking parasites) is believed to have affected population dynamics in recent years (Nettles et al. 2002). Scientists first documented the presence of paratuberculosis or Johne's disease in Key deer in 1996 (Nettles et al. 2002, Quist et al. 2002). Corn et al. (2006) monitored the disease and found that it had remained localized within the Big Pine Key and Newfound Harbor subpopulations. The level of this threat to Key deer is unknown, but could potentially be significant, depending on how infectious the disease is among Key deer

and sympatric animals (Quist et al. 2002). However, in the 13 years since its discovery, paratuberculosis in the population has not been significant. Nonetheless, density dependent disease is an issue that warrants continued scrutiny.

**Stressor:** Vehicular mortality
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Residential and commercial development over the past 20 years has increased the number of vehicles and vehicular traffic in the Keys. The main thoroughfare for the Keys U.S. 1 runs through much of the Key deer habitat. This additional traffic has increased the likelihood of Key deer/vehicle collisions. Vehicular mortality is the greatest known source of Key deer deaths. Telemetry data suggests that the majority of deer mortality attributed to road kills occurs on U.S. 1 (Lopez 2001). Although lower speed limits are an attempt to reduce traffic mortality, speeding motorists (Lopez 2001; Frank, personal communication, 2005) may continue to cause deaths in some areas. The Service has kept records on Key deer mortality since the 1960s and more than 73 percent of the cases are due to vehicular mortality (Silvy 1975; Lopez et al. 2003; Service unpublished data, 2009a). From 1996 to 2009, over half the vehicular mortalities have occurred along a 3.5-mile segment of U.S. 1, which bisects the southern end of Big Pine Key. Due to the high occurrences of Key deer-vehicle collisions along this road segment, the Service and biologists from the Florida Department of Transportation (FDOT) have attempted to address this mortality issue on U.S. 1 by installing and monitoring underpasses for deer. Braden et al. (2005) summary report to FDOT noted that the Key deer collisions were reduced by 83 to 92 percent inside the fenced segment and that the US 1 highway improvements have not restricted Key deer movements.

**Stressor:** Climate change
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The projected sea level rise may affect Key deer through changes in the underlying gradient between saline groundwater and the overlying freshwater lenses present in the lower keys. Sea level rise may also affect Key deer through changes in frequency and duration of hurricane storm surges, fire, and the availability of freshwater. On Big Pine Key, slash pine forest (rocklands) hold freshwater year round and are especially important to Key deer survival. Hurricane Georges made landfall at Big Pine Key in October 1998, and caused severe damage to the Keys vegetation and salinization of the freshwater wetlands. Ross et al. (2009) noted significant stress to the salt-intolerant slash pine forest (pine rocklands). Under the worstcase scenario, models predict inundation of a majority of the uplands important to Key deer by 2100 (Bergh 2009) and eventual conversion of existing coastal hammock and forest habitat to transitional habitat then to tidal areas dominated by mangroves.

***Recovery***

**Recovery Actions:**

- The protection afforded the Key deer through prohibitions on hunting, habitat management, and habitat protection through acquisition has resulted in an increase in (240 percent) in the Big Pine Key deer population. Despite the apparent increase in population levels of Key deer, there has been a contraction of the range of Key deer from 1970 to 1999 (Lopez 2001). Key deer have become increasingly abundant on Big Pine Key and adjacent islands, but have decreased to near extirpation on more distant islands such as Cudjoe and Sugarloaf Keys (Lopez 2001). Although Key deer were never abundant on Cudjoe and Sugarloaf Keys, they previously existed at such low numbers that local extirpation was thought to be likely in the near future (Lopez 2001). This contraction in the range has decreased the overall viability of the Key deer population by increasing the probability that a stochastic event, such as a hurricane or disease epidemic, may have had catastrophic impacts to the core population on and around Big Pine Key (Lopez et al. 2004). Recent relocation efforts, however, and the overall population increase have helped address this concern. The population now is at or near historical highs (Service 2007). As part of its recovery strategy, the Service relocated 39 Key deer to two islands within their existing range from 2003 to 2005. The Service moved 24 individuals (14 does, 10 bucks) from Big Pine Key to Sugarloaf Key and 15 individuals (9 does and 6 bucks) from Big Pine Key to Cudjoe Key. Sugarloaf Key and Cudjoe Key have supported a small number of Key deer in the past. Both islands were home to about five resident deer each. A survey of resident deer on Cudjoe Key prior to relocation produced two deer observed and the relocations appear to be a success due to high survival, low dispersal, and evidence of reproduction (lactation, fawn present, etc.) in translocated females (Parker et al. 2008).

***Conservation Measures and Best Management Practices:***

- The Service owns 67 percent of Big Pine Key and 76 percent of No Name Key. Together, these two islands support the core of the Key deer population (≈75–80 percent of the Key deer population). These islands also serve as a source of dispersing individuals to other islands (Harveson et al. 2006a,b). The core habitat and surrounding areas are the location for extensive urban development and Key deer behavioral changes due to interaction with humans. Between 1970 and 2015, the human population increased nearly 10-fold on Big Pine and No Name keys (US Census Bureau 2017). This human population growth leveled off with Monroe County projecting little human population growth through 2030 (Monroe County 2011). Current Big Pine and No Name Key human population is estimated to be approximately 5,000 individuals with some fluctuation around that number expected. Safe and expedient evacuation during hurricanes depends on the ability of US 1 to support adequate traffic levels. However, as US 1 is the primary location of Key deer road mortalities, additional development potentially could increase traffic and Key deer mortalities. Monroe County imposed a building moratorium in 1995 to prevent additional “take” of this endangered species and due to insufficient US 1 level of service (non-compliance with State of Florida transportation requirements, Monroe County 2006). This resulted in the US 1 Project, which was a combination of highway exclusion fencing, an additional lane for traffic flow, overpasses, and Key deer guards. The resulting project on Big Pine Key successfully offset additional Key deer mortalities (from presence of extra lane) on US 1 (Parker et al. 2011). It also spurred development of the Habitat conservation plan for Florida Key deer (Odocoileus virginianus clavium) and other protected species on Big Pine Key and No Name Key, Monroe County, Florida (USFWS 2006), which allowed limited development in exchange for habitat conservation. The recipients (Monroe County, Florida Department of Transportation [FDOT], and Florida Department of Community Affairs [FDCA]) developed a habitat conservation plan (HCP) to address habitat loss and vehicle mortality associated with development on Big Pine and No Name keys (Monroe County 2006). The HCP allows for the loss of up to 78 ha of potential Key deer habitat (about 2.4 percent of the core) between 2004 and 2023, including no more than 3 ha of native habitat.

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# SPECIES ACCOUNT: *Odocoileus virginianus leucurus* (Columbian white-tailed deer)

***Species Taxonomic and Listing Information***

**Commonly-used Acronym:** CWTD

**Listing Status:** Threatened; 03/11/1967; Pacific Region (R1) (USFWS, 2016)

**Physical Description**

White-tailed deer are generally distinguished from mule or black-tailed deer by their longer and thicker tail that is brown rather than black on the dorsal surface; a smaller metatarsal gland; white eye rings; smaller ears; and, in adult males, antlers with prongs arising from a single main beam (Baker 1984). The Columbian white-tailed deer has a reddish-brown summer coat and a grayish-brown winter coat. It ranges in size from 39 to 45 kilograms (kg) (85 to 100 pounds (lb)) for females and 52 to 68 kg (115 to 150 lb) for males (Oregon Department of Fish and Wildlife 1995).

**Taxonomy**

This species is one of 38 recognized subspecies of O. virginianus, a species with a contiguous geographic distribution that extends from southern Canada to South America (USFWS, 1983). The subspecies leucurus (Columbian white-tailed deer) may not be subspecifically distinct from subspecies ochrourus (Northwest white-tailed deer)(Gavin and May 1988). Subspecies leucurus has hybridized with O. hemionus (mule deer) in southwestern Washington (Gavin and May 1988) (NatureServe, 2015).

**Historical Range**

Historically, CWTD occupied a range of approximately 23,170 square miles (mi2) (60,000 square kilometers (km2 )) west of the Cascades Mountains; from Grants Pass, Oregon, in the south to The Dalles, Oregon, in the east and along the Cowlitz River to the north (USFWS, 2013).

**Current Range**

The range is approximately 93 mi2 (240 km2) for the Columbia River DPS in limited areas of Clatsop, Multnomah, and Columbia counties in Oregon, and Cowlitz, Pacific, Skamania, Wahkiakum, and now Clark counties in Washington (USFWS, 2016).

**Distinct Population Segments Defined**

Yes; Columbia River population

**Critical Habitat Designated**

No;

***Life History***

**Feeding Narrative**

Adult: White-tailed deer are considered generalist browsers that also graze on grasses and forbs (USFWS, 2013).

**Reproduction Narrative**

Adult: Rutting activity begins the first week of November; by the end of the month, reproductive behavior by males decreases noticeably, although some deer are capable of breeding as late as March. It is assumed the gestation period approaches that of eastern white-tailed deer (210 days). Available data indicate that nearly all adult females become pregnant and give birth to one or two fawns (USFWS, 1983).

**Geographic or Habitat Restraints or Barriers**

Adult: Invasive reed canarygrass and areas of flooding that result from landscape modification

**Environmental Specificity**

Adult: Broad (inferred from USFWS, 2013)

**Habitat Narrative**

Adult: Prefers wet prairie and lightly wooded bottomlands or "tidelands" along streams and rivers; woodlands are particularly attractive when interspersed with grasslands and pastures; along the Columbia River, Sitka spruce, dogwood, cottonwood, red alder, and willow dominate the vegetation; in inland habitats, along the Umpqua River, the tree community consists of Oregon white oak, madrone, California black oak, and Douglas-fir, with a shrubby ground cover of poison oak and wild rose (Matthews and Moseley 1990) (NatureServe, 2015). Habitat selection by fawns in the Columbia River DPS remains largely undocumented, although observations by Refuge biologists suggest that fawns on the JBH Mainland Unit are most often associated with pastures of tall, dense reed canary grass (Phalaris arundinacea L.) and tall fescue (Festuca arundinaceae), as well as mixed deciduous and Sitka spruce (Picea sitchensis) forest (USFWS 1983, Brookshier 2004). Habitat on the Julia Butler Hansen NWR includes Sitka spruce intertidal swamp and scrub-shrub tidal wetland (Hunting and Price islands), cottonwood/willow swamp and scrub-shrub tidal wetlands (Wallace Island and portions of the Westport, Oregon mainland), and a mix of tidal marsh, reed canary grass pasture, old growth nonnative blackberry (Rubus laciniatus), cottonwood (Populus trichocarpa), and tidal wetland (Crims Island) (USFWS, 2013).

***Dispersal/Migration***

**Motility/Mobility**

Adult: Maintain home ranges with spahes influenced by roads and water. Mean home range size for females was 158.5 ha; for males, mean area of home ranges was 192.2 ha. (Gavin et al 1984). Can swim across the Columbia River

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: non-migratory

**Dispersal**

Adult: Based on yearly survey efforts, however, we do know that no new subpopulations have formed without translocations, suggesting dispersal may be limited. (81 FR 71386)

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends***

**Population Trends:**

Fluctuates with the JBH Mainland Unit subpopulation in the 1980s (USFWS, 2013); almost extirpated in 1900 (USFWS, 1983). the overall population trend for the Columbia River DPS does appear to decline over time until 2004; however, closer examination revealed that the overall trend was strongly influenced by the decline at the JBHR Mainland Unit in the late 1980s. Although population estimates fluctuated, the population has been steadily increasing over time since 2004. We know that population numbers have been influenced by severe flooding in the late 1990s and early 2000s, and by the new subpopulation at Ridgefield NWR, which has been observed breeding and producing twins following translocations. Thus, we have biological evidence to support the positive population trend occurring since 2004. (81 FR 71386)

**Species Trends:**

Improving (USFWS, 2013 and 2016)

**Resiliency:**

N/A

**Representation:**

N/A

**Redundancy:**

N/A

**Number of Populations:**

81 FR 71386 reports on the population size of 6 separate units.

**Population Size:**

603 (USFWS, 2013). Population sizes for 2015 were: Puget Island, 228, Tenasillahe Island, 155, Westport/ Wallace Island, 190, JBHR Mainland Unit, 100, Upper Estuary Islands, 36 and Ridgefield NWR, 100 for a total of 966. (81 FR 71386). Based on surveys conducted between 2019 and 2021, we estimate there are 1,218 deer across 10 subpopulations in the Columbia River DPS (USFWS 2021, unpublished data).

**Minimum Viable Population Size:**

50 deer per subpopulation (81 FR 71386)

**Population Narrative:**

A total of 1,218 deer are estimated in 2021. The Columbia River DPS has experienced population fluctuations and its overall trend has been strongly influenced by large shifts in the abundance of the JBH Mainland Unit subpopulation (Clark et al. 2010; Figure 1A, Table 2). The ultimate genetic isolation between the Douglas County and Columbia River DPS populations has led to a decrease in observed genetic diversity in each population compared to the northeastern Oregon population. The Service reclassified the Columbian white-tailed deer (USFWS, 2016). CWTD were extirpated throughout most of their original range by 1900 (Jewett 1914; Bailey 1936 (USFWS, 1983).

***Threats and Stressors***

**Stressor:** Land conversion (NatureServe, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Primary cause for decline has been conversion of prairie habitat to crops and pastures. Logging has degraded forest habitat in some areas; some habitat periodically lost due to flooding of Columbia River; residential development is the primary threat in Douglas County, Oregon, especially along the North Umpqua River (Matthews and Moseley 1990) (NatureServe, 2015). Urban, suburban, and agricultural areas now limit population expansion, and existing occupied areas support densities of CWTD indicative of moderate to low-quality habitats, particularly lower lying and wetter habitat than the species would typically be associated with (USFWS, 2013).

**Stressor:** Hunting (NatureServe, 2015)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Uncontrolled sport and commercial hunting also had an impact (USFWS 1999; NatureServe, 2015). If subpopulations should decline, poaching could have an impact on CWTD numbers and would need to be monitored. Regulations and enforcement are in place to protect the CWTD; however, poaching still occurs and the level of poaching is not a threat that can be completely alleviated (USFWS, 2013).

**Stressor:** Flooding (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Flooding is a threat to CWTD habitat when grazing and fawning grounds become inundated for prolonged periods, and the risk of large flooding events could increase with impacts of climate change. In the past, significant flooding events have caused large-scale CWTD mortality and emigration from the JBH Mainland Unit (USFWS 2007). The JBH Mainland Unit has experienced three storm-related floods since 1996. These flooding events have been associated with a sudden drop in population numbers and a recovery over the following few years. During some historical flooding events, CWTD have left low-lying areas and did not return (particularly in areas which continued to sustain frequent flooding, for example Karlson Island) (USFWS, 2013).

**Stressor:** Invasive species (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The persistence of invasive species, especially reed canary grass, has reduced forage quality over much of the CWTD range but it remains unclear as to how much this change in forage quality is affecting the overall status of CWTD. While CWTD will eat the grass, it is only palatable for about 2 months in spring, and it is not a preferred forage species (USFWS, 2013).

**Stressor:** Disease (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The Revised Recovery Plan lists necrobacillosis (hoof disease) as a primary causal factor in CWTD mortality on the JBH NWR (USFWS 1983). Fusobacterium necrophorum is identified as the etiological agent in most cases of hoof disease, although concomitant bacteria such as Arcanobacterium pyogenes may also be at play (Langworth 1977; Chirino-Trejo et al. 2003). Damp soil or inundated pastures increase the risk of hoof disease among CWTD with foot injuries (Langworth 1977). Among 155 carcasses recovered from 1974 to 1977, hoof disease was evident in 31 percent (n=49) of the cases, although hoof disease only attributed directly to 3 percent (n=4) of CWTD mortalities (Gavin et al. 1984). Deer Hair Loss Syndrome (DHLS) was documented in Columbian black-tailed deer (CBTD) in northwest Oregon from 2000 to 2004 (Biederbeck 2004). DHLS results when a deer with an immune system weakened by internal parasites is plagued with ectoparasites, such as deer lice Damalinia (Cervicola) spp. The weakened deer suffer increased inflammation and irritation, which result in deer biting, scratching, and licking affected areas and, ultimately, removing hair in those regions. Cases were identified in CWTD only in 2002 and 2003. CWTD captured during translocations in recent years have occasionally exhibited evidence of hair loss. On the JBH NWR, DHLS is most often observed among fawns and yearlings during winter months (USFWS 2010c). Parasite loads were tested in 16 CWTD on the JBH Mainland Unit and Tenasillahe Island in February of 1998 (Creekmore and Glaser 1999). All CWTD tested showed evidence of the stomach worm, Haemonchus contortus, in fecal samples. Lung worm (Parelaphostrongylus spp.) and trematode eggs, possibly from liver flukes (Fascioloides spp.) were also detected. These results are generally not a concern among healthy populations, but for a population under nutritional stress, such as the Columbia River DPS of CWTD with less than optimal forage and habitat quality available, a high parasite load can increase the likelihood of mortality, especially among fawns (Creekmore and Glaser 1999) (USFWS, 2013).

**Stressor:** Predation (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Coyote predation was determined to be the primary cause of fawn mortality, accounting for 69 percent (n=61) of all documented mortalities (USFWS, 2013).

**Stressor:** Hybridization (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Hybridization with CBTD was not considered a significant threat to the Columbia River DPS of CWTD at the time of the development of the Revised Recovery Plan (USFWS 1983). However, later studies raised concerns over the presence of BTD genes in the isolated Columbia River DPS population. Hybridization can affect the genetic viability of the Columbia River DPS and additional research regarding hybridization could give broader insight to the implications and occurrence of this phenomenon, and how it may influence subspecies designation (USFWS, 2013).

**Stressor:** Vehicle collisions (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Collision with vehicles remains a concern, especially with respect to newly translocated CWTD. In 2010, 15 CWTD were translocated to Cottonwood Island, Washington, from Westport, Oregon. Seven of those translocated CWTD were killed by collisions with vehicles on US Highway 30 in Oregon and on Interstate 5 in Washington (Cowlitz Indian Tribe 2010). JBH NWR personnel recorded four CWTD killed by vehicle collisions in 2010 along Highway 4 and on the JBH Mainland Unit. The threat of deer collisions may increase over time as CWTD are translocated closer to urban areas and agricultural areas see increased housing development, but it is unlikely to ever rise to the level of putting the DPS at risk of extinction (USFWS, 2013).

**Stressor:** Climate change (USFWS, 2013)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Although in the foreseeable future, climate change and rising sea levels will not put the Columbia River DPS at risk of extinction, they could potentially represent a long-term future threat to CWTD occupying low lying habitat that is not adequately protected by well-maintained dikes. Climatic models have predicted significant sea level rise over the next century (Glick et al. 2007). Rising sea levels could degrade or inundate current habitat, forcing CWTD to move out of currently used habitat along the Columbia River into marginal or more developed habitat. A rise in groundwater levels could lower forage quality and allow invasive plants to expand their range into new areas (USFWS, 2013).

***Recovery***

**Reclassification Criteria:**
1. Maintain a minimum of at least 400 CWTD across the Columbia River DPS (USFWS, 2013).

2. Maintain three viable subpopulations, two of which are located on secure habitat (USFWS, 2013).

Recovery Priority Number: 15

**Delisting Criteria:**
1. Maintain a minimum of at least 400 CWTD across the Columbia River DPS (USFWS, 2013).

2. Maintain three viable subpopulations, all located on secure habitat (USFWS, 2013).

**Recovery Actions:**
- Establish necessary new populations of CWTD on existing habitat (USFWS, 1983).
- Encourage public support for CWTD restoration program (USFWS, 1983).
- Annually assess viability of each extant subpopulation of CWTD (USFWS, 1983).
- Ensure viability of extant populations (USFWS, 1983).
- Conduct a population viability analysis (PVA) of the Columbia River DPS of CWTD to address adequacy of recovery priorities and activities (this recommendation should be conducted as

soon as possible as the results will affect other recovery action items for CWTD). Given that such a large proportion of CWTD reside on unprotected habitats, consideration should be given to whether the overall population, minimum secure subpopulations, and distribution of the deer within the subpopulations are still adequate to achieve recovery (USFWS, 2013).

- Identify high quality upland habitat in areas that might support populations of CWTD regardless of land ownership: a) Develop a broad-based GIS map to identify potential suitable habitat over a large part of the Lower Columbia River basin, regardless of land ownership. b) Work closely with ODFW, WDFW, CLT, and the Cowlitz Tribe to identify additional high quality upland habitat within the historic range of CWTD. c) Conduct outreach to landowners/managers to determine the potential for translocation and restoration activities (USFWS, 2013).
- Explore the feasibility of recovery tools that facilitate the relocation of species into higher quality habitat such as: a) Section 10(j) of the Act to establish an experimental population of CWTD onto other Federal, State, Tribal, or private lands within CWTD historical range (consider habitat and land use practices that are similar to Douglas County DPS, as well as habitat that is not subject to rising sea levels and the associated stressors of disease and poor-quality forage) b) Habitat Conservation Planning under section 10(a)(1)(B) of the Act to work with nonfederal partners in establishing conservation objectives and planning that would help protect CWTD c) Discuss a partnership with ODFW and WDFW to facilitate the translocation of CWTD into areas of higher quality upland habitat. d) Due to past high rates of capture-related mortality, review translocation methods with regard to target habitat types, locations, timing, etc., to evaluate effectiveness. Discuss the pros and cons of various methods currently used and, if warranted, revise/develop methodology to enhance translocation methods, including evaluation of variables such as site specificity, timing, changes in technology and methods (e.g., soft release techniques), etc. e) Work with State, Federal, Tribal, and non-governmental entities to overcome barriers to establishing populations in new areas, being sure to address adequate habitat needs as well as potential damage concerns. f) Develop habitat restoration and management guidelines that will benefit CWTD for private, State, Federal, Tribal, and non-governmental landowners (USFWS, 2013).
- Continue habitat restoration and enhancement efforts on currently occupied CWTD habitat as well as on potential future CWTD translocation areas. a) Continue habitat restoration and enhancement efforts on the JBH Mainland Unit, including pasture restoration, tree planting for browse and cover, and invasive species control. b) Increase restoration efforts on the Upper Estuary Islands to promote a sustainable subpopulation of animals there (USFWS, 2013).
- Continue predator control on the JBH and Ridgefield NWRs (USFWS, 2013).
- Monitor translocated CWTD (USFWS, 2013).
- Work with ODFW and WDFW to address potential animal damage issues as CWTD expand their range (USFWS, 2013).
- Explore options to conduct additional translocations of CWTD (especially females) to Ridgefield NWR (USFWS, 2013).
- Conduct a second controlled trial for FLIR using humans on the ground in pre-arranged locations over the three habitat types normally found during surveys. This will help confirm the previous trial and its finding that FLIR undercounts CWTD by an average of 25 percent (USFWS, 2013).

- Explore opportunities for the Service or State, Federal, Tribal, and non-governmental partners to acquire lands or conservation easements in areas where CWTD already exist or in areas adjacent to current CWTD subpopulations (USFWS, 2013).
- Evaluate CWTD body condition on JBH lands: a) Capture, collar, and recapture CWTD repeatedly to assess body fat and pregnancy condition in different habitat types over time and evaluate differences, especially after habitat improvements have been made (e.g., JBH Mainland Unit, Tenasillahe Island, Crims Island, etc.). b) Compare body condition results to Douglas County DPS CWTD conditions. c) Continue documenting diet composition especially as habitat enhancements are implemented. d) Understanding diet composition of CWTD can be useful in understanding forage use and body condition. Given this understanding, habitat manipulations could be implemented and diet information could be re-collected in time increments to understand changes in body condition. This information could provide input to management decisions regarding habitat and forage type, quality, and quantity (USFWS, 2013).
- Conduct studies at Ridgefield NWR. a) Continue population estimation methods (e.g., FLIR surveys, ground counts) to monitor population trends for the Columbia River DPS. b) Review current population estimation methods, to determine if they are robust enough to adequately assess both true population size and to identify trends in the subpopulations. This includes area that may not have been surveyed before, but which may contain CWTD. The BTD:CWTD ratio may vary from site-to-site, complicating population estimates (USFWS, 2013).
- Assess the long-term recovery value of working toward either securing the habitat that maintains the Westport/Wallace Island subpopulation, or obtaining a landowner agreement that provides a management commitment to continue predator control. a) How important is it to ensure the current management at Westport continues? b) Should the Service or State, Federal, Tribal, and non-governmental partners invest time and money to do so? (USFWS, 2013).
- Review implications of the lack of genetic distinctness between northeastern Oregon white-tailed deer and Columbia River DPS deer. a) Researchers suggest augmenting the Columbia River DPS gene pool with individuals from the Douglas County DPS and the northeastern Oregon population of Odocoileus virginianus ochrorous, the latter of which has proven to be genetically similar to, but more diverse than the CWTD. b) Researchers suggest that subspecific designation may not be warranted for CWTD due to the observed genetic similarity between CWTD and O. v. ochrorous. This potential should be further investigated. c) Gather genetic information of CWTD at different sites. d) Cooperate with ODFW and WDFW to gather additional white-tailed deer genetic samples from southeast Washington and northeast Oregon. e) Consider the efficacy and feasibility of augmenting the Columbia River DPS with deer from the Douglas County population or the northeastern Oregon population (USFWS, 2013).
- Address fawn predation and doe survival. a) Determine whether predator control needs to continue indefinitely at JBH NWR, Ridgefield NWR, Westport, and other sites. b) Determine if predator control needs to occur prior to translocation efforts, or in conjunction with those efforts (USFWS, 2013).
- Determine why sex ratios in some areas are skewed: natural mortality rate of CWTD on JBH – does 20 percent, bucks 40 percent (USFWS, 2013).
- Review the current range of the Columbia River DPS as described in the Revised Recovery Plan and re-evaluate whether additional areas/counties should be included (USFWS, 2013).

- Discuss the status of the Upper Estuary Islands subpopulation and its potential to become a 3rd secure subpopulation. a) Is it possible to include Wallace Island in the Upper Estuary Islands numbers with the requirement that manual genetic interchange would occur over the long-term if necessary? b) Evaluate CWTD movement off of Cottonwood Island following the 2010 and 2013 translocations. Attempt to identify why most CWTD leave the island after translocation. Determine whether or not it is worth continuing to try and establish a stable population on Cottonwood Island (USFWS, 2013).
- Recommendations on future management, research, or recovery actions should be developed to address the potential threats that need evaluation given the discussion in this status review: a) Habitat loss/degradation b) Fawn survival c) Predation pressures d) Climate change/flooding e) Hybridization f) Genetic diversity g) Doe survival (USFWS, 2013).
- Issuing a 4(d) rule in this case will support conservation of the species by providing opportunities for CWTD translocations to new areas previously unavailable to create new subpopulations, encouraging habitat restoration of areas on private lands that may act as dispersal corridors for CWTD, and promoting coexistence between people and CWTD as the deer population increases. These activities will facilitate conservation partnerships with the agricultural community and private landowners to voluntarily create or restore habitat for new and existing subpopulations of CWTD, and encourage natural expansion of CWTD. Thus, we have determined that this 4(d) rule is necessary and advisable for the conservation and recovery of CWTD.

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81 FR 71386. (2016) Final Rule: Endangered and Threatened Wildlife and Plants

# SPECIES ACCOUNT: *Ovis canadensis nelsoni* (Peninsular bighorn sheep)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered, March 18, 1998 (63 FR 13134). Revised: Endangered, Distinct Population Segments, April 14, 2009 (74 FR 17288).

**Physical Description**

Peninsular bighorn sheep (Ovis canadensis nelsoni) are medium-sized bovids in the order Artiodactyla. They have muscular bodies and thick necks. The color of Peninsular bighorn sheep varies from dark brown in the northern mountains to pale tan in the southern desert. Rams have massive brown horns that curve up and back over their ears, then down, around, and up past their cheeks in a C-shaped curl that can spread to 83 centimeters (cm) (33 inches [in.]). Ewes have short, slender horns that never form more than a half-curl. An adult Peninsular bighorn sheep is 76 to 100 cm (30 to 39 in.) tall at the shoulders, and approximately 152 cm (60 in.) long. Rams are normally larger than ewes, weighing an average of 73 kilograms (kg) (160 pounds [lb.]), while the ewe's weigh an average of 48 kg (105 lb.) (USFWS 2011).

**Taxonomy**

In the 1998 final listing rule, Peninsular bighorn sheep were listed as a Distinct Population Segment (DPS) of the species bighorn sheep (Ovis canadensis). At the time of listing, at least six subspecies of bighorn sheep were named, including four desert bighorn sheep subspecies (O. c. cremnobates, O. c. mexicana, O. c. nelsoni, and O. c. weemsi). Ovis canadensis cremnobates is the name that previously had been applied to the Peninsular bighorn sheep. However, because of ongoing questions regarding the distinctiveness of the sub-specific taxa at that time, the Peninsular Ranges population was considered a DPS of the species O. canadensis rather than a subspecies or a DPS of a particular subspecies. In the proposed revised critical habitat rule that was published in the Federal Register on October 10, 2007, the U.S. Fish and Wildlife Service formally recognized the listed entity as the Peninsular bighorn sheep, a DPS of desert bighorn sheep (Ovis canadensis nelsoni). This is the currently accepted taxonomic placement of these animals. The taxonomic revision does not affect discreteness and significance of Peninsular bighorn sheep as a DPS (USFWS 2011).

**Historical Range**

Historically, Peninsular bighorn sheep were found along the Peninsular Ranges from the San Jacinto Mountains in Riverside County, California, south into the Volcan de Tres Virgenes Mountains near Santa Rosalia, Baja California, Mexico (USFWS 2011). At the time of listing, the metapopulation of Peninsular bighorn sheep was known to be distributed among at least eight subpopulations in Riverside, Imperial, and San Diego counties, from the San Jacinto Mountains south to the border of Mexico (USFWS 2011). The Santa Rosa Mountains were thought to have two subpopulations at the time of listing (USFWS 2011). Population estimates at the time of listing (1998) indicated approximately 280 Peninsular bighorn sheep existed in the United States, divided among approximately eight subpopulations or ewe groups (72 FR 57740).

**Current Range**

Since listing, an additional subpopulation was identified in the Santa Rosa Mountains. Currently, there are nine recovery regions for the Peninsular bighorn sheep metapopulations. These areas include San Jacinto Mountains; Santa Rosa Mountains—North of Highway 74 (North Santa Rosa Mountains); Santa Rosa Mountains—South of Highway 74 through Martinez Canyon (Central Santa Rosa Mountains); Santa Rosa Mountains—South of Martinez Canyon (South Santa Rosa Mountains); Coyote Canyon; North San Ysidro Mountains, Henderson Canyon to County Road S-22; South San Ysidro Mountains, County Road S-22 to State Highway 78; Vallecito Mountains; and Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area. However, the delineation of subpopulations is not limited to the delineation of recovery regions (USFWS 2011).

**Distinct Population Segments Defined**

Yes, April 14, 2009 (74 FR 17288).

**Critical Habitat Designated**

Yes; 4/14/2009.

**Legal Description**

On April 14, 2009, the U.S. Fish and Wildlife Service (Service), designated revised critical habitat for the Peninsular bighorn sheep, a distinct population segment (DPS) of desert bighorn sheep (Ovis canadensis nelsoni) occupying the Peninsular Ranges of Southern California, under the Endangered Species Act of 1973, as amended (Act). In total, approximately 376,938 acres (ac) (152,542 hectares (ha)) fall within the boundaries of the critical habitat designation. This revised designation of critical habitat for Peninsular bighorn sheep reduces the 2001 designation by approximately 467,959 ac (189,377 ha).

**Critical Habitat Designation**

Approximately 376,938 ac (152,542 ha) are disignated as critical habitat for Peninsular bighorn sheep in four unitst.

Unit 1: San Jacinto Mountains Unit 1 consists of approximately 4,597 ac (1,860 ha) in the San Jacinto Mountains, Riverside County. Unit 1 is generally located within an area bounded on the east by the city of Palm Springs, bounded on the north by Windy Point and Snow Canyon, and extends south to the northern Palm Canyon area. Land ownership within the unit includes approximately 3,135 ac (1,269 ha) of BLM land; 1,171 ac (474 ha) of USFS land; and 291 ac (118 ha) of Desert Water Authority (DWA) land (Table 2). Unit 1 begins at a low-elevation of about 450 ft (137 m) on the eastern slope and rises to about 4,600 ft (1,400 m) to the west. It is the northernmost unit of revised critical habitat for Peninsular bighorn sheep. This unit was occupied at the time of listing and is currently occupied. Unit 1 contains the physical and biological features essential to the conservation of Peninsular bighorn sheep including a range of vegetation types (PCE 2), foraging and watering areas including alluvial fans (PCE 4 and 5), and steep rocky terrain with elevations and slopes that provide for sheltering, lambing, mating, movement among and between ewe groups (PCE 1), and predator evasion (PCE 3). The physical and biological features essential to the conservation of Peninsular bighorn sheep in Unit 1 may require special management considerations or protection to ameliorate the threats of urban and industrial development (particularly in lower elevation areas) due to the proximity of this unit to the Palm Springs area, and to decrease the direct and indirect effects of human disturbance to Peninsular bighorn sheep and its habitat. Please see the ‘‘Special Management Considerations or Protection’’ section of this final rule for a detailed discussion of the threats to Peninsular bighorn sheep habitat and potential management considerations. We excluded approximately 4,323 ac (1,749 ha) of tribal land that meets the definition of critical habitat for Peninsular bighorn sheep from the final revised designation. We believe the designation of critical habitat would adversely impact our working relationship with the Tribe, and that Federal regulation through critical habitat designation would be viewed as an unwarranted and unwanted intrusion into tribal natural resource programs. Furthermore, the approximately 4,323 ac (1,749 ha) of tribal land within critical habitat are currently managed in a manner that provides conservation benefits to Peninsular bighorn sheep through implementation of a Tribal Council-approved management plan currently being implemented (2001 Tribal Conservation Strategy; MBA, 2001). The Tribe is also implementing a number of smaller scale habitat- and activity-specific plans that provide some benefit to Peninsular bighorn sheep: Indian Canyons Master Plan, 2002; Tahquitz Canyon Wetland Conservation Plan, 2000; Trail Plan, 2000; and the draft Tribal Fire Management Plan. Furthermore, the 4,323 ac (1,749 ha) of tribal land are within the plan area of the 2007 draft Tribal HCP (Helix Environmental Planning, 2007) that will incorporate additional conservation measures once finalized. See the ''Application of Section 4(b)(2)—Other Relevant Impacts—Conservation Partnerships'' section of this final rule for a detailed discussion of the tribal management plans. We also excluded lands within the plan area for the Coachella Valley MSHCP from Unit 1. In both the 2007 proposed revised rule and NOA published in the Federal Register on August 26, 2008, we stated we would consider the possible exclusion of approximately 6,287 ac (2,544 ha) of private land and Coachella Valley MSHCP permittee-owned land from the final critical habitat designation in Unit 1. We are excluding these areas from this final revised designation based on partnerships developed during the development of the Coachella Valley MSHCP that was finalized on October 1, 2008

Unit 2A: North Santa Rosa Mountains Unit 2A consists of approximately 45,100 ac (18,251 ha) in the northern Santa Rosa Mountains, Riverside County. Unit 2A is generally located on the east-facing slopes of the northern Santa Rosa Mountains, and extends from near the City of Rancho Mirage in the north to Martinez Canyon in the south, limited to the east by the communities of the northern Coachella Valley. Land ownership within the unit includes approximately 45,098 ac (18,251 ha) of BLM land and 2 ac (1 ha) of DWA land (Table 2). Unit 2A begins at a low-elevation of about 50 ft (15 m) on the eastern slope and rises to about 4,600 ft (1,400 m) to the west. This unit was occupied at the time of listing and remains occupied. Unit 2A contains the physical and biological features that are essential to the conservation of the Peninsular bighorn sheep including a range of vegetation types (PCE 2), foraging and watering areas including alluvial fans (PCE 4 and 5), and steep to very steep, rocky terrain with elevations and slopes that provide for sheltering, lambing, mating, movement among and between ewe groups (PCE 1), and predator evasion (PCE 3). The physical and biological features essential to the conservation of Peninsular bighorn sheep in Unit 2A may require special management considerations or protection to ameliorate the threats of urban, industrial, and agricultural development, and to decrease the direct and indirect effects of human disturbance to Peninsular bighorn sheep and its habitat, due to the proximity of this unit to the highly developed northern Coachella Valley. In particular, the essential features in this unit may require special management considerations or protection to alleviate threats to Peninsular bighorn sheep and its habitat associated with roadways, such as State Route 74 that cuts through the midsection of this unit and may impede movement between ewe groups. Please see the ''Special Management Considerations or Protection'' section of this final rule for a detailed discussion of the threats to Peninsular bighorn sheep habitat and potential management considerations. We excluded approximately 467 ac (189 ha) of Agua Caliente Band of Cahuilla Indians tribal lands meeting the definition of critical habitat for

Peninsular bighorn sheep from the final revised designation. As stated above under the description of Unit 1, the designation of critical habitat would likely adversely impact our working relationship with the Tribe, and we believe that Federal regulation through critical habitat designation would be viewed as an unwarranted and unwanted intrusion into tribal natural resource programs. Furthermore, these approximately 467 ac (189 ha) of tribal land within critical habitat are currently managed in a manner that provides conservation benefits to Peninsular bighorn sheep through implementation of a Tribal Council-approved management plan currently being implemented (2001 Tribal Conservation Strategy; MBA, 2001). The 467 ac (189 ha) of tribal land are within the plan area of the 2007 draft Tribal HCP (Helix Environmental Planning, 2007) that will incorporate additional conservation measures once finalized. See the ‘‘Application of Section 4(b)(2)—Other Relevant Impacts—Conservation Partnerships’’ section of this final revised rule for a detailed discussion of the tribal management plans. We also excluded lands within the plan area for the Coachella Valley MSHCP from Unit 2A. In the 2007 proposed revised rule and the NOA published in the Federal Register on August 26, 2008, we stated we would consider the possible exclusion of approximately 32,472 ac (13,141 ha) of private land and Coachella Valley MSHCP permittee-owned land from the final critical habitat designation in Unit 2A. We are excluding these areas from this final revised designation based on partnerships developed during the development of the Coachella Valley MSHCP that was finalized on October 1, 2008 (see the ‘‘Application of Section 4(b)(2)—Other Relevant Impacts— Conservation Partnerships’’ section for a detailed discussion). Unit 2B: South Santa Rosa Mountains South to Vallecito Mountains Unit 2B consists of approximately 248,021 ac (100,371 ha) in the southern Santa Rosa Mountains, Coyote Canyon, San Ysidro Mountains, Pinyon Mountains, and Vallecito Mountains, in Riverside, San Diego, and Imperial Counties. Unit 2B is generally located on the east-facing slopes of the above ranges, loosely bounded on the east by the Coachella Valley floor, and extends from the southern Santa Rosa Mountains in the north to the Fish Creek Mountains in the south. Land ownership within the unit includes approximately 16,266 ac (6,583 ha) of BLM land; 217,206 ac (87,901 ha) of land owned by the State of California (including portions of Anza-Borrego Desert State Park); and 14,549 ac (5,888 ha) of private land (Table 2). Unit 2B begins at a low-elevation of about 150 ft (45 m) on the eastern slope and rises to about 4,600 ft (1,400 m) to the west. This unit was occupied at the time of listing and remains occupied. This unit contains the physical and biological features that are essential to the conservation of Peninsular bighorn sheep including a range of vegetation types (PCE 2), foraging and watering areas including alluvial fans (PCE 4 and 5), and steep to very steep, rocky terrain with elevations and slopes that provide for sheltering, lambing, mating, movement among and between ewe groups (PCE 1), and predator evasion (PCE 3). The physical and biological features essential to the conservation of Peninsular bighorn sheep in Unit 2B may require special management considerations or protection to: (1) Ameliorate threats of urban, industrial, and agricultural development due to the proximity of this unit to the Coachella Valley, especially the lower elevation areas in the northeastern portions of this unit; (2) decrease the direct and indirect effects of human disturbance to Peninsular bighorn sheep and its habitat due to recreational activity, since most of this unit includes lands within AnzaBorrego Desert State Park, which is open to recreational activities; (3) alleviate threats to Peninsular bighorn sheep and its habitat associated with State Route 78, which cuts through the southern portion of this unit and may impede movement between ewe groups; and (4) alleviate threats to Peninsular bighorn sheep and its habitat associated with mining operations at Fish Canyon Quarry and various mining claims in the unit. Please see the ‘‘Special Management Considerations or Protection’’ section of this final rule for a detailed discussion of the threats to Peninsular bighorn sheep habitat and potential management considerations.

Unit 3: Carrizo Canyon Unit 3 consists of approximately 79,220 ac (32,059 ha) in the Carrizo Canyon area of San Diego and Imperial Counties, extending south to the U.S.- Mexico border. Unit 3 is generally located in Carrizo Canyon and the surrounding In-Ko-Pah Mountains, Jacumba Mountains, Coyote Mountains, and Tierra Blanca Mountains; it is loosely bounded on the north, east, and west by the Coachella Valley floor. Land ownership within the unit includes approximately 37,747 ac (15,276 ha) of BLM land; 35,533 ac (14,380 ha) of land owned by the State of California (including portions of Anza-Borrego Desert State Park); 5,426 ac (2,196 ha) of private land; and 514 ac (208 ha) of local park land (Table 2). Unit 3 begins at a low-elevation of about 400 ft (122 m) on the eastern slope and rises to about 4,600 ft (1,400 m) to the west. This unit was occupied at the time of listing and is currently occupied. This unit contains the physical and biological features that are essential to the conservation of Peninsular bighorn sheep including a range of vegetation types (PCE 2), foraging and watering areas including alluvial fans (PCE 4 and 5), and steep to very steep, rocky terrain with elevations and slopes that provide for sheltering, lambing, mating, movement among and between ewe groups (PCE 1), and predator evasion (PCE 3). The physical and biological features essential to the conservation of Peninsular bighorn sheep in Unit 3 may require special management considerations or protection to: (1) Decrease the direct and indirect effects of human disturbance to Peninsular bighorn sheep and its habitat due to recreational activity, since most of this unit includes lands within AnzaBorrego Desert State Park, which is open to recreational activities; (2) alleviate threats to Peninsular bighorn sheep and its habitat associated with Interstate 8, which cuts through the southern portion of this unit and may impede movement between ewe groups; and (3) alleviate threats to Peninsular bighorn sheep and its habitat associated with mining operations at Ocotillo Mineral Material Site and other mining claims that may occur in the unit. Please see the ‘‘Special Management Considerations or Protection’’ section of this final rule for a detailed discussion of the threats to Peninsular bighorn sheep habitat and potential management considerations.

**Primary Constituent Elements/Physical or Biological Features**

Critical habitat units are designated for Riverside, San Diego, and Imperial Counties, California. The primary constituent elements of critical habitat for the Peninsular bighorn sheep are:

(i) Moderate to steep, open slopes (20 to 60 percent) and canyons, with canopy cover of 30 percent or less (below 4,600 ft (1,402 m) elevation in Peninsular Ranges) that provide space for sheltering, predator detection, rearing of young, foraging and watering, mating, and movement within and between ewe groups;

(ii) Presence of a variety of forage plants, indicated by the presence of shrubs (e.g., Ambrosia spp., Caesalpinia spp., Hyptis spp., Sphaeralcea spp., Simmondsia spp.), that provide a primary food source year round, grasses (e.g., Aristida spp., Bromus spp.) and cacti (e.g., Opuntia spp.) that provide a source of forage in the fall, and forbs (e.g., Plantago spp., Ditaxis spp.) that provide a source of forage in the spring;

(iii) Steep, rugged slopes (60 percent slope or greater) (below 4,600 ft (1,402 m) elevation in Peninsular Ranges) that provide secluded space for lambing and terrain for predator evasion;

(iv) Alluvial fans, washes, and valley bottoms that provide important foraging areas where nutritious and digestible plants can be more readily found during times of drought and lactation, and that provide and maintain habitat connectivity by serving as travel routes between and within ewe groups, adjacent mountain ranges, and important resource areas (e.g., foraging areas and escape terrain); and

(v) Intermittent and permanent water sources that are available during extended dry periods and provide relatively nutritious plants and drinking water.

**Special Management Considerations or Protections**

Critical habitat does not include manmade structures (such as buildings, aqueducts, roads, and other paved areas) and the land on which they are located existing within the legal boundaries on the effective date of this rule.

Special management considerations or protection of the physical and biological features essential to the conservation of the DPS may be needed to alleviate the effects of human activity and disturbance to Peninsular bighorn sheep and ensure that the essential features remain available for use by Peninsular bighorn sheep. Restricting human use of trail systems and natural areas during lambing season, re-routing trails, and establishing exclusionary fencing around urban areas may reduce human effects on Peninsular bighorn sheep behavior.

Degradation and fragmentation of bighorn sheep habitat may occur during the construction phase of power lines and their associated structures. Currently, a large power line (Sunrise Powerlink) is approved for construction through Peninsular bighorn sheep critical habitat. Special management considerations and protection of the physical and biological features essential to the conservation of the DPS will be implemented to alleviate the effects of power line structures and their construction on Peninsular bighorn sheep and their habitat. Future construction of major infrastructure, such as power lines, should be avoided in critical habitat, and if unavoidable, should be constructed to minimize habitat effects and allow continued connectivity among ewe groups.

Mining operations occur within southern portions of Peninsular bighorn sheep habitat in Units 2B and 3. Mining activities and associated facilities negatively impact Peninsular bighorn sheep by causing the loss of vegetation structure required for foraging activities and destroying habitats used for escape, bedding, lambing, or connectivity between ranges (PCE 1, 2, 3, 4, and 5). Disturbance could modify the sheep’s behavior or cause bighorn sheep to flee an area. Special management considerations or protection of the physical and biological features essential to the conservation of the DPS may be needed to alleviate the effects of mining operations on Peninsular bighorn sheep habitat. Further mining operations should avoid (to the maximum extent possible) areas identified as meeting the definition of critical habitat for Peninsular bighorn sheep.

***Life History***

**Feeding Narrative**

Adult: Peninsular bighorn sheep are herbivores and use a wide variety of plant species as their food sources. Their diet is varied among seasons because of variation in forage availability, and at least 34 species of plants have been identified that have been eaten by Peninsular bighorn sheep. Several plant species, including joboba (Simmondsia chinensis), brittlebush (Encelia farinosa), white ratany (Krameria canescense), and bee sage (Hyptis emoryi) have been identified as important year-round food sources. During the fall, primary food sources include grasses such as sixweeks threeawn (Aristida adscensionis), red brome (Bromus madreitensis rubens), and cacti (Opuntia spp.). Forbs such as insularis (Plantago ovata) and common ditaxis (Ditaxis neomexicana) are primary food sources in the spring (USFWS 2011).During the reproductive season, due to the varied topography of bighorn sheep habitat, foraging ewes typically are concentrated on specific sites, such as alluvial fans and washes, where more productive soils support greater herbaceous growth and a greater diversity of browse species (USFWS 2011). These are therefore more important sources of higher-quality forage than steeper, rockier soils. Peninsular bighorn sheep also need foraging material, which can sometimes be scarce, in their home ranges (USFWS 2011). Peninsular bighorn ewes have a very demanding energy and protein requirement during late gestation, lambing, and nursing (USFWS 2011).Peninsular bighorn sheep are diurnal, but may be active at any time of the day or night (USFWS 2011). Their daily activity pattern includes alternating feeding and resting/ruminating periods. Forage quality influences activity patterns; when forages are low in digestibility, bighorn sheep must spend more time ruminating and digesting forage (USFWS 2011). Peninsular bighorn sheep digest plant-based material by initially softening it in the animal's first stomach, then regurgitating the digested mass (cud) and chewing it again (a process called ruminating) (USFWS 2011). Sometimes food resources are scarce in their home ranges due to the desert environments (USFWS 2000).In the Peninsular Ranges, bighorn sheep compete for resources with other native ungulates such as mule deer (Odocoileus hemionus) whose habitats overlap (primarily at the upper elevations of bighorn habitat), with possible geographical and seasonal differences in the degree of overlap. Peninsular bighorn sheep also face competition from domestic livestock, feral animals (horses) and humans. Cattle grazing can be detrimental to bighorn sheep populations, either through direct competition for forage or water, or through vegetation changes in response to cattle grazing (USFWS 2000).

**Reproduction Narrative**

Adult: Peninsular bighorn sheep rams and ewes tend to loosely segregate during much of the year, and come together primarily during the mating season (rut). The largest rams are the most successful breeders, but the small rams also breed. Ewes that fail to acquire a minimum level of energy reserves may not conceive, or will produce smaller offspring with a poorer change of survival. Reproductive success and survival of offspring depends on the mother's body weight, access to resources, quality of home range and age. Peninsular bighorn sheep produce relatively slowly and have one lamb per year (USFWS 2011).Breeding season is August through October; lambs are typically born between February and April, although some lambing may occur as late as August. Some rams are capable of successful breeding as early as 6 months of age (though breeding opportunities are limited by the social pressure of larger rams). Ewes first breed around 2 years of age (and typically until they are 16); however, even yearling ewes have produced lambs. Ewes isolate themselves from other females while bearing their lambs. As parturition (labor) approaches, ewes seek secluded sites with shelter, unobstructed views, and steep terrain for predator evasion. Lambs are weaned by 6 months of age, but ewes reduce their care of lambs when resources are scarce, putting their own nutrition needs over their lambs’. Lamb and yearling age classes experience high mortality rates relative to adult bighorns. After reaching adulthood at 2 years of age, bighorn sheep survival is high until approximately 10 years of age.

**Geographic or Habitat Restraints or Barriers**

Adult: Human-made barriers have reduced available habitat for Peninsular bighorn sheep, and impeded movement between groups can quickly eliminate genetic diversity through genetic drift (USFWS 2011).

**Spatial Arrangements of the Population**

Adult: Clumped according to resources.

**Environmental Specificity**

Adult: Moderate

**Tolerance Ranges/Thresholds**

Adult: Moderate

**Site Fidelity**

Adult: Moderate

**Habitat Narrative**

Adult: Peninsular bighorn sheep use a wide variety of habitats, including steep slopes, cliffs, rough and rocky topography with sparse vegetation, alluvial fans, washes, and the valley floor. Bighorn sheep have evolved predator-evasion behaviors such as the use of escape terrain, which is generally defined as steep, rugged slopes. Escape terrain is important because bighorn sheep typically do not depend on speed alone to outrun their predators, but use their exceptional climbing abilities to outmaneuver predators on steep, rocky outcrops and talus slopes. Areas of gentle terrain, such as valley floors, are important linkages between adjacent mountainous regions, providing bighorn sheep with temporary access to resources. Gentle terrain (e.g., alluvial fans and washes) also provides nutritious forage during droughts and other challenging periods, such as lactation. Variations in slope and aspect also help bighorn sheep survive in a harsh environment.During hot weather, desert bighorn sheep seek shade under boulders, hanging rocks, and cliffs, or they may move to north-facing slopes where temperatures are moderate. During inclement weather, bighorns may again seek caves, overhangs, or slopes that are protected from strong winds; and on cold winter days they may move to sunny, south-facing slopes. Water is an important resource for Peninsular bighorn sheep, and water sources are most valuable to bighorn sheep if they occur in close proximity to adequate escape terrain. In summer, most Peninsular bighorn sheep can be found within a 3- to 5-km (2- to 3-mi.) radius of water. Human-made barriers have reduced available habitat for Peninsular bighorn sheep, and impeded movement between groups can quickly eliminate genetic diversity through genetic drift (NatureServe 2015; USFWS 2000; USFWS 2011).

***Dispersal/Migration***

**Motility/Mobility**

Adult: High

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: Seasonal movements; Peninsular bighorn sheep migrate seasonally during the hot season, leaving mountain ranges where no standing water is known to exist (USFWS 2011).

**Dispersal**

Adult: The ewes limit their dispersal and exploratory abilities to those of rams. Rams do not show the same level of year-round philopatry (faithfulness to natal home range) and move more widely than ewes, often among different groups (USFWS 2011).

**Immigration/Emigration**

Adult: Limited

**Dependency on Other Individuals or Species for Dispersal**

Adult: Forage resources.

**Dispersal/Migration Narrative**

Adult: The ewes limit their dispersal and exploratory abilities to those of rams. Rams do not show the same level of year-round philopatry (faithfulness to natal home range) and move more widely than ewes, often among different ewe groups. As rams reach 2 to 4 years of age, they begin to follow older rams away from their natal group. A small amount of genetic exchange among subpopulations via movements by rams can counteract the inbreeding and associated decreases in genetic diversity that might otherwise develop in small isolated populations (USFWS 2011).Bighorn sheep are sensitive to habitat modification because they are relatively poor dispersers, largely learning their ranging patterns from older animals, with ewes then demonstrating extreme philopatry for the remainder of their lives. The movement patterns and habits of ewes are learned by their offspring, who learn about escape terrain, water sources, foraging areas, and lambing habitat. In the Peninsular Ranges, bighorn sheep migrate seasonally during the hot season, leaving mountain ranges where no standing water is known to exist (USFWS 2011).Bighorn sheep have large home ranges that allow animals to move in response to variations in predation pressure and changes in resource availability. Home range sizes averaged 25 square kilometers (km2) (9.65 square miles [sq. mi.]) for rams and 20 km2 (7.72 sq. mi.) for ewes in the San Jacinto Mountains. In the narrow band of available habitat, Peninsular bighorn sheep make use of sparse and sometimes sporadically available resources found in their home ranges. The size of individual or group home ranges depends on the juxtaposition of required resources such as water, forage, escape terrain, or lambing habitat, and therefore varies geographically. Home range size also is affected by forage quantity and quality, season, sex, and age of the animal. Many populations have a smaller home range in summer, presumably due to their limited movement away from permanent water sources at that time of year. During the cooler or wetter months of the year, bighorn sheep often exhibit an expanded range as animals move farther from water sources (USFWS 2011).

**Additional Life History Information**

Adult: The movement patterns and habits of ewes are learned by their offspring, who learn about escape terrain, water sources, foraging areas, and lambing habitat (USFWS 2011).

***Population Information and Trends***

**Population Trends:**

Stable (USFWS, 2021)

**Species Trends:**

Stable at San Jacinto Mountains, all other recovery region populations increasing (USFWS 2011).

**Number of Populations:**

9 Recovery Regions (USFWS, 2021)

**Population Size:**

~884 (USFWS, 2021)

**Resistance to Disease:**

Resistance is dependent on the disease, but new nonnative diseases have hurt Peninsular bighorn sheep populations (view the Threats & Stressors for more information).

**Adaptability:**

Low

**Additional Population-level Information:**

Prior to listing, the Peninsular bighorn sheep metapopulation experienced three documented extirpations of individual subpopulations at the following locations: (1) north of Chino Canyon (San Jacinto Mountains); (2) Dead Indian Canyon (North Santa Rosa Mountains); and (3) near the United States-Mexico Border (Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area). This changed the distribution in such a way that the range occupied by Peninsular bighorn sheep extended from south of Chino Canyon in the San Jacinto Mountains to north of Interstate 8 in the Jacumba Mountains.Since 1982, Bighorn Institute in Palm Desert, Riverside County, has maintained a captive breeding herd to conduct research and provide for population augmentation in the San Jacinto and North Santa Rosa mountains, and conduct additional research in the Central Santa Rosa Mountains. Since 1985, 122 captive-reared adult bighorn sheep (63 ewes and 59 rams) have been released into the San Jacinto and North Santa Rosa mountains. Released captive sheep readily assimilated into wild populations, which contributed significantly to the recent population resurgences of these two ewe groups. Breeding by captive-reared bighorn sheep has also been reported in the wild (USFWS 2011).The naturally fragment distribution of Peninsular bighorn sheep ewe groups result in distinct subpopulations that are geographically separated. These subpopulations can be grouped into a metapopulation. The potential for increased inbreeding and genetic drift (random changes in genetic frequencies) accompanies decreasing population sizes, and can lead to decreasing levels of heterozygosity (a measure of genetic diversity), which may have negative demographic effects through inbreeding depression (reduction in fitness due to mating among relatives) and loss of adaptability. There is also growing evidence that the level of heterozygosity affects the disease resistance of a population (USFWS 2011).

**Population Narrative:**

As summarized by the CDFW (2020, Table 3 therein), the Peninsular bighorn sheep population has generally increased since listing in 1998, but data since 2010 are limited. In 2016, the most recent range-wide data available, the CDFW (2020, Table 3 therein) estimated a stable rangewide population of 884 individuals, up from 335 since listing but down from 955 in 2010. Although there have been some variations in survey methodologies over time, these population estimates were based primarily on aerial (helicopter) visual counts that were then statistically adjusted based on mark-recapture (resighting) methods (CDFW 2020, p. 5). The methodology used may underestimate the populations somewhat, at least in the northern Recovery Regions (Bighorn Institute 2016, p. 3). The increased Peninsular bighorn sheep population was the result of multiple recovery efforts, including the Bighorn Institute’s long-running Captive Breeding and Wild Population Augmentation Program (Bighorn Institute 2016, p. 1). (USFWS, 2021)

***Threats and Stressors***

**Stressor:** Habitat destruction
**Exposure:** Urbanization alters habitat.
**Response:** Reduction in quality habitat and food resources; alteration of movement and migration areas.
**Consequence:** Reduction in population numbers; mortality.
**Narrative:** Peninsular bighorn sheep are typically restricted to habitat at elevations below 1,400 meters (4,600 feet). These low elevation areas are also the most preferable for human development. As a result, encroaching urban development and human-related disturbance have had the dual effects of restricting the remaining animals to a smaller area due to habitat loss and severing connections between subpopulations. Housing developments and golf courses occur in many of the alluvial fans and washes; this has important implications for bighorn sheep, because these areas are valuable for movement and forage. As human development encroaches into bighorn sheep habitat, resources have been and will continue to be eliminated or reduced in value, and the survival of subpopulations will continue to be threatened. Urbanization in and around the Coachella Valley has altered foraging resources (native plants displaced with nonnative and potentially toxic plants), water resources (altering the hydrology or access to water), and habitat continuity (affecting predator-evasion requirements). The City of Borrego Springs has increased in size and approved several urban developments directly adjacent to Peninsular bighorn sheep habitat in the North San Ysidro and South San Ysidro mountains. As a result, mortality events associated with urbanization near bighorn sheep habitat have increased significantly, and will likely continue. Urban and commercial development (proliferation of residential and commercial development, roads and highways, mining, water projects, and trails and recreational uses) have caused habitat loss, degradation, and fragmentation in four recovery regions (San Jacinto, North Santa Rosa, Central Santa Rosa, and South Santa Rosa mountains); agriculture has used water resources (habitat loss) in at least one recovery region (South Santa Rosa Mountains); mines have caused habitat loss in two recovery regions (Vallecito Mountains and south Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area); roads and highways have caused negative effects associated with the fragmentation of six recovery regions (North Santa Rosa Mountains, Central Santa Rosa Mountains, North San Ysidro Mountains, South San Ysidro Mountains, Vallecito Mountains, and south Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area); trails and recreational uses caused fragmentation and degradation range-wide; and off-highway vehicle use impacted two recovery regions (Central Santa Rosa Mountains and south Carrizo Canyon/Tierra Blanca) (USFWS 2011).

**Stressor:** Alteration of the natural fire regime
**Exposure:** Reduction in habitat quality.
**Response:** Changes in distribution, forage, and predation opportunities.
**Consequence:** Avoidance of certain habitat areas.
**Narrative:** In the Peninsular Ranges, fire is a natural event that can benefit bighorn sheep forage quality by opening up dense stands of chaparral for use during early plant successional stages, while also removing the dense vegetation that predators use preferentially at higher elevations. Human fire suppression activities attempt to prevent wildfire, and may allow vegetation to grow unchecked without its natural control by periodic fires. This may influence the distribution of bighorn sheep by causing them to avoid areas with low visibility. Although not identified as a threat at the time of listing, fire suppression has been a threat to bighorn sheep habitat since its inception as a fire management strategy, because it has steadily increased fuel load and

decreased foraging area at high elevations range-wide (USFWS 2011).

**Stressor:** Nonnative plants
**Exposure:** Removal or changes in key resources (water sources), and consumption of toxic plants.
**Response:** Dehydration, predation, and biological changes.
**Consequence:** Mortality and reduction in population numbers.
**Narrative:** The presence of tamarisk or saltcedar (Tamarix spp.) is a major threat to Peninsular bighorn sheep because of its rapid reproductive and dispersal rates, which allow it to outcompete native plant species in canyon bottoms and washes. Tamarisk significantly reduces or eliminates the standing water on which bighorn sheep depend, and it grows to thick, often impenetrable stands that block access to water sources and provide cover for predators.Nonnative Saharan mustard (Brassica tournefortii) and Mediterranean grass (Schismus barbatus) also alter the habitat by outcompeting native species for limited resources, such as soil moisture. Nonnative plants have become a significant component of the native habitat community at low elevations in all recovery regions. Some species of nonnative ornamental plants (used for decorative purposes in urban developments) have been identified as toxic to Peninsular bighorn sheep, and have caused Peninsular bighorn sheep mortalities (USFWS 2011).

**Stressor:** Disease
**Exposure:** Thought to be associated with domestic livestock and irrigated areas.
**Response:** Endo and ectoparasitism.
**Consequence:** Mortality and reduction in population numbers.
**Narrative:** Researchers and land managers suggest that disease plays an important role in the population dynamics of Peninsular bighorn sheep. Numerous endoparasites and ectoparasites are known to occur in bighorn sheep. A variety of bacterial, fungal, and viral infections have also been isolated or detected from Peninsular bighorn sheep individuals by serologic assay. Such pathogens include bluetongue virus, contagious ecthyma virus, parainfluenza-3 virus, bovine respiratory syncytial virus, Anaplasma, Chlamydia, Leptospira, Pasteurella, Psoroptes, and Dermacentor. Disease manifestation may occur during stressful periods for the population, such as high or low population levels, reproductive activity, low nutrient availability, and climatic extremes. Lambs and older sheep may be most susceptible to disease, and disease has been considered to be responsible for high lamb mortality rates. The consequences of novel exposure to nonnative pathogens can be very serious, because Peninsular bighorn sheep have not evolved resistance to such pathogens. Several viruses discovered in sick Peninsular bighorn sheep lambs were nonnative and thought to have been introduced by domestic livestock. At the time of listing, irrigated lawns, golf courses, and ponded waters in and around the Santa Rosa Mountains were thought to facilitate the exposure and spread of pathogens—such as the biting midge and the strongyle (gastrointestinal) parasite—to Peninsular bighorn sheep. The life cycle of the strongyle parasite cannot be completed in an arid environment. However, high moisture content made available through artificially maintained urban sources (i.e., artificial water sources and irrigated lawns) provides suitable conditions for survival of the parasite through the larval stage. In addition, since the time of listing, a pneumonia outbreak that began in the Peninsular Ranges in the mid-1990s has continued (USFWS 2011).

**Stressor:** Predation
**Exposure:** Unnatural cover, and abundance and distribution of prey species.
**Response:** Increased predator attacks.
**Consequence:** Injury, increased mortality, and reduction in population numbers.

**Narrative:** Bighorn sheep evolved in the presence of predators, and have developed effective physical and behavioral mechanisms for dealing with them. Similar to other desert bighorn populations, sheep in the Peninsular Ranges have likely experienced varying levels of mountain lion predation for thousands of years. However, when other factors such as drought; habitat loss; and fragmentation due to urbanization, diseases, fire suppression, and other factors reduce populations to low levels or alter the abundance and distribution of alternate prey species (such as mule deer), then the influence of predation on population dynamics may increase. The expansion of unnatural environments at the urban interface may have increased the risk of predation in some subpopulations. Encroaching development generally increases the abundance of domestic dogs along the urban-wilderness interface, and these dogs are capable of injuring and killing lambs, ewes, and rams. Furthermore, developed areas provide unnatural cover (such as hedgerows) and dense patches of tall vegetation, which are suitable hiding places for predators to use when ambushing prey. Since the time of listing, predation coinciding with low population numbers has been a fairly constant threat, especially in the two northernmost recovery regions (USFWS 2011).

**Stressor:** Human interaction
**Exposure:** Increase in human interaction.
**Response:** Changes in behavior.
**Consequence:** Reduction in population numbers, and avoidance of certain habitat areas.
**Narrative:** Peninsular bighorn sheep can experience high levels of human activity within their home ranges. Mortalities and avoidance of habitat have been associated with human disturbance. Peninsular bighorn sheep—especially in the Northern Peninsular Ranges—exhibit differences in behavior, and subpopulations have different experiences with humans. However, Peninsular bighorn sheep evolved to tolerate occasional normal disruptions, such as the presence of a predator. Beyond a certain threshold of human activity, they are overwhelmed. Human disturbance tends to be a problem for only about 6 months out of the year, when temperatures are tolerable for hikers. A number of hiking trails and human access points have been closed since the time of listing and, in some cases, bighorn sheep have returned to these areas now that human access has subsided (USFWS 2011).

**Stressor:** Urban-related mortality
**Exposure:** Roads, plants, cars, and swimming pools.
**Response:** Changes in behavior and migration.
**Consequence:** Mortality, reduction of population numbers, and avoidance of habitat.
**Narrative:** Since listing, mortalities of Peninsular bighorn sheep related to urbanization have continued and increased. It has been recorded that Peninsular bighorn sheep have died from causes related to urbanization, including poisoning from toxic nonnative decorative plants, attacks from domesticated canines, and drowning in swimming pools. In additional, bighorn sheep have been struck by vehicles while attempting to cross highways and roads. Since the expansion of urban development in Peninsular bighorn sheep ranges, the mortality rate related top vehicle strikes has increased and is now a potential threat to the population. In addition, some bighorn sheep are hesitant to cross roads, reducing their access to resources (USFWS 2011).

**Stressor:** Climate change and drought
**Exposure:** Dryer conditions and less water availability.
**Response:** See narrative.

**Consequence:** Reduction in population numbers, and mortality.
**Narrative:** The southwestern United States (including the Colorado Desert, where Peninsular bighorn sheep exist) has been warming and drying during the last 12,000 years, which has altered the distribution of flora and fauna. However, the greatest rate of change has occurred in the last 150 years. Furthermore, the Intergovernmental Panel on Climate Change found that the annual mean warming in North America is likely to exceed the global mean warming in most areas, and the southwest specifically is likely to experience the largest increase in summer warming, along with a likely decrease in annual mean precipitation. Mortality among desert bighorn sheep has been shown to increase with drought. The predicted summer temperature increase and precipitation decrease in the southwestern United States may alter resource distribution and availability for Peninsular bighorn sheep (USFWS 2011).

***Recovery***

**Reclassification Criteria:**
Peninsular bighorn sheep may be considered for downlisting to threatened status as an interim management goal, when all of the following objective, measurable criteria are met:

As determined by a scientifically credible monitoring plan, at least 25 ewes must be present in each of the following nine regions of the Peninsular Ranges during each of the 6 consecutive years (equivalent to approximately one bighorn sheep generation), without continued population augmentation: San Jacinto Mountains, Santa Rosa Mountains—North of Highway 74, Santa Rosa Mountains—South of Highway 74 through Martinez Canyon, Santa Rosa Mountains—South of Martinez Canyon, Coyote Canyon, North San Ysidro Mountains (Henderson Canyon to County Road S-22), South San Ysidro Mountains (County Road S-22 to State Highway 78), Vallecito Mountains, and Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area (USFWS 2000).

Regulatory mechanisms and land management commitments have been established that provide for long-term protection of Peninsular bighorn sheep and all essential habitat, as described in Section II.D.1 of the Recovery Plan. Given the major threat of fragmentation to species in metapopulation structures, connectivity among all portions of habitat must be established and assured through land management commitments, so that bighorn sheep are able to move freely throughout all habitats. In preparation for delisting, protection by means other than the Endangered Species Act must be assured. Such protection should include alternative mechanisms for regulation by federal, state, and local governments, and land management commitments that would provide the protection needed for continued population stability (USFWS 2000).

Recovery Priority Number: 9C

**Delisting Criteria:**
Peninsular bighorn sheep may be considered recovered to a status no longer requiring protection under the Endangered Species Act and thereafter removed from the List of Endangered and Threatened Wildlife (50 CFR Part 17) when all of the following criteria are met:

As determined by a scientifically credible monitoring plan, at least 25 adult ewes are present in each of the nine regions of the Peninsular Ranges listed under reclassification criteria, during each of 12 consecutive years (approximately two bighorn sheep generations), including the 6 years under reclassification criteria, without continued population augmentation (USFWS 2000).

The range-wide population must average 750 individuals (adults and yearlings) with a stable or increasing population trend over 12 consecutive years (approximately two generations), as in delisting criterion 1 (USFWS 2000).

Regulatory mechanisms and land management commitments have been established that provide for long-term protection of Peninsular bighorn sheep and all essential habitat, as described in Section II.D.1 of the recovery plan. Furthermore, connection among all portions of habitat must be established and assured through land management commitments, so that bighorn sheep are able to move freely throughout the Peninsular Ranges. Delisting would result in loss of protection under the Endangered Species Act; therefore, continued protection by other means must be assured. This protection should include alternative mechanisms, land management commitments, or conservation programs that would provide the long-term protection needed for continued population viability (USFWS 2000).

**Recovery Actions:**
- Promote population increase and protect habitat (USFWS 2000).
- Initiate or continue research programs necessary to monitor and guide recovery efforts (USFWS 2000).
- Develop and implement education and public awareness programs (USFWS 2000).
- We recommend changing the recovery priority number for Peninsular bighorn sheep from 3 degrees Celsius (°C) to 9°C. Threats identified at listing continue to impact Peninsular bighorn sheep and its habitat (USFWS 2011).
- Identify migratory routes and establish permanently protected corridors or linkages between all subpopulations, especially between the following locations: a. South San Jacinto and North San Jacinto mountains, b. San Jacinto and North Santa Rosa mountains, c. South San Ysidro and North San Ysidro mountains, and d. Jacumba Mountains and Mexico (USFWS 2011).
- Work with our partners to identify specific “no development” zones, cluster proposed development, and/or trade development rights to minimize general habitat impacts and maximize the functionality of corridor/linkage areas (USFWS 2011).
- Study, monitor, and manage the effects of disease and domesticated livestock on Peninsular bighorn sheep in the United States and Mexico (USFWS 2011).
- Construct wildlife crossing overpasses or underpasses over every major barrier (highways, roads, etc.) to assist movement between subpopulations and reduce vehicle collision mortality (USFWS 2011).
- Research and address the effects of both future renewable energy projects and border activities on the recovery of Peninsular bighorn sheep, and create planning guidance to minimize impacts (USFWS 2011).
- Implement management actions to minimize impacts from recreational activities associated with hiking trails in the northern Peninsular Ranges and illegal off-highway vehicle use where it occurs (USFWS 2011).
- Research and quantify the urban and agriculture water withdrawals from the Peninsular Ranges. Address and minimize the effects of water withdrawals on the habitat and individual Peninsular bighorn sheep (USFWS 2011).

- Work with partners and programs (such as the Partners for Fish and Wildlife Program) to identify recovery-related opportunities, such as the construction of additional fences, near major urban centers—including the cities of La Quinta, Borrego Springs, and possibly Ocotillo (USFWS 2011).
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***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be completed over the next 5 years. Successful implementation of these actions will reduce threats to the Peninsular bighorn sheep and provide information to better understand the biological and physical factors limiting the population growth and distribution. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid with future restoration efforts. • Continue to work with Coachella Valley Conservation Commission, the City of La Quinta, CDFW, and other appropriate partners to exclude Peninsular bighorn sheep from urban areas in La Quinta by building a fence (the current preferred method) or other barrier as determined. • Continue to work with CDFW and other appropriate partners to ensure a range-wide survey is conducted in 2022 or soon thereafter to get a ewe count for each Recovery Region and to generate range-wide and Recovery Region-specific population estimations. • Continue to work with partners to identify protected and non-protected important habitat areas and dispersal routes (termed “essential habitat” in the final recovery plan); acquire or otherwise protect non-protected areas. • Continue to work with partners to determine the effects of human recreation on Peninsular bighorn sheep behavior and habitat use to inform adaptive management of the Coachella Valley MSHCP Trails Plan. • Continue to work with U.S. Customs and Border Protection, CDFW, and other partners to address Peninsular bighorn sheep cross-border connectivity. (USFWS, 2021)

***Additional Threshold Information:***

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# SPECIES ACCOUNT: *Perimyotis subflavus* (Tricolored bat)

***Species Taxonomic and Listing Information***

**Commonly-used Acronym:** TCB

**Listing Status:** Proposed Endangered (9/13/2022)

**Physical Description**

Tricolored bats are one of the smallest bats in eastern North America and is distinguished by its unique tricolored fur that appears dark ar the base, lighter in the middle, and dark at the tip. They may appear yellowish, silvery-gray, chocolate brown, or black. Females are heavier than males and young are darker and grayer than adults. They have 34 teeth (compared with 38 teeth in eastern North American Myotis spp. for which it is sometimes confused), a calcar (i.e., spur of cartilage arising from the inner side of the ankle) with no keel, and only the anterior third of the uropatagium (i.e., the membrane that stretches between the legs) is furred (USFWS 2021).

**Taxonomy**

The tricolored bat was first described by Cuvier in 1832 from specimens collected from the eastern U.S., likely Georgia. Various common names have been applied to TCB, including Georgian bat, pigmy bat, southern pipistrel, and most commonly: eastern pipistrelle. In addition, this species has been identified by different scientific names: Vespertilio subflavus, V. erythrodactylus, V. monticola, Vesperugo veraecrucis and Pipistrellus subflavus. In 1897, the species was placed into genus Pipistrellus where it remained until recent phylogenetic analyses confirmed tricolored bats do not share a recent common ancestor with other Pipistrellus-like bats and consequently belong in their own genus, Perimyotis. There were four recognized subspecies (Pipistrellus subflavus subflavus, P. s. clarus, P. s. floridanus, and P. s. veraecrucis) based on geographic variation in color, size, and cranial measurements. When the genus reclassification from Pipistrellus to Perimyotis was completed, no separate subspecies were proposed. For the purposes of the Service's SSA, we considered tricolored bats a valid taxon and monotypic.

**Historical Range**

Historical range and current range appear to be similar based on available data.

**Current Range**

Tricolored bats are known from 39 States (Alabama, Arkansas, Colorado, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Vermont, Virginia, Wisconsin, West Virginia, Wyoming), Washington D.C., 4 Canadian Provinces (Ontario, Quebec, New Brunswick, Nova Scotia), and Guatemala, Honduras, Belize, Nicaragua and Mexico. The species current distribution in New Mexico, Colorado, Wyoming, South Dakota and Texas is the result of westward range expansion in recent decades as well as into the Great Lakes basin. This expansion is largely attributed to increases in trees along rivers and increases in suitable winter roosting sites, such as abandoned mines and other human-made structures.

**Critical Habitat Designated**

No;

**Legal Description**

Not prudent

***Life History***

**Food/Nutrient Resources**

**Food Source**

Adult: Flying Insects (USFWS, 2021)

**Food/Nutrient Narrative**

Adult: Tricolored bats are opportunistic feeders and consume small insects including caddisflies (Trichoptera), flying moths (Lepidoptera), small beetles (Coleoptera), small wasps and flying ants (Hymenoptera), true bugs (Homoptera), and flies (Diptera). They emerge early in the evening and forage at treetop level or above but may forage closer to ground later in the evening. Tricolored bats exhibit slow, erratic, fluttery flight while foraging and commonly forage with eastern red bats (Lasiurus borealis) and silver-haired bats (Lasionycteris noctivagans). They forage most commonly over waterways and forest edges. Maximal distance traveled from roost areas to foraging grounds was 4.3 km for reproductive (pregnant or lactating) adult females in Indiana and 24.4 km for males in Tennessee (USFWS, 2021).

**Reproductive Strategy**

Adult: Viviparity (USFWS, 2021)

**Lifespan**

Adult: The oldest tricolored bat on record was captured in Illinois 14.8 years after it was originally banded (USFWS, 2021).

**Breeding Season**

Adult: Give birth between May-July (USFWS, 2021)

**Key Resources Needed for Breeding**

Adult: Maternity roost (USFWS, 2021)

**Other Reproductive Information**

Adult: The oldest tricolored bat on record was captured in Illinois 14.8 years after it was originally banded. Survival is believed to be low for the first year of life and peaks in the third year (USFWS, 2021).

**Reproduction Narrative**

Adult: Male and female tricolored bats converge at cave and mine entrances between mid-August and mid-October to swarm and mate. Adult females store sperm in their uterus during the winter and fertilization occurs soon after spring emergence from hibernation. Females typically give birth to two young, rarely one or three, between May and July. Young grow rapidly and begin to fly at 3 weeks of age and achieve adult-like flight and foraging ability at 4 weeks. Adults often abandon maternity roosts soon after weaning, but young remain longer. Tricolored bats are considered juveniles (i.e., subadults) when entering their first hibernation and most probably do not mate their first fall. Maternity colonies consist of 1 to 8 (mean = 4.4) females and pups at tree roosts in Indiana. An average of 6.9 adult females and pups were observed per colony in Arkansas (range 3 to 13). Maternity colonies include up to 18 females in trees in Nova Scotia. Colonies found in buildings averaged 15 adult females (range 7 to 29 adult females). The largest colony on record was recorded in a Massachusetts barn (19 adult females and 37 young) (USFWS, 2021).

**Habitat Narrative**

Adult: During spring, summer, and fall (i.e., non-hibernating seasons), tricolored bats primarily roost among live and dead leaf clusters of live or recently dead deciduous hardwood trees. They will also roost in Spanish moss (Tillandsia usneoides) in the southern portions of their range, Usnea trichodea lichen in the northern portions of the range, and during summer in pine needles, eastern red cedar (Juniperus virginiana), within artificial roosts (e.g., barns, beneath porch roofs, bridges, concrete bunkers), and rarely within caves. Females exhibit high site fidelity and form maternity colonies and switch roost trees regularly. Males roost individually. In winter, tricolored bats hibernate (i.e., reduce their metabolic rates, body temperatures, and heart rate) in caves and mines. Where caves are sparse in the southern U.S., tricolored bats often hibernate in road-associated culverts, tree cavities, and abandoned water wells. They exhibit high site fidelity to hibernacula across years. Tricolored bats are one of the first cave-hibernating species to enter hibernation in the fall and one of the last to leave in the spring. Numbers of hibernating bats peaks in caves and mines in December or later, suggesting some may use alternative hibernacula and move to caves and mines when it is colder. Hibernating tricolored bats typically roost individually or in small clusters of both sexes away from other bats, as opposed to forming large clusters. They often roost on cave walls and ceilings are are rarely found in cave crevices. Tricolored bats are known to use smaller caves and mines that are not suitable hibernacula for other bat species (USFWS, 2021).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Tricolored bats disperse from winter hibernacula to summer roosting habitat in the spring. At least some tricolored bats engage in latitudinal migration that is more typically associated with hoary bats (Lasiurus cinereus), eastern red bats, and silver-haired bats, and this behavior is more common for males than for females. The maximum migration distance on record is a female who migrated a straight-line distance of 243 km from her winter hibernaculum in southern Tennessee to a summer roost in Georgia. Other migration records between winter hibernacula and summer habitat include less than 80 km, 44 km, and 137 km. Hibernaculum to hibernaculum movement up to 209 km has also been documented between two consecutive winters (USFWS, 2021).

***Population Information and Trends***

**Population Trends:**

All three representation units have shown declining abundance. Abundance has declined 89%, 57%, and 24% in the Eastern RPU, Northern RPU, and Southern RPU, respectively. The number of winter colonies (i.e., occupied hibernacula) have also decreased 46%, 24%, and 34% in the Eastern RPU, Northern RPU, and Southern RPU, respectively. Lastly, across all RPUs, the potential for population growth is currently undetectable, i.e., (λ) >1 is 0%. (USFWS, 2021)

**Species Trends:**

Available evidence indicates tricolored bat abundance will continue to decline substantially over the next 10 years under current conditions. Evidence of past decline is demonstrated in available data in both winter and summer. Rangewide winter abundance has declined by 52% and the number of extant winter colonies (populations) by 29% since 2000. There has also been a noticeable shift towards smaller colony sizes. The magnitude of the winter declines, although widespread, varies spatially (USFWS, 2021).

***Threats and Stressors***

**Stressor:** White-nose syndrome (USFWS, 2021)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** White-nose syndrome is the foremost stressor on tricolored bat. White-nose syndrome is a disease of bats that is caused by the fungal pathogen Pd. The disease and pathogen were first discovered in eastern New York in 2007 (with photographs showing presence since 2006), and since then have spread to 39 states and 7 provinces in North America. Pd invades the skin of bats, initiating a cascade of physiological and behavioral processes that often lead to mortality. Infection leads to increases in the frequency and duration of arousals during hibernation and raises energetic costs during torpor bouts, both of which cause premature depletion of critical fat reserves needed to survive winter. Bats that do not succumb to starvation in hibernacula often seek riskier roosting locations near entrances to roosts or emerge from roosts altogether, where they face exposure to winter conditions and scarce prey resources on the landscape. The weeks following emergence from hibernation also mark a critical period because prey availability is still limited, energetic costs of healing from WNS are high, and the potential for immune reconstitution inflammatory syndrome that can lead directly to mortality or impact reproductive success. As of May 2021, white-nose syndrome was confirmed in 12 species in North America, including tricolored bats, and numerous other species in Europe and Asia. The fungal pathogen is spread primarily via bat-bat and bat-environment-bat movement and interactions. The effect of white-nose syndrome on tricolored bats has been extreme, such that most summer and winter colonies experienced severe declines following the arrival of white-nose syndrome. Just 4 years after the discovery of white-nose, for example, tricolored bats experienced a 75% decline in winter counts across 42 sites in Vermont, New York and Pennsylvania. Similarly, the arrival of white-nose led to a 10–fold decrease in tricolored bat colony size. Most recently, data from 27 states and 2 provinces was used to conclude white-nose syndrome caused estimated population declines of 90–100% across 59% of tricolored bat range. There appear to be differences in how severe effects of white-nose are to tricolored bats in culverts vs. caves (USFWS, 2021).

**Stressor:** Wind-related mortality (USFWS, 2021)
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Wind power is a rapidly growing portion of North America's energy portfolio in part due to changes in State energy goals and recent technological advancements and declining costs, allowing turbines to be placed in less windy areas. As of 2019, wind power was the largest source of renewable energy in the country, providing 7.2% of U.S. energy. Modern utility-scale wind power installations (wind facilities) often encompass tens or hundreds of turbines, generating hundreds of MW of energy each year. Installed wind capacity in the U.S. as of 2020 was 104,628 MW. The remarkable potential for bat mortality at wind facilities became known around 2003, when post-construction studies at the Buffalo Mountain, Tennessee, and Mountaineer, West Virginia, wind projects documented the highest bat mortalities reported at the time (31.4 bats/MW and 31.7 bats/MW, respectively). Bat fatalities continue to be documented at wind power installations across North America and Europe. Bat fatality varies across facilities, between seasons, and among species. The effectiveness of curtailment at reducing species-specific fatality rates for tricolored bats, however, has not been documented (USFWS, 2021).

**Stressor:** Climate change (USFWS, 2021)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** There is growing concern about impacts to bat populations in response to climate change from changes in hibernation, mortality from extreme drought, cold, or excessive rainfall, cyclones, loss of roosts from sea level rise, and impacts from human responses to climate change (e.g., wind turbines). Climate change is also likely to influence disease dynamics as temperature, humidity, phenology and other factors affect the interactions between Pd and hibernating bats. However, the impact of climate change is unknown for most species. Climate change may impact these bats in ways that are more difficult to measure. This may include phenological mismatch (e.g., timing of various insect hatches not aligning with key life history periods of spring emergence, pregnancy, lactation, or fall swarming). In addition, there may be shifts in distribution of forest communities, invasive plants, invasive forest pest species, or insect prey. Long-term increases in global temperatures are correlated with shifts in butterfly ranges and similar responses are anticipated in moths and other insect prey. Milder winters may result in range expansions of insects or pathogens with a distribution currently limited by cold temperatures (e.g., hemlock woolly adelgid (Adelges tsugae), southern pine beetle (Dendroctonus frontalis)) (USFWS, 2021).

**Stressor:** Habitat loss (USFWS, 2021)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Changes in landcover may be associated with losses in suitable roosting or foraging habitat, longer flights between suitable roosting and foraging habitats due to habitat fragmentation, fragmentation of maternity colonies, and direct injury or mortality. While temporary or permanent habitat loss may occur throughout the species’ range, impacts to the tricolored bat and its habitat typically occur at a more local-scale (i.e., individuals and potentially colonies). Impacts to tricolored bats from loss of habitat vary depending on the timing, location, and extent of the removal. Impacts from forest habitat removal may range from minor (e.g., removal of a small portion of foraging habitat in largely forested landscapes with robust tricolored bat populations) to significant (e.g., removal of roosting habitat in highly fragmented landscapes with small, disconnected populations). Adverse impacts are more likely in areas with

little forest or highly fragmented forests (e.g., western U.S. and central Midwestern states), as there is a higher probability of removing roosts or causing loss of connectivity between roosting and foraging habitat (USFWS, 2021).

***Recovery***

***Conservation Measures and Best Management Practices:***

- To reduce bat fatalities, some facilities “feather” turbine blades (i.e., pitch turbine blades parallel with the prevailing wind direction to slow rotation speeds) at low wind speeds when bats are more at risk. The wind speed at which the turbine blades begin to generate electricity is known as the "cut-in speed," and this can be set at the manufacturer's speed or at a higher threshold, typically referred to as curtailment. Most studies have shown all-bat fatality reductions of >50% associated with feathering below wind speeds of 4.0–6.5 meters per second (m/s) (USFWS, 2021).
- Conservation Measures Associated with WNS There are multiple national and international efforts underway in attempt to reduce the impacts of WNS. To date, there are no proven measures to reduce the severity of impacts. Efforts associated with the national response to WNS were initially aimed at determining the cause of the disease and reducing or slowing its spread. The response broadened and was formalized by the National Plan for Assisting States, Federal Agencies, and Tribes in Managing White-nose Syndrome in Bats which provides the strategic framework for implementation of a collaborative, national response to WNS by state, Federal, Tribal and non-governmental partners (USFWS 2011). The U.S. plan integrates closely with a sister plan for Canada, assuring a coordinated response across much of North America. Implementation of the WNS National Plan is overseen by executive and steering committees comprising representation from the Department of Interior, Department of Agriculture, Department of Defense, and State wildlife agencies under the authority of a multi-species recovery team under the ESA, with the USFWS serving the lead coordinating role. In 2021, the WNS National Plan is being revised to reflect current state of knowledge and identify key elements to continue to effectively respond to this disease. Goals and actions address the greatest needs and knowledge gaps to be pursued, including: coordinated disease surveillance and diagnostic efforts; inter-programmatic data management; development and implementation of disease management, conservation and recovery strategies; and communication and outreach among partners and with the public. These efforts are also supported by the North American Bat Monitoring Program (NABat), which is coled by USGS and USFWS, to integrate data across jurisdictional borders in support of population level information that supports management decisions at different scales. Actions under the National Plan are intended to be supported through multiple funding programs in different agencies. For several years, many state, Federal, Tribal, and private partners have annually provided funding and physical efforts or both toward WNS research. For its part, the USFWS supports management activities of many partners, research to address key information needs, and development and application of management solutions. The USFWS maintains a website (www.whitenosesyndrome.org) and social media accounts to address many of the communication needs for both internal and external audiences. Over 100 state and Federal agencies, Tribes, organizations and institutions are engaged in this collaborative work to combat WNS and conserve affected bats. Partners from all the states in TCB’s range, Canada, and Mexico are engaged in collaborations to conduct disease surveillance, population monitoring, and management actions in preparation for or response to WNS (USFWS, 2021).
- Roosting/Foraging/Commuting Habitat Loss Conservation Measures All states have active forestry programs with a variety of goals and objectives. Several states have established habitat protection buffers around known Indiana bat hibernacula that will also serve to benefit TCB by maintaining

sufficient quality and quantity of swarming habitat. Some states conduct some of their own forest management activities in the winter within known federally listed endangered and/or threatened bat home ranges, as a measure that would protect maternity colonies and nonvolant pups during summer months. The USFWS routinely works with project sponsors and Federal agencies to minimize the amount of forest loss associated with their projects and to provide mitigation for impacts associated with forest loss within the range of the federally listed Indiana bat. Examples of largescale efforts to address impacts associated with habitat loss include: rangewide transportation consultation for Indiana bats and northern longeared bat 9 , NiSource Habitat Conservation Plan10, and rangewide in-lieu fee program for Indiana bats. Many of the beneficial actions associated with these and similar efforts may benefit TCB if they occur in overlapping ranges. Depending on the type and timing of activities, forest management can be beneficial to bat species (e.g., maintaining or increasing suitable roosting and foraging habitat). Forest management that results in heterogeneous (including forest type, age, and structural characteristics) forest habitat appears to benefit North American tree roosting bats (Silvis et al. 2016, p. 37). For example, creation of small canopy openings could increase solar exposure to roosts, leading to warmer conditions that result in more rapid development of young (Perry and Thill 2007, p. 224). Preserving mature forest habitats should allow for increased roosting opportunities (Veilleux et al. 2003, p. 1072; Perry and Thill 2007, p. 978; Thames 2020, pp. 32– 34) which may increase survival or reproductive success. Consequently, we should continue to pursue tried and true management approaches, such as providing for the continual recruitment of mature forest in landscapes with a variety of well-connected forested habitat types (USFWS, 2021).

- Conservation Measures Addressing Hibernacula Loss and Disturbance Protecting TCB from disturbance during winter is essential because increased arousals from hibernation require greater energy expenditures at a time when food and water resources are scarce or unavailable. This is even more important for hibernacula impacted by WNS because more frequent arousals from torpor increases the probability of mortality in bats with limited fat stores (Boyles and Willis 2010, p. 96). One method of reducing disturbance at bat hibernacula is through installation of bat-friendly gates that allow passage of bats while reducing disturbance from human entry as well as avoiding changes to the cave microclimate from air restrictions (Kilpatrick et al. 2020, p. 6). Many state and Federal agencies, conservation organizations, and land trusts have installed batfriendly gates to protect important hibernation sites. The National Park Service has proactively taken steps to minimize effects to underground bat habitat resulting from vandalism, recreational activities, and abandoned mine closures (Plumb and Budde 2011, unpublished data). Further, the USFS has closed hibernacula during the winter hibernation period, primarily due to the threat of WNS, although this will reduce disturbance to bats in general inhabiting these hibernacula (USFS 2013, unpaginated). Because of concern over the importance of bat roosts, including hibernacula, the American Society of Mammalogists developed guidelines for protection of roosts, many of which have been adopted by government agencies and special interest groups (Sheffield et al. 1992, p. 707). Also, regulations, such as the Federal Cave Resources Protection Act (16 U.S.C. 4301 et seq.), protects caves on Federal lands. Finally, many Indiana bat hibernacula have been gated and some have been permanently protected via acquisition or easement, which provides benefits to other bats that use these sites for hibernation (USFWS, 2021).

***Additional Threshold Information:***

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**References**

U.S. Fish and Wildlife Service. 2021. Species Status Assessment (SSA) Report for the Tricolored Bat (Perimyotis subflavus), Version 1.1. Hadley, Massachusetts. 166 pp.

# SPECIES ACCOUNT: *Perognathus longimembris pacificus* (Pacific pocket mouse)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; September 29, 1994 (59 FR 49752).

**Physical Description**

The Pacific pocket mouse (Perognathus longimembris pacificus) is a member of the family Heteromyidae. All members of this family are nocturnal granivores with external, fur-lined cheek pouches. The body pelage of the little pocket mouse is silky, and the dorsal pelage ranges in color from predominately brown, to a pinkish or ochraceous buff. The ventral pelage is whitish. There are typically two small patches of lighter hairs at the base of the ear. The tail can be either distinctly or indistinctly bicolored. The Pacific pocket mouse is among the smallest subspecies of little pocket mice, ranging up to 131 millimeters (mm) (5.2 inches [in.]) in length from nose to tip of tail. Little pocket mice weigh 7 to 9 grams (0.25 to 0.33 ounces) (USFWS 1998).

**Taxonomy**

The Pacific pocket mouse is one of 16 recognized subspecies of the little pocket mouse (Perognathus longimembris) (USFWS 2010). This subspecies is the smallest member of the family Heteromyidae, which consists of spiny pocket mice (Heteromys and Liomys), pocket mice (Perognathus and Chaetodipus), kangaroo rats (Dipodomys), and kangaroo mice (Microdipodops) (59 FR 49752).

**Historical Range**

Historical records indicate that the Pacific pocket mouse occurred in eight general areas, encompassing some 29 separate trapping sites. The records included locations in Los Angeles County in Marina del Rey/El Segundo, Wilmington, and Clifton. Locations in Orange County include the San Joaquin Hills and Dana Point. The species was found in Black Gully and nearby "Spyglass Hill" in the San Joaquin Hills. There are possible recent records from Crystal Cove State Park, although they are awaiting confirmation due to uncertainty over results of recent walk-over and trapping surveys. In San Diego County, the Pacific pocket mouse occurred at three general locales: the San Onofre Area, the Santa Margarita River Estuary, and the lower Tijuana River Valley (59 FR 49752).

**Current Range**

The Pacific pocket mouse is endemic to the immediate coast of southern California—from Marina del Rey and El Segundo in Los Angeles County, south to the vicinity of the Mexican border in San Diego County. Range-wide surveys and all other relevant information indicate that the Pacific pocket mouse remains patchily distributed. Much of the habitat that may have supported the subspecies has been lost in association with large-scale development of the coastal lowlands of southern California. There are no records of Pacific pocket mouse from Los Angeles County since 1938, and the Clifton and Wilmington locales have been developed. Habitat in the Hyperion area of Marina del Rey/El Segundo has been lost to urban development. The El Segundo dunes contain the best remaining habitat in the vicinity of Marina del Rey/El Segundo, but a portion of the dunes formerly supported a residential development and this area has reportedly been trapped extensively without success. Between 1972 and 1993, there were no records of the Pacific pocket mouse until the subspecies was rediscovered at the Dana Point Headlands in Orange County. This was the only known extant population of the subspecies at the time of its listing in 1994. Shortly thereafter, Pacific pocket mouse was discovered at three additional locations, all within the boundaries of Marine Corps Base Camp Pendleton in San Diego County. The sites include San Mateo North, on a south-facing slope in the northwestern corner of Camp Pendleton; San Mateo South, in a military training area on Camp Pendleton, approximately 3.2 kilometers (km) (2 miles [mi.]) from the coastline; and Santa Margarita, immediately north of the Santa Margarita River (USFWS 2010). Current occupied habitat for the Pacific pocket mouse is estimated to be less than 100 total acres at the three sites (Bolster 1998).

**Distinct Population Segments Defined**

No

**Critical Habitat Designated**

No;

***Life History***

**Feeding Narrative**

Adult: The Pacific pocket mouse collects and stores seeds in fur-lined cheek pouches (USFWS 1998). They primarily consume seeds, selecting seeds averaging 1.4 mm (0.06 in.) in size, and occasionally feed on insects and green vegetation (USFWS 2010). They have a low bioenergetic requirement; they are nocturnal and hibernate/aestivate based on food availability and temperature (USFWS 2010). Co-occurring rodents of similar size (such as the western harvest mouse [Reithrodontomys megalotus]) may compete for the same seeds (USFWS 2010). An intensive field study of the dietary preferences of Pacific pocket mouse, based on fecal analysis, found that their diet included arthropods and seeds or green vegetation from California buckwheat (Eriogonum fasciculatum), California broom (Lotus scoparius), lemonadeberry (Rhus integrifolia), sage (Salvia sp.), storksbill (Erodium sp.), Cleveland's cryptantha (Cryptantha clevelandii), and grasses. They were also found to consume a higher proportion of forb seeds in the spring, and a higher proportion of grass seeds later in the year, which may relate to seasonal food availability (USFWS 2010).

**Reproduction Narrative**

Adult: Relatively little is known of the breeding biology of Pacific pocket mice. The Pacific pocket mouse breeding season begins in April and runs through July; pregnant and lactating females have been found from April through June, with immatures noted from June through September (USFWS 1998). The little pocket mouse has a gestation period of 22 to 23 days. The Pacific pocket mouse typically has one litter per year, but may have as many as to two litters per year, with approximately two to eight young per litter (NatureServe 2015). The young are weaned around 30 days, and sexual maturity is reached at 41 days of age. A small number of juveniles may breed within 1 month of weaning (USFWS 1998). The sex ratio of this subspecies varies by population: at the Dana Point Headlands, the sex ratio was 1.1 to 1 (male to female); at the San Mateo Creek population, the sex ratio was 0.8 to 1 (male to female) (USFWS 1998). The lifespan is approximately 4 to 6 years in captivity. Key resources needed for reproduction include suitable habitat and an abundance of green vegetation for feeding and nesting purposes.Larger population size and greater survivorship are positively associated with rainfall and annual plant seed availability. These factors suggest that the Pacific pocket mouse may be capable of shifting demographic strategies depending on resource availability. Under periods of high rainfall and plant production, the Pacific pocket mouse is likely to exhibit maximum reproduction and relatively low survival rates, while minimum reproduction and maximum survival rates would be expected during times of drought and poor primary production (USFWS 2010).

**Spatial Arrangements of the Population**

Adult: Clumped

**Environmental Specificity**

Adult: Narrow/specialist.

**Tolerance Ranges/Thresholds**

Adult: Low

**Site Fidelity**

Adult: Low

**Dependency on Other Individuals or Species for Habitat**

Adult: Observations on captive animals indicate that this subspecies, like other heteromyids, is aggressively solitary (USFWS 1998).

**Habitat Narrative**

Adult: The Pacific pocket mouse is commonly associated with coastal sage scrub vegetation, but has been found in a range of plant communities, including coastal strand, coastal dunes, ruderal vegetation on river alluvium, and coastal sage scrub. Within these vegetation associations, the Pacific pocket mouse is thought to prefer open, sparsely vegetated areas and small open patches in dense vegetation (USFWS 2010). The subspecies occurs on fine-grain, sandy or gravelly substrates in the immediate vicinity (within 4 km [2.5 mi.]) of the Pacific Ocean (USFWS 1998). Sandy soils may be necessary for constructing their burrows, where they cache food. Observations on captive animals indicate that this subspecies, like other heteromyids, is aggressively solitary (USFWS 1998). Key resources needed for habitat include sandy soils with open, sparsely vegetated areas and small open patches in dense vegetation. The Pacific pocket mouse has not been documented in dense nonnative grasslands, which are often associated with loam to clay soils. It is therefore suspected that the density of vegetation at ground level, along with the soil conditions, make this vegetation community unsuitable for this subspecies (USFWS 2010).

***Dispersal/Migration***

**Motility/Mobility**

Adult: Low

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: Nonmigratory

**Dispersal**

Adult: Moderate; Pacific pocket mice exhibit substantial individual variability in movement, with some individuals appearing to remain relatively sedentary and others making long-distance excursions of 150 meters (m) (492 feet [ft.]) or more, sometimes coinciding with a shift in use area. Males consistently are observed to have larger home ranges than females, with additional variability in movement over time and space possibly relating to breeding status, the age composition of the population, population density, and/or site conditions (USFWS 2010).

**Immigration/Emigration**

Adult: Immigrates/emigrates; may be able to quickly colonize unoccupied suitable habitat adjoining areas of occupancy, with the rate of invasion likely dependent on the density of the surrounding population (USFWS 2010).

**Dispersal/Migration Narrative**

Adult: The Pacific pocket mouse is a relatively sedentary subspecies with low mobility. It is nonmigratory, but has a moderate capacity for dispersal. Pacific pocket mice exhibit substantial individual variability in movement, with some individuals appearing to remain relatively sedentary and others making long-distance excursions of 150 m (492 ft.) or more, sometimes coinciding with a shift in use area. Males consistently are observed to have larger home ranges than females, with additional variability in movement over time and space possibly relating to breeding status, the age composition of the population, population density, and/or site conditions. They may immigrate/emigrate to quickly colonize unoccupied suitable habitat adjoining areas of occupancy, with the rate of invasion likely dependent on the density of the surrounding population. In 1993, 36 animals were captured in approximately 1.4 ha (3.5 ac.) of occupied habitat on the Dana Point Headlands. One study reported a movement (by recapture) of about 22 m (72 ft.). Most other recaptures are at the first capture location (USFWS 2010).

**Additional Life History Information**

Adult: In 1993, 36 animals were captured in approximately 1.4 hectares (ha) (3.5 acres [ac.]) of occupied habitat on the Dana Point Headlands. One study reported a movement (by recapture) of about 22 m (72 ft.). Most other recaptures are at the first capture location (USFWS 2010).

***Population Information and Trends***

**Number of Populations:**

3 (USFWS 2020)

**Additional Population-level Information:**

A genetic study found that, among the extant populations, San Mateo North and San Mateo South share the greatest number of genetic markers. This suggests that these populations were the most recent to be historically connected. Currently, these sites appear to be effectively isolated from one another and are separated by fallow agricultural fields and associated roads in the San Mateo floodplain, San Mateo Creek, a State Park campground, and Cristianitos Road. The Santa Margarita population, the largest of the known extant occurrences of the Pacific pocket mouse, is critical to maintenance of the subspecies because it is the only known population of appreciable size and extent where large numbers and re-colonization dynamics are likely to protect against localized extirpations (USFWS 2010).

**Population Narrative:**

PPM is currently extant at three fragmented populations, which are impacted by small population size and other threats discussed under Factors A, C, and E. The fragmented, relatively small populations are vulnerable to demographic, genetic, and environmental stochasticity (random fluctuations in sex ratios; loss of alleles or shifts in allele frequencies; and random, natural events impacting populations, respectively), and genetic study reveals that all of the PPM populations are vulnerable to continued loss of genetic variation over time. Loss of genetic variation decreases the capacity of PPM to adapt to changing environmental conditions in the future, and to withstand population-level disturbances from human activities (military training activities, construction and maintenance activities, etc.), predators, or nonnative species. (USFWS, 2020)

***Threats and Stressors***

**Stressor:** Habitat destruction
**Exposure:** Urban, suburban, and agricultural uses.
**Response:** Mortality
**Consequence:** Extirpation of populations, and extinction.
**Narrative:** The conversion of native habitats resulting from urban, suburban, and agricultural development apparently is the leading cause of the large-scale destruction of Pacific pocket mouse habitat. A recent comprehensive review of the Pacific pocket mouse included considerations of the fate of confirmed (historically-occupied) Pacific pocket mouse habitat. The large majority of native habitats within the historic range of the Pacific pocket mouse in coastal Los Angeles, Orange, and San Diego counties has been converted to urban, suburban, and agricultural uses (USFWS 1998).

**Stressor:** Habitat loss and fragmentation
**Exposure:** Development in coastal southern California.
**Response:** Removal and degradation of habitats.
**Consequence:** Smaller populations, increased risk of extinction, and increased susceptibility to stochastic events.
**Narrative:** Habitats within the historic range of the Pacific pocket mouse have been highly fragmented or degraded by highways, roads, structures, lighting, foot traffic, other human activities, and the proliferation of nonnative plant and animal species (USFWS 1998). There is a potential that undiscovered populations of the Pacific pocket mouse may persist within their historic range. Habitat loss and habitat fragmentation in coastal southern California have continued and are likely to continue in the foreseeable future. The development continues to fragment the remaining coastal habitat with the potential to support Pacific pocket mice within their historical range (USFWS 2010). Fragmented and degraded habitats support smaller populations, which are more susceptible to random extinction events (USFWS 1998).

**Stressor:** Nonnative Argentine ants (Linepithema humile)
**Exposure:** Argentine ants have invaded coastal sage scrub in Pacific pocket mouse habitat.
**Response:** They may displace native ants.
**Consequence:** Native ants are important for seed dispersal in habitat fragments. Argentine ants have the potential to alter ecosystem processes important for maintenance of the sage scrub vegetation community by displacing native ants (USFWS 2010).
**Narrative:** Nonnative Argentine ants have been identified as a potential threat to the Pacific pocket mouse, because of their ability to displace native ants that are important for seed

dispersal in habitat fragments. This threat was identified based on the potential for Argentine ants to alter ecosystem processes important for maintenance of the sage scrub vegetation community occupied by the Pacific pocket mouse (USFWS 2010).

**Stressor:** Depredation: domestic and feral cats
**Exposure:** Occur in residential developments that are adjacent to Pacific pocket mouse populations.
**Response:** Domestic and feral cats have the ability to rapidly deplete rodent populations.
**Consequence:** May diminish remaining populations of the Pacific pocket mouse.
**Narrative:** Domestic and feral cats have been observed entering occupied Pacific pocket mouse habitat at San Mateo South. Cats pose a predatory threat to Pacific pocket mice at the San Mateo South location and other known population locations. Cats have the ability to rapidly deplete rodent populations (USFWS 2010).

**Stressor:** Small population size
**Exposure:** Pacific pocket mice can sometimes exhibit dramatic population fluctuations.
**Response:** Small populations are more likely to become extirpated due to demographic, environmental, and genetic stochastic risks.
**Consequence:** Extirpation of populations, and extinction.
**Narrative:** Pacific pocket mice can sometimes exhibit dramatic population fluctuations. Small populations are more likely to become extirpated due to demographic, environmental, and genetic stochastic risks (USFWS 2010).

**Stressor:** Military training activities
**Exposure:** Increased foot and off-road vehicle traffic, and addition of new training elements.
**Response:** Removal or reduction of vegetation, and soil compaction.
**Consequence:** Crushing of burrows, and reducing the quality of soils for constructing burrows.
**Narrative:** Military training at the Oscar One training site has caused observed impacts, including removal or reduction of vegetation, soil compaction, addition of new training elements, and increased foot and off-road vehicle traffic. Direct impacts to mice have included crushing of burrows, degradation of habitat quality by reducing vegetative cover and availability of seed resources, and reduction in the quality of soils for constructing burrows (USFWS 2010).

**Stressor:** Fire and fuel management
**Exposure:** Fire suppression at Dana Point and San Mateo North, as well as prescribed fire within the Santa Margarita Pacific at Camp Pendleton.
**Response:** Alteration of habitat and available food resources.
**Consequence:** Stress on remaining populations, contributing to population decline.
**Narrative:** Fire management practices, both for fire suppression and for prescribed fire, have impacts on the habitat of the Pacific pocket mouse. At Dana Point and San Mateo North, a lack of recent fire has resulted in a majority of these sites being dominated by mature large-stature sage scrub shrubs that overlap with one another and provide nearly continuous canopy cover over the ground. This may be reducing habitat quality for the Pacific pocket mouse by eliminating habitat openings and by suppressing growth of annual forbs and grasses that are an important source of seeds. Prescribed fire is frequently used within the range of the Santa Margarita population to prevent fires ignited by ordnance training from escaping the vicinity of the live firing ranges. It is likely that the high frequency of fires in Edson Range is suppressing the Pacific pocket mouse population (USFWS 2010).

**Stressor:** Recreational activities
**Exposure:** Public use.
**Response:** Habitat disturbance and degradation, and invasion by nonnative species.
**Consequence:** Increased extirpation risks.
**Narrative:** Recreational use of areas that contain Pacific pocket mouse populations occurs in Dan Point Headlands, San Mateo North, and San Mateo south. Use of these areas may cause habitat disturbances, including deposition of trash, creation of trails, bare areas, and compacted soils. Indirect impacts may include the invasion of these sites by nonnative annual grasses and weeds, and disturbance by nonnative animals. This may exacerbate the extirpation risks of these populations by degrading habitat quality (USFWS 2010).

**Stressor:** Existing regulatory mechanisms
**Exposure:** Populations occurring on federally owned land.
**Response:**
**Consequence:** May exacerbate the extirpation risks of these populations by degrading habitat quality.
**Narrative:** Three of the four known extant populations occur on federally owned land in Marine Corps Base Camp Pendleton. The interagency consultation requirements of the Endangered Species Act (ESA) are the primary regulatory mechanism mandating Pacific pocket mouse conservation, and are likely inadequate to provide for conservation of the Pacific pocket mouse in the absence of the protections afforded by ESA. These impacts may exacerbate the extirpation risks of these populations by degrading habitat quality (USFWS 2010).

***Recovery***

**Reclassification Criteria:**
Recovery of the Pacific pocket mouse will likely take approximately 25 years. The U.S. Fish and Wildlife Service (USFWS) may consider reclassifying the Pacific pocket mouse to threatened status if and when:

Ten populations are independently viable and stable or increasing, and their habitats are secure (free from risk of loss) and fully protected through fee ownership by a resource agency or conservation program, conservation easement, or other means of permanent protection. Populations of Pacific pocket mice shall be considered viable if the appropriate analysis of measured population parameters indicate that each population has a 95 percent or greater chance of surviving for 100 years (USFWS 2010).

Occupied habitat consists of a minimum of 2,000 ha (4,940 ac.) that are secure and fully protected through fee ownership by a resource agency or conservation program, conservation easement, or other means of permanent protection (USFWS 2010).

All Pacific pocket mouse populations are managed through a program to maintain genetic diversity for future generations (USFWS 2010).

All Pacific pocket mouse populations and essential habitat are managed so that current and potential threats (e.g., predation and disease) are eliminated or minimized to the extent that each population is not at risk of extirpation. Essential habitat is defined to mean that habitat necessary for the full recovery of the subspecies (USFWS 2010).

**Delisting Criteria:**
The USFWS will consider delisting the Pacific pocket mouse if and when:

All actions necessary for reclassification to threatened have been implemented.

Any necessary protection, restoration, and enhancement activities (on all sites that have been determined to be essential to the recovery of the subspecies) are successfully completed (USFWS 1998).

Populations of the Pacific pocket mouse are representative of the full (existing) genetic variability and historical geographical range of the subspecies, and occur in habitats that collectively represent the full range of parameters observed and described in the past or during prescribed, future research and monitoring efforts (USFWS 1998).

To delist the subspecies, we must also determine that the following five factors no longer continue to adversely affect the survival and recovery of the subspecies: (1) the present or threatened modification, or curtailment, of the subspecies' habitat or range; (2) overutilization for commercial, recreational, scientific, or educational purposes; (3) disease and predation; (4) inadequacy of existing regulatory mechanisms; and (5) other human-made or natural factors affecting the continued existence of the subspecies. A final decision relating to the delisting of the subspecies would be made only after a thorough review of all relevant information, including prescribed research (USFWS 1998).

**Recovery Actions:**
- Identify and protect all extant populations and essential habitat (USFWS 1998).
- Prepare and implement habitat management plans (USFWS 1998).
- Enhance and expand Pacific pocket mouse habitat (USFWS 1998).
- Conduct research on the life history, ecology, and population biology of the Pacific pocket mouse (USFWS 1998).
- Identify and implement measures to create additional populations (USFWS 1998).
- Enhance public awareness of and appreciation for the Pacific pocket mouse recovery program through educational and interpretive programs (USFWS 1998).
- Work with the U.S. Marine Corps to develop and implement management plans to support extant populations at San Mateo North, San Mateo South, and Santa Margarita (USFWS 2010).
- Work with the San Diego Zoological Society Institute for Conservation Research to establish a captive-bred population of Pacific pocket mouse that can be used to support translocation research and establishment of additional Pacific pocket mouse populations (USFWS 2010).
- Work with the U.S. Marine Corps to perform translocation experiments in the vicinity of the Santa Margarita Pacific pocket mouse population (USFWS 2010).
- Assess the status of the San Mateo North Pacific pocket mouse population and translocate Pacific pocket mice to that location following habitat enhancement efforts to augment or reestablish a Pacific pocket mouse population in this vicinity (USFWS 2010).
- Contact and work with landowners at identified receiver sites to obtain permission and perform environmental reviews necessary to support translocations to those sites (USFWS

2010).

- Work with the Marine Corps to reestablish functional connectivity between the San Mateo North and San Mateo South Pacific pocket mouse populations (USFWS 2010).
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***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS 1. Improve the status of Pacific pocket mouse on MCBCP by incorporating measures into the recently completed PPM Management Plan to avoid and minimize impacts to reduce military training impacts to the Santa Margarita population, and enhance habitat at South San Mateo and Santa Margarita. 2. Improve the status of PPM at Dana Point by implementing the Dana Point monitoring and habitat enhancement plan, and working with CNLM to revise and update the habitat monitoring and management plan for the Dana Point Preserve. 3. Finalize a PPM genetic management plan and implement strategies to maintain and increase genetic variation within the extant, captive, and reintroduced populations, with a particular focus to improve the genetic health of the Dana Point population over the near term. 4. Continue the PPM captive breeding program to provide a source of animals for reintroductions. 5. Continue efforts to create additional wild PPM populations from the captive population by: a) continuing with the reintroduction effort at LCWP; b) refining and adding to the prioritized list of reintroduction sites within the species historical range; and c) securing landowner permissions and authorizations to proceed with reintroductions at the top ranked sites. (USFWS, 2020)

***Additional Threshold Information:***

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# SPECIES ACCOUNT: *Peromyscus polionotus phasma* (Anastasia Island beach mouse)

***Species Taxonomic and Listing Information***

**Commonly-used Acronym:** AIBM

**Listing Status:** Endangered; 05/12/1989; Southeast Region (R4) (USFWS, 2016)

**Physical Description**

A large subspecies relative to other forms of the polionotus complex. Ten adult Anastasia island beach mice from the type locality averaged 138.5 millimeters (mm) (5.40 inches (in)) in total length and 53 mm (2.07 in) in tail length (Osgood 1909). Howell (unpublished ins, ca. 1940) described the coloration as light ochraceous buff dorsally, white underparts, a unicolor tail, and indistinct white markings on the nose and face (USFWS, 1993).

**Taxonomy**

The Anastasia Island beach mouse was described in 1898 by Bangs as a full species, Peromyscus phasma. Osgood (1909) relegated it to subspecific standing under P. polionotus. The type locality is Point Romo, Anastasia Island, St. Johns County, Florida. (USFWS, 1993).

**Historical Range**

Historic range: mouth of St. Johns River at Jacksonville (Duval County) to southern end of Anastasia Island (St. Johns County), Florida (NatureServe, 2015).

**Current Range**

Formerly occupied two adjacent barrier islands on Florida's east coast but currently restricted to the northernmost and southernmost ends of Anastasia Island (Frank and Humphrey 1992). In the early 1990s, a second population was being established within the historic range at Guana River State Park on an adjacent island several kilometers to the north (Frank 1992); as of early 1995, the reintroduction was going well (Tardona 1995) (NatureServe, 2015). At the time of listing in 1989, AIBM were known to occur along the 14.5 miles of Anastasia Island in St. Johns County, Florida within ASP and FMNM and in the dunes and swales in between. ASP continues to provide 3.5 miles of suitable habitat and undeveloped coastline to support AIBM at the north end of Anastasia Island (FDEP 2016). AIBM continue to occupy the narrow coastal dune habitat area between ASP and FMNM on private lands as well as several St. Johns County Parks (10 miles) (FWC, 2019; Miller 2019; Kropp and Dupree 2015; and Doonan pers. comm.). The width of this occupied habitat varies; Frank and Humphrey (1992) described an idealized cross section of dune topography for Anastasia Island which was approximately 500 feet wide, but most of the dune and swale habitat along the central section of Anastasia Island is much narrower due to the residential development of St. Augustine Beach, Butler Beach and Crescent Beach. AIBM continues to occupy the one mile of undeveloped coastal dune and swale habitat along the ocean and inlet shorelines at FMNM (FWC, 2019; Kropp and Dupree 2015). Habitat at FMNM is similar to ASP; however, beyond the primary dunes the habitat becomes woody, contains dense swales, and is bordered by oak forest to the west (Frank and Humphrey 1992; NPS 2012). Due to the interconnected habitat, Anastasia Island appears to support one population AIBM were reintroduced into historical habitat at GTMNERR in 1992-1993. Fifty-five mice (27 females and

28 males) were trapped at ASP (37) and FMNM (18) and placed in soft-release enclosures at GTMNERR (Frank 1995). This population was augmented again in 2000 (21 males and 12 females) trapped at ASP (33 total) (Bard pers. comm.). The last beach mouse was captured in 2006 and trapping ended in 2012 after 6 years with no captures (Marcum, pers. comm.) due to the probability of extirpation. There has not been any monitoring at this location since 2012 until a 2018 camera trap survey was conducted but it did not detect AIBM (USFWS 2018). It is possible AIBM have gone undetected due to the dynamic nature of small mammal populations and we currently consider the status of this population as unknown but likely extirpated. The 4.2 miles of undeveloped coastal habitat at GTMNERR provides a very narrow dune system for AIBM to use, as does the dune habitat north of GTMNERR along the remainder of the residential beaches to Mickler's Landing and very little dune and swale habitat south of the GTMNERR to St. Augustine Inlet (USFWS 2019)

**Distinct Population Segments Defined**

No

**Critical Habitat Designated**

No;

***Life History***

**Feeding Narrative**

Adult: Eats fruits and seeds of dune plants, especially sea oats and sea rocket; feeds on invertebrates when seeds scarce (Matthews and Moseley 1990).; Food Habits: Invertivore (Adult, Immature), Granivore (Adult, Immature)Primarily nocturnal.; (NatureServe, 2015)

**Reproduction Narrative**

Adult: May breed all year. Much breeding activity occurs November-January. Produces 2 or more litters per year. Gestation averages 23-24 days (nonlactating) or 28-29 days (lactating). Litter size averages 3-4 (USFWS 1988). Young are weaned in about 18 days. Minimum age at conception is 5 weeks. Apparently monogamous mating system (Kirkland and Layne 1989). Density in high quality habitat 2-90/ha (mean around 30/ha) (Frank 1992).; (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Beach dune and coastal strand habitats. Occurs in a narrow strip of sand dunes along the eastern side of Anastasia Island (Frank and Humphrey 1992). Favors beaches with grass/shrub cover. Sleeps and gives birth in underground burrows; entrances are in clumps of grass or beneath sheltering vegetation (Matthews and Moseley 1990). (NatureServe, 2015) Narrow environmental specificity, high ecological integrity, low tolerance range and high site fidelity are inferred based on the very specific habitat this species inhabits (NatureServe, 2015).

***Dispersal/Migration***

**Motility/Mobility**

Adult: High (NatureServe, 2015)

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: Non-migrant (NatureServe, 2015)

**Dispersal**

Adult: Low (inferred from NatureServe, 2015)

**Immigration/Emigration**

Adult: Unlikely (inferred from NatureServe, 2015)

**Dispersal/Migration Narrative**

Adult: Mice are highly mobile and NatureServe (2015) notes this species is non-migratory. Low dispersal and unlikely immigration/emigration are inferred based on species habitat and the isolated nature of the known populations (NatureServe, 2015).

***Population Information and Trends***

**Population Trends:**

short term trend = Increasing (NatureServe, 2015)

**Species Trends:**

Stable. At the time of listing in 1989, AIBM were distributed along the length of Anastasia Island, from the northern end at St. Augustine Inlet, Anastasia State Park (ASP), to the southern end at Matanzas Inlet, Fort Matanzas National Monument (FMNM). AIBM distribution in the coastal dunes and swales along the entire length of Anastasia Island continues today. Since the 2007 Review, there has been a decline in captures during trapping of the primary dunes at the northern section of ASP near the St. Augustine Inlet (FDEP 2016). This decline generally has corresponded to a net loss of primary dune habitat along the northern third of ASP. A 2011 track tube survey confirmed AIBM presence in the restored primary dune habitat at the south end of ASP, an area previously prone to overwash (Kropp and Dupree 2015). This is consistent with the observed habitat restoration and stability gained within the central and southern sections of the park since 2007. These ASP habitat conditions appear to be a function of one or more of the local, coastal navigation/shoreline/dune stabilization projects over the past twenty years, which include maintenance dredging of St. Augustine Inlet, dredging the inlet's ebb tidal shoal, and beach renourishment and dune stabilization efforts south of St. Augustine Inlet. Track tube and trapping surveys in 2011 confirmed that St. Augustine Beach, Butler Beach, and Crescent Beach dune habitats south of ASP and north of FMNM continue to be occupied (Kropp and Dupree 2015; Doonan, pers. comm.). These track tube surveys also indicated that FMNM continues to be occupied. Post Hurricane Mathew (2016) and Irma (2017) track tube monitoring indicate

AIBM continue to occupy the coastal dunes along the entire length of Anastasia Island (FWC 2019). We do not know the current status of the reintroduced population north of St. Augustine Inlet at the Guana-Tolomato-Matanzas National Estuarine Research Reserve (GTMNERR) which has over 4 miles of primary and secondary dunes and coastal scrub habitat located beyond this steep dune system. In 1992, 55 AIBM from ASP and FMNM were released in the coastal dunes of GTMNERR and appeared to flourish. In 2000 an additional 33 AIBM from ASP were released at GTMNERR. We reported in 2007 that this population was in decline and there had not been any captures since the summer of 2006. With no additional captures after 6 years, monitoring was discontinued in 2012 (Marcum, pers. comm.) due the probability that AIBM were extirpated from the GTMNERR. The effort to reintroduce mice into the historic range north of St. Augustine Inlet may have been unsuccessful. Due to the dynamic nature of small mammal populations, beach mice could have gone undetected and we consider the status of this small population as unknown but likely extirpated. In October 2016, Hurricane Matthew moved north along the Atlantic coast of Florida causing a substantial storm surge, erosion and destruction along Anastasia Island’s dune habitats. Hurricane Irma, which made landfall and traversed along Florida’s Gulf Coast in September 2017, also caused a storm surge event and additional damage to Anastasia Island’s coastal habitats. A multi-agency monitoring effort to better understand impacts from the hurricanes and improve recovery efforts was initiated in January 2018 and completed in March 2019 (FWC 2019) and is summarized as follows. Track tube stations were installed along the length of Anastasia Island; 131 track tubes were place at ASP, FMNM and at 4 St. Johns County (SJC) properties in between. Live-trapping was conducted along transects in suitable habitats at ASP (4 transects) and FMNM (3 transects) in June, September, and December 2018 to confirm species identification; opportunist trapping was done on the SJC properties. Initial track tube detection rates for AIBM were 32% at ASP and 36% at FMNM. Detection rates reached highs of 91% at ASP and 68% at FMNM in March, then declined through the fall before increasing again in December. Trapping data confirmed that AIBM was the only rodent species present in dune habitats at all sites. Results and observations indicate that AIBM and the coastal dune habitats they depend upon have been recovering from Hurricanes Mathew and Irma and that AIBM continue to occupy the coastal dunes along the entire length of Anastasia Island. As there was extensive loss and damage to fore dune habitats, a restoration strategy that is site-specific for ASP and FMNM has been developed and these strategies can be applied on county and private properties along the central section of Anastasia Island (Miller 2019). The AIBM distribution along Anastasia Island remains stable and the reintroduced population at GTMNERR is unknown and we believe they are likely extirpated (USFWS 2019).

**Number of Populations:**

1 - 5 (NatureServe, 2015)

**Population Size:**

1 - 1000 individuals (NatureServe, 2015

**Population Narrative:**

NatureServe (2015) notes that the short term trend for this species is increasing. In addition NatureServe notes that there are 1-5 known populations with the total number of individuals estimated between 1 and 1,000. Low resiliency, representation and redundancy are inferred from NatureServe (2015) based on low number of populations and restricted range and habitat.

***Threats and Stressors***

**Stressor:** Predation (NatureServe, 2015)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Beach mouse populations may be regulated by predation by house cats (Frank and Humphrey 1992, Frank 1992), populations of which are introduced/augmented through development. (NatureServe, 2015). Beach mice have a number of natural non-native predators including the coachwhip, corn snake, pygmy rattlesnake, Eastern diamondback rattlesnake, short-eared and great-horned owl, great blue heron, northern-harrier, loggerhead shrike, gray fox, striped skunk, long-tailed weasel, raccoon, bobcat, ghost crabs, red fox and coyotes (USFWS, 2007).

**Stressor:** Development/Construction/Beach driving (NatureServe, 2015)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Development has degraded and fragmented much of the remaining habitat (Frank and Humphrey 1992) (NatureServe, 2015). Beach driving is also mentioned as a cause of human made habitat destruction (USFWS, 2007)

**Stressor:** Storms/hurricanes
**Exposure:**
**Response:**
**Consequence:** Loss of habitat/loss of individuals
**Narrative:** Vulnerable to extinction that could be caused by severe hurricanes (Frank 1992). (NatureServe, 2015)

**Stressor:** Climate change
**Exposure:** Sea level rise
**Response:** May alter habitat
**Consequence:** Population decline
**Narrative:** Sea level rise is a long-term threat to AIBM and all coastal dependent species based on numerous prediction models. According to the Third National Climate Assessment, release May 2014, sea level rise and increasing storm surge events are occurring and are impacting coastal species and ecosystems (Melillo et al. 2014 and Wolf 2014). It is expected that low-lying coastal habitat will be affected most severely by sea level rise. Models such as the Sea Level Rise Affecting Marshes Model (SLAMM) can be used to project different levels of rise such as a 6-foot rise would remove significant amounts of habitat within ASP and FMNM. The varying and dynamic elements of climate science are inherently long term, complex, and interrelated. At present, the science is not exact enough to precisely predict when and where climate impacts will occur. Although we may know the direction of change, it may not be possible to predict its precise timing or magnitude. Future planning will include guidance and use scenario planning to develop management strategies that account for potential environmental changes, given the future uncertainties in climatic conditions (USFWS 2019).

***Recovery***

**Reclassification Criteria:**
1. The continued viability of the beach mouse populations at the northern and southern ends of Anastasia Island must be assured. Natural population fluctuations must be shown to remain within limits adequate to avoid extinction from chance events or genetic deterioration. Accordingly, each population of the mouse should support a breeding population of 500 if the subspecies is to be considered for reclassification (USFWS, 1993).

2. At least two more viable populations should be established. These populations should be within the mainland portion of the historic range of the subspecies (USFWS, 1993).

3. All populations should be monitored for at least 5 consecutive years to assure that condition 1 is met before considering reclassification (USFWS, 1993).

Recovery Priority Number: 6C

**Delisting Criteria:**
The Anastasia Island beach mouse shall be considered for delisting when the following criteria are met: 1. The three (3) Anastasia Island Resiliency Units (RU) exhibit stable or increasing demographic and/or occupancy trends as compared to historic levels, and exhibit natural recruitment. (addresses Factors A, C and E) 2. Establish two (2) Resiliency Units of AIBM through reintroduction between St. Augustine Inlet and the St. Johns River that exhibit stable or increasing demographic trends and are comparable to the ASP and FMNM RUs, and exhibit natural recruitment. (addresses Factors A, C and E) 3. When in addition to the above criteria, it can be demonstrated that despite habitat loss associated with sea level rise and development within all of the RUs, sufficient suitable habitat remains for AIBM to remain viable into the foreseeable future. (addresses Factors A, C and E) (viable per criterions 1 and 2) (USFWS 2019b)

**Recovery Actions:**
- Protect beach mouse habitat. Use provisions of the ESA to protect beach mice. Protect beach mouse on private lands. Implement or encourage specific management actions (USFWS, 1993).
- Monitor beach mice. Both subspecies should be monitored to assure that further declines in range and numbers do not occur without recovery actions being taken. Monitoring will also provide information on sites from which to select animals for reintroduction. Both trapping and sign should be used in monitoring these subspecies (USFWS, 1993).
- Reestablish populations. Identify recipient sites. Identify donor populations. Release mice into new sites. Monitor introduced populations (USFWS, 1993).
- Initiate captive propagation. Identify donor site for breeding stock. Establish breeding colony. Identify and prepare recipient sites. Reintroduce mice. Monitor success of new populations (USFWS, 1993).
- Educate public. The general public regularly uses beach areas in and adjacent to beach mouse habitat for recreational purposes. Public support for beach mouse recovery should therefore be encouraged. The public should understand that continued existence of beach mice is an indication that healthy beach and dune systems are being maintained. Responsible agencies should produce brochures, signs, and other materials to educate the public about the ecological role of beach mice in beach and dune communities. The public should be informed of recreational practices that are compatible with the continued existence of beach mice (USFWS, 1993).

- Revise the current recovery plan to define objective measurable criteria (both reclassification and delisting criteria), better address the five factors, and update ecological information for the AIBM. Currently, the recovery plan includes both the AIBM and the Southeastern beach mouse. Individual plans should be developed for these two subspecies to address the specific recovery actions and recovery criteria relating to each subspecies (USFWS 2019).
- Continue fostering a working partnership with partners and stakeholders: Florida Fish and Wildlife Conservation Commission, Florida Department of Environmental Protection's Anastasia State Park and Division of Beaches and Shores, U.S. Army Corps of Engineers, Fort Matanzas National Monument, Guana-Tolomoto-Matanzas National Estuarine Research Reserve, and St. Johns County and beach front communities of South Ponte Vedra, Vilano Beach, St. Augustine Beach, Butler Beach and Crescent Beach for recovery of Anastasia Island beach mouse and all beach mice subspecies (USFWS 2019).
- Develop an emergency response plan to outline and update actions to be taken in case of severe threats to the persistence of AIBM (i.e., forecasted category 5 hurricane, feral cat population increase, population crash) (Traylor-Holzer and Lacy 2007). An emergency action plan has been developed for ASP, which provides a protocol for the live trapping and removal of mice from the park in case of a hurricane (FDEP 2016) (USFWS 2019).
- Improve the management of AIBM habitat at ASP, FMNM, GTMNERR and St. Johns County Parks to expand and or improve the available habitat and travel corridors for AIBM. Enforce the use of crossovers in areas with suitable beach mouse habitat to reduce impacts to the dunes. Restore and manage habitats with native plant species that are also food sources for AIBM. Continue to educate the public at the public parks about the importance of the dune habitat (USFWS 2019).
- Develop and implement a monitoring program for AIBM, including a survey to determine presence/absence of the reintroduced population at GTMNERR. This plan should include some goals and objectives such as habitat mapping; obtaining demographic, landscape, or dispersal data; estimating future population trends or the likelihood of extinction; assessing management options; or evaluating future research priorities. A monitoring program is necessary for several other recommendations listed, particularly the Emergency Response Plan, land acquisition, translocation, and habitat management projects (USFWS 2019).
- A comprehensive translocation plan is needed to identify key sites, set criteria for when translocations are needed, consider genetic as well as demographic characteristics of the donor and recipient populations, and should include an assessment of the suitability of the recipient habitat (i.e., habitat quality, have feral cats and other threats been minimized or removed) (USFWS 2019).
- Continue genetic sampling and conduct a taxonomic assessment of the species and its subspecies. A priority is to determine genetic diversity across Anastasia Island and set goals for improving. Sampling can also tell us if inbreeding depression is occurring. This information will help the Service determine what constitutes a stable population for AIBM recovery (USFWS 2019).
- Perform a population viability analysis to estimate the probability of survival of beach mice populations of differing effective breeding size (USFWS 2019).
- Remove feral cats from areas of suitable AIBM habitat. Develop an outreach/education program focused on the threats feral and free-ranging cats pose to wildlife (USFWS 2019).
- Use top down construction techniques for new, repair or replacement of dune walkovers (USFWS 2019).

- Revise current recovery plan to include updated objectives and measurable recovery criteria (USFWS, 2007).
- Provide funding and technical support for further research on: The effects of prescribed burning and other management tools (e.g. removal of Wax myrtle) on AIBM. Continue working with public land managers to increase management of their sites. Improve the management of coastal strand habitat at GTMNEER-Guana River to expand all available habitat for AIBM. Continue genetic sampling of different populations. Perform population viability analysis to estimate probability of survival of animal populations of differing effective breeding size (USFWS, 2007).
- Develop an emergency response plan to outline actions taken in case of severe threats to the persistence of AIBM (USFWS, 2007).
- Develop and implement a monitoring program for AIBM (USFWS, 2007).
- Discuss with FMNM on how to better monitor beach mouse populations and manage the habitat, and address the threats for AIBM (USFWS, 2007).
- Develop a translocation plan to identify key sites, set criteria for when translocations are needed, consider genetic as well as demographic characteristics of the donor and recipient populations and include an assessment of the suitability of the recipient habitat. Public-private partnerships should also be explored (USFWS, 2007).
- Continue to educate the public (USFWS, 2007).
- Enforce the use of crossovers in areas with suitable beach mouse habitat to reduce impacts to the dunes (USFWS, 2007).
- Continue feral cat removal and control from areas of suitable AIBM habitat (USFWS, 2007).

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# SPECIES ACCOUNT: *Sorex ornatus relictus* (Buena Vista Lake ornate Shrew)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; March 6, 2002 (67 FR 10101).

**Physical Description**

The Buena Vista Lake shrew (Sorex ornatus relictus) has a long snout; tiny bead-like eyes; ears that are concealed, or nearly concealed, by soft fur; and five toes on each foot (65 FR 35033). The upper surface of the Buena Vista Lake shrew is blackish-brown, with a pepper-and-salt pattern of buffy brown and black, the black predominating. The sides are more buffy brown than the upper surface. The lower surface is smoke gray. The tail is not noticeably bicolored and darkens toward the end, both above and below. Ranges of external measurements from the type specimen and two additional specimens are: total length, 98 to 105 millimeters (3.86 to 4.13 inches [in.]); tail length, 35 to 39 mm (1.38 to 1.54 in.); hind foot length, 11.5 to 13 mm (0.45 to 0.51 in.); and ear length from the notch 6.5 to 8.5 mm (0.26 to 0.33 in.). Weights ranged from 4.1 to 7.6 grams (0.14 to 0.27 ounce) (USFWS 1998).

**Taxonomy**

The Buena Vista Lake shrew is one of nine subspecies of the ornate shrew (Sorex ornatus). Seven of the subspecies occur only in California; one occurs in California and Baja California; and one subspecies only occurs in Baja California (USFWS 2011). The Buena Vista Lake shrew differs morphologically from ornate shrew (S. ornatus ornatus), whose range surrounds that of Buena Vista Lake shrew. The coloration of the Buena Vista Lake shrew is distinctly darker, grayish-black rather than brown. The body size is slightly larger, but the tail is shorter. The teeth are essentially the same, but the third and fifth unicuspids (teeth behind the incisors that have a single main cusp) are even smaller relative to the other teeth (USFWS 1998).

**Historical Range**

The Buena Vista Lake shrew formerly occurred in wetlands around Buena Vista Lake, and presumably throughout the Tulare Basin. The Tulare Basin, essentially occupying the southern half to the San Joaquin Valley, had no regular outlet to the ocean and contained Buena Vista, Kern, and Tulare lakes. These lakes were fed by the Kern, Kaweah, Tule and Kings rivers and their tributaries, and were interconnected by hundreds of square miles of tule marshes and other permanent and seasonal lakes, wetlands, and sloughs (USFWS 2011). As early as 1933, the distribution of this species began to be much more restricted due to the disappearance of lakes and sloughs. Buena Vista Lake and the surrounding lakes and valley freshwater marshes have been drained and cultivated. Furthermore, canals in the area are steep-sided and kept free of vegetation (USFWS 1998).

**Current Range**

For more than 50 years, the shrew was known only from the type locality at Buena Vista Lake, where it was presumed to be extinct because its wetland habitat had been replaced by residential and agricultural lands. The shrew was rediscovered at Kern Lake Preserve (Kern Preserve) in 1986, on private property, and at Kern National Wildlife Refuge (Kern NWR) in 1992. Other remnant patches of wetland and riparian communities within the Tulare Basin have not been surveyed and may support the Buena Vista Lake shrew. These include Jerry Slough, overflow channels of the Kern River owned and managed by the Semitropic Water District as a groundwater recharge basin 10 miles (mi.) south of Kern NWR; and the privately owned Creighton Ranch, near the eastern shore of historical Tulare Lake in Tulare County (USFWS 2011). The Buena Vista Lake shrew is now known from four isolated locations along an approximately 113-kilometer (70-mi.) stretch on the western side of the Tulare Basin. The four locations are the former Kern Preserve on the old Kern Lake bed, the Kern Fan recharge area, Cole Levee Ecological Preserve (Cole Levee), and the Kern NWR (67 FR 10101).

**Distinct Population Segments Defined**

No

**Critical Habitat Designated**

Yes; 1/24/2005.

**Legal Description**

On July 2, 2013, the Service designated approximately 2,485 acres (ac) (1,006 hectares (ha)), in six units in Kings and Kern Counties, California, as critical habitat for the subspecies.

**Critical Habitat Designation**

The six units designated are: (1) Kern National Wildlife Refuge Unit, (2) Goose Lake Unit, (4) Coles Levee Unit, (5) Kern Lake Unit, (6) Semitropic Ecological Reserve Unit, and (7) Lemoore Wetland Reserve Unit. Note that proposed Unit 3 (the Kern Fan Water Recharge Unit) has been excluded from final designation due to the existing habitat conservation plan.

Unit 1: Kern National Wildlife Refuge Unit Unit 1 consists of a total of approximately 387 ac (157 ha). The Kern NWR Unit is completely comprised of Federal lands, and is located within the Kern NWR in northwestern Kern County. The Kern NWR Critical Habitat Unit consists of three subunits: Subunit 1A is approximately 274 ac (111 ha); subunit 1B is 66 ac (27 ha); and subunit 1C is 47 ac (19 ha). The unit was occupied at the time of listing, is currently occupied, and contains the physical and biological features that are essential to the conservation of the shrew. Shrew habitat in Unit 1 receives water from the California Aqueduct. One of the areas where Buena Vista Lake shrews are present has standing water from September 1 through approximately April 15. After that time, the trees in the area may receive irrigation water so the area may possibly remain damp through May, but the area is dry for approximately 3 months during the summer. Another area of known Buena Vista Lake shrew occurrences has standing water from the second week of August through the winter and into early July, and is only dry for a short time during the summer. Buena Vista Lake shrew have been captured in remnant riparian and slough habitat at the Refuge (Service 2005, pp. 48, 49). Like all the critical habitat units we are designating here (see Criteria Used to Designate Critical Habitat, above), this unit is essential to the conservation of the shrew because it is occupied, and because the subunits include riparian habitat that contain the appropriate physical or biological features and primary constituent elements for the shrew. Populus fremontii trees (Fremont cottonwood) and Salix spp. (willow) are the dominant woody plants in riparian areas. Additional plants include bulrushes, cattails, Juncus spp. (rushes), Heleocharis palustris (spike rush), and Sagittaria longiloba (arrowhead). Other plant communities on the refuge that support shrews are valley iodine bush scrub, dominated by iodine bush, seepweed, Frankenia salina (alkali heath), and salt-cedar scrub, which is dominated by Tamarix spp. (salt cedar). Both of these communities occupy sites with moist, alkaline soils. The Kern NWR completed a Comprehensive Conservation Plan (CCP) for the Kern and Pixley NWRs in February 2005 (Service 2005, pp. 1-103). The CCP provides objectives for maintenance and restoration of Buena Vista Lake shrew habitat on the Kern NWR. Objectives listed in the CCP include: completing baseline censuses and monitoring for the shrew; enhancement and maintenance of the 215-ac (87-ha) riparian habitat through regular watering to provide habitat for riparian species including the shrew; and additional restoration of 15 ac (6 ha) of riparian habitat along canals in a portion of the Refuge to benefit the shrew and riparian bird species (Service 2005, pp. 84, 85). The physical and biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats from nonnative species such as salt cedar, and from changes in hydrology due to offsite water management.

Unit 2: Goose Lake Unit The Goose Lake Unit consists of a total of approximately 1,274 ac (515 ha) of private land, and is located about 10 mi (16 km) south of Kern NWR in northwestern Kern County, in the historical lake bed of Goose Lake. The Goose Lake Unit consists of two subunits: Subunit 2A contains 159 ac (64 ha), and Subunit 2B contains 1,115 ac (451 ha). We consider that the unit was occupied at the time of listing and assume that it was not identified as occupied at that time because it had not yet been surveyed for small mammals. In January 2003, when the area was first surveyed for small mammals, approximately 6.5 ac (2.6 ha) of potential shrew habitat located along the Goose Lake sloughs were surveyed (ESRP 2004, p. 8), resulting in the capture of five Buena Vista Lake shrews. The maximum distance between two shrew captures was 1.6 mi (2.6 km), suggesting that Buena Vista Lake shrews are widely distributed on the site. The unit has been determined to have the necessary physical or biological features present and therefore meets the definition of critical habitat under section 3(5)(A)(i) of the Act. The unit was included in the 2004 proposed critical habitat designation. Although we continue to presume that the unit meets the definition of critical habitat under section 3(5)(A)(i) of the Act (prong 1), we are also designating the unit under section 3(5)(A)(ii) of the Act (prong 2). As discussed above under Criteria Used To Identify Critical Habitat, even if subsequent evidence were to indicate that the unit was not occupied at the time of listing, it would remain critical habitat under the second prong of the Act's definition. The unit is essential for the conservation of the shrew because it is among the very few remaining areas that support both an extant shrew population and the physical and biological features necessary to conserve that population. In the past, Buena Vista Lake shrew habitat in this unit experienced widespread losses due to the diversion of water for agricultural purposes. However, small, degraded examples of freshwater marsh and riparian communities still exist in the area of Goose Lake and Jerry Slough (a portion of historical Goose Slough, an overflow channel of the Kern River), allowing shrews to persist in the area. Dominant vegetation along the slough channels includes frankenia, iodine bush, and seepweed. The northern portion of the unit consists of scattered mature iodine bush shrubs in an area that has relatively moist soils. The southern portion of the unit is characterized by a dense mat of saltgrass and clumps of iodine bush and seepweed. A portion of the unit currently exhibits inundation and saturation during the winter months. Dominant vegetation in these areas has included cattails, bulrushes, and saltgrass. The area consisting of the former bed of Goose Lake is managed by the Semitropic Water Storage District (WSD) as a ground-water recharge basin. Water from the California Aqueduct is transferred to the Goose Lake area in years of abundant water, where it is allowed to recharge the aquifer that is used for irrigated agriculture. At the time that the unit was originally proposed, the landowners, in cooperation with Ducks Unlimited, Inc. and Semitropic WSD, proposed to create and restore habitat for waterfowl in the unit area; wetland restoration that we expected to substantially increase the quantity and quality of Buena Vista Lake shrew habitat on the site. Restoration activities were completed in the last 6 years. The physical and biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats from nonnative species such as salt cedar, from recreational use, and from changes in hydrology due to water management and maintenance of water conveyance facilities. No conservation agreements currently cover this land.

Unit 4: Coles Levee Unit The Coles Levee Unit is approximately 270 ac (109 ha) in Kern County, of which 217 ac (88 ha) is owned by Aera Energy. An additional 46 ac (19 ha) are State lands within the Tule Elk Reserve, and 6 ac (2 ha) are part of a Kern County park. The unit is located northeast of Tupman Road near the town of Tupman, is directly northeast of the California Aqueduct, and is largely within the Coles Levee Ecosystem Preserve, which was established as a mitigation bank in 1992, in an agreement between Atlantic Richfield Company (ARCO) and CDFW. The preserve serves as a mitigation bank to compensate for the loss of habitat for listed upland species; the Buena Vista Lake shrew is not a covered species. ARCO had been issued an incidental take permit under section 10(a)(1)(B) of the Act for the Coles Levee Ecological Preserve Area (Service 2001, p. 1). However, the take authorization provided by the permit lapsed when ARCO sold the property to the current owner and the permit was not transferred. Habitat on the preserve consists mostly of highly degraded upland saltbush and mesquite scrub, and is interlaced with slough channels for the historical Kern River fan where the river entered Buena Vista Lake from the northeast. Most slough channels are dry except in times of heavy flooding. This site runs parallel to the Kern River bed and contains approximately 2 mi (3.2 km) of much-degraded riparian vegetation along the Kern River. A manmade pond, which was constructed in the late 1990s or early 2000s, is located within the unit. Water from the adjacent oil fields is constantly pumped into the basin. Vegetation includes bulrushes, Urtica dioica (stinging nettle), Baccharis salicifolia (mulefat), salt grass, Atriplex lentiformis (quailbush), and Conium maculatum (poison hemlock). A few willows and Fremont cottonwoods are scattered throughout the area. In the 2009 proposed rule (74 FR 53999. October 21, 2009), we reproposed 214 ac (87 ha) of critical habitat as the Coles Levee Unit. In this unit, Buena Vista Lake shrews were originally captured along a nature trail that was adjacent to a slough, and were close to the water's edge where there was abundant ground cover but little or no canopy cover. The unit is delineated in a general southeast to northwest direction, along both sides of the Kern River Flood Channel and Outlet Canal, which runs through the Preserve. During a construction project in the summer of 2011, two Buena Vista Lake shrews were found just north of the previous northerly boundary of the unit. We have therefore extended the unit boundary along both sides of the canal to encompass the contiguous riparian habitat to the point where water is no longer retained and riparian vegetation essentially stops, thereby including riparian habitat along the Outlet Canal within the Tule Elk Reserve. This unit is essential to the conservation of the species because it was occupied at the time of listing (67 FR 10102), is considered currently occupied, and includes willow-cottonwood riparian habitat that contains the PCEs. The physical and biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats from construction activities associated with projects to tie-in water conveyance facilities to the California Aqueduct and oil and gas- related activities, including pipeline projects. The area adjacent to Coles Levee is a site of active gas and oil production, and the Coles Levee Unit is within an area that was recently proposed for additional oil and gas exploration.

Unit 5: Kern Lake Unit The Kern Lake Unit is approximately 85 ac (35 ha) in size, and is located at the edge of the historical Kern Lake, approximately 16 miles south of Bakersfield in southwestern Kern County. This unit lies between Hwy 99 and Interstate 5, south of Herring Road near the New Rim Ditch. The Kern Lake Unit consists of two subunits: Subunit 5A contains 34 ac (14 ha), and Subunit 5B contains 51 ac (21 ha). The unit was occupied at the time of listing, is considered currently occupied, and contains the physical and biological features that are essential to the conservation of the Buena Vista Lake shrew. Since the advent of reclamation and development, the surrounding lands have seen intensive cattle and sheep ranching and, more recently, cotton and alfalfa farming. Currently, Kern Lake itself is generally a dry lake bed; however, the unit contains wet alkali meadows and a spring-fed pond known as ``Gator Pond,'' which is located near the shoreline of the lake bed. A portion of the runoff from the surrounding hills travels through underground aquifers, surfacing as artesian springs at the pond. The heavy clay soils support a distinctive assemblage of native species, providing an island of native vegetation situated among agricultural lands. The unit contains three ecologically significant natural communities: freshwater marsh, alkali meadow, and iodine bush scrub. This unit is essential to the conservation of the species because it is currently occupied and includes habitat that contains the PCEs identified for the shrew. The Kern Lake area was formerly managed by the Nature Conservancy for the J.G. Boswell Company, and was once thought to contain the last remaining population of the Buena Vista Lake shrew. The physical and biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats from reductions in water delivery, from effects of surrounding agricultural use, and from industrial and commercial development. This area does not have a conservation easement and is managed by the landowners. We are unaware of any plans to develop this site; however, it is within a matrix of lands managed for agricultural production.

Unit 6: Semitropic Ecological Reserve Unit The Semitropic Ecological Reserve Unit is approximately 372 ac (151 ha) in size and is located about 7 mi (11 km) south of Kern NWR and 7 mi (11 km) north of the Goose Lake Unit along the Main Drain Canal in Kern County. It is bordered on the south by State Route 46, approximately 2 mi (3 km) east of the intersection with Interstate 5. The CDFW holds 345 ac (140 ha) under fee title, and manages the area as part of the Semitropic Ecological Reserve. An additional 27 ac (11 ha) of the unit are private land. We consider that the unit was occupied at the time of listing and assume that it was not identified as occupied at that time because it had not yet been surveyed for small mammals (see Criteria Used To Identify Critical Habitat). Buena Vista Lake shrews were identified in the unit on April 27, 2005, when it was first surveyed for small mammals (ESRP 2005, pp. 10-13). At that time, Buena Vista Lake shrews were found in the southwestern portion of the unit, next to the Main Drain Canal. The unit has been determined to have the necessary PCEs present and therefore meets the definition of critical habitat under section 3(5)(A)(i) of the Act. Although we presume that the unit meets the definition of critical habitat under section 3(5)(A)(i) of the Act, we are also designating the unit under section 3(5)(A)(ii) of the Act. Even if the unit was not occupied at the time of listing, it is essential for the conservation of the Buena Vista Lake shrew due to its location approximately midway between Units 1 and 2, and location near the southern edge of remnant natural wetland and riparian habitat. The unit is also essential for the conservation of the shrew because it is considered to be currently occupied, and contains a matrix of riparian and wetland habitat, including riparian habitat both along the canal and within and adjacent to oxbow and slough features. The major vegetative associations at the site are valley saltbush scrub and valley sink scrub. Valley saltbush scrub is found within the relatively well-drained soils at slightly higher elevations, and the valley sink scrub is found in the heavier clay soils. Dominant vegetation at the site includes Bromus diandrus (ripgut brome), Bromus madritensis ssp. rubens (red brome), Carex spp. (sedges), Juncus spp. (rushes), Polygonum spp. (knotweed), Polypogon monspeliensis (rabbitfoot grass), Rumex crispus (curly dock), and Vulpia myuros (foxtail fescue). There is a light overstory of cottonwoods at the trapping location where the most Buena Vista Lake shrews have been observed. The physical and biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats from ongoing oil and gas exploration and development, ongoing conversion of natural lands for agricultural development, changes in water management, weed control activities including use of herbicides, and the occurrence of range trespass in an open range area. Semitropic reserve lands are not fenced and are subject to occasional range trespass by sheep and cattle (CDFW 2012). State lands in the unit were acquired under the provisions of the Metro Bakersfield Habitat Conservation Plan (HCP), and are managed for listed upland species. Location of the Main Drain Canal in the unit, and the presence of wetland features are expected to benefit the shrew, although the shrew is not a covered species under the HCP. The State does not yet have a management plan for the Semitropic Ecological Reserve.

Unit 7: Lemoore Wetland Reserve Unit The Lemoore Wetland Reserve Unit, 97 ac (39 ha) in size, is located east of the Lemoore Naval Air Station and is 4 mi (6 km) west of the City of Lemoore in Kings County. The unit is bounded along the southern border by State Route 198, and on the north and west sides by a bare water-conveyance canal. The unit is managed by the Natural Resources Conservation Service for waterfowl enhancement. We consider that the unit was occupied at the time of listing and that it was not identified as occupied at that time because it had not yet been surveyed for small mammals (see Criteria Used To Identify Critical Habitat). Buena Vista Lake shrews were identified in the unit in April 2005, when it was first surveyed for small mammals (ESRP 2005, pp. 10-13). The unit has been determined to have the necessary PCEs present and, therefore, meets the definition of critical habitat under section 3(5)(A)(i) of the Act. Although we presume that the unit meets the definition of critical habitat under section 3(5)(A)(i) of the Act, we are also designating the unit under section 3(5)(A)(ii) of the Act. The unit is essential for the conservation of the shrew due to its location at the northernmost extent of the subspecies' range and its geographic isolation from other units, due to occupancy, and due to remnant natural wetland and riparian habitat that contains the PCEs. The site is part of an area that was created to provide a place for city storm water to percolate and drop potential contaminants to shield the Kings River during years of flood runoff. Portions of the area are flooded periodically, forming fragmented wetland communities throughout the area. The plant communities of the Lemoore Wetland Reserve Unit include a mixture of vegetation communities: nonnative grassland, vernal marsh, and elements of valley sink scrub. Commonly occurring plants include Brassica nigra (black mustard), red brome, B. hordeaceus (soft chess), saltgrass, alkali heath, rushes, Lactuca serriola (prickly lettuce), rabbitfoot grass, cottonwood, Rumex crispus (curly dock), Salix ssp. (willow), Scirpus ssp. (bulrush), Sonchus oleraceus (common sowthistle), cattails, foxtail fescue and Xanthium strumarium (cocklebur). This unit is essential to the conservation of the species because it is currently occupied and contains the PCEs identified for the shrew.

**Primary Constituent Elements/Physical or Biological Features**

Critical habitat units are designated for Kings and Kern Counties, California. Within these areas, the primary constituent elements of the physical or biological features essential to the conservation of the Buena Vista Lake shrew consist of permanent and intermittent riparian or wetland communities that contain:

(i) A complex vegetative structure with a thick cover of leaf litter or dense mats of low-lying vegetation. Associated plant species can include, but are not limited to, Fremont cottonwoods, willows, glasswort, wild-rye grass, and rush grass. Although moist soil in areas with an overstory of willows or cottonwoods appears to be favored, such overstory may not be essential.

(ii) Suitable moisture supplied by a shallow water table, irrigation, or proximity to permanent or semipermanent water.

(iii) A consistent and diverse supply of prey. Although the specific prey species used by the Buena Vista Lake shrew have not been identified, ornate shrews are known to eat a variety of terrestrial and aquatic invertebrates, including amphipods, slugs, and insects.

**Special Management Considerations or Protections**

Critical habitat does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas) and the land on which they are located existing within the legal boundaries on the effective date of this rule.

All designated critical habitat units will require some level of management to address the current and future threats to the physical and biological features essential to the conservation of the Buena Vista Lake shrew. Special management considerations or protection may be required to minimize habitat destruction, degradation, or fragmentation associated with such threats as the following: Changes in the water supply allocations, water diversions, flooding, oil and gas extraction, nonnative vegetation, and agriculture. For example, the Coles Levee area is within the boundaries of a proposed oil and gas exploration proposal. Agricultural pressures to convert land to agriculture remain in the southern San Joaquin Valley, with agricultural conversion to orchards noted to have occurred recently in the general area.

The Buena Vista Lake shrew also faces high risks from random catastrophic events (such as floods or drought) (Service 1998, p. 163). The low numbers of Buena Vista Lake shrews located in small isolated areas increases the risk of a random catastrophic event eliminating entire populations or severely diminishing Buena Vista Lake shrew numbers to the point that recovery is precluded. These threats and others mentioned above could render the habitat less suitable for the Buena Vista Lake shrew by washing away leaf litter and complex vegetation structure (floods) or drying wetland habitat so that vegetative and prey communities die (drought), and special management may be needed to address these threats.

***Life History***

**Feeding Narrative**

Adult: The specific feeding and foraging habits of the Buena Vista Lake shrew are unknown (USFWS 1998). The Buena Vista Lake shrew is an invertivore that feeds indiscriminately on the available larvae and on adults of several species of aquatic and terrestrial insects, some of which are detrimental to agricultural crops. They are also known to consume spiders, centipedes, slugs, snails, and earthworms on a seasonally available basis. Shrews have a high rate of metabolism because of their small size, forcing them to be constantly searching for food to maintain their body temperatures, especially in cold conditions. Food probably is not cached and stored, so the shrew must forage periodically day and night to maintain its high metabolic rate. The Buena Vista Lake shrew prefers moist habitat that has a diversity of terrestrial and aquatic insect prey. Imported water to the Tulare Basin has resulted in an upward movement of selenium, which has become concentrated in the shrew's invertebrate prey; the potential dietary selenium levels are within the range that is known to be toxic to small mammals (NatureServe 2015; 67 FR 10101; USFWS 1998; USFWS 2011).

**Reproduction Narrative**

Adult: Nothing is known specifically about the reproduction and mating system of the Buena Vista Lake shrew. Most ornate shrews have a gestation period of 21 days. They can have one to two litters per year, with four to six young per litter (Bolster 1998). The life expectancy of most ornate shrews is 12 to 16 months (Bolster 1998). The breeding season begins in February or March and ends with the onset of the dry season in May or June; or may extend later in the year, based on habitat quality and availability of water. The Buena Vista Lake shrew prefers moist habitat that has a diversity of terrestrial and aquatic insect prey (67 FR 10101).

**Geographic or Habitat Restraints or Barriers**

Adult: Habitat fragmentation from the impoundment and diversion of streams, draining of marshes and lakes, and widespread land-leveling (USFWS 2011).

**Spatial Arrangements of the Population**

Adult: Clumped

**Environmental Specificity**

Adult: Narrow/specialist.

**Tolerance Ranges/Thresholds**

Adult: Moderate

**Site Fidelity**

Adult: High

**Dependency on Other Individuals or Species for Habitat**

Adult: No

**Habitat Narrative**

Adult: Ornate shrews in general tend to be associated with the structure of vegetation rather than with species composition of the community. Historically, Buena Vista Lake shrews occupied valley freshwater marshes on the perimeter of Buena Vista Lake and probably occurred throughout the Tulare Basin (USFWS 1998). Currently, the Buena Vista Lake shrew occupies a very small, reduced range in the southern San Joaquin Valley, where there are only a few extant occurrences known. The species may have lost more than 95 percent of historical habitat, because most of its former wetland habitat has been drained, converted to agriculture, or dried up because of water diversion (NatureServe 2015).The Buena Vista Lake shrew requires a complex vegetative structure with a thick cover of leaf litter or dense mats of low-lying vegetation (78 FR 39835). Associated plant species can include, but are not limited to sedges (Carex sp.), foxtail barley (Hordeum murinum), spikerushes (Eleocharis sp.), black mustard

(Brassica nigra), rushes (Juncus spp.), bromes (Bromus sp.), stinging nettle (Urtica dioica), mulefat (Baccharis salicifolia), bush lupine (Lupinus albifrons), and wild rose (Rosa californica), along with cattails (Typha sp.), tules (Schoenoplectus acutus), and other aquatic plants. Areas with an overstory of willows (Salix sp.) or cottonwoods (Populus sp.) appear to be favored, but may not be an essential habitat feature (USFWS 2011). Habitat fragmentation from the impoundment and diversion of streams, draining of marshes and lakes, and widespread land-leveling serves as a geographic/habitat barrier or restraint (USFWS 2011).

***Dispersal/Migration***

**Motility/Mobility**

Adult: Low

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: Nonmigratory

**Dispersal**

Adult: Low

**Immigration/Emigration**

Adult: Unlikely

**Dependency on Other Individuals or Species for Dispersal**

Adult: No

**Dispersal/Migration Narrative**

Adult: Little is known about home range, or territoriality of the Buena Vista Lake shrew or ornate shrews in general. Buena Vista Lake shrews have low motility and are nonmigratory. The limited available habitat of the Buena Vista Lake shrew is fragmented, and therefore limits dispersal. Due to lack of study, information about the home range size of the shrew is lacking. In other species of ornate shrews, juveniles establish their home range—a small area in which they nest, forage, and explore—and remain in this area for most of their life. The distribution and size of a shrew's territory varies, and is primarily influenced by the availability of food (USFWS 2011).

**Additional Life History Information**

Adult: Due to lack of study, information about the home range size of the shrew is lacking. In other species of ornate shrews, juveniles establish their home range—a small area in which they nest, forage, and explore—and remain in this area for most of their life. The distribution and size of a shrew's territory varies, and is primarily influenced by the availability of food (USFWS 2011).

***Population Information and Trends***

**Population Trends:**

Unknown (NatureServe 2015)

**Species Trends:**

Unknown (NatureServe 2015)

**Resiliency:**

Current Resiliency As discussed above in section 4(1), demographic factors contributing to BVLOS population resiliency include population size, connectivity, and genetic diversity. Environmental factors include the extent and type of contiguous habitat available to the population, the extent and stability of dispersal habitat connecting to other populations, and the extent and nutritional safety of the prey base. Those are in turn affected by various stressors, including agricultural and urban development, lack of water in a given year, climate change, selenium and pesticides. Figure 9, below, provides a graphical representation of how these factors interact to affect the resiliency of a given BVLOS population. (USFWS, 2020)

**Representation:**

Current Representation Representation (ability to adapt to long-term changes) involves maximizing genetic diversity across the subspecies. This in turn requires preservation of populations in locations representative of the environmental variation across the range, as well as populations representative of any distinct genetic groups known to exist. For the former group, emphasis should be given to preservation of representative populations at the northern, southern, and middle portions of the range. The relatively high current resiliency values at Wind Wolves – The Willows, and Kern NWR sites thus make important contributions to representation for the middle and southern portions of the range. The most northerly representative sites, at NAS Lemoore and Lemoore Wetland Reserve, both have moderate current resiliency however. Improvements at those sites would thus particularly benefit continuing representation of the diversity of the subspecies. With regard to preservation of representative populations in known genetic groups, the recent discovery of three population clusters with moderate genetic variation across them (Maldonado et al. 2017, pp. 61–63; see section 6(9), above) is informative. One cluster, consisting of Lemoore Wetland Reserve, the two Wind Wolves sites, and Goose Lake, has high resiliency at one location and moderate resiliency at the other three sites, leaving it relatively well-positioned for preservation. Another cluster, consisting of Atwell Island, Kern NWR, The Semitropic Ecological Reserve (referred to as "Main Drain Canal" in Figure 8), Coles Levee, and the Kern Fan Recharge, includes two sites with high current resiliencies, and so is also relatively well-positioned for preservation of representative sites. The third cluster, however, has only one population (Kern Lake), and that is on private land with low protection and management. The likelihood of preserving representatives of this genetic cluster is thus lower than for the other clusters, and overall representation would increase if protection or management at the site could somehow be improved. (USFWS, 2020)

**Redundancy:**

Current Redundancy Since no BVLOS population is known to be particularly large, redundancy (the ability of the subspecies to withstand catastrophic events) is dependent on the existence of multiple populations. We are currently aware of 15 occupied population locations, including one (Coles Levee Ecosystem Reserve) that we assume is still occupied despite failure to find BVLOS during the most recent survey in 2017 (see Table 1 above). At the time of our last Five Year Review, in 2011, only eight occupied locations were known, whereas at the time of listing in 2002 BVLOS were only known from four locations (FWS 2011, p. 3). One area surveyed but considered unoccupied in 2011 (Pixley NWR) has been shown by recent surveys to now be occupied. Accordingly, the current redundancy of the shrew appears significantly improved from time of listing. Unfortunately, given the apparent lack of connecting dispersal habitat between any all the populations except the two at Wind Wolves, and given the low dispersal distances documented in closely related shrews (see section 2(4), above), it is unclear how any populations could be recolonized if they were to be lost due to some catastrophe. Additional research into BVLOS dispersal capabilities and likely dispersal corridors is needed. Given the small extent of habitat at the Poso Creek site, the shrews found there may conceivably have been dispersing rather than part of a permanent population. That site is over 13 mi (21 km) from the next closest known occupied site, however, so if the shrews found there were dispersing that would imply much better dispersal capabilities than currently assumed. (USFWS, 2020)

**Number of Populations:**

Unknown; to date, surveys for the shrew have been conducted at 21 sites, and shrews were found to be present in eight of them (USFWS 2011).

**Population Size:**

Unknown (USFWS 2011)

**Resistance to Disease:**

Unknown (USFWS 2011)

**Adaptability:**

Low

**Additional Population-level Information:**

At the time of the proposed listing for the Buena Vista Lake shrew, there was one known extant population on the Kern Preserve, a private property totaling about 34 hectares (ha) (83 acres). Since that time, two Buena Vista Lake shrew were trapped on the southern side of the Kern NWR in 1998. In 1999, the California State University Stanislaus Foundation's Endangered Species Recovery Program found nine more shrews along the banks of an artificial pond adjacent to the nature center at the Cole Levee, and five more at the Kern County's water recharge area along the Kern Fan. Over the last 20 years, a number of surveys have taken place, all of which were unsuccessful in capturing any Buena Vista Lake shrews. Other remnant patches of wetland and riparian communities in the Tulare Basin have not been surveyed, and may support the Buena Vista Lake shrew (67 FR 10101).

**Population Narrative:**

When the species was listed in 2002, the shrew was only known to occur in four locations along an approximately 70-mi. stretch on the western side of the Tulare Basin. The four locations were the former Kern Preserve in the old Kern Lake bed, the Kern Fan recharge area, Cole Levee, and the Kern NWR. To date, surveys for the shrew have been conducted at 21 sites, and shrews were found to be present in eight of them (USFWS 2011). These eight sites are Goose Lake, Atwell Island, Main Drain Canal/Chicca & Sons Twin Farms South Field Ranch, Lemoore Wetlands preserve, Cole Levee, Kern fan water recharge area, the Kern NWR, and the Kern Preserve (USFWS 2011). Other remnant patches of wetland and riparian communities in the Tulare Basin have not been surveyed, and may support the Buena Vista Lake shrew (67 FR 10101).The abundance of the shrew is unknown due to the lack of regular surveys in areas of past occurrences and in areas possessing suitable habitat. Surveys were only conducted in places containing very high-quality shrew habitat, and in places where access was allowed by the land owner. Based on these surveys, the shrew has been documented as far south as the

Kern Preserve and as far north as Atwell Island. Population size and health cannot be estimated with the available data, but based on the scarcity of suitable habitat in the San Joaquin Valley and the low number of specimens collected in areas with high-quality habitat, the species is expected to be extremely rare. The small sample sizes obtained from each locality is a reflection of the rarity and difficulty of capturing shrews in these areas (USFWS 2011).

***Threats and Stressors***

**Stressor:** Habitat loss
**Exposure:** Agricultural and urban development.
**Response:** Habitat degradation.
**Consequence:** Population decline.
**Narrative:** All of the natural plant communities in the Tulare Basin have been affected by the alteration of the area for urban and agricultural development. As more canals are built, and more water is diverted for agricultural irrigation of the historic floodplains of the major rivers of the southern San Joaquin Valley, less water is available to sustain the riparian and wetland areas on which the shrew relies for all aspects of its life. This will continue to cause the already very rare subspecies to decline (USFWS 2011).

**Stressor:** Predation
**Exposure:** Avian predators.
**Response:**
**Consequence:** Unknown
**Narrative:** There are several avian predators, such as barn owls (Tyto alba), short-eared owls (Asio flammeus), long-eared owls (Asio otus), and great horned owls (Bubo virginianus), that are known to prey on shrews (USFWS 2011). The overall impact that predation may have on the number of individuals and densities of the shrew remains unknown (USFWS 2011).

**Stressor:** Hybridization
**Exposure:** Overlapping shrew population ranges.
**Response:** Hybridization
**Consequence:** Genetic alteration.
**Narrative:** If shrew population ranges overlap or come in contact through expansion, hybridization may occur in closely related species and certain subspecies. Over time, a population of a subspecies could become genetically indistinguishable from a larger population of an intruding subspecies, so that the true genotypes of the invaded subspecies no longer exist (USFWS 2011).

**Stressor:** Selenium toxicity
**Exposure:** Irrigation
**Response:** Accumulation in plants and animals.
**Consequence:** Adverse effects to growth, reproduction, and survival.
**Narrative:** Selenium toxicity of soils in the Tulare Basin has resulted from the concentration of already naturally elevated levels of selenium on the western side of the San Joaquin Valley. Due to extensive agricultural irrigation, selenium has been leached from the soils and concentrated in the shallow groundwater. In areas where this groundwater reaches the surface or subsurface, selenium can accumulate in both plants and animals. Elevated concentrations of selenium may cause adverse effects to growth, reproduction, and survival of the shrew (USFWS 2011).

**Stressor:** Exposure to pesticides
**Exposure:** Spraying crops, canals, and ditch banks.
**Response:** Lethal and sub-lethal pesticide concentration.
**Consequence:** Possible reduced reproduction, and death by starvation.
**Narrative:** The Buena Vista Lake shrew is exposed to the wide-scale use of pesticides throughout its range and may be directly exposed to lethal and sub-lethal concentrations of pesticides from drift or direct spraying of crops, canals, and ditch banks. Reduced reproduction in shrews could be directly caused by ingested pesticides. Additionally, shrews could die from starvation by the loss of their prey base (USFWS 2011).

**Stressor:** Small population size
**Exposure:** Extreme weather, introduction of nonnative species, pollution, and development.
**Response:** Limited gene flow, genetic variation, and ability to adapt to drastic environmental events.
**Consequence:** Lower fitness and survivability.
**Narrative:** Due to low population numbers and a high degree of habitat fragmentation, the Buena Vista Lake shrew is particularly vulnerable to sudden changes in its environment, be they natural events such as extreme weather or epidemic diseases, or anthropogenic changes such as the introduction of a nonnative species, chemical runoff or spill, or human development of an ecologically important area. Limited gene flow and genetic variation in a population has the capacity to limit the species' ability to adapt to drastic environmental events, and can result in lower breeding success or inbreeding; this can result in decreased fitness and survivability of the shrew (USFWS 2011).

**Stressor:** Climate change
**Exposure:** Predictions indicate warmer temperatures, more intense precipitation events, and increased summer continental drying.
**Response:** Alteration of available habitat.
**Consequence:** Immense stress on the species.
**Narrative:** Current climate change predictions for terrestrial areas indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying. Due to the shrew’s reliance on dense riparian vegetation and to the continuing diversion of water from wetland areas for agricultural use, and because the shrew’s decline was greatly attributed to the loss of wetland habitat required for its survival, it can be assumed that increased drying could place immense stress on the species (USFWS 2011).

**Stressor:** Pesticides (USFWS, 2020)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Because BVLOS are distributed among small patches of habitat in a landscape otherwise dominated by agriculture, they could be exposed to lethal or unhealthy concentrations of pesticides sprayed on nearby crops, or of herbicides sprayed on roadsides and canal banks (FWS 2011, p. 15). Pesticides could also affect BVLOS indirectly by lowering their prey base (Ma and Talmage 2001, p. 11). (USFWS, 2020)

**Stressor:** Selenium (USFWS, 2020)

**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The soils on the western side of the San Joaquin Valley have naturally elevated selenium concentrations (FWS 2011, p. 15). Due to extensive agricultural irrigation, selenium has been leached from the soils and concentrated in the shallow groundwater along the western side of the San Joaquin Valley. In areas where this groundwater reaches the surface or subsurface, selenium can accumulate in both plants and animals. Selenium can then enter the food chain of the shrew by becoming concentrated in insects that forage on the vegetation or reside in soils that concentrate these salts and result in adverse effects to growth, reproduction, and survival of the shrew (Saiki and Lowe 1987, pp. 664–666; Moore et al. 1989, pp. 4, 6, 7, 15, 16). (USFWS, 2020)

**Stressor:** Inbreeding Depression (USFWS, 2020)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Inbreeding depression is caused by the loss of genetic diversity in small populations due to genetic drift, leaving deleterious alleles as the only remaining variants of some genes (Soule 1980, pp. 157–158). It also results from increased mating between closely related individuals in small populations, thereby increasing the likelihood that both parents pass on the same recessive deleterious alleles to their young (Lande and Barrowclough 1987, p. 96). It can result in abnormal sperm, congenital defects, and lowered disease resistance (Soulé 1980, pp. 157–158; Gilpin 1987, p. 132; O'Brien 2003, pp. 62–63). Migration between populations can help prevent inbreeding depression by reducing genetic isolation and thereby raising the effective population size. If it occurs at all, however, migration among BVLOS populations is likely limited to years of high rainfall when creeks or ponds expand to temporarily produce additional habitat (Cypher pers. comm. 2019, p. 2; Tenant pers. comm. 2019a, p. 1). A population typically requires an "effective" population size of at least 100 reproducing adults to avoid inbreeding depression (Frankham et al. 2014, p. 58). The "effective size" of a population ("Ne") refers to the number of breeding individuals in an "ideal" population (with characteristics that minimize loss of alleles) (Lande and Barrowclough 1987, pp. 88–89). Because most populations lack many of the characteristics of ideal populations, the actual (census) size of a population ("N") is often much greater than its effective size. Various estimates of Ne as compared to N, (Ne/N), across different species range from averages of 0.10 to 0.19 (Palstra and Ruzzante 2008, p. 3,431; Frankham et al. 2014, p. 60), and medians of 0.12 to 0.23 (Palstra and Fraser 2012, p. 2,360; Frankham et al. 2014, p. 60). This would translate to census populations of roughly 625 reproductive individuals for isolated populations (Ne/N = 0.16), and somewhat less (maybe 500, depending on migration levels) for populations in which genetic exchange is possible due to connecting dispersal habitat. (USFWS, 2020)

***Recovery***

**Reclassification Criteria:**
Reclassification criteria have not yet been developed for the Buena Vista Lake shrew.

Recovery Priority Number: 3C

**Delisting Criteria:**
The species was listed as a species of concern at the time the recovery plan (USFWS 1998) was written and published. Although recovery criteria were not detailed in the plan, long-term conservation-recovery criteria were provided (USFWS 2011).

Secure and protect recovery areas totaling at least 2,000 ha (4,940 ac.) of occupied habitat in three or more disjunct sites (USFWS 1998).

Approve management plans for those sites that feature survival of the species as an objective, and implement those plans (USFWS 1998).

Implement a periodic monitoring plan that demonstrates continuing presence of Buena Vista Lake shrews at occupied sites (USFWS 1998).

**Recovery Actions:**
- Develop and implement a regional cooperative program and participation plan (USFWS 1998).
- Protect and secure core habitat areas (USFWS 1998).
- Determine distributions and population statuses of featured species (USFWS 1998).
- Conduct important research and population monitoring (USFWS 1998).
- Maintain and establish linkages in existing natural lands, and between islands of habitat on the valley floor and natural lands around the fringe of the valley (USFWS 1998).
- Apply adaptive management to protected areas (USFWS 1998).
- If necessary, reintroduce Buena Vista Lake shrew to appropriate habitat within their historic range (USFWS 1998).
- Periodically review the status to determine whether listing as endangered or threatened is necessary (USFWS 1998).
- Conserve habitat and restore riparian and wetland vegetation communities (USFWS 2011).
- Estimate population sizes at existing and potentially inhabited sites (USFWS 2011).
- Establish habitat connectivity between populations (USFWS 2011).
- Develop agreements with private entities to assess and protect areas with potential habitat (USFWS 2011).
- Develop management plans and agreements with land owners and managers (USFWS 2011).
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***Conservation Measures and Best Management Practices:***
- RECOMMENDATIONS FOR FUTURE ACTIONS x Investigate water flow options for habitat restoration at specific sites. The Semitropic Ecological Reserve and the Kern River Overflow Canal at Interstate 5 and Highway 46 are both experiencing serious habitat loss due to recent changes in water conveyance to the Kern NWR (SSA report, sec. 6(3)). Involved parties should investigate possible ways to redirect enough water through those sites to maintain or restore shrew habitat at the sites. x Conduct studies of population size: As discussed in the SSA report (sec. 6(13)), BVLOS population sizes remain unknown at all of the occupied locations. Without that information, characterizations regarding the status of the populations at the various occupied locations remain speculative. x Conduct studies of dispersal and migration between populations: It is unknown at this point to what extent there is genetic interchange between any of the populations, and if so, along what routes and

under what conditions. Recovery of the subspecies will be strongly affected by the extent of such interchange, since small isolated populations are more subject to inbreeding depression, and cannot naturally be recolonized if they become extirpated. x Develop and implement a BVLOS management plan. Using information obtained from studies of population sizes and interpopulation migration, as well as information from recent genetics studies, an overall management plan for the subspecies should be produced. The plan could then be used to characterize the relative importance of the various populations and connecting habitat corridors (actual or potential) in order to guide conservation actions. x Encourage conservation among private landowners: Several BVLOS populations are located on private lands, and the majority of potential connecting habitat passes through private lands as well. The cooperation and support of those landowners for BVLOS conservation actions is therefore key to the survival and recovery of the subspecies. In addition to basic outreach, Safe Harbor Agreements should be pursued as a means of allowing landowners to document or encourage the presence of BVLOS on their lands. Water flow agreements might also be possible, whereby landowners providing habitat for BVLOS are given access to additional water in order to maintain that habitat. (USFWS, 2020)

- NEPA requires Federal agencies to analyze projects they undertake, authorize, or fund, for potential impacts to the human environment, including natural resources (FWS 2011, p. 14). In cases where that analysis reveals significant environmental effects, the Federal agency must propose mitigation alternatives that would offset those effects (40 CFR 1502.16). These mitigations usually provide some protection for listed species (FWS 2011, p. 14). However, NEPA does not require that adverse impacts be fully mitigated, only that impacts be assessed and the analysis disclosed to the public. (USFWS, 2020)

***Additional Threshold Information:***

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# SPECIES ACCOUNT: *Tamias minimus atristriatus* (Penasco least chipmunk)

***Species Taxonomic and Listing Information***

**Listing Status:** Endangered (Jan, 2025)

**Physical Description**

The Peñasco least chipmunk is grayish-brown mixed with cinnamon-buff on the rump and thighs (Sullivan 1993, p. 1). The Peñasco least chipmunk has pale yellowish orange hindfeet, a light beige, yellowish, or orange belly, and dark underfur (Frey 2010, p. 11). The gray-footed chipmunk (Tamias canipes) occurs with the similar Peñasco least chipmunk and they are easily confused in the field (New Mexico Department of Game and Fish (NMDGF) 2008, p. 1). Frey reported that these species can be difficult to distinguish without physically comparing specimens (Frey 2007, p. 17). Specimens of the Peñasco least chipmunk from the Sacramento Mountains had a mean body length of 11.4 centimeters (cm) 4.5 (in) a mean tail length of 9.3 cm (3.7 in), a mean ear length of 1.4 cm (0.6 in), and a mean hindfoot length of 3.0 cm (1.2 in) (Frey 2010, p. 7). An identification key for the subspecies is provided in Frey (2007, pp. 1721).

**Taxonomy**

The Peñasco least chipmunk was originally described as a distinct species (Eutamias atristriatus) based on specimens collected in 1902 (Bailey 1913, pp. 129130). In a revision of the North American chipmunks, Howell (1929) reclassified the Peñasco least chipmunk as Tamias minimus atristriatus. Tamias minimus atristriatus is genetically distinct from other subspecies of least chipmunk (Sullivan and Petersen 1988, p. 21) and is recognized as a valid subspecies (Wilson and Reeder 2005, entire).

**Historical Range**

The historical range of the Peñasco least chipmunk is in the Sacramento and White Mountains, in Lincoln and Otero Counties, New Mexico (USFWS, 2024)

**Current Range**

Species has not been observed in the Sacramento Mountains since 1965. (USFWS, 2024)

**Distinct Population Segments Defined**

No.

**Critical Habitat Designated**

Yes; 1/9/2025.

**Legal Description**

We, the U.S. Fish and Wildlife Service (Service), list the Penasco least chipmunk (Neotamias minimus atristriatus), a mammal from New Mexico, as an endangered species under the Endangered Species Act of 1973 (Act), as amended. We also designate critical habitat. In total, approximately 1,774 hectares (4,386 acres) in Lincoln County, New Mexico, fall within the boundaries of the critical habitat designation. This rule extends the protections of the Act to this species and its designated critical habitat.

**Critical Habitat Designation**

We are designating three units as critical habitat for the Pen˜ asco least chipmunk. The critical habitat areas we describe below constitute our current best assessment of areas that meet the definition of critical habitat for the Pen˜ asco least chipmunk. The three areas we designate as critical habitat are: (1) Nogal Peak, (2) Crest Trail, and (3) Sierra Blanca. Table 3 shows the critical habitat units and the approximate area of each unit.  (1,774 total Acres)

Unit 1: Nogal Peak, New Mexico Unit 1 consists of approximately 393 hectares (972 acres) of subalpine habitat within the Lincoln National Forest Wilderness Area and is occupied. This unit is within the critical habitat designation in Lincoln County, New Mexico, for the Mexican spotted owl, which is listed as a threatened species under the Act. Elevation ranges approximately 2,570–3,031 meters (8,432–9,944 feet) above mean sea level. Mean elevation in Unit 1 is 2,772 meters (9,094 feet) with a standard deviation of 70 meters (230 feet). Approximately 79 percent of Unit 1 is classified as grassforb mix or Gambel oak. Unit 1 contains all the physical or biological features that are essential to the conservation of the Pen˜ asco least chipmunk. This unit is federally owned by the U.S. Forest Service; it is 100 percent within the Lincoln National Forest Wilderness Area. Threats to the physical or biological features within the unit include forest encroachment into the open meadows, grazing, and destruction of habitat by nonnative species (feral hogs). Special management considerations that may reduce these threats include prescribed fire and forest management to maintain the open subalpine meadows with native vegetation, continued closure of the encompassing U.S. Forest Service allotment to grazing, and feral hog management.

Unit 2: Crest Trail, New Mexico Unit 2 consists of approximately 910 hectares (2,249 acres) of subalpine habitat. Although it is considered unoccupied, we have determined that it is essential for the conservation of the species because it provides important connectivity between Unit 1 and Unit 3, both of which are known to be occupied by the species. The unit has all of the physical or biological features essential for the conservation of the Pen˜ asco least chipmunk: It is in the White Mountains, at elevations of 2,500–3,597 meters (8,200–11,800 feet), with rock outcrop, and appropriate vegetation characteristics. Therefore, we conclude that this area is habitat for the subspecies. Due to the location between Units 1 and 3 and the overall suitability of the habitat, it is possible the Pen˜ asco least chipmunk is present in the unoccupied unit; however, with no confirmed records, the unit is being treated as unoccupied for purposes of this designation. Surveys of the southern portion of this unit in 2018 did not detect Pen˜ asco least chipmunks, but an additional 8 kilometers (5 miles) of habitat remain unsurveyed. Approximately 90 percent of this unit is within the critical habitat designation for the Mexican spotted owl in Lincoln County, New Mexico. This unit is federally owned by the U.S. Forest Service and is 100 percent within the Lincoln National Forest Wilderness Area. Elevation ranges approximately 2,621–3,292 meters (8,599–10,800 feet) above mean sea level. Mean elevation in Unit 2 is 2,876 meters (9,436 feet) with a standard deviation of 139 meters (456 feet). Approximately 44 percent of Unit 2 is classified as grass-forb mix or Gambel oak.

Unit 3: Sierra Blanca, New Mexico Unit 3 includes approximately 471 hectares (1,165 acres) of subalpine habitat, contains the physical or biological features that are essential to the conservation of the species, and is known to be occupied. This unit is federally owned by the U.S. Forest Service; approximately 30 percent overlaps with the Lincoln National Forest Wilderness Area. One hundred percent of the unit is also Mexican spotted owl critical habitat in Lincoln

County, New Mexico. Elevation ranges approximately 2,763–3,518 meters (9,065–11,542 feet) above mean sea level. Mean elevation in Unit 3 is 3,167 meters (10,390 feet) with a standard deviation of 131 meters (428 feet). Approximately 34 percent of Unit 3 is classified as grass-forb mix or Gambel oak. Unit 3 contains all the physical or biological features that are essential to the conservation of the species. Threats to the unit include forest encroachment into the open meadows, recreation, development, land use, and land management, grazing, and destruction of habitat by nonnative species (feral hogs). Special management considerations that may address these threats include prescribed fire and forest management to maintain the open subalpine meadows with native vegetation, continued closure of the encompassing U.S. Forest Service allotment to grazing, and feral hog management. In the proposed rule, Unit 3 comprised 1,357 hectares (3,353 acres), an area which included land owned by the U.S. Forest Service and the Mescalero Apache Tribe. We have excluded from the final designation the portion owned by the Mescalero Apache Tribe and an adjacent parcel of U.S. Forest Service land operated by the Tribe, approximately 886 hectares (2,189 acres) (see Consideration of Impacts Under Section 4(b)(2) of the Act, below).

**Primary Constituent Elements/Physical or Biological Features**

Within these areas, the physical or biological features essential to the conservation of the Penasco least chipmunk consist of the following components:

(i) Areas within the White Mountains that: (A) Are between elevations of 2,500– 3,597 meters (8,200–11,800 feet); (B) Contain rock outcrops or talus; (C) Are subalpine Thurber's fescue meadow/grassland communities found within openings of spruce-fir forest, above tree line in the glacial cirque, containing tall bunchgrasses, including Thurber's fescue, sedges, flowering forbs, and shrubs; and (D) Contain widely spaced largediameter conifers, such as Engelmann spruce or ponderosa pine, intermixed in low densities with the meadow/ grassland vegetation.

(ii) Forage, including species of Asteraceae, flowers and fruits of gooseberry (Ribes spp.), wild strawberry (Fragaria spp.), pinyon (Pinus edulis) nuts, Gambel oak (Quercus gambelii) acorns, and insects.

**Special Management Considerations or Protections**

Critical habitat does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas) and the land on which they are located existing within the legal boundaries on January 9, 2025.

The features essential to the conservation of the Pen˜ asco least chipmunk may require special management considerations or protections to reduce the following threats: (1) forest encroachment due to altered fire regime; (2) recreation, development, land use, and land management; and (3) destruction of habitat by nonnative species (feral hogs).

Management activities that could ameliorate these threats include, but are not limited to, prescribed fire and forest management to maintain the open subalpine meadows with native vegetation; continued closure of the encompassing U.S. Forest Service allotment to grazing; and feral hog management.

***Life History***

**Feeding Narrative**

Adult: Peñasco least chipmunks forage mainly on the ground or in shrubs (Hoffmeister 1986, p. 15).The seeds of shrubs and forbs are their main food source, though they also feed on arthropods, leaves, fruits, flowers, and fungi (Bailey 1931, p. 91; Vaughn 1974, pp. 770772). The least chipmunk does not develop fat deposits in the fall, but relies on brief periods of activity to consume cached food for survival over the winter (Verts and Carraway 2001).

**Reproduction Narrative**

Adult: Least chipmunks dig burrows for nesting, often under large rocks, but may also use tree cavities or other natural structures (Verts and Carraway 2001, pp. 67).In spring, females typically produce one litter of 4-5 pups (Skryja 1974, p. 223). The average life span of the least chipmunk is 0.7 years (Erlien and Tester 1984, p. 2).

**Habitat Narrative**

Adult: The Peñasco least chipmunk has been found in two different and distinctive habitat types in New Mexico: 1) the ponderosa pine forest zone in the Sacramento Mountains; and 2) high elevation talus slopes and glacial cirques surrounded by Englemann spruce (Picea engelmanni), quaking aspen (Populus tremuloides), corkbark fir (Abies lasiocarpa), and Douglas fir (Pseudotsuga menziesii) above treeline in the White Mountains (Sullivan 1993; p. 3; Frey and Boykin 2007, pp. 2728). In the Sacramento Mountains, historic mature ponderosa pine forests have been described as lacking lower limbs and providing an open structure with dense grass cover (U.S. Forest Service (Forest Service) 2002, pp. BiiBiii; Frey and Boykin 2007, p. 51). The Sacramento Mountains population appears to have been nearly exclusively associated with large open mature stands of ponderosa pine forest, which have mostly been eliminated and subsequently replaced by denseconiferous stands of young trees that are unsuitable for the least chipmunk (Kaufmann et al. 1998, pp. 4648; Frey and Boykin 2007, pp. 27, 51). In contrast, in the White Mountains, which are about 40 kilometers (km) (30 miles (mi)) north of the Sacramento Mountains, the least chipmunk has only been associated with patches of rock and talus above treeline within close proximity of Sierra Blanca Peak (Frey and Boykin 2007, p. 28). Least chipmunks dig burrows for nesting, often under large rocks, but may also use tree cavities or other natural structures (Verts and Carraway 2001, pp. 67).

***Dispersal/Migration***

***Population Information and Trends***

**Population Trends:**

Decline

**Species Trends:**

Decline

**Resiliency:**

Current Resiliency Condition of Peñasco Least Chipmunk Populations. The current condition of each demographic and habitat factor and the overall condition of each population of the Peñasco least chipmunk is displayed in Table 5.2.4. Based on the demographic and habitat factors discussed, the Sacramento Mountains population is considered to be in Very Low (-2) overall condition. There have been no detections of Peñasco least chipmunk in the Sacramento

Mountains since 1966, despite extensive survey effort, indicating that this population may be extirpated. Even if it is still extant, it has no connectivity with other populations and likely no subpopulation structure. The Sacramento Mountains have little to no remaining suitable habitat, and land use and management have severely decreased Peñasco least chipmunk resources. For the White Mountains population, in terms of habitat factors, there is a moderate level of habitat availability and moderate habitat availability trends, and land use or management is not known to significantly reduce Peñasco least chipmunk resources. However, in terms of demographic factors, the White Mountains population has a low density and decreasing population trend. The population is extremely isolated (i.e., there would be no connectivity with the Sacramento Mountains population if it were extant), and the White Mountains population has no known subpopulation structure. Given these Low and Very Low condition demographic factors, the White Mountains population is in Low (-1) overall condition. (USFWS, 2024)

**Representation:**

Maintaining representation in the form of genetic or ecological diversity is important to maintain the capacity of the Peñasco least chipmunk to adapt to future environmental changes. Because one of the two populations of Peñasco least chipmunk may be extirpated, and the extant population persists in extremely low numbers, genetic diversity is likely extremely low. Sullivan (1985, pp. 431–433) found that Peñasco least chipmunks in the White Mountains showed the lowest levels of within-population genetic variation out of nine least chipmunk populations in New Mexico, Arizona, and Colorado, with 1 allele per locus, 4.2% polymorphic loci, and an observed heterozygosity of 0. In addition, the subspecies has a historical distribution in two very different ecological settings: one in a high-elevation subalpine meadow zone in the White Mountains, and one in a lower-elevation ponderosa pine zone in the Sacramento Mountains. Because the Sacramento Mountains may no longer support the subspecies, the Peñasco least chipmunk has already lost ecological representation across its range. (USFWS, 2024)

**Redundancy:**

The Peñasco least chipmunk needs to have at least two resilient populations distributed throughout its range to provide for redundancy. Generally, the more populations a subspecies has, and the wider the distribution of those populations, the more redundancy the subspecies will exhibit. Redundancy reduces the risk that a large portion of the subspecies’ range will be negatively affected by a catastrophic natural or anthropogenic event at a given point in time. Subspecies that are well-distributed across their historical ranges are considered less susceptible to extinction and more likely to be viable than subspecies confined to small portions of their ranges (Carroll et al. 2010, entire). Because one of the two populations of Peñasco least chipmunk may be extirpated, the Peñasco least chipmunk currently lacks any redundancy. (USFWS, 2024)

**Number of Populations:**

Unknown, but likely only one

**Population Size:**

Unknown

**Additional Population-level Information:**

there is currently an overall lack of suitable Peñasco least chipmunk habitat in the Sacramento Mountains. This conclusion aligns with analyses and conclusions of Frey and Hays. Currently the species is only found in the White Mountains (USFWS, 2024)

**Population Narrative:**

The distribution and abundance of the least chipmunk has dramatically declined since the early 20th century (Frey and Boykin 2007, p. 50). Despite field surveys in 1981-1982, 1991-1996, 2000, and 2005-2006 (reviewed in Frey and Boykin 2007, entire), the least chipmunk population within the Sacramento Mountains has not been verified since 1966. Although it is unknown whether the Sacramento Mountains population persists, most authors believe it has been extirpated (Hope and Frey 2000 p. 10; Frey and Boykin 2007, pp. 12-18, 50; Wampler 2007; Frey 2009, p. 5). From at least 1994, the Lincoln National Forest has reported that the subspecies no longer occurs on the Sacramento Ranger District within its historically occupied habitat (Forest Service 1993, p. 26; 2008, p. 31; 2011, p. 62). The persistence of the White Mountain population of least chipmunk was last verified in 1998 and 2000 (Ortiz 1999; Hope and Frey 2000). The core of this population is likely associated with a large area of rocky habitat on Sierra Blanca Peak and probably extended to adjacent areas such as Buck Mountain on Forest Service lands (Frey and Boykin 2007, p. 50). The subalpine areas in the White Mountains likely contain suitable habitat for the least chipmunk because this area has remained relatively unaltered from historic conditions (Frey and Boykin 2007, p. 40).

***Threats and Stressors***

**Stressor:** Timber harvest
**Exposure:** Habitat degradation, destruction, and fragmentation
**Response:**
**Consequence:**
**Narrative:** The Peñasco least chipmunk faces threats from present or threatened destruction, modification, and curtailment of its habitat from the alteration or loss of mature ponderosa pine forests in one of the two historically-occupied areas. The subspecies is further threatened by residential development, fire suppression and exclusion, and high-intensity fire. In the Sacramento Mountains, the subspecies habitat requirements of open ponderosa pine forests have essentially been eliminated due to the historical impact of these activities. Ongoing impacts due to these activities continue to further degrade these habitats and further preclude recovery of these areas. Further, the existing regulatory mechanisms have not been adequate to prevent the continuing decline of the least chipmunk. The documented decline in occupied localities, in conjunction with the small numbers of individuals captured, are linked to widespread habitat alteration (Frey and Boykin 2007). Moreover, the highly-fragmented nature of its current distribution is a significant contributor to the vulnerability of this subspecies and increases the likelihood of very small, isolated populations being extirpated (Factor E). As a result of this fragmentation, even if suitable habitat exists (or is restored) in the Sacramento Mountains, the likelihood of natural recolonization of historic habitat or population expansion from the White Mountains is extremely remote.

**Stressor:** Livestock grazing
**Exposure:**
**Response:**
**Consequence:**

**Narrative:** Grazing has contributed to the altered composition of ponderosa pine forests in the Sacramento Mountains, particularly in James Canyon, which has been heavily overgrazed (Alexander et al. 1984, p.16; Sullivan et al. undated, p. 2). Overgrazing, drought, and erosion eliminated continuous stretches of grass that would have historically carried surface fires necessary for maintaining the open ponderosa pine habitat utilized by the least chipmunk. As a result, overgrazing contributed to the risk of high-intensity fire in the Sacramento Mountains. In 1964, White Mountain Wilderness status was conferred on the adjacent 19,533 hectare-area (48,266 acres) and all grazing halted (Dyer and Moffett 1999, p. 451); therefore grazing is not an in issue in the White Mountains.

**Stressor:** Residential development
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** The least chipmunk population in the White Mountains is not currently threatened by residential development. In the Sacramento Mountains, however, the subspecies habitat has been altered by development associated with private lands in James Canyon. The James Canyon area historically supported more stands of pure ponderosa pine than any other area on the Lincoln National Forest (Kaufmann et al. 1998, p. 46). Residential development of private land continues to fragment the small areas of remnant least chipmunk habitat within the Sacramento Mountains. The human population in James Canyon and surrounding areas has increased to several thousand residents over the last several decades (Forest Service 1999, p. 3; 2000 p. 43). This area is now the most heavily developed part of the Sacramento Mountains with campgrounds, a ski area, and numerous subdivisions with summer and year-round homes (Kaufmann et al. 1998, pp. 46, 48). Residential development activities within James Canyon and other surrounding areas in the Sacramento Mountains will continue to destroy or modify areas that potentially could be restored for use by the subspecies. Further, the extensive fragmentation of the historic habitat within the Sacramento Mountains and the isolation of this area from the extant Sierra Blanca locality (separated by 40 km (30 mi)) indicates that natural recolonization of the Sacramento Mountains by the Peñasco least chipmunk is highly unlikely.

**Stressor:** High-intensity crown fires
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Fire exclusion, and the resulting overstocked, dense forests has also significantly increased the potential for high-intensity, destructive crown fires (Covington and Moore 1992, p. 94; Allen et al. 2002, p. 1420). In fact, since 1921, seven large stand-replacing type fires have occurred in the area east of the Village of Cloudcroft that historically contained habitat of the least chipmunk (Forest Service 2002, p. 3.18). Five of these fires have burned since 1993 (Forest Service 2002, p. 3.18). Within the watersheds that historically supported the least chipmunk in the Sacramento Mountains, 94 percent of the area is highly susceptible to stand-replacing fires (Forest Service 2002, p. 3.20). During June 2012, the Little Bear Fire burned 17,806 ha (44,000 ac) within the White Mountains, including Buck Mountain and adjacent areas (Forest Service 2012a, pp. 1, 4, 10). It is unknown whether the subspecies was affected because suitable habitat in the White Mountains is generally associated with patches of rock and talus above treeline that are unlikely to burn with high severity. Nevertheless, because of continued exclusion and suppression of fire in the Sacramento Mountains, we conclude that further curtailment of the

range of the subspecies is likely through the prevention of restoration of ponderosa pine and increasing the risk of high-intensity fire. The continued implementation of the Forest Services strategy of fire suppression and exclusion is likely to remove and effectively eliminate, degrade, or fragment any remaining potential habitat of the least chipmunk in the Sacramento Mountains.

**Stressor:** Inadequate regulatory mechanisms
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** Even though the least chipmunk is state-listed (NMDGF) as endangered, this designation only conveys protection from collection or intentional harm; no New Mexico State statutes address habitat protection, indirect effects, or other threats to the subspecies identified by the State as endangered. Because most of the risks to the least chipmunk are from effects to habitat, protecting individuals from direct take will not ensure long-term protection of the subspecies. The least chipmunk has been on the Regional Foresters Sensitive Species List since 1990 (Forest Service 1999a). The Regional Foresters Sensitive Species List policy is applied to projects implemented under the 1982 National Forest Management Act Planning Rule (49 FR 43026, September 30, 1982). All existing plans continue to operate under the 1982 Planning Rule and all of its associated implementing regulations and policies; however, all new plans and plan revisions must conform to the new 2012 planning requirements (68 FR 21162, April 9, 2012). The Lincoln National Forest will begin to revise their Forest Plan in 2015. When this Forest Plan is revised, it is unclear whether the 2012 planning requirements will provide adequate protection to the least chipmunk. In the interim, the Forest Plan will continue to operate under the 1982 planning rule (Forest Service 2012, entire; 2013, entire). However, even if increased protections were afforded to the subspecies due to its Forest Service sensitive-species status and potential updated planning rule, the single extant population in the White Mountains is likely insufficient to conserve the Peñasco least chipmunk.

***Recovery***

**Recovery Actions:**

- Ponderosa pine habitat restoration (e.g., following the principles outlined in Allen et al. 2002, pp. 14241428) will be necessary before significant risk reduction for the Peñasco least chipmunk is possible.
- Reintroductions of the subspecies in the Sacramento Mountains will be necessary before significant risk reduction for the Peñasco least chipmunk is possible.
- Additional surveys should be conducted for the least chipmunk in the Sacramento and White Mountains, including private lands and the Mescalero Apache Nation.
- A conservation strategy should be developed for the subspecies, to guide coordinated conservation efforts by multiple partners.

**References**

USFWS 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for Tamias minimus atristriatus (Peñasco least chipmunk)

Southwest Region

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# SPECIES ACCOUNT: *Thomomys mazama glacialis* (Roy Prairie pocket gopher)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; Pacific Region (R1) (USFWS, 2016)

**Physical Description**

Adult Mazama pocket gophers are reddish brown to black above, and the underparts are lead-colored with buff-colored tips. The lips, nose, and patches behind the ears are black; the wrists are white. Adults range from 7 to 9 inches (189 to 220 millimeters (mm)) in total length, with tails that range from 2 to 3 inches (45 to 85 mm)(Verts and Carraway 2000, p.2). Mazama pocket gophers are morphologically similar to other species of pocket gophers that exploit a subterranean existence. They are stocky and tubular in shape, with short necks, powerful limbs, long claws, and tiny ears and eyes. Their short, nearly hairless tails are highly sensitive and probably assist when navigating tunnels. The “pockets” are external, fur-lined cheek pouches on either side of the mouth that are used to transport nesting material and plant cuttings. Mazama pocket gophers reach reproductive age in the spring of the year after their birth and produce litters between spring and early summer. Litter size ranges from one to nine (Wight 1918, p. 14), with an average of five (Scheffer 1938, p. 222). They do not hibernate in winter; they remain active throughout the year (Case and Jasch 1994, p. B-20) (USFWS, 2016).

**Taxonomy**

Although the species Thomomys mazama, or Mazama pocket gopher, includes numerous subspecies that are found in the States of Washington, Oregon, and California, only the subspecies found in the State of Washington have recently been considered for listing. The Mazama pocket gopher complex consists of 15 subspecies, eight of which occur only in Washington, five of which occur only in Oregon, one that occurs only in California, and one subspecies with a distribution that spans the boundary between Oregon and California (Hall 1981, p. 467). The first pocket gophers collected in western Washington were considered subspecies of the northern pocket gopher (Thomomys talpoides)(Goldman 1939), until 1960 when the complex of pocket gophers found in western Washington was determined to be more similar to the western pocket gopher (T. mazama)(Johnson and Benson 1960, p. 20). Eight western Washington subspecies of Mazama pocket gopher (T. mazama, ssp. couchi, glacialis, louiei, melanops, pugetensis, tacomensis, tumuli, and yelmensis) have been identified (Hall 1981, p. 467). Thomomys mazama is recognized as a valid species by the Integrated Taxonomic Information System (ITIS 2012). Although there have been suggestions that potential changes to the classification of some of these subspecies should be considered, we have no information to suggest that any of the presently recognized subspecies are the subject of serious dispute. We follow the subspecies designations of Verts and Carraway (2000), as this text represents the currently accepted taxonomy for the species T. mazama. Verts and Carraway (2000, p.1) recognize T. m. glacialis, pugetensis, tumuli, and yelmensis as separate subspecies (the Roy Prairie, Olympia, Tenino, and Yelm pocket gophers, respectively) based on morphological characteristics, distribution, and differences in number of chromosomes. Due to the close proximity of the four subspecies located in Thurston and Pierce Counties, and the fact that at least three of them occur in the same clade, we refer to these four subspecies (T. m. glacialis, pugetensis, tumuli, and yelmensis) as “the four Thurston/Pierce subspecies” of the Mazama

pocket gopher (USFWS, 2016).

**Current Range**

In Washington, Mazama pocket gophers are found west of the Cascade Mountain Range, in the Olympic Mountains and in the Puget Sound trough, with an additional single locality known from Wahkiakum County (Verts and Carraway 2000, p.3). Their populations are concentrated in well-drained friable soils often associated with glacial outwash. The Roy Prairie pocket gopher (Thomomys mazama glacialis) is found in the vicinity of the Roy Prairie and on JBLM in Pierce County. The subspecies was described as plentiful in 1983 but by 1993 the type locality was described as a “small population” (Steinberg 1996, p. 24). Due to proximity to the subspecies’ type locality, it is likely that the 91st Division Prairie and Marion Prairie in Pierce County support this subspecies. Soil series and soil series complexes in and around this area that may support pocket gophers include Alderwood, Everett, Everett-Spanaway complex, Everett-Spanaway-Spana complex, Nisqually, Spana-Spanaway-Nisqually complex, and Spanaway (USFWS, 2016).

**Critical Habitat Designated**

No;

***Life History***

**Feeding Narrative**

Adult: Pocket gophers are generalist herbivores and their diet includes a wide variety of plant material, including leafy vegetation, succulent roots, shoots, and tubers. In natural settings pocket gophers play a key ecological role by aerating soils, activating the seed bank, and stimulating plant growth, though they can be considered pests in agricultural systems. In prairie and meadow ecosystems, pocket gopher activity plays an important role in maintaining species richness and diversity. Foraging primarily takes place below the surface of the soil, where pocket gophers snip off roots of plants before occasionally pulling the whole plant below ground to eat or store in caches. If above-ground foraging occurs, it’s usually within a few feet of an opening and forage plants are quickly cut into small pieces and carried back to the nest or cache (Wight 1918, p. 12). Any water they need is obtained from their food (Gettinger 1984, pp. 749-750; Wight 1918, p. 13). The probability of pocket gopher occupancy is much higher in areas with less than 10 percent woody vegetation cover (Olson 2011a, p. 16), presumably because such vegetation will shade out the forbs, bulbs, and grasses that pocket gophers prefer to eat, and high densities of woody plants make travel both below and above the ground difficult (USFWS, 2016).

**Reproduction Narrative**

Adult: Pocket gophers reach sexual maturity during the spring of the year following their birth, and generally produce one litter per year (Case and Jasch 1994, p. B-20), though timing of sexual maturity has been shown to vary with habitat quality (Patton and Brylski 1987, p. 502; Patton and Smith 1990, p. 76). Gestation lasts approximately 18 days (Andersen 1978, p. 421; Schramm 1961, p. 169). Young are born in the spring to early summer (Wight 1918, p. 13), and are reared by the female. Aside from the breeding season, males and females remain segregated in their own tunnel systems. There are 1-9 pups per litter (averaging 5), born without hair, pockets, or teeth, and they must be kept warm by the mother or “packed” in dried vegetation (Case and Jasch 1994, p. B-20; Wight 1918, p. 14). Juvenile pelage starts growing in at just over a week (Andersen 1978, p. 420). The young eat vegetation in the nest within three weeks of birth, with eyes and ears opening and pockets developing at about a month (Andersen 1978, p. 420; Wight 1918, p. 14). At six weeks they are weaned, fighting with siblings, and nearly ready to disperse (Andersen 1978, p. 420; Wight 1918, p. 15), which usually occurs at about two months of age (Stinson 2005, p. 26). They attain their adult weight between four and five months of age (Andersen 1978, pp. 419, 421). Most pocket gophers live only a year or two, with few living to three or four years of age (Hansen 1962, pp. 152, 153; Livezey and Verts 1979, p. 39) (USFWS, 2016).

**Spatial Arrangements of the Population**

Adult: Clumped (USFWS, 2016)

**Habitat Narrative**

Adult: The Mazama pocket gopher (pocket gopher) is associated with glacial outwash prairies in western Washington, an ecosystem of conservation concern (Hartway and Steinberg 1997, p. 1), as well as alpine and subalpine meadows and other meadow-like openings at lower elevations. Steinberg and Heller (1997, p. 46) found that pocket gophers are even more patchily distributed than are prairies, as there are some seemingly high quality prairies within the species' range that lack pocket gophers; e.g., Mima Mounds Natural Area Preserve (NAP), and 13th Division Prairie on Joint Base Lewis-McChord (JBLM). Pocket gopher distribution is affected by the rock content of soils, drainage, forage availability, and climate (Case and Jasch 1994, p. B-21; Hafner et al. 1998, p. 279; Reichman 2007, pp. 273-274; Steinberg and Heller 1997, p. 45; Stinson 2005, p. 31; WDFW 2009). Prairie and meadow habitats used by pocket gophers have a naturally patchy distribution. In their prairie habitats, there is an even patchier distribution of soil rockiness which may further restrict the total area that pocket gophers can utilize (Steinberg and Heller 1997, p. 45; WDFW 2009). We assume that meadow soils have a similarly patchy distribution of rockiness, though the soil surveys to support this are, at this time, incomplete. In western Washington, pocket gophers currently occupy the following soils series: Alderwood, Cagey, Carstairs, Everett, Everett-Spanaway complex, Everett-Spanaway-Spana complex, Godfrey, Grove, Indianola, Kapowsin, McKenna, Murnen, Nisqually, Norma, Shelton, Spana, Spana-Spanaway-Nisqually complex, Spanaway, Spanaway-Nisqually complex, and Yelm. No soil survey information is currently available for occupied sites in the Olympic National Park, so the soils occupied there are unknown. We purposely avoid using specific map unit names, because we know that there are imperfections in soil mapping. Maps are based on the technology, standards, and tools available at the time soil surveys were conducted, sometimes up to 50 years ago. We recognize that soil survey boundaries may be adjusted in the future, and that soil series names may be added or removed to soil survey maps and databases. As a result, the overlap of pocket gopher locations with soil series names may be different in the future. The soils information presented here is based on best scientific data available at the time of listing. We also recognize that some of these soil series or soil series complexes are not typically either deep or well-drained. For a variety of reasons, mapped soil types may or may not have all of the characteristics described by the U.S. Department of Agriculture, Natural Resources Conservation Service, and the actual soils that occur on sites may have characteristics that make them more or less habitable by pocket gophers. These reasons may include: map boundary or transcription errors, map projection errors or differences, map identification or typing errors, soil or hydrological manipulations that have occurred since mapping took place, and small-scale inclusions that are different from the mapped soil. Because soils are mapped at large scales, mapped soils may not identify smaller inclusions. Any of the soil series or soil series complexes listed above could potentially be suitable for the four Thurston/Pierce subspecies of the

Mazama pocket gopher. And, the four Thurston/Pierce subspecies of the Mazama pocket gopher may also inhabit soil series not included in the above list. Although some soils are sandier, more gravelly, or may have more or less silt than described, most all soils used by pocket gophers are friable (easily pulverized or crumbled), loamy, and deep, and generally have slopes less than 15 percent. There have been reports of pocket gophers (subspecies unknown) occurring on other types of soils, on managed forest lands in Capitol State Forest (owned by the Washington State Department of Natural Resources, WDNR) and Vail Forest (owned by Weyerhaeuser) in Thurston County. These were subsequently determined to be moles (Scapanus spp.), based on trapping conducted in these areas by the Washington State Department of Fish and Wildlife (WDFW) during 2012 (Thompson, pers. comm. 2012b). A study of the relationship between soil rockiness and pocket gopher distribution revealed a strong negative correlation between the proportion of medium-sized rocks in the soil, and the presence of pocket gophers (eight of nine prairies sampled); medium sized rocks were considered greater than 0.5 inch (12.7 mm), but less than 2 inches (50.8 mm) in diameter (Steinberg 1996, p. 32). In observations of pocket gopher distribution on JBLM, pocket gophers did not occur in areas with a high percentage of Scot's broom cover (Cytisus scoparius), or where mole populations were particularly dense (Steinberg 1995, p. 26). A more recent study on JBLM also found that pocket gopher presence was negatively associated with Scot's broom; however, the researcher found no relationship between pocket gopher presence and mole density (Olson 2011a, pp. 12, 13). Pocket gopher burrows consist of a series of main runways, off which lateral tunnels lead to the surface of the ground (Wight 1918, p. 7). Pocket gophers dig their burrows using their sharp teeth and claws and then push the soil out through the lateral tunnels (Case and Jasch 1994, p. B-20; Wight 1918, p. 8). Nests containing dried vegetation are generally located near the center of each pocket gopher's home tunnel system (Wight 1918, p. 10). Food caches and store piles are usually placed near the nest, and excrement is piled into blind tunnels or loop tunnels, and then covered with dirt, leaving the nest and main runways clean (Wight 1918, p. 11). (USFWS, 2016).

***Dispersal/Migration***

**Motility/Mobility**

Adult: High (USFWS, 2016)

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: Non-migratory (USFWS, 2016)

**Dispersal**

Adult: Low (USFWS, 2016)

**Immigration/Emigration**

Adult: Unlikely (USFWS, 2016)

**Dispersal/Migration Narrative**

Adult: Pocket gophers have limited dispersal capabilities (Williams and Baker 1976, p. 303). Mazama pocket gophers are smaller in size than other sympatric or peripatric Thomomys species (Verts and Carraway 2000, p. 1). Both dispersal distance and home range size are therefore likely to be smaller than for other Thomomys species. Dispersal distances may vary based on surface or soil conditions and size of the animal. For other, larger, Thomomys species, dispersal distances average about 131 feet (40 meters) (Barnes Jr. 1973, pp. 168, 169; Daly and Patton 1990, pp. 1286, 1288; Williams and Baker 1976, p. 306). Initial results from research being conducted on JBLM indicate that juvenile pocket gophers usually make movements from 13.1 to 32.8 feet (4-10 meters), though these may not be dispersal movements. One juvenile made a distinct dispersal movement of 525 feet (160 meters) in a single day (Olson 2012, p. 5). Suitable dispersal habitat is free of barriers to movement, and may need to contain foraging habitat if an animal is required to make a long-distance dispersal movement. Potential barriers include, but are not limited to, forest edges, roads (paved and unpaved), abrupt elevation changes, Scot’s broom thickets (Olson 2012, p. 3), highly cultivated lawns, inhospitable soil types or substrates (Olson 2008, p. 4), development and buildings, slopes greater than 35 percent, and open water. Barriers may be permeable, meaning that they impede movement from place to place without completely blocking it, or they may be impermeable, meaning they cannot be crossed. Permeable barriers, as well as lower quality dispersal habitats, may present a risk of mortality for animals that use them (e.g., open areas where predation risk is increased, or a paved area where vehicular mortality is high). The WDFW conducted a study to determine dispersal distances of juvenile pocket gophers on JBLM. Twenty-eight juveniles were radio-collared and tracked for 17 to 56 days, with all but three animals tracked for more than 30 days. Of these, only nine gophers moved more than 32.8 feet (10 meters), and 10 gophers were never found more than 13.1 feet (4 meters) from any previous location (Olson 2012, p. 5). Only one animal dispersed what would be considered a larger distance, moving 525 feet (160 meters) in a single day.

***Population Information and Trends***

**Population Trends:**

Decreasing (USFWS, 2016)

**Population Narrative:**

There are few data on historical or current population sizes of Mazama pocket gopher (pocket gopher) populations in Washington, although several local populations and one subspecies are believed to be extinct. Knowledge of the past status of the pocket gopher is limited to distributional information. Recent surveys have focused on determining current distribution, primarily in response to development applications. In addition, in 2012, WDFW initiated a five county-wide distribution survey. Because the object of all of these surveys has mainly been presence/absence only, total population numbers for each subspecies are unknown. And, the precise boundaries of each subspecies’ range are not currently known. Local population estimates have been reported but are based on using apparent gopher mounds to delineate the number of territories, a method that has not been validated (Stinson 2005, pp. 40, 41). Olson (2011a, p. 2) evaluated this methodology on pocket gopher populations at the Olympia Airport and Wolf Haven International. Although there was a positive relationship between the number of mounds and number of pocket gophers, the relationship varies spatially, temporally, and demographically (Olson 2011a, pp. 2, 39). Based on the results of Olson’s 2011 study, we believe past population estimates (Stinson 2005) may have been too high. As there is no generally accepted standard survey protocol to determine population size for pocket gophers, it is not currently possible to obtain an estimate of subspecies population sizes or trends. Overall habitat availability has declined, however, and habitat has a finite ability to support pocket gophers. For these reasons, the Service concludes that the overall population trend of each of the four Thurston/Pierce subspecies of the Mazama pocket gopher is negative. Increased survey effort since 2007 has resulted in the identification of numerous additional occupied sites located on private lands, especially in Thurston County (WDFW 2013a). Some of these new detections are adjacent to other known occupied sites, such as the population at the Olympia Airport. The full extent of these smaller discontiguous sites is currently unknown, and no research has been done to determine whether or not these aggregations are “stepping stone” sites that may facilitate dispersal into nearby unoccupied suitable habitat, or if they are population sinks (sites that do not add to the overall population through recruitment). Others of these additional occupied sites are separate locations, seemingly unassociated (physically) with known populations (Tirhi, in litt. 2008). The largest known expanse of areas occupied by any subspecies in Washington occur on JBLM (Roy Prairie and Yelm pocket gophers), and at the Olympia and Shelton airports (Olympia and Shelton pocket gophers, respectively). A translocated population occurs on Wolf Haven International’s land near Tenino, Washington. Between 2005 and 2008, over 200 gophers from a variety of areas in Thurston County (some from around Olympia Airport (Olympia pocket gopher, T. m. pugetensis)) and some from near the intersection of Rich Road and Yelm Highway (assumed to be Olympia pocket gophers) were released into the 38 acres (15 ha) mounded prairie site. Based on the best available information, we do not believe the property previously supported pocket gophers. Today pocket gophers continue to occupy the site (Tirhi, in litt. 2011); however, current population estimates are not available. Another site, West Rocky Prairie Wildlife Area, has received a total of 560 translocated pocket gophers (T. m. pugetensis) from the Olympia Airport between 2009 and 2011. Initial translocation efforts were unsuccessful; a majority of the pocket gophers died within three days due to predation (Olson 2009, p. 3). Modified release techniques used in 2010 and 2011 resulted in improved survival rates (Olson 2011b, p. 4). It is too soon to know if the population will become self-sustaining, or if additional translocations of gophers will be necessary.

***Threats and Stressors***

**Stressor:** Destruction, Modification, or Curtailment of Habitat and Range (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The primary long term threats to the pocket gopher are the loss, conversion, and degradation of habitat, particularly to urban development, successional changes to grassland habitat, and the spread of invasive plants. The threats also include increased predation pressure, which is closely linked to habitat degradation. The prairies of south Puget Sound are one of the rarest ecosystems in the United States (Dunn and Ewing 1997b, p. v; Noss et al. 1995, p. I-2). Dramatic changes have occurred on the landscape over the last 150 years, including a 90 to 95 percent reduction in the extent of the prairie ecosystem. In the south Puget Sound region, where most of western Washington’s prairies historically occurred, less than 10 percent of the original prairie persists, and only three percent remains dominated by native vegetation (Crawford and Hall 1997, pp. 13, 14). Development: Native prairies and grasslands have been severely reduced throughout the range of the four Thurston/Pierce subspecies of Mazama pocket gopher, especially as a result of conversion to residential and commercial development and agriculture. Prairie habitat continues to be lost, particularly to residential development (Stinson 2005, p. 70), by removal and fragmentation of native vegetation, and the excavation, and/or heavy equipment-caused compaction of surfaces and conversion to non-habitat (e.g., buildings, pavement, other infrastructure), rendering soils unsuitable for burrowing. Residential development is associated with increased infrastructure, such as new road construction, which is

one of the primary causes of landscape fragmentation (Watts et al. 2007, p. 736). Activities that accompany low-density development are correlated with decreased levels of biodiversity, mortality to wildlife, and facilitated introduction of nonnative invasive species (Trombulak and Frissell 2001; Watts et al. 2007, p. 736). In the south Puget Sound lowlands, the glacial outwash soils and gravels underlying the prairies are deep and valued for use in construction and road building, which leads to their degradation and destruction. In the south Puget Sound, Nisqually loamy soils appear to support high densities of pocket gophers (Stinson, in litt. 2010a Olson 2008, p. 6), the vast majority of which occur in developed areas of Thurston County, or within the Urban Growth Areas for the cities of Olympia, Tumwater, and Lacey (WDFW 2009), where future development is most likely to occur. Where pocket gopher populations presumably extended across an undeveloped expanse of open prairie (Dalquest and Scheffer 1942, pp. 95, 96), areas currently occupied by the four Thurston/Pierce subspecies of the Mazama pocket gopher are now isolated to small fragmented patches due to development and conversion of suitable habitat to incompatible uses. The presumed extinction of the Tacoma pocket gopher is likely linked directly to residential and commercial development, which has replaced nearly all pocket gopher habitats in the historical range of the subspecies (Stinson 2005, pp. 18, 34, 46). One of the historical Tacoma pocket gopher sites was converted to a large gravel pit and golf course (Steinberg 1996, pp. 24, 27; Stinson 2005, pp. 47, 120). In addition, two gravel pits are now operating on part of the site recognized as the type locality for the Roy Prairie pocket gopher (Stinson 2005, p. 42), and another is in operation near Tenino (Stinson, in litt. 2010b) in the vicinity of the type locality for the Tenino pocket gopher. Multiple pocket gopher sites in Pierce and Thurston Counties may be, or have been, lost to gravel pit development, golf course development, or residential and commercial development (Stinson, in litt. 2005; Stinson 2005, pp. 26, 42; Stinson, in litt. 2010b). Multiple prairies that used to contain uninterrupted expanses of prairie habitat suitable for pocket gophers within the range of the four Thurston/Pierce subspecies have been developed to cities, neighborhoods, agricultural lands, or military bases, and/or negatively impacted by such development, including Baker Prairie, Bush Prairie, Chambers Prairie, Frost Prairie, Grand Mound Prairie, Little Chambers Prairie, Marion Prairie, Roy Prairie, Ruth Prairie, Woods Prairie, Violet Prairie, and Yelm Prairie. Some of these prairie areas still contain smaller areas that support pocket gophers, and some appear to no longer support pocket gophers at all (WDFW 2012). Where their properties coincide with pocket gopher occupancy, many private lands developers and landowners in Thurston County have agreed to create set-asides or agree to other mitigation activities in order to obtain development permits from the County (Tirhi, in litt. 2008). However, it is unknown if any pocket gophers will remain on these sites due to the small size of the set-asides, extensive grading in some areas adjacent to set-asides, lack of dedicated funding for enforcement or monitoring of set-aside maintenance (Thurston County Long Range Planning and Resource Stewardship, in litt. 2011, p. 2), and lack of control of predation by domestic or feral cats and dogs. In addition, some landowners have received variances from Thurston County that allowed development to occur without a requirement to set aside areas for pocket gophers. A population of Olympia pocket gophers is located at and around the Port of Olympia's Olympia Airport, which is sited on the historical Bush Prairie. Gophers on Bush Prairie are currently vulnerable to negative impacts from proposed future development by the Port of Olympia and ongoing development by adjacent landowners. The Port of Olympia has plans to develop large portions of the existing grassland that likely supports the largest population of the Olympia pocket gopher in Washington (Stinson 2007, in litt.; Port of Olympia and WDFW 2008, p.1; Port of Olympia 2012). The Olympia Airport is realigning the airport runway, which is in known occupied habitat. They continue to work with the Service and WDFW on mitigating airport expansion activities that may negatively impact gophers (Tirhi, in litt. 2010). The Olympia pocket gopher has a population at the Olympia Airport that spans several hundred acres, and there are two translocated populations: one at West Rocky Prairie Wildlife Area (some individuals from the Olympia Airport) and one at Wolf Haven (individuals from the Olympia Airport and some from near the intersection of Rich Road and Yelm Highway). The population centered on the Olympia Airport could be negatively impacted by plans for development both on and off the airport, while the two translocated populations are currently secure from intense commercial and residential development pressures as they occur on conserved lands. The Roy Prairie pocket gopher is known to occur across a large expanse of prairie on JBLM, which is currently secure from the threat of development. The Tenino pocket gopher has a single known population, which has been detected during surveys on the Rocky Prairie NAP, although the intermittent nature of these detections suggests it must be part of a larger metapopulation that occurs across nearby areas that have not been accessible for surveys. No known development poses a threat to the NAP, but any future conversion of the surrounding area to incompatible land use would likely hinder the recovery of this subspecies. The Yelm pocket gophers on Tenalquot prairie (which is owned in large part by JBLM) and Scatter Creek Wildlife Area are also secure from such residential and commercial development, but the Yelm pocket gopher habitat on Rock Prairie north of Old Highway 99 is in an area that is likely to be developed soon, which may negatively affect any local populations in the vicinity. Loss or Curtailment of Natural Disturbance Processes: The suppression and loss of ecological disturbance regimes across vast portions of the landscape, such as fire, has resulted in altered vegetation structure in the prairies and meadows and has facilitated invasion by native and nonnative woody vegetation, rendering habitat unusable for the four Thurston/Pierce subspecies of Mazama pocket gopher. The basic ecological processes that maintain prairies and meadows have disappeared from, or have been altered on, all but a few protected and managed sites. Historically, the prairies and meadows of the south Puget Sound region are thought to have been actively maintained by native peoples, who lived here for at least 10,000 years before the arrival of Euro-American settlers (Boyd 1986; Christy and Alverson 2011, p. 93). Frequent burning reduced the encroachment and spread of shrubs and trees (Boyd 1986; Chappell and Kagan 2001, p. 42), favoring open grasslands with a variety of native plants and animals. Following Euro-American settlement of the region in the mid-19th century, fire was actively suppressed on grasslands, allowing encroachment by woody vegetation into the remaining prairie habitat and oak woodlands (Agee 1993, p. 360; Altman et al. 2001, p. 262; Boyd 1986; Franklin and Dyrness 1973, p. 122; Kruckeberg 1991, p. 287)Fires on the prairie create a mosaic of vegetation conditions, which serve to maintain native prairie plant communities. In some prairie patches fires will kill encroaching woody vegetation and reset succession back to bare ground, creating early successional vegetation conditions suitable for many native prairie species. Early succession forbs and grasses are favored by pocket gophers. The historical fire frequency on prairies has been estimated to be 3 to 5 years (Foster 2005, p. 8). On sites where regular fires occur, there is a high complement of native plants and fewer invasive species. These types of fires maintain the native short-statured plant communities favored by pocket gophers. The result of fire suppression has been the invasion of the prairies and oak woodlands by native and nonnative plant species (Dunn and Ewing 1997a, p. v; Tveten and Fonda 1999, p. 146), notably woody plants such as the native Douglas-fir (Pseudotsuga menziesii) and the nonnative Scot’s broom. On tallgrass prairies in midwestern North America, fire suppression has led to degradation and the loss of native grasslands (Curtis 1959, pp. 296, 298; Panzer 2002, p. 1297). On northwestern prairies, fire suppression has allowed Douglas-fir to encroach on and outcompete native prairie vegetation for light, water, and nutrients (Stinson 2005, p. 7). This increase in woody vegetation and nonnative plant species has resulted in less available prairie habitat overall and habitat that is unsuitable for and avoided by many native prairie species, including pocket gophers (Olson 2011a, pp. 12, 16; Pearson et al. 2005, pp. 2, 27; Tveten and Fonda 1999, p. 155). Pocket gophers prefer early successional vegetation as forage. Woody plants shade out the forbs and grasses that pocket gophers prefer to eat, and high densities of woody plants make travel both below and above the ground difficult. In locations with poor forage, pocket gophers tend to have larger territories, which may be difficult or impossible to establish in densely forested areas. The probability of pocket gopher occupancy is much higher in areas with less than 10 percent woody vegetation cover (Olson 2011a, p. 16). On JBLM alone, over 16,000 acres (6,477 ha) of prairie has converted to Douglas-fir forest since the mid-19th century (Foster and Shaff 2003, p. 284). Where controlled burns or direct tree removal are not used as a management tool, this encroachment will continue to cause the loss of open grassland habitats for pocket gophers and is an ongoing threat to the species. Restoration in some of the south Puget Sound grasslands has resulted in temporary control of Scot's broom and other invasive plants through the careful and judicious use of herbicides, mowing, grazing, and fire. Fire has been used as a management tool to maintain native prairie composition and structure and is generally acknowledged to improve the health and composition of grassland habitat by providing a short-term nitrogen addition, which results in a fertilizer effect to vegetation, thus aiding grasses and forbs to sprout. Unintentional fires ignited by military training burn patches of prairie grasses and forbs on JBLM on an annual basis. These light ground fires create a mosaic of conditions within the grassland, maintaining a low vegetative structure of native and nonnative plant composition, and patches of bare soil. Because of the topography of the landscape, fires create a patchy mosaic of areas that burn completely, some areas that do not burn, and areas where consumption of the vegetation is mixed in its effects to the habitat. One of the benefits of fire in grasslands is that it tends to kill regenerating conifers, and reduces the cover of nonnative shrubs such as Scot's broom, although Scot's broom seed stored in the soil can be stimulated by fire (Agee 1993, p. 367). Fire also improves conditions for many native bulb-forming plants, such as Camassia spp. (Agee and Dunwiddie 1984). On sites where regular fires occur, such as on JBLM, there is a high complement of native plants and fewer invasive species. These types of fires maintain the native, short-statured plant communities favored by pocket gophers. Management practices such as intentional burning and mowing require expertise in timing and technique to achieve desired results. If applied at the wrong season, frequency, or scale, fire and mowing can be detrimental to the restoration of native prairie species. Excessive and high-intensity burning can result in a lack of vegetation or encourage regrowth of nonnative grasses. Where such burning has occurred over a period of more than 50 years on the artillery ranges of JBLM, prairies are covered by nonnative forbs and grasses instead of native perennial bunchgrasses (Tveten and Fonda 1999, pp. 154, 155). Pocket gophers are not commonly found in areas colonized by Douglas-fir trees because pocket gophers require forbs and grasses of an early successional stage for food (Witmer et al. 1996a, p. 96). Pocket gophers observed on JBLM did not occur in areas with high cover of Scot's broom (Steinberg 1995, p. 26). A more recent study on JBLM also found that pocket gopher presence was negatively associated with Scot's broom (Olson 2011a, pp. 12, 13, 16). Some subspecies may disperse through forested areas or may temporarily establish territories on forest edges, but there is currently not enough data available to determine how common this behavior may be or which subspecies employ it. The four Thurston/Pierce subspecies of the Mazama pocket gopher occur on prairie-type habitats, many of which, if not actively managed to maintain vegetation in an early-successional state, have been invaded by shrubs and trees that either preclude pocket gophers or limit their ability to fully occupy the landscape. Typical management at civilian airports prevents woody vegetation from encroaching onto surrounding areas for flight safety reasons. Woody vegetation encroachment is therefore not a threat at civilian airports. Military Training: Pocket gopher populations occurring on JBLM are exposed to differing levels of training activities on the base. The Department of Defense's (DOD) proposed actions under their "Grow the Army" initiative include stationing 5,700 new soldiers, new combat service support units, a combat aviation brigade, facility demolition and construction to support the increased troop levels, and additional aviation, maneuver, and live fire training (75 FR 55313, September 10, 2010). The increased training activities will affect nearly all training areas at JBLM, resulting in an increased risk of accidental fires, and habitat destruction and degradation attributable to vehicle use in occupied areas, mounted and dismounted training, bivouac activities, and digging. Even though the training areas on the base are degraded, with implementation of agreed-upon conservation measures, these areas still provide habitat for the Roy Prairie and Yelm pocket gopher. JBLM's recently signed Endangered Species Management Plan (ESMP) for the Mazama pocket gopher will serve to minimize threats across the base by redirecting some training activities to areas outside of occupied habitat, designating areas where no vehicles are permitted, designating areas where vehicles will remain on roads only, and designating areas where no digging is allowed, among other conservation measures. JBLM has further committed to enhancing and expanding suitable habitat for the Roy Prairie and Yelm pocket gophers in "priority habitat" areas on base (areas that were proposed as critical habitat); enforcing restrictions on recreational use of occupied habitat by dog owners and horseback riders; and continuing to support the off-base recovery of the four Thurston/Pierce subspecies of the Mazama pocket gopher. Several moderate- to large-sized areas supporting pocket gophers have been identified on JBLM. These areas are within the historical ranges of the Roy Prairie (Pierce County) and Yelm (Thurston County) pocket gophers. Their absence from some sites of what is presumed to have been formerly suitable habitat may be related to compaction of the soil due to years of mechanized vehicle training (Steinberg 1995, p. 36). Training infrastructure (e.g., roads, firing ranges, bunkers) also degrades pocket gopher habitat and may lead to reduced use of these areas by pocket gophers. For example, JBLM has plans to add a third rifle range on the south impact area where it overlaps with a densely occupied pocket gopher site. The area may be usable by pocket gophers when the project is completed; however, construction of the rifle range may result in removal of forage and direct mortality of pocket gophers through crushing of burrows (Stinson, in litt. 2011). Recent survey access to the center of the artillery impact area on 91st Division Prairie, where bombardment is presumably of the highest intensity, did detect some unspecified level of occupancy by the Roy Prairie pocket gopher (WDFW 2013b, enclosure 1, p. 6). This apparently suitable central portion of the 91st Division Prairie is subject to repeated and ongoing bombardment, which may create an ecological trap for dispersing juveniles. JBLM training areas have varying levels of use; some allow excavation and off-road vehicle use, while other areas have restrictions that limit off-road vehicle use. The ESMP specifically requires coordination between the JBLM Fish and Wildlife personnel and the JBLM entities responsible for training activities (e.g., Range Support, battalion commanders, and/or first field grade officers) to ensure all parties are aware of where occupied areas occur in relation to training activities, the effects of training, and the potential ramifications of habitat destruction or animal mortality. Since military training has the potential to directly or indirectly harm or harass pocket gophers, we conclude that these activities will negatively impact the Roy Prairie and Yelm pocket gophers. JBLM has committed to operational restrictions on portions of the base in order to avoid and minimize potential impacts to Roy Prairie and Yelm pocket gophers. Currently-occupied areas will be buffered from training activities, with an emphasis on occupied habitat in "priority habitat" areas. Regular surveys will be conducted with the goals of determining distribution, protecting pocket gophers and their habitat from disturbance or destruction, and determining population status. Where possible, JBLM will alleviate training pressure by transferring activities to unoccupied areas where encroaching forest has been removed. This strategy has the effect of both releasing large areas of land that were historically prairie and providing unoccupied areas where training is free of the risk of negatively impacting Roy Prairie or Yelm pocket gophers. While the Service fully supports the implementation of these impact minimization efforts and will continue to collaborate with DOD to address all aspects of training impacts on the species, not all adverse impacts on pocket gophers can be fully avoided. Military training continues to pose a threat to the Roy Prairie and Yelm subspecies at this time. No military training occurs in the ranges of the Olympia or Tenino subspecies of the Mazama pocket gopher (USFWS, 2016).

**Stressor:** Poor Connectivity Between Small and Isolated Populations (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Isolated genetics
**Narrative:** Most species' populations fluctuate naturally, responding to various factors such as weather events, disease, and predation. Populations that are small, fragmented, or isolated by habitat loss or modification of naturally patchy habitat, and other human-related factors, are more vulnerable to extirpation by natural randomly occurring events, cumulative effects, and to genetic effect (collectively known as small population effects). These effects can include genetic drift (loss of recessive alleles), founder effects (over time, an increasing percentage of the population inheriting a narrow range of traits), and genetic bottlenecks leading to increasingly lower genetic diversity, with consequent negative effects on evolutionary potential. To date, of the eight subspecies of Mazama pocket gopher in Washington, only the Olympic pocket gopher has been documented as having low genetic diversity (Welch and Kenagy 2008, p. 7), although the six other extant subspecies have local populations that are small, fragmented, and physically isolated from one another. The four Thurston/Pierce subspecies of the Mazama pocket gopher face threats from loss or fragmentation of habitat. Historically, pocket gophers probably persisted by continually recolonizing habitat patches after local extinctions. However, widespread development and conversion of habitat has resulted in widely separated populations, and intervening habitat corridors are now gone, with the effect of impeding or stopping much of the natural recolonization that historically occurred (Stinson 2005, p. 46). Although pocket gophers are not known to have low genetic diversity, small population sizes at most sites, coupled with disjunct and fragmented habitat, may contribute to further population declines. Little is known about the local or rangewide reproductive success of pocket gophers found in Washington State (USFWS, 2016).

**Stressor:** Predation and Pest Control (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Predation: Predation influences the distribution, abundance, and diversity of species in ecological communities. Generally, predation leads to changes in both the population size of the predator and that of the prey. In unfavorable environments, prey species are stressed or living at low population densities such that predation is likely to have negative effects on all prey species, thus lowering species richness. In addition, when a nonnative predator is introduced to the ecosystem, negative effects on the prey population may be higher than those from co-evolved native predators. The effect of predation may be magnified when populations are small, and the disproportionate effect of predation on declining populations has been shown to drive

rare species even further towards extinction (Woodworth 1999, pp. 74, 75). Predation has an impact on populations of the four Thurston/Pierce subspecies of Mazama pocket gopher. Urbanization, particularly in the south Puget Sound region, has resulted in not only habitat loss, but also increased exposure to feral and domestic cats and dogs. Domestic cats are known to have serious impacts on small mammals and birds and have been implicated in the decline of several endangered and threatened mammals, including marsh rabbits (Sylvilagus palustris) in Florida and the salt-marsh harvest mouse (Reithrodontomys raviventris) in California (Ogan and Jurek 1997, p. 89). Domestic cats and dogs have been specifically identified as common predators of pocket gophers (Case and Jasch 1994, p. B-21; Henderson 1981, p. 233; Wight 1918, p. 21) and at least two pocket gopher locations were found as a result of house cats bringing home pocket gopher carcasses (WDFW 2001). Informal interviews with area biologists document multiple incidents of domestic pet predation on pocket gophers (Chan, in litt. 2013; Clouse, in litt. 2012 Skriletz 2013 in litt., Wood 2013 in litt.). There is also one recorded instance of a WDFW biologist being presented with a dead Mazama pocket gopher by a dog during an east Olympia, Washington, site visit in 2006 (Burke Museum 2012 McAllister 2013 in litt.). Some local populations of the pocket gopher occur in areas where people recreate with their dogs, bringing these potential predators into environments that may otherwise be relatively free of them, consequently increasing the risks to individual pocket gophers and populations that may be small and isolated The four Thurston/Pierce subspecies of Mazama pocket gopher occur in rapidly developing areas. Local populations that survive commercial and residential development (adjacent to and within habitat) are potentially vulnerable to extirpation by domestic and feral cats and dogs (Case and Jasch 1994, p. B-21; Henderson 1981, p. 233). As stated previously, predation is a natural part of the pocket gopher's life history; however, the effect of predation may be magnified when populations are small and habitat is fragmented. The disproportionate effect of additional predation on declining populations has been shown to drive rare species even further towards extinction (Woodworth 1999, pp. 74, 75). Predation, particularly from nonnative species, will likely continue to be a threat to the four Thurston/Pierce subspecies of the Mazama pocket gopher now and in the future. This is particularly likely where development abuts gopher habitat, resulting in increased numbers of cats and dogs in the vicinity, and in areas where people recreate with their dogs – particularly if dogs are off-leash and not prevented from harassing wildlife. In such areas, where local populations of pocket gophers are already small, this additional predation pressure (above natural levels of predation) is expected to further negatively impact population numbers. Pest Control: Pocket gophers are often considered a pest because they sometimes damage crops and seedling trees, and their mounds can create a nuisance. Several site locations were found as a result of trapping conducted on Christmas tree farms, a nursery, and in a livestock pasture (WDFW 2001). The type locality for the Cathlamet pocket gopher is on a commercial tree farm. Pocket gophers from Thurston County were used in a rodenticide experiment as recently as 1995 (Witmer et al. 1996a, p. 97). In Washington State it is currently illegal to trap or poison Mazama pocket gophers, or to trap or poison moles where they overlap with Mazama pocket gopher populations, but not all property owners are cognizant of these laws, nor are most citizens capable of differentiating between moles, pocket gophers, or the signs of their habitation (e.g., soil disturbance). In light of this, it is reasonable to believe that mole trapping or poisoning still has the potential to adversely affect pocket gopher populations. Local populations that survive commercial and residential development (adjacent to and within habitat) may be subsequently extirpated by trapping or poisoning. Lethal control by trapping or poisoning is most likely to be a threat to the four Thurston/Pierce subspecies where their ranges overlap residential properties (USFWS, 2016).

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 6C

**Delisting Criteria:**
Common Criterion 1: Reserve Establishment Multiple discrete Reserves (Reserve Cores, Reserve Complexes, or both) are established for each of the four MPG subspecies (see subspecies-specific criteria below for Reserve numbers and distribution (USFWS, 2022)

Common Criterion 2: Demographic Viability Each Reserve supports a self-sustaining population with a minimum of 1,000 individuals of the target subspecies. A minimum of 5 years of monitoring utilizing Service-approved protocols across a 10-year period have been conducted and demonstrate the self-sustaining nature of local MPG populations on each Reserve (USFWS, 2022).

Common Criterion 3: Habitat Area Each Reserve Core provides approximately 250 to 500 acres (about 100 to 200 ha), or more, of medium- and high-quality habitat (see Appendix A for a description of medium- and high-quality habitat). Each Reserve Complex provides a comparable amount of medium- and high-quality habitat (i.e., approximately 250 to 500 acres (100 to 200 ha), located on functionally connected Reserve Satellites. Each Reserve Satellite contains at least 10 acres (approximately 4 ha) of contiguous medium- or high-quality habitat (USFWS, 2022).

In addition to the three Common Criteria, above: RPPG Criterion 1 There are a minimum of three (3) Reserves (as defined and described in Common Criterion 1).

**Recovery Actions:**
- 1. Protect, conserve, and enhance MPG habitat. (Priority 1a) • Identify and prioritize creation and protection of Reserves. • Purchase occupied and highly suitable lands in Reserve areas. • Implement other short- and long-term strategies to protect Reserves and other important MPG sites from development pressure (e.g., mitigation lands, interim permitting strategy, in lieu fee, programmatic HCPs; municipal HCPs). • Develop and cooperatively implement programs for the protection and conservation of MPGs, south Puget Sound prairies, oak savanna, and other prairie-dependent species. This can include, but is not limited to, grant funding, habitat acquisition, habitat restoration, regulatory reform programs and policies, management plans, zoning, mitigation, research, and monitoring for each subspecies. • Implement conservation programs to avoid, minimize, or offset effects of RPPG and YPG habitat impacts resulting from military training. • Monitor implementation of habitat protection activities for MPG conservation (e.g., set-asides, mitigation banks). • 2. Identify MPG limiting factors and sources of mortality or harm and implement best management practices to minimize impacts. (Priority 1b) Assessment of ecologically important limiting factors and evaluating the success of management measures that have been implemented is necessary for effective adaptive management. To minimize adverse effects of threats, best management practices should be implemented by all partners. • Evaluate the effects of vegetation management on MPGs and their habitat. • Determine if and how translocated populations within the range of TPG are affecting demographic and genetic characteristics of this subspecies; develop solutions if needed. • Identify landscape features that influence MPG dispersal and distribution. • Evaluate

impacts of other anthropogenic stressors affecting MPGs (e.g., cats, dogs, recreational uses, etc.). • Evaluate natural factors affecting population health and distribution within and between sites. • Conduct demographic and genetic studies. • Revise population viability analysis every 10 years, or when new genetic or demographic information becomes available. • Implement measures to avoid, minimize, or mitigate impacts to individual RPPGs or YPGs as a result of military training. These include the activities described in the JBLM INRMP and the ESMC for MPGs; and the activities, reasonable and prudent measures, and terms and conditions included in the biological opinion(s) addressing training and related activities at JBLM. • Develop and implement best management practices to avoid and minimize effects of activities in occupied MPG habitat, including: use of mechanical equipment, particularly heavy equipment operations; implementation and use of restoration tools and techniques (including use of prescribed fire); management of predation by domestic and feral dogs and cats; and minimizing incidental or intentional MPG mortality resulting from control of fossorial animals (such as moles) as pest species (i.e., by poisoning and trapping). 3. To achieve Reserve targets for each subspecies, evaluate the need to either create new local populations or increase the number of individuals in existing local populations within each Recovery Area or Recovery Unit. If needed, create new local populations or increase current (2020) local population sizes through habitat creation and population augmentation. Monitor Reserves/Reserve Complexes as needed to determine status and trend of populations prior to final monitoring requirements in Common Criterion 2. (Priority 2) • Evaluate the range-wide need to increase the number of populations. • Monitor local populations in individual Reserves as needed to determine status and trend prior to final monitoring requirements in Common Criterion 2. • Evaluate the range-wide need to augment existing populations. • If needed, evaluate and modify methods of captive breeding, handling, transport, and translocation. • If needed, develop and test best practices for habitat expansion. • If needed, evaluate sites for suitability and prioritize for habitat expansion. • If translocation or habitat expansion is justified, evaluate legal aspects and complete compliance analysis and documentation (permitting, National Environmental Policy Act, etc.) • If needed and appropriate, establish additional populations within unoccupied areas of the historical range. • If needed and appropriate, implement and monitor habitat expansion through vegetation manipulation (tree and shrub removal, mowing, restoration, etc.). 4. Strengthen outreach and cooperation with stakeholders and partner agencies. (Priority 2) Coordination with landowners, management agencies, and interested members of the public is necessary to effectively implement necessary recovery actions across a broad range of land ownership. • Facilitate coordination and information sharing. • Implement outreach and education. 5. Monitor Reserves to determine local population status and trend, sufficient to determine if population goals required in Common Criterion 2 have been met. (Priority 3) Population survey and monitoring with consistent and repeatable methodology is necessary to assess whether Reserves have met population targets in Common Criterion 2 and to provide baseline information for development of a post-delisting monitoring plan. • Verify existing comprehensive survey/monitoring scheme (Olson 2017). Implement survey/monitoring scheme at each Reserve to determine if local population goals required in Common Criteria 2 have been met. (USFWS, 2021)

- Roy Prairie pocket gopher 1. Protect, conserve, and enhance RPPG habitat. $29,921,000 Priority: 1a 2. Identify MPG limiting factors and sources of mortality or harm and implement best management practices to minimize impacts. $1,240,000 Priority 1b 3. To achieve Reserve targets for each subspecies, evaluate the need to either create new local populations or increase the number of individuals in existing local populations in the RPPG

Recovery Area (Costs for this TBD). Monitor Reserves as needed to determine status and trend of populations prior to final monitoring requirements in Common Criterion 2. $4,078,000 Priority 2 4. Strengthen outreach and cooperation with stakeholders and partner agencies. $1,302,000 Priority 2 5. Monitor population status, trend, and distribution, sufficient to determine if population goals required in Common Criterion 2 have been met. $1.301,000 Priority 3 (USFWS, 2021)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Future research and management recommendations include: (1) Protect, conserve, and enhance Mazama pocket gopher habitat within the range of each subspecies through habitat acquisition, habitat easement, habitat conservation plans, habitat restoration, and other conservation tools. (2) Conduct research to identify limiting factors and sources of mortality or harm for Mazama pocket gophers and implement best management practices to minimize impacts across the range of each subspecies. (3) If needed, create new local populations or increase population sizes on conserved lands. Monitor each subspecies' population to determine status and trend. (4) Strengthen outreach and cooperation with stakeholders and partner agencies. (USFWS, 2020)

**References**

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USFWS. 2021. Draft Recovery Plan for Four Subspecies of Mazama Pocket Gopher. Draft Recovery Plan for Four Subspecies of Mazama Pocket Gopher Roy Prairie pocket gopher (Thomomys mazama glacialis) Olympia pocket gopher (Thomomys mazama pugetensis) Tenino pocket gopher (Thomomys mazama tumuli) Yelm pocket gopher (Thomomys mazama yelmensis). 29 pp + Attachments.

USFWS. 2022. Recovery plan for four subspecies of Mazama pocket gopher. Portland, Oregon. xi +33 pp.+ appendices.

USFWS 2020. 5-YEAR REVIEW Mazama Pocket Gophers: Olympia, Roy Prairie, Tenino, and Yelm pocket gophers (Thomomys mazama pugetensis, T. m. glacialis, T. m. tumuli, and T. m. yelmensis). 9 pp.

# SPECIES ACCOUNT: *Thomomys mazama pugetensis* (Olympia pocket gopher)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; Pacific Region (R1) (USFWS, 2016)

**Physical Description**

Adult Mazama pocket gophers are reddish brown to black above, and the underparts are lead-colored with buff-colored tips. The lips, nose, and patches behind the ears are black; the wrists are white. Adults range from 7 to 9 inches (189 to 220 millimeters (mm)) in total length, with tails that range from 2 to 3 inches (45 to 85 mm)(Verts and Carraway 2000, p.2). Mazama pocket gophers are morphologically similar to other species of pocket gophers that exploit a subterranean existence. They are stocky and tubular in shape, with short necks, powerful limbs, long claws, and tiny ears and eyes. Their short, nearly hairless tails are highly sensitive and probably assist when navigating tunnels. The “pockets” are external, fur-lined cheek pouches on either side of the mouth that are used to transport nesting material and plant cuttings. Mazama pocket gophers reach reproductive age in the spring of the year after their birth and produce litters between spring and early summer. Litter size ranges from one to nine (Wight 1918, p. 14), with an average of five (Scheffer 1938, p. 222). They do not hibernate in winter; they remain active throughout the year (Case and Jasch 1994, p. B-20) (USFWS, 2016).

**Taxonomy**

Although the species Thomomys mazama, or Mazama pocket gopher, includes numerous subspecies that are found in the States of Washington, Oregon, and California, only the subspecies found in the State of Washington have recently been considered for listing. The Mazama pocket gopher complex consists of 15 subspecies, eight of which occur only in Washington, five of which occur only in Oregon, one that occurs only in California, and one subspecies with a distribution that spans the boundary between Oregon and California (Hall 1981, p. 467). The first pocket gophers collected in western Washington were considered subspecies of the northern pocket gopher (Thomomys talpoides)(Goldman 1939), until 1960 when the complex of pocket gophers found in western Washington was determined to be more similar to the western pocket gopher (T. mazama)(Johnson and Benson 1960, p. 20). Eight western Washington subspecies of Mazama pocket gopher (T. mazama, ssp. couchi, glacialis, louiei, melanops, pugetensis, tacomensis, tumuli, and yelmensis) have been identified (Hall 1981, p. 467). Thomomys mazama is recognized as a valid species by the Integrated Taxonomic Information System (ITIS 2012). Although there have been suggestions that potential changes to the classification of some of these subspecies should be considered, we have no information to suggest that any of the presently recognized subspecies are the subject of serious dispute. We follow the subspecies designations of Verts and Carraway (2000), as this text represents the currently accepted taxonomy for the species T. mazama. Verts and Carraway (2000, p.1) recognize T. m. glacialis, pugetensis, tumuli, and yelmensis as separate subspecies (the Roy Prairie, Olympia, Tenino, and Yelm pocket gophers, respectively) based on morphological characteristics, distribution, and differences in number of chromosomes. Due to the close proximity of the four subspecies located in Thurston and Pierce Counties, and the fact that at least three of them occur in the same clade, we refer to these four subspecies (T. m. glacialis, pugetensis, tumuli, and yelmensis) as “the four Thurston/Pierce subspecies” of the Mazama

pocket gopher (USFWS, 2016).

**Current Range**

In Washington, Mazama pocket gophers are found west of the Cascade Mountain Range, in the Olympic Mountains and in the Puget Sound trough, with an additional single locality known from Wahkiakum County (Verts and Carraway 2000, p.3). Their populations are concentrated in well-drained friable soils often associated with glacial outwash. The type locality for the Olympia pocket gopher (Thomomys mazama pugetensis) was the prairie on and around the Olympia Airport (Dalquest and Scheffer 1944, p. 445). Gophers continue to occupy this area. Soil series and soil series complexes in and around this area that may support pocket gophers include Alderwood, Cagey, Everett, Indianola, McKenna, Nisqually, Norma, Spana, Spanaway- Nisqually complex, and Yelm (USFWS, 2016).

**Critical Habitat Designated**

Yes; 4/9/2014.

**Legal Description**

On April 9, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat for three subspecies of the Mazama pocket gopher (the Olympia pocket gopher, Thomomys mazama pugetensis; the Tenino pocket gopher, T. m. tumuli; and the Yelm pocket gopher, T. m. yelmensis) under the Endangered Species Act of 1973, as amended (Act). In total, approximately 1,607 acres (650 hectares) in Thurston County, Washington, fall within the boundaries of the critical habitat designation for the Olympia, Tenino, and Yelm pocket gophers. The effect of this regulation was to designate critical habitat for the Olympia, Tenino, and Yelm subspecies of the Mazama pocket gopher found in Thurston County, Washington, under the Act.

**Critical Habitat Designation**

Olympia Pocket Gopher Critical Habitat—Olympia Airport Unit. This unit consists of 676 ac (274 ha) and is made up of land owned by the Port of Olympia, a municipal corporation. The Olympia Airport Unit is located south of the cities of Olympia and Tumwater, in Thurston County, Washington. This unit is occupied by the Olympia pocket gopher and contains the physical or biological features essential to the conservation of the subspecies due to the underlying soil series (Cagey, Everett, Indianola, and Nisqually), suitable forb and grass vegetation present onsite, and its large size

**Primary Constituent Elements/Physical or Biological Features**

Critical habitat for the Olympia pocket gopher is desingated in Thurston County, Washington. Within this area, the primary constituent elements of the physical or biological features essential to the conservation of the Olympia pocket gopher consist of two components:

(i) Friable, loamy, and deep soils, some with relatively greater content of sand, gravel, or silt, all generally on slopes less than 15 percent in the following soil series or soil series complex: (A) Alderwood; (B) Cagey; (C) Everett; (D) Godfrey; (E) Indianola; (F) Kapowsin; (G) McKenna; (H) Nisqually; (I) Norma; (J) Spana; (K) Spanaway; (L) Spanaway-Nisqually complex; and (M) Yelm.

(ii) Areas equal to or larger than 50 ac (20 ha) in size that provide for breeding, foraging, and dispersal activities, found in the soil series listed in paragraph (2)(i) of this entry that have: (A) Less than 10 percent woody vegetation cover; (B) Vegetative cover suitable for foraging by gophers. Pocket gophers' diets include a wide variety of plant material, including leafy vegetation, succulent roots, shoots, tubers, and grasses. Forbs and grasses that Mazama pocket gophers eat are known to include, but are not limited to: Achillea millefolium (common yarrow), Agoseris spp. (agoseris), Cirsium spp. (thistle), Bromus spp. (brome), Camassia spp. (camas), Collomia linearis (tiny trumpet), Epilobium spp. (several willowherb spp.), Eriophyllum lanatum (woolly sunflower), Gayophytum diffusum (groundsmoke), Hypochaeris radicata (hairy cat's ear), Lathyrus spp. (peavine), Lupinus spp. (lupine), Microsteris gracilis (slender phlox), Penstemon spp. (penstemon), Perideridia gairdneri (Gairdner's yampah), Phacelia heterophylla (varileaf phacelia), Polygonum douglasii (knotweed), Potentilla spp. (cinquefoil), Pteridium aquilinum (bracken fern), Taraxacum officinale (common dandelion), Trifolium spp. (clover), and Viola spp. (violet); and (C) Few, if any, barriers to dispersal. Barriers to dispersal may include, but are not limited to, forest edges, roads (paved and unpaved), abrupt elevation changes, Scot's broom thickets, highly cultivated lawns, inhospitable soil types or substrates, development and buildings, slopes greater than 35 percent, and open water.

**Special Management Considerations or Protections**

Critical habitat does not include manmade structures (such as buildings, aqueducts, runways, roads, railroad tracks, and other paved areas) and the land on which they are located existing within the legal boundaries on May 9, 2014.

The physical or biological features essential to the conservation of each subspecies may require special management considerations or protection to restore, protect, and maintain the essential features found there. The physical or biological features in this subunit are threatened by: Loss of habitat through conversion to incompatible uses, such as development; predation; and the habitat degradation or destruction due to the inadequacy of existing regulatory mechanisms.

The physical or biological features essential to the conservation of the four Thurston/Pierce subspecies of the Mazama pocket gopher may require special management considerations or protection to control or prevent the establishment of invasive woody plants, which create shade and compete for light, food and nutrients otherwise utilized by the forb, bulb, and grass species that the gophers require for forage. Management may be implemented using hand tools or mechanical methods, prescribed fire, and the judicious use of herbicides. Although several management techniques are being implemented on public lands, we may need to improve our outreach to educate private landowners on controlling their pets and appropriately managing grazing on their properties, as well as to developing incentives for landowners who agree to conserve habitat. Incentives would create protected areas, through agreements or acquisitions. These would include corridors between existing protected habitat areas that may require management, enhancement actions, and long-term maintenance.

***Life History***

**Feeding Narrative**

Adult: Pocket gophers are generalist herbivores and their diet includes a wide variety of plant material, including leafy vegetation, succulent roots, shoots, and tubers. In natural settings pocket gophers play a key ecological role by aerating soils, activating the seed bank, and stimulating plant growth, though they can be considered pests in agricultural systems. In prairie and meadow ecosystems, pocket gopher activity plays an important role in maintaining species richness and diversity. Foraging primarily takes place below the surface of the soil, where pocket gophers snip off roots of plants before occasionally pulling the whole plant below ground to eat or store in caches. If above-ground foraging occurs, it's usually within a few feet of an opening and forage plants are quickly cut into small pieces and carried back to the nest or cache (Wight 1918, p. 12). Any water they need is obtained from their food (Gettinger 1984, pp. 749-750; Wight 1918, p. 13). The probability of pocket gopher occupancy is much higher in areas with less than 10 percent woody vegetation cover (Olson 2011a, p. 16), presumably because such vegetation will shade out the forbs, bulbs, and grasses that pocket gophers prefer to eat, and high densities of woody plants make travel both below and above the ground difficult (USFWS, 2016).

**Reproduction Narrative**

Adult: Pocket gophers reach sexual maturity during the spring of the year following their birth, and generally produce one litter per year (Case and Jasch 1994, p. B-20), though timing of sexual maturity has been shown to vary with habitat quality (Patton and Brylski 1987, p. 502; Patton and Smith 1990, p. 76). Gestation lasts approximately 18 days (Andersen 1978, p. 421; Schramm 1961, p. 169). Young are born in the spring to early summer (Wight 1918, p. 13), and are reared by the female. Aside from the breeding season, males and females remain segregated in their own tunnel systems. There are 1-9 pups per litter (averaging 5), born without hair, pockets, or teeth, and they must be kept warm by the mother or "packed" in dried vegetation (Case and Jasch 1994, p. B-20; Wight 1918, p. 14). Juvenile pelage starts growing in at just over a week (Andersen 1978, p. 420). The young eat vegetation in the nest within three weeks of birth, with eyes and ears opening and pockets developing at about a month (Andersen 1978, p. 420; Wight 1918, p. 14). At six weeks they are weaned, fighting with siblings, and nearly ready to disperse (Andersen 1978, p. 420; Wight 1918, p. 15), which usually occurs at about two months of age (Stinson 2005, p. 26). They attain their adult weight between four and five months of age (Andersen 1978, pp. 419, 421). Most pocket gophers live only a year or two, with few living to three or four years of age (Hansen 1962, pp. 152, 153; Livezey and Verts 1979, p. 39) (USFWS, 2016).

**Spatial Arrangements of the Population**

Adult: Clumped (USFWS, 2016)

**Habitat Narrative**

Adult: The Mazama pocket gopher (pocket gopher) is associated with glacial outwash prairies in western Washington, an ecosystem of conservation concern (Hartway and Steinberg 1997, p. 1), as well as alpine and subalpine meadows and other meadow-like openings at lower elevations. Steinberg and Heller (1997, p. 46) found that pocket gophers are even more patchily distributed than are prairies, as there are some seemingly high quality prairies within the species' range that lack pocket gophers; e.g., Mima Mounds Natural Area Preserve (NAP), and 13th Division Prairie on Joint Base Lewis-McChord (JBLM). Pocket gopher distribution is affected by the rock content of soils, drainage, forage availability, and climate (Case and Jasch 1994, p. B-21; Hafner et al. 1998, p. 279; Reichman 2007, pp. 273-274; Steinberg and Heller 1997, p. 45; Stinson 2005, p. 31; WDFW 2009). Prairie and meadow habitats used by pocket gophers have a naturally patchy distribution. In their prairie habitats, there is an even patchier distribution of soil rockiness which may further restrict the total area that pocket gophers can utilize (Steinberg and Heller 1997, p. 45; WDFW 2009). We assume that meadow soils have a similarly patchy distribution of rockiness, though the soil surveys to support this are, at this time, incomplete. In western Washington, pocket gophers currently occupy the following soils series: Alderwood, Cagey, Carstairs, Everett, Everett-Spanaway complex, Everett-Spanaway-Spana complex, Godfrey, Grove, Indianola, Kapowsin, McKenna, Murnen, Nisqually, Norma, Shelton, Spana, Spana-Spanaway-Nisqually complex, Spanaway, Spanaway-Nisqually complex, and Yelm. No soil survey information is currently available for occupied sites in the Olympic National Park, so the soils occupied there are unknown. We purposely avoid using specific map unit names, because we know that there are imperfections in soil mapping. Maps are based on the technology, standards, and tools available at the time soil surveys were conducted, sometimes up to 50 years ago. We recognize that soil survey boundaries may be adjusted in the future, and that soil series names may be added or removed to soil survey maps and databases. As a result, the overlap of pocket gopher locations with soil series names may be different in the future. The soils information presented here is based on best scientific data available at the time of listing. We also recognize that some of these soil series or soil series complexes are not typically either deep or well-drained. For a variety of reasons, mapped soil types may or may not have all of the characteristics described by the U.S. Department of Agriculture, Natural Resources Conservation Service, and the actual soils that occur on sites may have characteristics that make them more or less habitable by pocket gophers. These reasons may include: map boundary or transcription errors, map projection errors or differences, map identification or typing errors, soil or hydrological manipulations that have occurred since mapping took place, and small-scale inclusions that are different from the mapped soil. Because soils are mapped at large scales, mapped soils may not identify smaller inclusions. Any of the soil series or soil series complexes listed above could potentially be suitable for the four Thurston/Pierce subspecies of the Mazama pocket gopher. And, the four Thurston/Pierce subspecies of the Mazama pocket gopher may also inhabit soil series not included in the above list. Although some soils are sandier, more gravelly, or may have more or less silt than described, most all soils used by pocket gophers are friable (easily pulverized or crumbled), loamy, and deep, and generally have slopes less than 15 percent. There have been reports of pocket gophers (subspecies unknown) occurring on other types of soils, on managed forest lands in Capitol State Forest (owned by the Washington State Department of Natural Resources, WDNR) and Vail Forest (owned by Weyerhaeuser) in Thurston County. These were subsequently determined to be moles (Scapanus spp.), based on trapping conducted in these areas by the Washington State Department of Fish and Wildlife (WDFW) during 2012 (Thompson, pers. comm. 2012b). A study of the relationship between soil rockiness and pocket gopher distribution revealed a strong negative correlation between the proportion of medium-sized rocks in the soil, and the presence of pocket gophers (eight of nine prairies sampled); medium sized rocks were considered greater than 0.5 inch (12.7 mm), but less than 2 inches (50.8 mm) in diameter (Steinberg 1996, p. 32). In observations of pocket gopher distribution on JBLM, pocket gophers did not occur in areas with a high percentage of Scot's broom cover (Cytisus scoparius), or where mole populations were particularly dense (Steinberg 1995, p. 26). A more recent study on JBLM also found that pocket gopher presence was negatively associated with Scot's broom; however, the researcher found no relationship between pocket gopher presence and mole density (Olson 2011a, pp. 12, 13). Pocket gopher burrows consist of a series of main runways, off which lateral tunnels lead to the surface of the ground (Wight 1918, p. 7). Pocket gophers dig their burrows using their sharp teeth and claws and then push the soil out through the lateral tunnels (Case and Jasch 1994, p. B-20; Wight 1918, p. 8). Nests containing dried vegetation are generally located near the center of each pocket gopher's home tunnel system (Wight 1918, p. 10). Food caches and store piles are usually placed near the nest, and excrement is piled into blind tunnels or loop tunnels, and then covered with dirt, leaving the nest and main runways clean (Wight 1918, p. 11). (USFWS, 2016).

***Dispersal/Migration***

**Motility/Mobility**

Adult: High (USFWS, 2016)

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: Non-migratory (USFWS, 2016)

**Dispersal**

Adult: Low (USFWS, 2016)

**Immigration/Emigration**

Adult: Unlikely (USFWS, 2016)

**Dispersal/Migration Narrative**

Adult: Pocket gophers have limited dispersal capabilities (Williams and Baker 1976, p. 303). Mazama pocket gophers are smaller in size than other sympatric or peripatric Thomomys species (Verts and Carraway 2000, p. 1). Both dispersal distance and home range size are therefore likely to be smaller than for other Thomomys species. Dispersal distances may vary based on surface or soil conditions and size of the animal. For other, larger, Thomomys species, dispersal distances average about 131 feet (40 meters) (Barnes Jr. 1973, pp. 168, 169; Daly and Patton 1990, pp. 1286, 1288; Williams and Baker 1976, p. 306). Initial results from research being conducted on JBLM indicate that juvenile pocket gophers usually make movements from 13.1 to 32.8 feet (4-10 meters), though these may not be dispersal movements. One juvenile made a distinct dispersal movement of 525 feet (160 meters) in a single day (Olson 2012, p. 5). Suitable dispersal habitat is free of barriers to movement, and may need to contain foraging habitat if an animal is required to make a long-distance dispersal movement. Potential barriers include, but are not limited to, forest edges, roads (paved and unpaved), abrupt elevation changes, Scot’s broom thickets (Olson 2012, p. 3), highly cultivated lawns, inhospitable soil types or substrates (Olson 2008, p. 4), development and buildings, slopes greater than 35 percent, and open water. Barriers may be permeable, meaning that they impede movement from place to place without completely blocking it, or they may be impermeable, meaning they cannot be crossed. Permeable barriers, as well as lower quality dispersal habitats, may present a risk of mortality for animals that use them (e.g., open areas where predation risk is increased, or a paved area where vehicular mortality is high). The WDFW conducted a study to determine dispersal distances of juvenile pocket gophers on JBLM. Twenty-eight juveniles were radio-collared and tracked for 17 to 56 days, with all but three animals tracked for more than 30 days. Of these, only nine gophers moved more than 32.8 feet (10 meters), and 10 gophers were never found more than 13.1 feet (4 meters) from any previous location (Olson 2012, p. 5). Only one animal dispersed what would be considered a larger distance, moving 525 feet (160 meters) in a single day.

***Population Information and Trends***

**Population Trends:**

Decreasing (USFWS, 2016)

**Population Narrative:**

There are few data on historical or current population sizes of Mazama pocket gopher (pocket gopher) populations in Washington, although several local populations and one subspecies are believed to be extinct. Knowledge of the past status of the pocket gopher is limited to distributional information. Recent surveys have focused on determining current distribution, primarily in response to development applications. In addition, in 2012, WDFW initiated a five county-wide distribution survey. Because the object of all of these surveys has mainly been presence/absence only, total population numbers for each subspecies are unknown. And, the precise boundaries of each subspecies' range are not currently known. Local population estimates have been reported but are based on using apparent gopher mounds to delineate the number of territories, a method that has not been validated (Stinson 2005, pp. 40, 41). Olson (2011a, p. 2) evaluated this methodology on pocket gopher populations at the Olympia Airport and Wolf Haven International. Although there was a positive relationship between the number of mounds and number of pocket gophers, the relationship varies spatially, temporally, and demographically (Olson 2011a, pp. 2, 39). Based on the results of Olson's 2011 study, we believe past population estimates (Stinson 2005) may have been too high. As there is no generally accepted standard survey protocol to determine population size for pocket gophers, it is not currently possible to obtain an estimate of subspecies population sizes or trends. Overall habitat availability has declined, however, and habitat has a finite ability to support pocket gophers. For these reasons, the Service concludes that the overall population trend of each of the four Thurston/Pierce subspecies of the Mazama pocket gopher is negative. Increased survey effort since 2007 has resulted in the identification of numerous additional occupied sites located on private lands, especially in Thurston County (WDFW 2013a). Some of these new detections are adjacent to other known occupied sites, such as the population at the Olympia Airport. The full extent of these smaller discontiguous sites is currently unknown, and no research has been done to determine whether or not these aggregations are "stepping stone" sites that may facilitate dispersal into nearby unoccupied suitable habitat, or if they are population sinks (sites that do not add to the overall population through recruitment). Others of these additional occupied sites are separate locations, seemingly unassociated (physically) with known populations (Tirhi, in litt. 2008). The largest known expanse of areas occupied by any subspecies in Washington occur on JBLM (Roy Prairie and Yelm pocket gophers), and at the Olympia and Shelton airports (Olympia and Shelton pocket gophers, respectively). A translocated population occurs on Wolf Haven International's land near Tenino, Washington. Between 2005 and 2008, over 200 gophers from a variety of areas in Thurston County (some from around Olympia Airport (Olympia pocket gopher, T. m. pugetensis)) and some from near the intersection of Rich Road and Yelm Highway (assumed to be Olympia pocket gophers) were released into the 38 acres (15 ha) mounded prairie site. Based on the best available information, we do not believe the property previously supported pocket gophers. Today pocket gophers continue to occupy the site (Tirhi, in litt. 2011); however, current population estimates are not available. Another site, West Rocky Prairie Wildlife Area, has received a total of 560 translocated pocket gophers (T. m. pugetensis) from the Olympia Airport between 2009 and 2011. Initial translocation efforts were unsuccessful; a majority of the pocket gophers died within three days due to predation (Olson 2009, p. 3). Modified release techniques used in 2010 and 2011 resulted in improved survival rates (Olson 2011b, p. 4). It is too soon to know if the population will become self-sustaining, or if additional translocations of gophers will be necessary.

***Threats and Stressors***

**Stressor:** Destruction, Modification, or Curtailment of Habitat and Range (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The primary long term threats to the pocket gopher are the loss, conversion, and degradation of habitat, particularly to urban development, successional changes to grassland habitat, and the spread of invasive plants. The threats also include increased predation pressure, which is closely linked to habitat degradation. The prairies of south Puget Sound are one of the rarest ecosystems in the United States (Dunn and Ewing 1997b, p. v; Noss et al. 1995, p. I-2). Dramatic changes have occurred on the landscape over the last 150 years, including a 90 to 95 percent reduction in the extent of the prairie ecosystem. In the south Puget Sound region, where most of western Washington's prairies historically occurred, less than 10 percent of the original prairie persists, and only three percent remains dominated by native vegetation (Crawford and Hall 1997, pp. 13, 14). Development: Native prairies and grasslands have been severely reduced throughout the range of the four Thurston/Pierce subspecies of Mazama pocket gopher, especially as a result of conversion to residential and commercial development and agriculture. Prairie habitat continues to be lost, particularly to residential development (Stinson 2005, p. 70), by removal and fragmentation of native vegetation, and the excavation, and/or heavy equipment-caused compaction of surfaces and conversion to non-habitat (e.g., buildings, pavement, other infrastructure), rendering soils unsuitable for burrowing. Residential development is associated with increased infrastructure, such as new road construction, which is one of the primary causes of landscape fragmentation (Watts et al. 2007, p. 736). Activities that accompany low-density development are correlated with decreased levels of biodiversity, mortality to wildlife, and facilitated introduction of nonnative invasive species (Trombulak and Frissell 2001; Watts et al. 2007, p. 736). In the south Puget Sound lowlands, the glacial outwash soils and gravels underlying the prairies are deep and valued for use in construction and road building, which leads to their degradation and destruction. In the south Puget Sound, Nisqually loamy soils appear to support high densities of pocket gophers (Stinson, in litt. 2010a Olson 2008, p. 6), the vast majority of which occur in developed areas of Thurston County, or within the Urban Growth Areas for the cities of Olympia, Tumwater, and Lacey (WDFW 2009), where future development is most likely to occur. Where pocket gopher populations presumably extended across an undeveloped expanse of open prairie (Dalquest and Scheffer 1942, pp. 95, 96), areas currently occupied by the four Thurston/Pierce subspecies of the Mazama pocket gopher are now isolated to small fragmented patches due to development and conversion of suitable habitat to incompatible uses. The presumed extinction of the Tacoma pocket gopher is likely linked directly to residential and commercial development, which has replaced nearly all pocket gopher habitats in the historical range of the subspecies (Stinson 2005, pp. 18, 34, 46). One of the historical Tacoma pocket gopher sites was converted to a large gravel pit and golf course (Steinberg 1996, pp. 24, 27; Stinson 2005, pp. 47, 120). In addition, two gravel pits are now operating on part of the site recognized as the type locality for the Roy Prairie pocket gopher (Stinson 2005, p. 42), and another is in operation near Tenino (Stinson, in litt. 2010b) in the vicinity of the type locality for the Tenino pocket gopher. Multiple pocket gopher sites in Pierce and Thurston Counties may be, or have been, lost to gravel pit development, golf course development, or residential and commercial development (Stinson, in litt. 2005; Stinson 2005, pp. 26, 42; Stinson, in litt. 2010b). Multiple prairies that used to contain uninterrupted expanses of prairie habitat suitable for pocket gophers within the range of the four Thurston/Pierce subspecies have been developed to cities, neighborhoods, agricultural lands, or military bases, and/or negatively impacted by such development, including Baker Prairie, Bush Prairie,

Chambers Prairie, Frost Prairie, Grand Mound Prairie, Little Chambers Prairie, Marion Prairie, Roy Prairie, Ruth Prairie, Woods Prairie, Violet Prairie, and Yelm Prairie. Some of these prairie areas still contain smaller areas that support pocket gophers, and some appear to no longer support pocket gophers at all (WDFW 2012). Where their properties coincide with pocket gopher occupancy, many private lands developers and landowners in Thurston County have agreed to create set-asides or agree to other mitigation activities in order to obtain development permits from the County (Tirhi, in litt. 2008). However, it is unknown if any pocket gophers will remain on these sites due to the small size of the set-asides, extensive grading in some areas adjacent to set-asides, lack of dedicated funding for enforcement or monitoring of set-aside maintenance (Thurston County Long Range Planning and Resource Stewardship, in litt. 2011, p. 2), and lack of control of predation by domestic or feral cats and dogs. In addition, some landowners have received variances from Thurston County that allowed development to occur without a requirement to set aside areas for pocket gophers. A population of Olympia pocket gophers is located at and around the Port of Olympia's Olympia Airport, which is sited on the historical Bush Prairie. Gophers on Bush Prairie are currently vulnerable to negative impacts from proposed future development by the Port of Olympia and ongoing development by adjacent landowners. The Port of Olympia has plans to develop large portions of the existing grassland that likely supports the largest population of the Olympia pocket gopher in Washington (Stinson 2007, in litt.; Port of Olympia and WDFW 2008, p.1; Port of Olympia 2012). The Olympia Airport is realigning the airport runway, which is in known occupied habitat. They continue to work with the Service and WDFW on mitigating airport expansion activities that may negatively impact gophers (Tirhi, in litt. 2010). The Olympia pocket gopher has a population at the Olympia Airport that spans several hundred acres, and there are two translocated populations: one at West Rocky Prairie Wildlife Area (some individuals from the Olympia Airport) and one at Wolf Haven (individuals from the Olympia Airport and some from near the intersection of Rich Road and Yelm Highway). The population centered on the Olympia Airport could be negatively impacted by plans for development both on and off the airport, while the two translocated populations are currently secure from intense commercial and residential development pressures as they occur on conserved lands. The Roy Prairie pocket gopher is known to occur across a large expanse of prairie on JBLM, which is currently secure from the threat of development. The Tenino pocket gopher has a single known population, which has been detected during surveys on the Rocky Prairie NAP, although the intermittent nature of these detections suggests it must be part of a larger metapopulation that occurs across nearby areas that have not been accessible for surveys. No known development poses a threat to the NAP, but any future conversion of the surrounding area to incompatible land use would likely hinder the recovery of this subspecies. The Yelm pocket gophers on Tenalquot prairie (which is owned in large part by JBLM) and Scatter Creek Wildlife Area are also secure from such residential and commercial development, but the Yelm pocket gopher habitat on Rock Prairie north of Old Highway 99 is in an area that is likely to be developed soon, which may negatively affect any local populations in the vicinity. Loss or Curtailment of Natural Disturbance Processes: The suppression and loss of ecological disturbance regimes across vast portions of the landscape, such as fire, has resulted in altered vegetation structure in the prairies and meadows and has facilitated invasion by native and nonnative woody vegetation, rendering habitat unusable for the four Thurston/Pierce subspecies of Mazama pocket gopher. The basic ecological processes that maintain prairies and meadows have disappeared from, or have been altered on, all but a few protected and managed sites. Historically, the prairies and meadows of the south Puget Sound region are thought to have been actively maintained by native peoples, who lived here for at least 10,000 years before the arrival of Euro-American settlers (Boyd 1986; Christy and Alverson 2011, p. 93). Frequent burning reduced the encroachment and spread of shrubs and trees (Boyd 1986; Chappell and Kagan 2001, p. 42), favoring open grasslands with a variety of native plants and animals. Following Euro-American settlement of the region in the mid-19th century, fire was actively suppressed on grasslands, allowing encroachment by woody vegetation into the remaining prairie habitat and oak woodlands (Agee 1993, p. 360; Altman et al. 2001, p. 262; Boyd 1986; Franklin and Dyrness 1973, p. 122; Kruckeberg 1991, p. 287)Fires on the prairie create a mosaic of vegetation conditions, which serve to maintain native prairie plant communities. In some prairie patches fires will kill encroaching woody vegetation and reset succession back to bare ground, creating early successional vegetation conditions suitable for many native prairie species. Early succession forbs and grasses are favored by pocket gophers. The historical fire frequency on prairies has been estimated to be 3 to 5 years (Foster 2005, p. 8). On sites where regular fires occur, there is a high complement of native plants and fewer invasive species. These types of fires maintain the native short-statured plant communities favored by pocket gophers. The result of fire suppression has been the invasion of the prairies and oak woodlands by native and nonnative plant species (Dunn and Ewing 1997a, p. v; Tveten and Fonda 1999, p. 146), notably woody plants such as the native Douglas-fir (Pseudotsuga menziesii) and the nonnative Scot's broom. On tallgrass prairies in midwestern North America, fire suppression has led to degradation and the loss of native grasslands (Curtis 1959, pp. 296, 298; Panzer 2002, p. 1297). On northwestern prairies, fire suppression has allowed Douglas-fir to encroach on and outcompete native prairie vegetation for light, water, and nutrients (Stinson 2005, p. 7). This increase in woody vegetation and nonnative plant species has resulted in less available prairie habitat overall and habitat that is unsuitable for and avoided by many native prairie species, including pocket gophers (Olson 2011a, pp. 12, 16; Pearson et al. 2005, pp. 2, 27; Tveten and Fonda 1999, p. 155). Pocket gophers prefer early successional vegetation as forage. Woody plants shade out the forbs and grasses that pocket gophers prefer to eat, and high densities of woody plants make travel both below and above the ground difficult. In locations with poor forage, pocket gophers tend to have larger territories, which may be difficult or impossible to establish in densely forested areas. The probability of pocket gopher occupancy is much higher in areas with less than 10 percent woody vegetation cover (Olson 2011a, p. 16). On JBLM alone, over 16,000 acres (6,477 ha) of prairie has converted to Douglas-fir forest since the mid-19th century (Foster and Shaff 2003, p. 284). Where controlled burns or direct tree removal are not used as a management tool, this encroachment will continue to cause the loss of open grassland habitats for pocket gophers and is an ongoing threat to the species. Restoration in some of the south Puget Sound grasslands has resulted in temporary control of Scot's broom and other invasive plants through the careful and judicious use of herbicides, mowing, grazing, and fire. Fire has been used as a management tool to maintain native prairie composition and structure and is generally acknowledged to improve the health and composition of grassland habitat by providing a short-term nitrogen addition, which results in a fertilizer effect to vegetation, thus aiding grasses and forbs to sprout. Unintentional fires ignited by military training burn patches of prairie grasses and forbs on JBLM on an annual basis. These light ground fires create a mosaic of conditions within the grassland, maintaining a low vegetative structure of native and nonnative plant composition, and patches of bare soil. Because of the topography of the landscape, fires create a patchy mosaic of areas that burn completely, some areas that do not burn, and areas where consumption of the vegetation is mixed in its effects to the habitat. One of the benefits of fire in grasslands is that it tends to kill regenerating conifers, and reduces the cover of nonnative shrubs such as Scot's broom, although Scot's broom seed stored in the soil can be stimulated by fire (Agee 1993, p. 367). Fire also improves conditions for many native bulb-forming plants, such as Camassia spp. (Agee and Dunwiddie 1984). On sites where regular fires occur, such as on

JBLM, there is a high complement of native plants and fewer invasive species. These types of fires maintain the native, short-statured plant communities favored by pocket gophers. Management practices such as intentional burning and mowing require expertise in timing and technique to achieve desired results. If applied at the wrong season, frequency, or scale, fire and mowing can be detrimental to the restoration of native prairie species. Excessive and high-intensity burning can result in a lack of vegetation or encourage regrowth of nonnative grasses. Where such burning has occurred over a period of more than 50 years on the artillery ranges of JBLM, prairies are covered by nonnative forbs and grasses instead of native perennial bunchgrasses (Tveten and Fonda 1999, pp. 154, 155). Pocket gophers are not commonly found in areas colonized by Douglas-fir trees because pocket gophers require forbs and grasses of an early successional stage for food (Witmer et al. 1996a, p. 96). Pocket gophers observed on JBLM did not occur in areas with high cover of Scot's broom (Steinberg 1995, p. 26). A more recent study on JBLM also found that pocket gopher presence was negatively associated with Scot's broom (Olson 2011a, pp. 12, 13, 16). Some subspecies may disperse through forested areas or may temporarily establish territories on forest edges, but there is currently not enough data available to determine how common this behavior may be or which subspecies employ it. The four Thurston/Pierce subspecies of the Mazama pocket gopher occur on prairie-type habitats, many of which, if not actively managed to maintain vegetation in an early-successional state, have been invaded by shrubs and trees that either preclude pocket gophers or limit their ability to fully occupy the landscape. Typical management at civilian airports prevents woody vegetation from encroaching onto surrounding areas for flight safety reasons. Woody vegetation encroachment is therefore not a threat at civilian airports. Military Training: Pocket gopher populations occurring on JBLM are exposed to differing levels of training activities on the base. The Department of Defense's (DOD) proposed actions under their “Grow the Army” initiative include stationing 5,700 new soldiers, new combat service support units, a combat aviation brigade, facility demolition and construction to support the increased troop levels, and additional aviation, maneuver, and live fire training (75 FR 55313, September 10, 2010). The increased training activities will affect nearly all training areas at JBLM, resulting in an increased risk of accidental fires, and habitat destruction and degradation attributable to vehicle use in occupied areas, mounted and dismounted training, bivouac activities, and digging. Even though the training areas on the base are degraded, with implementation of agreed-upon conservation measures, these areas still provide habitat for the Roy Prairie and Yelm pocket gopher. JBLM's recently signed Endangered Species Management Plan (ESMP) for the Mazama pocket gopher will serve to minimize threats across the base by redirecting some training activities to areas outside of occupied habitat, designating areas where no vehicles are permitted, designating areas where vehicles will remain on roads only, and designating areas where no digging is allowed, among other conservation measures. JBLM has further committed to enhancing and expanding suitable habitat for the Roy Prairie and Yelm pocket gophers in “priority habitat” areas on base (areas that were proposed as critical habitat); enforcing restrictions on recreational use of occupied habitat by dog owners and horseback riders; and continuing to support the off-base recovery of the four Thurston/Pierce subspecies of the Mazama pocket gopher. Several moderate- to large-sized areas supporting pocket gophers have been identified on JBLM. These areas are within the historical ranges of the Roy Prairie (Pierce County) and Yelm (Thurston County) pocket gophers. Their absence from some sites of what is presumed to have been formerly suitable habitat may be related to compaction of the soil due to years of mechanized vehicle training (Steinberg 1995, p. 36). Training infrastructure (e.g., roads, firing ranges, bunkers) also degrades pocket gopher habitat and may lead to reduced use of these areas by pocket gophers. For example, JBLM has plans to add a third rifle range on the south impact area where it overlaps with a densely occupied pocket gopher site. The area may be usable by pocket gophers when the project is completed; however, construction of the rifle range may result in removal of forage and direct mortality of pocket gophers through crushing of burrows (Stinson, in litt. 2011). Recent survey access to the center of the artillery impact area on 91st Division Prairie, where bombardment is presumably of the highest intensity, did detect some unspecified level of occupancy by the Roy Prairie pocket gopher (WDFW 2013b, enclosure 1, p. 6). This apparently suitable central portion of the 91st Division Prairie is subject to repeated and ongoing bombardment, which may create an ecological trap for dispersing juveniles. JBLM training areas have varying levels of use; some allow excavation and off-road vehicle use, while other areas have restrictions that limit off-road vehicle use. The ESMP specifically requires coordination between the JBLM Fish and Wildlife personnel and the JBLM entities responsible for training activities (e.g., Range Support, battalion commanders, and/or first field grade officers) to ensure all parties are aware of where occupied areas occur in relation to training activities, the effects of training, and the potential ramifications of habitat destruction or animal mortality. Since military training has the potential to directly or indirectly harm or harass pocket gophers, we conclude that these activities will negatively impact the Roy Prairie and Yelm pocket gophers. JBLM has committed to operational restrictions on portions of the base in order to avoid and minimize potential impacts to Roy Prairie and Yelm pocket gophers. Currently-occupied areas will be buffered from training activities, with an emphasis on occupied habitat in “priority habitat” areas. Regular surveys will be conducted with the goals of determining distribution, protecting pocket gophers and their habitat from disturbance or destruction, and determining population status. Where possible, JBLM will alleviate training pressure by transferring activities to unoccupied areas where encroaching forest has been removed. This strategy has the effect of both releasing large areas of land that were historically prairie and providing unoccupied areas where training is free of the risk of negatively impacting Roy Prairie or Yelm pocket gophers. While the Service fully supports the implementation of these impact minimization efforts and will continue to collaborate with DOD to address all aspects of training impacts on the species, not all adverse impacts on pocket gophers can be fully avoided. Military training continues to pose a threat to the Roy Prairie and Yelm subspecies at this time. No military training occurs in the ranges of the Olympia or Tenino subspecies of the Mazama pocket gopher (USFWS, 2016).

**Stressor:** Poor Connectivity Between Small and Isolated Populations (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Isolated genetics
**Narrative:** Most species’ populations fluctuate naturally, responding to various factors such as weather events, disease, and predation. Populations that are small, fragmented, or isolated by habitat loss or modification of naturally patchy habitat, and other human-related factors, are more vulnerable to extirpation by natural randomly occurring events, cumulative effects, and to genetic effect (collectively known as small population effects). These effects can include genetic drift (loss of recessive alleles), founder effects (over time, an increasing percentage of the population inheriting a narrow range of traits), and genetic bottlenecks leading to increasingly lower genetic diversity, with consequent negative effects on evolutionary potential. To date, of the eight subspecies of Mazama pocket gopher in Washington, only the Olympic pocket gopher has been documented as having low genetic diversity (Welch and Kenagy 2008, p. 7), although the six other extant subspecies have local populations that are small, fragmented, and physically isolated from one another. The four Thurston/Pierce subspecies of the Mazama pocket gopher face threats from loss or fragmentation of habitat. Historically, pocket gophers probably

persisted by continually recolonizing habitat patches after local extinctions. However, widespread development and conversion of habitat has resulted in widely separated populations, and intervening habitat corridors are now gone, with the effect of impeding or stopping much of the natural recolonization that historically occurred (Stinson 2005, p. 46). Although pocket gophers are not known to have low genetic diversity, small population sizes at most sites, coupled with disjunct and fragmented habitat, may contribute to further population declines. Little is known about the local or rangewide reproductive success of pocket gophers found in Washington State (USFWS, 2016).

**Stressor:** Predation and Pest Control (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Predation: Predation influences the distribution, abundance, and diversity of species in ecological communities. Generally, predation leads to changes in both the population size of the predator and that of the prey. In unfavorable environments, prey species are stressed or living at low population densities such that predation is likely to have negative effects on all prey species, thus lowering species richness. In addition, when a nonnative predator is introduced to the ecosystem, negative effects on the prey population may be higher than those from co-evolved native predators. The effect of predation may be magnified when populations are small, and the disproportionate effect of predation on declining populations has been shown to drive rare species even further towards extinction (Woodworth 1999, pp. 74, 75). Predation has an impact on populations of the four Thurston/Pierce subspecies of Mazama pocket gopher. Urbanization, particularly in the south Puget Sound region, has resulted in not only habitat loss, but also increased exposure to feral and domestic cats and dogs. Domestic cats are known to have serious impacts on small mammals and birds and have been implicated in the decline of several endangered and threatened mammals, including marsh rabbits (Sylvilagus palustris) in Florida and the salt-marsh harvest mouse (Reithrodontomys raviventris) in California (Ogan and Jurek 1997, p. 89). Domestic cats and dogs have been specifically identified as common predators of pocket gophers (Case and Jasch 1994, p. B-21; Henderson 1981, p. 233; Wight 1918, p. 21) and at least two pocket gopher locations were found as a result of house cats bringing home pocket gopher carcasses (WDFW 2001). Informal interviews with area biologists document multiple incidents of domestic pet predation on pocket gophers (Chan, in litt. 2013; Clouse, in litt. 2012 Skriletz 2013 in litt., Wood 2013 in litt.). There is also one recorded instance of a WDFW biologist being presented with a dead Mazama pocket gopher by a dog during an east Olympia, Washington, site visit in 2006 (Burke Museum 2012 McAllister 2013 in litt.). Some local populations of the pocket gopher occur in areas where people recreate with their dogs, bringing these potential predators into environments that may otherwise be relatively free of them, consequently increasing the risks to individual pocket gophers and populations that may be small and isolated The four Thurston/Pierce subspecies of Mazama pocket gopher occur in rapidly developing areas. Local populations that survive commercial and residential development (adjacent to and within habitat) are potentially vulnerable to extirpation by domestic and feral cats and dogs (Case and Jasch 1994, p. B-21; Henderson 1981, p. 233). As stated previously, predation is a natural part of the pocket gopher’s life history; however, the effect of predation may be magnified when populations are small and habitat is fragmented. The disproportionate effect of additional predation on declining populations has been shown to drive rare species even further towards extinction (Woodworth 1999, pp. 74, 75). Predation, particularly from nonnative species, will likely continue to be a threat to the four Thurston/Pierce subspecies of the Mazama

pocket gopher now and in the future. This is particularly likely where development abuts gopher habitat, resulting in increased numbers of cats and dogs in the vicinity, and in areas where people recreate with their dogs – particularly if dogs are off-leash and not prevented from harassing wildlife. In such areas, where local populations of pocket gophers are already small, this additional predation pressure (above natural levels of predation) is expected to further negatively impact population numbers. Pest Control: Pocket gophers are often considered a pest because they sometimes damage crops and seedling trees, and their mounds can create a nuisance. Several site locations were found as a result of trapping conducted on Christmas tree farms, a nursery, and in a livestock pasture (WDFW 2001). The type locality for the Cathlamet pocket gopher is on a commercial tree farm. Pocket gophers from Thurston County were used in a rodenticide experiment as recently as 1995 (Witmer et al. 1996a, p. 97). In Washington State it is currently illegal to trap or poison Mazama pocket gophers, or to trap or poison moles where they overlap with Mazama pocket gopher populations, but not all property owners are cognizant of these laws, nor are most citizens capable of differentiating between moles, pocket gophers, or the signs of their habitation (e.g., soil disturbance). In light of this, it is reasonable to believe that mole trapping or poisoning still has the potential to adversely affect pocket gopher populations. Local populations that survive commercial and residential development (adjacent to and within habitat) may be subsequently extirpated by trapping or poisoning. Lethal control by trapping or poisoning is most likely to be a threat to the four Thurston/Pierce subspecies where their ranges overlap residential properties (USFWS, 2016).

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 6C

**Delisting Criteria:**
Common Criterion 1: Reserve Establishment. Multiple discrete Reserves (Reserve Cores, Reserve Complexes, or both) are established for each of the four MPG subspecies (see subspecies-specific criteria below for Reserve numbers and distribution (USFWS, 2022b)

Common Criterion 2: Demographic Viability. Each Reserve supports a self-sustaining population with a minimum of 1,000 individuals of the target subspecies. A minimum of 5 years of monitoring utilizing Service-approved protocols across a 10-year period have been conducted and demonstrate the self-sustaining nature of local MPG populations on each Reserve (USFWS, 2022b).

Common Criterion 3: Habitat Area. Each Reserve Core provides approximately 250 to 500 acres (about 100 to 200 ha), or more, of medium- and high-quality habitat (see Appendix A for a description of medium- and high-quality habitat). Each Reserve Complex provides a comparable amount of medium- and high-quality habitat (i.e., approximately 250 to 500 acres (100 to 200 ha), located on functionally connected Reserve Satellites. Each Reserve Satellite contains at least 10 acres (approximately 4 ha) of contiguous medium- or high-quality habitat (USFWS, 2022b).

OPG Criterion 1 There are a minimum of three (3) Reserves (as defined and described in Common Criterion 1), with at least one on each side of Interstate Highway 5 (I-5). The third Reserve may be on either side of I-5. (USFWS, 2022.)

**Recovery Actions:**

- Olympia pocket gopher 1. Protect, conserve, and enhance OPG habitat. $33,954,000 Priority 1a 2. Identify MPG limiting factors and sources of mortality or harm and implement best management practices to minimize impacts. $1,240,000 Priority 1b 3. To achieve Reserve targets for each subspecies, evaluate the need to either create new local populations or increase the number of individuals in existing local populations in the RPPG Recovery Area (Costs for this TBD). Monitor Reserves as needed to determine status and trend of populations prior to final monitoring requirements in Common Criterion 2. $4,018,000 Priority 2 4. Strengthen outreach and cooperation with stakeholders and partner agencies. $1,302,000 Priority 2 5. Monitor population status, trend, and distribution, sufficient to determine if population goals required in Common Criterion 2 have been met. $1,301,000 Priority 3 (USFWS, 2021)
- 1. Protect, conserve, and enhance MPG habitat. (Priority 1a) • Identify and prioritize creation and protection of Reserves. • Purchase occupied and highly suitable lands in Reserve areas. • Implement other short- and long-term strategies to protect Reserves and other important MPG sites from development pressure (e.g., mitigation lands, interim permitting strategy, in lieu fee, programmatic HCPs; municipal HCPs). • Develop and cooperatively implement programs for the protection and conservation of MPGs, south Puget Sound prairies, oak savanna, and other prairie-dependent species. This can include, but is not limited to, grant funding, habitat acquisition, habitat restoration, regulatory reform programs and policies, management plans, zoning, mitigation, research, and monitoring for each subspecies. • Implement conservation programs to avoid, minimize, or offset effects of RPPG and YPG habitat impacts resulting from military training. • Monitor implementation of habitat protection activities for MPG conservation (e.g., set-asides, mitigation banks). • 2. Identify MPG limiting factors and sources of mortality or harm and implement best management practices to minimize impacts. (Priority 1b) Assessment of ecologically important limiting factors and evaluating the success of management measures that have been implemented is necessary for effective adaptive management. To minimize adverse effects of threats, best management practices should be implemented by all partners. • Evaluate the effects of vegetation management on MPGs and their habitat. • Determine if and how translocated populations within the range of TPG are affecting demographic and genetic characteristics of this subspecies; develop solutions if needed. • Identify landscape features that influence MPG dispersal and distribution. • Evaluate impacts of other anthropogenic stressors affecting MPGs (e.g., cats, dogs, recreational uses, etc.). • Evaluate natural factors affecting population health and distribution within and between sites. • Conduct demographic and genetic studies. • Revise population viability analysis every 10 years, or when new genetic or demographic information becomes available. • Implement measures to avoid, minimize, or mitigate impacts to individual RPPGs or YPGs as a result of military training. These include the activities described in the JBLM INRMP and the ESMC for MPGs; and the activities, reasonable and prudent measures, and terms and conditions included in the biological opinion(s) addressing training and related activities at JBLM. • Develop and implement best management practices to avoid and minimize effects of activities in occupied MPG habitat, including: use of mechanical equipment, particularly heavy equipment operations; implementation and use of restoration tools and techniques (including use of prescribed fire); management of predation by domestic and feral dogs and cats; and minimizing incidental or intentional MPG mortality resulting from control of fossorial animals (such as moles) as pest species (i.e., by poisoning and trapping). 3. To achieve Reserve targets for each subspecies, evaluate

the need to either create new local populations or increase the number of individuals in existing local populations within each Recovery Area or Recovery Unit. If needed, create new local populations or increase current (2020) local population sizes through habitat creation and population augmentation. Monitor Reserves/Reserve Complexes as needed to determine status and trend of populations prior to final monitoring requirements in Common Criterion 2. (Priority 2) • Evaluate the range-wide need to increase the number of populations. • Monitor local populations in individual Reserves as needed to determine status and trend prior to final monitoring requirements in Common Criterion 2. • Evaluate the range-wide need to augment existing populations. • If needed, evaluate and modify methods of captive breeding, handling, transport, and translocation. • If needed, develop and test best practices for habitat expansion. • If needed, evaluate sites for suitability and prioritize for habitat expansion. • If translocation or habitat expansion is justified, evaluate legal aspects and complete compliance analysis and documentation (permitting, National Environmental Policy Act, etc.) • If needed and appropriate, establish additional populations within unoccupied areas of the historical range. • If needed and appropriate, implement and monitor habitat expansion through vegetation manipulation (tree and shrub removal, mowing, restoration, etc.). 4. Strengthen outreach and cooperation with stakeholders and partner agencies. (Priority 2) Coordination with landowners, management agencies, and interested members of the public is necessary to effectively implement necessary recovery actions across a broad range of land ownership. • Facilitate coordination and information sharing. • Implement outreach and education. 5. Monitor Reserves to determine local population status and trend, sufficient to determine if population goals required in Common Criterion 2 have been met. (Priority 3) Population survey and monitoring with consistent and repeatable methodology is necessary to assess whether Reserves have met population targets in Common Criterion 2 and to provide baseline information for development of a post-delisting monitoring plan. • Verify existing comprehensive survey/monitoring scheme (Olson 2017). Implement survey/monitoring scheme at each Reserve to determine if local population goals required in Common Criteria 2 have been met. (USFWS, 2021)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Future research and management recommendations include: (1) Protect, conserve, and enhance Mazama pocket gopher habitat within the range of each subspecies through habitat acquisition, habitat easement, habitat conservation plans, habitat restoration, and other conservation tools. (2) Conduct research to identify limiting factors and sources of mortality or harm for Mazama pocket gophers and implement best management practices to minimize impacts across the range of each subspecies. (3) If needed, create new local populations or increase population sizes on conserved lands. Monitor each subspecies' population to determine status and trend. (4) Strengthen outreach and cooperation with stakeholders and partner agencies. (USFWS, 2020)
- Washington Department of Fish and Wildlife recommends the Mazama pocket gopher should remain state-listed as Threatened, but should be considered for downlisting to Sensitive status when the following objectives have been met (Stinson 2019, p. 56): 1) Two reserves or reserve complexes are established in each of the Bush Prairie, Mound-Frost Prairie, and 91st Division Prairie recovery areas, and one reserve each in Rocky Prairie, Tenalquot-Yelm Prairie, Chambers Prairie, and Scotts Prairie recovery areas; and, 2) Each of the reserves/reserve complexes in at least five of seven reserve areas, supports a population of ≥ 1,000 Mazama Pocket Gophers. (USFWS, 2020)

**References**

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Designation of Critical Habitat for Mazama Pocket Gophers

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USFWS. 2021. Draft Recovery Plan for Four Subspecies of Mazama Pocket Gopher. Draft Recovery Plan for Four Subspecies of Mazama Pocket Gopher Roy Prairie pocket gopher (Thomomys mazama glacialis) Olympia pocket gopher (Thomomys mazama pugetensis) Tenino pocket gopher (Thomomys mazama tumuli) Yelm pocket gopher (Thomomys mazama yelmensis). 29 pp + Attachments.

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# SPECIES ACCOUNT: *Thomomys mazama tumuli* (Tenino pocket gopher)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; Pacific Region (R1) (USFWS, 2016)

**Physical Description**

Adult Mazama pocket gophers are reddish brown to black above, and the underparts are lead-colored with buff-colored tips. The lips, nose, and patches behind the ears are black; the wrists are white. Adults range from 7 to 9 inches (189 to 220 millimeters (mm)) in total length, with tails that range from 2 to 3 inches (45 to 85 mm)(Verts and Carraway 2000, p.2). Mazama pocket gophers are morphologically similar to other species of pocket gophers that exploit a subterranean existence. They are stocky and tubular in shape, with short necks, powerful limbs, long claws, and tiny ears and eyes. Their short, nearly hairless tails are highly sensitive and probably assist when navigating tunnels. The “pockets” are external, fur-lined cheek pouches on either side of the mouth that are used to transport nesting material and plant cuttings. Mazama pocket gophers reach reproductive age in the spring of the year after their birth and produce litters between spring and early summer. Litter size ranges from one to nine (Wight 1918, p. 14), with an average of five (Scheffer 1938, p. 222). They do not hibernate in winter; they remain active throughout the year (Case and Jasch 1994, p. B-20) (USFWS, 2016).

**Taxonomy**

Although the species Thomomys mazama, or Mazama pocket gopher, includes numerous subspecies that are found in the States of Washington, Oregon, and California, only the subspecies found in the State of Washington have recently been considered for listing. The Mazama pocket gopher complex consists of 15 subspecies, eight of which occur only in Washington, five of which occur only in Oregon, one that occurs only in California, and one subspecies with a distribution that spans the boundary between Oregon and California (Hall 1981, p. 467). The first pocket gophers collected in western Washington were considered subspecies of the northern pocket gopher (Thomomys talpoides)(Goldman 1939), until 1960 when the complex of pocket gophers found in western Washington was determined to be more similar to the western pocket gopher (T. mazama)(Johnson and Benson 1960, p. 20). Eight western Washington subspecies of Mazama pocket gopher (T. mazama, ssp. couchi, glacialis, louiei, melanops, pugetensis, tacomensis, tumuli, and yelmensis) have been identified (Hall 1981, p. 467). Thomomys mazama is recognized as a valid species by the Integrated Taxonomic Information System (ITIS 2012). Although there have been suggestions that potential changes to the classification of some of these subspecies should be considered, we have no information to suggest that any of the presently recognized subspecies are the subject of serious dispute. We follow the subspecies designations of Verts and Carraway (2000), as this text represents the currently accepted taxonomy for the species T. mazama. Verts and Carraway (2000, p.1) recognize T. m. glacialis, pugetensis, tumuli, and yelmensis as separate subspecies (the Roy Prairie, Olympia, Tenino, and Yelm pocket gophers, respectively) based on morphological characteristics, distribution, and differences in number of chromosomes. Due to the close proximity of the four subspecies located in Thurston and Pierce Counties, and the fact that at least three of them occur in the same clade, we refer to these four subspecies (T. m. glacialis, pugetensis, tumuli, and yelmensis) as “the four Thurston/Pierce subspecies” of the Mazama

pocket gopher (USFWS, 2016).

**Current Range**

Tenino pocket gophers (Thomomys mazama tumuli) were originally found in the vicinity of the Rocky Prairie NAP, near Tenino (Dalquest and Scheffer 1942, p. 96), a relatively small prairie area. Gophers still reside there, but WDFW researchers have not seen consistent occupancy of the area in recent years (Olson, in litt. 2010), suggesting that the activity intermittently detected in the NAP may be attributable to individuals dispersing from a currently unidentified nearby source. Soil series and soil series complexes in this area that may support pocket gophers include Everett, Nisqually, Norma, Spanaway, and Spanaway-Nisqually complex. In Washington, Mazama pocket gophers are found west of the Cascade Mountain Range, in the Olympic Mountains and in the Puget Sound trough, with an additional single locality known from Wahkiakum County (Verts and Carraway 2000, p.3). Their populations are concentrated in well-drained friable soils often associated with glacial outwash (USFWS, 2016).

**Critical Habitat Designated**

Yes; 4/9/2014.

**Legal Description**

On April 9, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat for three subspecies of the Mazama pocket gopher (the Olympia pocket gopher, Thomomys mazama pugetensis; the Tenino pocket gopher, T. m. tumuli; and the Yelm pocket gopher, T. m. yelmensis) under the Endangered Species Act of 1973, as amended (Act). In total, approximately 1,607 acres (650 hectares) in Thurston County, Washington, fall within the boundaries of the critical habitat designation for the Olympia, Tenino, and Yelm pocket gophers. The effect of this regulation was to designate critical habitat for the Olympia, Tenino, and Yelm subspecies of the Mazama pocket gopher found in Thurston County, Washington, under the Act.

**Critical Habitat Designation**

Tenino Pocket Gopher Critical Habitat—Rocky Prairie Unit. This unit consists of 399 ac (162 ha) and is owned by one commercial land owner and Burlington Northern Santa Fe Railroad. The Rocky Prairie Unit is located north of the city of Tenino, Thurston County, Washington; is likely occupied by the Tenino pocket gopher; and contains the physical or biological features essential to the conservation of the species due to the underlying soil series or soil series complex (Everett, Nisqually, Spanaway, and Spanaway-Nisqually complex), suitable forb and grass vegetation present onsite, and its large size.

**Primary Constituent Elements/Physical or Biological Features**

Critical habitat for the Tenino pocket gopher is designated in Thurston County, Washington. Within this area, the primary constituent elements of the physical or biological features essential to the conservation of Tenino pocket gopher consist of two components:

(i) Friable, loamy, and deep soils, some with relatively greater content of sand, gravel, or silt, all generally on slopes less than 15 percent in the following soil series or soil series complex: (A) Alderwood; (B) Cagey; (C) Everett; (D) Indianola; (E) Kapowsin; (F) Nisqually; (G) Norma; (H) Spanaway; (I) Spanaway-Nisqually complex; and (J) Yelm.

(ii) Areas equal to or larger than 50 ac (20 ha) in size that provide for breeding, foraging, and dispersal activities, found in the soil series listed in paragraph (2)(i) of this entry that have: (A) Less than 10 percent woody vegetation cover; (B) Vegetative cover suitable for foraging by gophers. Pocket gophers' diets include a wide variety of plant material, including leafy vegetation, succulent roots, shoots, tubers, and grasses. Forbs and grasses that Mazama pocket gophers are known to eat include, but are not limited to: Achillea millefolium (common yarrow), Agoseris spp. (agoseris), Cirsium spp. (thistle), Bromus spp. (brome), Camassia spp. (camas), Collomia linearis (tiny trumpet), Epilobium spp. (several willowherb spp.), Eriophyllum lanatum (woolly sunflower), Gayophytum diffusum (groundsmoke), Hypochaeris radicata (hairy cat's ear), Lathyrus spp. (peavine), Lupinus spp. (lupine), Microsteris gracilis (slender phlox), Penstemon spp. (penstemon), Perideridia gairdneri (Gairdner's yampah), Phacelia heterophylla (varileaf phacelia), Polygonum douglasii (knotweed), Potentilla spp. (cinquefoil), Pteridium aquilinum (bracken fern), Taraxacum officinale (common dandelion), Trifolium spp. (clover), and Viola spp. (violet); and (C) Few, if any, barriers to dispersal. Barriers to dispersal may include, but are not limited to, forest edges, roads (paved and unpaved), abrupt elevation changes, Scot's broom thickets, highly cultivated lawns, inhospitable soil types or substrates, development and buildings, slopes greater than 35 percent, and open water.

**Special Management Considerations or Protections**

Critical habitat does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas) and the land on which they are located existing within the legal boundaries on May 9, 2014.

The physical or biological features essential to the conservation of each subspecies may require special management considerations or protection to restore, protect, and maintain the essential features found there. The physical or biological features in this subunit are threatened by: Loss of habitat through conversion to incompatible uses, such as pit mining; development on adjacent or surrounding areas; the loss of natural disturbance processes and invasion by woody plants; predation; small or isolated populations as a result of habitat fragmentation; habitat degradation or destruction as the result of the inadequacy of existing regulatory mechanisms; and control as a pest species. We additionally evaluated this area as if it were presently unoccupied by the Tenino pocket gopher, and have determined that it is nonetheless essential to the conservation of the species.

The physical or biological features essential to the conservation of the four Thurston/Pierce subspecies of the Mazama pocket gopher may require special management considerations or protection to control or prevent the establishment of invasive woody plants, which create shade and compete for light, food and nutrients otherwise utilized by the forb, bulb, and grass species that the gophers require for forage. Management may be implemented using hand tools or mechanical methods, prescribed fire, and the judicious use of herbicides. Although several management techniques are being implemented on public lands, we may need to improve our outreach to educate private landowners on controlling their pets and appropriately managing grazing on their properties, as well as to developing incentives for landowners who agree to conserve habitat. Incentives would create protected areas, through agreements or acquisitions. These would include corridors between existing protected habitat areas that may require management, enhancement actions, and long-term maintenance.

***Life History***

**Feeding Narrative**

Adult: Pocket gophers are generalist herbivores and their diet includes a wide variety of plant material, including leafy vegetation, succulent roots, shoots, and tubers. In natural settings pocket gophers play a key ecological role by aerating soils, activating the seed bank, and stimulating plant growth, though they can be considered pests in agricultural systems. In prairie and meadow ecosystems, pocket gopher activity plays an important role in maintaining species richness and diversity. Foraging primarily takes place below the surface of the soil, where pocket gophers snip off roots of plants before occasionally pulling the whole plant below ground to eat or store in caches. If above-ground foraging occurs, it's usually within a few feet of an opening and forage plants are quickly cut into small pieces and carried back to the nest or cache (Wight 1918, p. 12). Any water they need is obtained from their food (Gettinger 1984, pp. 749-750; Wight 1918, p. 13). The probability of pocket gopher occupancy is much higher in areas with less than 10 percent woody vegetation cover (Olson 2011a, p. 16), presumably because such vegetation will shade out the forbs, bulbs, and grasses that pocket gophers prefer to eat, and high densities of woody plants make travel both below and above the ground difficult (USFWS, 2016).

**Reproduction Narrative**

Adult: Pocket gophers reach sexual maturity during the spring of the year following their birth, and generally produce one litter per year (Case and Jasch 1994, p. B-20), though timing of sexual maturity has been shown to vary with habitat quality (Patton and Brylski 1987, p. 502; Patton and Smith 1990, p. 76). Gestation lasts approximately 18 days (Andersen 1978, p. 421; Schramm 1961, p. 169). Young are born in the spring to early summer (Wight 1918, p. 13), and are reared by the female. Aside from the breeding season, males and females remain segregated in their own tunnel systems. There are 1-9 pups per litter (averaging 5), born without hair, pockets, or teeth, and they must be kept warm by the mother or "packed" in dried vegetation (Case and Jasch 1994, p. B-20; Wight 1918, p. 14). Juvenile pelage starts growing in at just over a week (Andersen 1978, p. 420). The young eat vegetation in the nest within three weeks of birth, with eyes and ears opening and pockets developing at about a month (Andersen 1978, p. 420; Wight 1918, p. 14). At six weeks they are weaned, fighting with siblings, and nearly ready to disperse (Andersen 1978, p. 420; Wight 1918, p. 15), which usually occurs at about two months of age (Stinson 2005, p. 26). They attain their adult weight between four and five months of age (Andersen 1978, pp. 419, 421). Most pocket gophers live only a year or two, with few living to three or four years of age (Hansen 1962, pp. 152, 153; Livezey and Verts 1979, p. 39) (USFWS, 2016).

**Spatial Arrangements of the Population**

Adult: Clumped (USFWS, 2016)

**Habitat Narrative**

Adult: The Mazama pocket gopher (pocket gopher) is associated with glacial outwash prairies in western Washington, an ecosystem of conservation concern (Hartway and Steinberg 1997, p. 1), as well as alpine and subalpine meadows and other meadow-like openings at lower elevations. Steinberg and Heller (1997, p. 46) found that pocket gophers are even more patchily distributed than are prairies, as there are some seemingly high quality prairies within the species' range that lack pocket gophers; e.g., Mima Mounds Natural Area Preserve (NAP), and 13th Division Prairie on Joint Base Lewis-McChord (JBLM). Pocket gopher distribution is affected by the rock content of soils, drainage, forage availability, and climate (Case and Jasch 1994, p. B-21; Hafner et al. 1998, p. 279; Reichman 2007, pp. 273-274; Steinberg and Heller 1997, p. 45; Stinson 2005, p. 31; WDFW 2009). Prairie and meadow habitats used by pocket gophers have a naturally patchy distribution. In their prairie habitats, there is an even patchier distribution of soil rockiness which may further restrict the total area that pocket gophers can utilize (Steinberg and Heller 1997, p. 45; WDFW 2009). We assume that meadow soils have a similarly patchy distribution of rockiness, though the soil surveys to support this are, at this time, incomplete. In western Washington, pocket gophers currently occupy the following soils series: Alderwood, Cagey, Carstairs, Everett, Everett-Spanaway complex, Everett-Spanaway-Spana complex, Godfrey, Grove, Indianola, Kapowsin, McKenna, Murnen, Nisqually, Norma, Shelton, Spana, Spana-Spanaway-Nisqually complex, Spanaway, Spanaway-Nisqually complex, and Yelm. No soil survey information is currently available for occupied sites in the Olympic National Park, so the soils occupied there are unknown. We purposely avoid using specific map unit names, because we know that there are imperfections in soil mapping. Maps are based on the technology, standards, and tools available at the time soil surveys were conducted, sometimes up to 50 years ago. We recognize that soil survey boundaries may be adjusted in the future, and that soil series names may be added or removed to soil survey maps and databases. As a result, the overlap of pocket gopher locations with soil series names may be different in the future. The soils information presented here is based on best scientific data available at the time of listing. We also recognize that some of these soil series or soil series complexes are not typically either deep or well-drained. For a variety of reasons, mapped soil types may or may not have all of the characteristics described by the U.S. Department of Agriculture, Natural Resources Conservation Service, and the actual soils that occur on sites may have characteristics that make them more or less habitable by pocket gophers. These reasons may include: map boundary or transcription errors, map projection errors or differences, map identification or typing errors, soil or hydrological manipulations that have occurred since mapping took place, and small-scale inclusions that are different from the mapped soil. Because soils are mapped at large scales, mapped soils may not identify smaller inclusions. Any of the soil series or soil series complexes listed above could potentially be suitable for the four Thurston/Pierce subspecies of the Mazama pocket gopher. And, the four Thurston/Pierce subspecies of the Mazama pocket gopher may also inhabit soil series not included in the above list. Although some soils are sandier, more gravelly, or may have more or less silt than described, most all soils used by pocket gophers are friable (easily pulverized or crumbled), loamy, and deep, and generally have slopes less than 15 percent. There have been reports of pocket gophers (subspecies unknown) occurring on other types of soils, on managed forest lands in Capitol State Forest (owned by the Washington State Department of Natural Resources, WDNR) and Vail Forest (owned by Weyerhaeuser) in Thurston County. These were subsequently determined to be moles (Scapanus spp.), based on trapping conducted in these areas by the Washington State Department of Fish and Wildlife (WDFW) during 2012 (Thompson, pers. comm. 2012b). A study of the relationship between soil rockiness and pocket gopher distribution revealed a strong negative correlation between the proportion of medium-sized rocks in the soil, and the presence of pocket gophers (eight of nine prairies sampled); medium sized rocks were considered greater than 0.5 inch (12.7 mm), but less than 2 inches (50.8 mm) in diameter (Steinberg 1996, p. 32). In observations of pocket gopher distribution on JBLM, pocket gophers did not occur in areas with a high percentage of Scot's broom cover (Cytisus scoparius), or where mole populations were particularly dense (Steinberg 1995, p. 26). A more recent study on JBLM also found that pocket gopher presence was negatively associated with Scot's broom; however, the researcher found no relationship between pocket gopher presence and mole density (Olson 2011a, pp. 12, 13). Pocket gopher burrows consist of a series of main runways, off which lateral tunnels lead to the surface of the ground (Wight 1918, p. 7). Pocket gophers dig their burrows using their sharp teeth and claws and then push the soil out through the lateral tunnels (Case and Jasch 1994, p. B-20; Wight 1918, p. 8). Nests containing dried vegetation are generally located near the center of each pocket gopher's home tunnel system (Wight 1918, p. 10). Food caches and store piles are usually placed near the nest, and excrement is piled into blind tunnels or loop tunnels, and then covered with dirt, leaving the nest and main runways clean (Wight 1918, p. 11). (USFWS, 2016).

***Dispersal/Migration***

**Motility/Mobility**

Adult: High (USFWS, 2016)

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: Non-migratory (USFWS, 2016)

**Dispersal**

Adult: Low (USFWS, 2016)

**Immigration/Emigration**

Adult: Unlikely (USFWS, 2016)

**Dispersal/Migration Narrative**

Adult: Pocket gophers have limited dispersal capabilities (Williams and Baker 1976, p. 303). Mazama pocket gophers are smaller in size than other sympatric or peripatric Thomomys species (Verts and Carraway 2000, p. 1). Both dispersal distance and home range size are therefore likely to be smaller than for other Thomomys species. Dispersal distances may vary based on surface or soil conditions and size of the animal. For other, larger, Thomomys species, dispersal distances average about 131 feet (40 meters) (Barnes Jr. 1973, pp. 168, 169; Daly and Patton 1990, pp. 1286, 1288; Williams and Baker 1976, p. 306). Initial results from research being conducted on JBLM indicate that juvenile pocket gophers usually make movements from 13.1 to 32.8 feet (4-10 meters), though these may not be dispersal movements. One juvenile made a distinct dispersal movement of 525 feet (160 meters) in a single day (Olson 2012, p. 5). Suitable dispersal habitat is free of barriers to movement, and may need to contain foraging habitat if an animal is required to make a long-distance dispersal movement. Potential barriers include, but are not limited to, forest edges, roads (paved and unpaved), abrupt elevation changes, Scot's broom thickets (Olson 2012, p. 3), highly cultivated lawns, inhospitable soil types or substrates (Olson 2008, p. 4), development and buildings, slopes greater than 35 percent, and open water. Barriers may be permeable, meaning that they impede movement from place to place without completely blocking it, or they may be impermeable, meaning they cannot be crossed. Permeable barriers, as well as lower quality dispersal habitats, may present a risk of mortality for animals that use them (e.g., open areas where predation risk is increased, or a paved area where vehicular mortality is high). The WDFW conducted a study to determine dispersal distances of juvenile pocket gophers on JBLM. Twenty-eight juveniles were radio-collared and tracked for 17 to 56 days, with all but three animals tracked for more than 30 days. Of these, only nine gophers moved more than 32.8 feet (10 meters), and 10 gophers were never found more than 13.1 feet (4 meters) from any previous location (Olson 2012, p. 5). Only one animal dispersed what would be considered a larger distance, moving 525 feet (160 meters) in a single day.

***Population Information and Trends***

**Population Trends:**

Decreasing (USFWS, 2016)

**Population Narrative:**

There are few data on historical or current population sizes of Mazama pocket gopher (pocket gopher) populations in Washington, although several local populations and one subspecies are believed to be extinct. Knowledge of the past status of the pocket gopher is limited to distributional information. Recent surveys have focused on determining current distribution, primarily in response to development applications. In addition, in 2012, WDFW initiated a five county-wide distribution survey. Because the object of all of these surveys has mainly been presence/absence only, total population numbers for each subspecies are unknown. And, the precise boundaries of each subspecies' range are not currently known. Local population estimates have been reported but are based on using apparent gopher mounds to delineate the number of territories, a method that has not been validated (Stinson 2005, pp. 40, 41). Olson (2011a, p. 2) evaluated this methodology on pocket gopher populations at the Olympia Airport and Wolf Haven International. Although there was a positive relationship between the number of mounds and number of pocket gophers, the relationship varies spatially, temporally, and demographically (Olson 2011a, pp. 2, 39). Based on the results of Olson's 2011 study, we believe past population estimates (Stinson 2005) may have been too high. As there is no generally accepted standard survey protocol to determine population size for pocket gophers, it is not currently possible to obtain an estimate of subspecies population sizes or trends. Overall habitat availability has declined, however, and habitat has a finite ability to support pocket gophers. For these reasons, the Service concludes that the overall population trend of each of the four Thurston/Pierce subspecies of the Mazama pocket gopher is negative. Increased survey effort since 2007 has resulted in the identification of numerous additional occupied sites located on private lands, especially in Thurston County (WDFW 2013a). Some of these new detections are adjacent to other known occupied sites, such as the population at the Olympia Airport. The full extent of these smaller discontiguous sites is currently unknown, and no research has been done to determine whether or not these aggregations are "stepping stone" sites that may facilitate dispersal into nearby unoccupied suitable habitat, or if they are population sinks (sites that do not add to the overall population through recruitment). Others of these additional occupied sites are separate locations, seemingly unassociated (physically) with known populations (Tirhi, in litt. 2008). The largest known expanse of areas occupied by any subspecies in Washington occur on JBLM (Roy Prairie and Yelm pocket gophers), and at the Olympia and Shelton airports (Olympia and Shelton pocket gophers, respectively). A translocated population occurs on Wolf Haven International's land near Tenino, Washington. Between 2005 and 2008, over 200 gophers from a variety of areas in Thurston County (some from around Olympia Airport (Olympia pocket gopher, T. m. pugetensis)) and some from near the intersection of Rich Road and Yelm Highway (assumed to be Olympia pocket gophers) were released into the 38 acres (15 ha) mounded prairie site. Based on the best available information, we do not believe the property previously supported pocket gophers. Today pocket gophers continue to occupy the site (Tirhi, in litt. 2011); however, current population estimates are not available. Another site, West Rocky Prairie Wildlife Area, has received a total of 560 translocated pocket gophers

(T. m. pugetensis) from the Olympia Airport between 2009 and 2011. Initial translocation efforts were unsuccessful; a majority of the pocket gophers died within three days due to predation (Olson 2009, p. 3). Modified release techniques used in 2010 and 2011 resulted in improved survival rates (Olson 2011b, p. 4). It is too soon to know if the population will become self-sustaining, or if additional translocations of gophers will be necessary.

***Threats and Stressors***

**Stressor:** Destruction, Modification, or Curtailment of Habitat and Range (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The primary long term threats to the pocket gopher are the loss, conversion, and degradation of habitat, particularly to urban development, successional changes to grassland habitat, and the spread of invasive plants. The threats also include increased predation pressure, which is closely linked to habitat degradation. The prairies of south Puget Sound are one of the rarest ecosystems in the United States (Dunn and Ewing 1997b, p. v; Noss et al. 1995, p. I-2). Dramatic changes have occurred on the landscape over the last 150 years, including a 90 to 95 percent reduction in the extent of the prairie ecosystem. In the south Puget Sound region, where most of western Washington's prairies historically occurred, less than 10 percent of the original prairie persists, and only three percent remains dominated by native vegetation (Crawford and Hall 1997, pp. 13, 14). Development: Native prairies and grasslands have been severely reduced throughout the range of the four Thurston/Pierce subspecies of Mazama pocket gopher, especially as a result of conversion to residential and commercial development and agriculture. Prairie habitat continues to be lost, particularly to residential development (Stinson 2005, p. 70), by removal and fragmentation of native vegetation, and the excavation, and/or heavy equipment-caused compaction of surfaces and conversion to non-habitat (e.g., buildings, pavement, other infrastructure), rendering soils unsuitable for burrowing. Residential development is associated with increased infrastructure, such as new road construction, which is one of the primary causes of landscape fragmentation (Watts et al. 2007, p. 736). Activities that accompany low-density development are correlated with decreased levels of biodiversity, mortality to wildlife, and facilitated introduction of nonnative invasive species (Trombulak and Frissell 2001; Watts et al. 2007, p. 736). In the south Puget Sound lowlands, the glacial outwash soils and gravels underlying the prairies are deep and valued for use in construction and road building, which leads to their degradation and destruction. In the south Puget Sound, Nisqually loamy soils appear to support high densities of pocket gophers (Stinson, in litt. 2010a Olson 2008, p. 6), the vast majority of which occur in developed areas of Thurston County, or within the Urban Growth Areas for the cities of Olympia, Tumwater, and Lacey (WDFW 2009), where future development is most likely to occur. Where pocket gopher populations presumably extended across an undeveloped expanse of open prairie (Dalquest and Scheffer 1942, pp. 95, 96), areas currently occupied by the four Thurston/Pierce subspecies of the Mazama pocket gopher are now isolated to small fragmented patches due to development and conversion of suitable habitat to incompatible uses. The presumed extinction of the Tacoma pocket gopher is likely linked directly to residential and commercial development, which has replaced nearly all pocket gopher habitats in the historical range of the subspecies (Stinson 2005, pp. 18, 34, 46). One of the historical Tacoma pocket gopher sites was converted to a large gravel pit and golf course (Steinberg 1996, pp. 24, 27; Stinson 2005, pp. 47, 120). In addition, two gravel pits are now operating on part of the site recognized as the type locality for the Roy Prairie pocket gopher

(Stinson 2005, p. 42), and another is in operation near Tenino (Stinson, in litt. 2010b) in the vicinity of the type locality for the Tenino pocket gopher. Multiple pocket gopher sites in Pierce and Thurston Counties may be, or have been, lost to gravel pit development, golf course development, or residential and commercial development (Stinson, in litt. 2005; Stinson 2005, pp. 26, 42; Stinson, in litt. 2010b). Multiple prairies that used to contain uninterrupted expanses of prairie habitat suitable for pocket gophers within the range of the four Thurston/Pierce subspecies have been developed to cities, neighborhoods, agricultural lands, or military bases, and/or negatively impacted by such development, including Baker Prairie, Bush Prairie, Chambers Prairie, Frost Prairie, Grand Mound Prairie, Little Chambers Prairie, Marion Prairie, Roy Prairie, Ruth Prairie, Woods Prairie, Violet Prairie, and Yelm Prairie. Some of these prairie areas still contain smaller areas that support pocket gophers, and some appear to no longer support pocket gophers at all (WDFW 2012). Where their properties coincide with pocket gopher occupancy, many private lands developers and landowners in Thurston County have agreed to create set-asides or agree to other mitigation activities in order to obtain development permits from the County (Tirhi, in litt. 2008). However, it is unknown if any pocket gophers will remain on these sites due to the small size of the set-asides, extensive grading in some areas adjacent to set-asides, lack of dedicated funding for enforcement or monitoring of set-aside maintenance (Thurston County Long Range Planning and Resource Stewardship, in litt. 2011, p. 2), and lack of control of predation by domestic or feral cats and dogs. In addition, some landowners have received variances from Thurston County that allowed development to occur without a requirement to set aside areas for pocket gophers. A population of Olympia pocket gophers is located at and around the Port of Olympia's Olympia Airport, which is sited on the historical Bush Prairie. Gophers on Bush Prairie are currently vulnerable to negative impacts from proposed future development by the Port of Olympia and ongoing development by adjacent landowners. The Port of Olympia has plans to develop large portions of the existing grassland that likely supports the largest population of the Olympia pocket gopher in Washington (Stinson 2007, in litt.; Port of Olympia and WDFW 2008, p.1; Port of Olympia 2012). The Olympia Airport is realigning the airport runway, which is in known occupied habitat. They continue to work with the Service and WDFW on mitigating airport expansion activities that may negatively impact gophers (Tirhi, in litt. 2010). The Olympia pocket gopher has a population at the Olympia Airport that spans several hundred acres, and there are two translocated populations: one at West Rocky Prairie Wildlife Area (some individuals from the Olympia Airport) and one at Wolf Haven (individuals from the Olympia Airport and some from near the intersection of Rich Road and Yelm Highway). The population centered on the Olympia Airport could be negatively impacted by plans for development both on and off the airport, while the two translocated populations are currently secure from intense commercial and residential development pressures as they occur on conserved lands. The Roy Prairie pocket gopher is known to occur across a large expanse of prairie on JBLM, which is currently secure from the threat of development. The Tenino pocket gopher has a single known population, which has been detected during surveys on the Rocky Prairie NAP, although the intermittent nature of these detections suggests it must be part of a larger metapopulation that occurs across nearby areas that have not been accessible for surveys. No known development poses a threat to the NAP, but any future conversion of the surrounding area to incompatible land use would likely hinder the recovery of this subspecies. The Yelm pocket gophers on Tenalquot prairie (which is owned in large part by JBLM) and Scatter Creek Wildlife Area are also secure from such residential and commercial development, but the Yelm pocket gopher habitat on Rock Prairie north of Old Highway 99 is in an area that is likely to be developed soon, which may negatively affect any local populations in the vicinity. Loss or Curtailment of Natural Disturbance Processes: The suppression and loss of ecological disturbance regimes across vast portions of the landscape, such as fire, has resulted in altered vegetation structure in the prairies and meadows and has facilitated invasion by native and nonnative woody vegetation, rendering habitat unusable for the four Thurston/Pierce subspecies of Mazama pocket gopher. The basic ecological processes that maintain prairies and meadows have disappeared from, or have been altered on, all but a few protected and managed sites. Historically, the prairies and meadows of the south Puget Sound region are thought to have been actively maintained by native peoples, who lived here for at least 10,000 years before the arrival of Euro-American settlers (Boyd 1986; Christy and Alverson 2011, p. 93). Frequent burning reduced the encroachment and spread of shrubs and trees (Boyd 1986; Chappell and Kagan 2001, p. 42), favoring open grasslands with a variety of native plants and animals. Following Euro-American settlement of the region in the mid-19th century, fire was actively suppressed on grasslands, allowing encroachment by woody vegetation into the remaining prairie habitat and oak woodlands (Agee 1993, p. 360; Altman et al. 2001, p. 262; Boyd 1986; Franklin and Dyrness 1973, p. 122; Kruckeberg 1991, p. 287)Fires on the prairie create a mosaic of vegetation conditions, which serve to maintain native prairie plant communities. In some prairie patches fires will kill encroaching woody vegetation and reset succession back to bare ground, creating early successional vegetation conditions suitable for many native prairie species. Early succession forbs and grasses are favored by pocket gophers. The historical fire frequency on prairies has been estimated to be 3 to 5 years (Foster 2005, p. 8). On sites where regular fires occur, there is a high complement of native plants and fewer invasive species. These types of fires maintain the native short-statured plant communities favored by pocket gophers. The result of fire suppression has been the invasion of the prairies and oak woodlands by native and nonnative plant species (Dunn and Ewing 1997a, p. v; Tveten and Fonda 1999, p. 146), notably woody plants such as the native Douglas-fir (Pseudotsuga menziesii) and the nonnative Scot's broom. On tallgrass prairies in midwestern North America, fire suppression has led to degradation and the loss of native grasslands (Curtis 1959, pp. 296, 298; Panzer 2002, p. 1297). On northwestern prairies, fire suppression has allowed Douglas-fir to encroach on and outcompete native prairie vegetation for light, water, and nutrients (Stinson 2005, p. 7). This increase in woody vegetation and nonnative plant species has resulted in less available prairie habitat overall and habitat that is unsuitable for and avoided by many native prairie species, including pocket gophers (Olson 2011a, pp. 12, 16; Pearson et al. 2005, pp. 2, 27; Tveten and Fonda 1999, p. 155). Pocket gophers prefer early successional vegetation as forage. Woody plants shade out the forbs and grasses that pocket gophers prefer to eat, and high densities of woody plants make travel both below and above the ground difficult. In locations with poor forage, pocket gophers tend to have larger territories, which may be difficult or impossible to establish in densely forested areas. The probability of pocket gopher occupancy is much higher in areas with less than 10 percent woody vegetation cover (Olson 2011a, p. 16). On JBLM alone, over 16,000 acres (6,477 ha) of prairie has converted to Douglas-fir forest since the mid-19th century (Foster and Shaff 2003, p. 284). Where controlled burns or direct tree removal are not used as a management tool, this encroachment will continue to cause the loss of open grassland habitats for pocket gophers and is an ongoing threat to the species. Restoration in some of the south Puget Sound grasslands has resulted in temporary control of Scot's broom and other invasive plants through the careful and judicious use of herbicides, mowing, grazing, and fire. Fire has been used as a management tool to maintain native prairie composition and structure and is generally acknowledged to improve the health and composition of grassland habitat by providing a short-term nitrogen addition, which results in a fertilizer effect to vegetation, thus aiding grasses and forbs to sprout. Unintentional fires ignited by military training burn patches of prairie grasses and forbs on JBLM on an annual basis. These light ground fires create a mosaic of conditions within the grassland, maintaining a low vegetative structure of native and nonnative plant composition, and patches of bare soil. Because of the topography of the landscape, fires create a patchy mosaic of areas that burn completely, some areas that do not burn, and areas where consumption of the vegetation is mixed in its effects to the habitat. One of the benefits of fire in grasslands is that it tends to kill regenerating conifers, and reduces the cover of nonnative shrubs such as Scot's broom, although Scot's broom seed stored in the soil can be stimulated by fire (Agee 1993, p. 367). Fire also improves conditions for many native bulb-forming plants, such as Camassia spp. (Agee and Dunwiddie 1984). On sites where regular fires occur, such as on JBLM, there is a high complement of native plants and fewer invasive species. These types of fires maintain the native, short-statured plant communities favored by pocket gophers. Management practices such as intentional burning and mowing require expertise in timing and technique to achieve desired results. If applied at the wrong season, frequency, or scale, fire and mowing can be detrimental to the restoration of native prairie species. Excessive and high-intensity burning can result in a lack of vegetation or encourage regrowth of nonnative grasses. Where such burning has occurred over a period of more than 50 years on the artillery ranges of JBLM, prairies are covered by nonnative forbs and grasses instead of native perennial bunchgrasses (Tveten and Fonda 1999, pp. 154, 155). Pocket gophers are not commonly found in areas colonized by Douglas-fir trees because pocket gophers require forbs and grasses of an early successional stage for food (Witmer et al. 1996a, p. 96). Pocket gophers observed on JBLM did not occur in areas with high cover of Scot's broom (Steinberg 1995, p. 26). A more recent study on JBLM also found that pocket gopher presence was negatively associated with Scot's broom (Olson 2011a, pp. 12, 13, 16). Some subspecies may disperse through forested areas or may temporarily establish territories on forest edges, but there is currently not enough data available to determine how common this behavior may be or which subspecies employ it. The four Thurston/Pierce subspecies of the Mazama pocket gopher occur on prairie-type habitats, many of which, if not actively managed to maintain vegetation in an early-successional state, have been invaded by shrubs and trees that either preclude pocket gophers or limit their ability to fully occupy the landscape. Typical management at civilian airports prevents woody vegetation from encroaching onto surrounding areas for flight safety reasons. Woody vegetation encroachment is therefore not a threat at civilian airports. Military Training: Pocket gopher populations occurring on JBLM are exposed to differing levels of training activities on the base. The Department of Defense's (DOD) proposed actions under their "Grow the Army" initiative include stationing 5,700 new soldiers, new combat service support units, a combat aviation brigade, facility demolition and construction to support the increased troop levels, and additional aviation, maneuver, and live fire training (75 FR 55313, September 10, 2010). The increased training activities will affect nearly all training areas at JBLM, resulting in an increased risk of accidental fires, and habitat destruction and degradation attributable to vehicle use in occupied areas, mounted and dismounted training, bivouac activities, and digging. Even though the training areas on the base are degraded, with implementation of agreed-upon conservation measures, these areas still provide habitat for the Roy Prairie and Yelm pocket gopher. JBLM's recently signed Endangered Species Management Plan (ESMP) for the Mazama pocket gopher will serve to minimize threats across the base by redirecting some training activities to areas outside of occupied habitat, designating areas where no vehicles are permitted, designating areas where vehicles will remain on roads only, and designating areas where no digging is allowed, among other conservation measures. JBLM has further committed to enhancing and expanding suitable habitat for the Roy Prairie and Yelm pocket gophers in "priority habitat" areas on base (areas that were proposed as critical habitat); enforcing restrictions on recreational use of occupied habitat by dog owners and horseback riders; and continuing to support the off-base recovery of the four Thurston/Pierce subspecies of the Mazama pocket gopher. Several moderate- to large-sized areas supporting pocket gophers have been identified on JBLM. These areas are within the historical ranges of the Roy Prairie (Pierce County) and Yelm (Thurston County) pocket gophers. Their absence from some sites of what is presumed to have been formerly suitable habitat may be related to compaction of the soil due to years of mechanized vehicle training (Steinberg 1995, p. 36). Training infrastructure (e.g., roads, firing ranges, bunkers) also degrades pocket gopher habitat and may lead to reduced use of these areas by pocket gophers. For example, JBLM has plans to add a third rifle range on the south impact area where it overlaps with a densely occupied pocket gopher site. The area may be usable by pocket gophers when the project is completed; however, construction of the rifle range may result in removal of forage and direct mortality of pocket gophers through crushing of burrows (Stinson, in litt. 2011). Recent survey access to the center of the artillery impact area on 91st Division Prairie, where bombardment is presumably of the highest intensity, did detect some unspecified level of occupancy by the Roy Prairie pocket gopher (WDFW 2013b, enclosure 1, p. 6). This apparently suitable central portion of the 91st Division Prairie is subject to repeated and ongoing bombardment, which may create an ecological trap for dispersing juveniles. JBLM training areas have varying levels of use; some allow excavation and off-road vehicle use, while other areas have restrictions that limit off-road vehicle use. The ESMP specifically requires coordination between the JBLM Fish and Wildlife personnel and the JBLM entities responsible for training activities (e.g., Range Support, battalion commanders, and/or first field grade officers) to ensure all parties are aware of where occupied areas occur in relation to training activities, the effects of training, and the potential ramifications of habitat destruction or animal mortality. Since military training has the potential to directly or indirectly harm or harass pocket gophers, we conclude that these activities will negatively impact the Roy Prairie and Yelm pocket gophers. JBLM has committed to operational restrictions on portions of the base in order to avoid and minimize potential impacts to Roy Prairie and Yelm pocket gophers. Currently-occupied areas will be buffered from training activities, with an emphasis on occupied habitat in “priority habitat” areas. Regular surveys will be conducted with the goals of determining distribution, protecting pocket gophers and their habitat from disturbance or destruction, and determining population status. Where possible, JBLM will alleviate training pressure by transferring activities to unoccupied areas where encroaching forest has been removed. This strategy has the effect of both releasing large areas of land that were historically prairie and providing unoccupied areas where training is free of the risk of negatively impacting Roy Prairie or Yelm pocket gophers. While the Service fully supports the implementation of these impact minimization efforts and will continue to collaborate with DOD to address all aspects of training impacts on the species, not all adverse impacts on pocket gophers can be fully avoided. Military training continues to pose a threat to the Roy Prairie and Yelm subspecies at this time. No military training occurs in the ranges of the Olympia or Tenino subspecies of the Mazama pocket gopher (USFWS, 2016).

**Stressor:** Poor Connectivity Between Small and Isolated Populations (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Isolated genetics
**Narrative:** Most species’ populations fluctuate naturally, responding to various factors such as weather events, disease, and predation. Populations that are small, fragmented, or isolated by habitat loss or modification of naturally patchy habitat, and other human-related factors, are more vulnerable to extirpation by natural randomly occurring events, cumulative effects, and to genetic effect (collectively known as small population effects). These effects can include genetic

drift (loss of recessive alleles), founder effects (over time, an increasing percentage of the population inheriting a narrow range of traits), and genetic bottlenecks leading to increasingly lower genetic diversity, with consequent negative effects on evolutionary potential. To date, of the eight subspecies of Mazama pocket gopher in Washington, only the Olympic pocket gopher has been documented as having low genetic diversity (Welch and Kenagy 2008, p. 7), although the six other extant subspecies have local populations that are small, fragmented, and physically isolated from one another. The four Thurston/Pierce subspecies of the Mazama pocket gopher face threats from loss or fragmentation of habitat. Historically, pocket gophers probably persisted by continually recolonizing habitat patches after local extinctions. However, widespread development and conversion of habitat has resulted in widely separated populations, and intervening habitat corridors are now gone, with the effect of impeding or stopping much of the natural recolonization that historically occurred (Stinson 2005, p. 46). Although pocket gophers are not known to have low genetic diversity, small population sizes at most sites, coupled with disjunct and fragmented habitat, may contribute to further population declines. Little is known about the local or rangewide reproductive success of pocket gophers found in Washington State (USFWS, 2016).

**Stressor:** Predation and Pest Control (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Predation: Predation influences the distribution, abundance, and diversity of species in ecological communities. Generally, predation leads to changes in both the population size of the predator and that of the prey. In unfavorable environments, prey species are stressed or living at low population densities such that predation is likely to have negative effects on all prey species, thus lowering species richness. In addition, when a nonnative predator is introduced to the ecosystem, negative effects on the prey population may be higher than those from co-evolved native predators. The effect of predation may be magnified when populations are small, and the disproportionate effect of predation on declining populations has been shown to drive rare species even further towards extinction (Woodworth 1999, pp. 74, 75). Predation has an impact on populations of the four Thurston/Pierce subspecies of Mazama pocket gopher. Urbanization, particularly in the south Puget Sound region, has resulted in not only habitat loss, but also increased exposure to feral and domestic cats and dogs. Domestic cats are known to have serious impacts on small mammals and birds and have been implicated in the decline of several endangered and threatened mammals, including marsh rabbits (Sylvilagus palustris) in Florida and the salt-marsh harvest mouse (Reithrodontomys raviventris) in California (Ogan and Jurek 1997, p. 89). Domestic cats and dogs have been specifically identified as common predators of pocket gophers (Case and Jasch 1994, p. B-21; Henderson 1981, p. 233; Wight 1918, p. 21) and at least two pocket gopher locations were found as a result of house cats bringing home pocket gopher carcasses (WDFW 2001). Informal interviews with area biologists document multiple incidents of domestic pet predation on pocket gophers (Chan, in litt. 2013; Clouse, in litt. 2012 Skriletz 2013 in litt., Wood 2013 in litt.). There is also one recorded instance of a WDFW biologist being presented with a dead Mazama pocket gopher by a dog during an east Olympia, Washington, site visit in 2006 (Burke Museum 2012 McAllister 2013 in litt.). Some local populations of the pocket gopher occur in areas where people recreate with their dogs, bringing these potential predators into environments that may otherwise be relatively free of them, consequently increasing the risks to individual pocket gophers and populations that may be small and isolated The four Thurston/Pierce subspecies of Mazama pocket gopher occur in rapidly

developing areas. Local populations that survive commercial and residential development (adjacent to and within habitat) are potentially vulnerable to extirpation by domestic and feral cats and dogs (Case and Jasch 1994, p. B-21; Henderson 1981, p. 233). As stated previously, predation is a natural part of the pocket gopher's life history; however, the effect of predation may be magnified when populations are small and habitat is fragmented. The disproportionate effect of additional predation on declining populations has been shown to drive rare species even further towards extinction (Woodworth 1999, pp. 74, 75). Predation, particularly from nonnative species, will likely continue to be a threat to the four Thurston/Pierce subspecies of the Mazama pocket gopher now and in the future. This is particularly likely where development abuts gopher habitat, resulting in increased numbers of cats and dogs in the vicinity, and in areas where people recreate with their dogs – particularly if dogs are off-leash and not prevented from harassing wildlife. In such areas, where local populations of pocket gophers are already small, this additional predation pressure (above natural levels of predation) is expected to further negatively impact population numbers. Pest Control: Pocket gophers are often considered a pest because they sometimes damage crops and seedling trees, and their mounds can create a nuisance. Several site locations were found as a result of trapping conducted on Christmas tree farms, a nursery, and in a livestock pasture (WDFW 2001). The type locality for the Cathlamet pocket gopher is on a commercial tree farm. Pocket gophers from Thurston County were used in a rodenticide experiment as recently as 1995 (Witmer et al. 1996a, p. 97). In Washington State it is currently illegal to trap or poison Mazama pocket gophers, or to trap or poison moles where they overlap with Mazama pocket gopher populations, but not all property owners are cognizant of these laws, nor are most citizens capable of differentiating between moles, pocket gophers, or the signs of their habitation (e.g., soil disturbance). In light of this, it is reasonable to believe that mole trapping or poisoning still has the potential to adversely affect pocket gopher populations. Local populations that survive commercial and residential development (adjacent to and within habitat) may be subsequently extirpated by trapping or poisoning. Lethal control by trapping or poisoning is most likely to be a threat to the four Thurston/Pierce subspecies where their ranges overlap residential properties (USFWS, 2016).

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 6C

**Delisting Criteria:**
Common Criterion 1: Reserve Establishment. Multiple discrete Reserves (Reserve Cores, Reserve Complexes, or both) are established for each of the four MPG subspecies (see subspecies-specific criteria below for Reserve numbers and distribution (USFWS, 2022b)

Common Criterion 2: Demographic Viability. Each Reserve supports a self-sustaining population with a minimum of 1,000 individuals of the target subspecies. A minimum of 5 years of monitoring utilizing Service-approved protocols across a 10-year period have been conducted and demonstrate the self-sustaining nature of local MPG populations on each Reserve (USFWS, 2022b).

Common Criterion 3: Habitat Area Each Reserve Core provides approximately 250 to 500 acres (about 100 to 200 ha), or more, of medium- and high-quality habitat (see Appendix A for a description of medium- and high-quality habitat). Each Reserve Complex provides a comparable amount of medium- and high-quality habitat (i.e., approximately 250 to 500 acres (100 to 200 ha), located on functionally connected Reserve Satellites. Each Reserve Satellite contains at least 10 acres (approximately 4 ha) of contiguous medium- or high-quality habitat (USFWS, 2022b).

TPG Criterion 1 There are a minimum of two (2) Reserves (as defined and described in Common Criterion 1), with at least one on Rocky Prairie. (USFWS, 2022b).

**Recovery Actions:**

- Tenino pocket gopher 1. Protect, conserve, and enhance OPG habitat. $28,118,000 Priority 1a 2. Identify MPG limiting factors and sources of mortality or harm and implement best management practices to minimize impacts. $1,240,000 Priority 1b 3. To achieve Reserve targets for each subspecies, evaluate the need to either create new local populations or increase the number of individuals in existing local populations in the RPPG Recovery Area (Costs for this TBD). Monitor Reserves as needed to determine status and trend of populations prior to final monitoring requirements in Common Criterion 2. $2,691,000 Priority 2 4. Strengthen outreach and cooperation with stakeholders and partner agencies. $1,282,000 Priority 2 5. Monitor population status, trend, and distribution, sufficient to determine if population goals required in Common Criterion 2 have been met. $846,000 Priority 3 (USFWS, 2021)
- 1. Protect, conserve, and enhance MPG habitat. (Priority 1a) • Identify and prioritize creation and protection of Reserves. • Purchase occupied and highly suitable lands in Reserve areas. • Implement other short- and long-term strategies to protect Reserves and other important MPG sites from development pressure (e.g., mitigation lands, interim permitting strategy, in lieu fee, programmatic HCPs; municipal HCPs). • Develop and cooperatively implement programs for the protection and conservation of MPGs, south Puget Sound prairies, oak savanna, and other prairie-dependent species. This can include, but is not limited to, grant funding, habitat acquisition, habitat restoration, regulatory reform programs and policies, management plans, zoning, mitigation, research, and monitoring for each subspecies. • Implement conservation programs to avoid, minimize, or offset effects of RPPG and YPG habitat impacts resulting from military training. • Monitor implementation of habitat protection activities for MPG conservation (e.g., set-asides, mitigation banks). • 2. Identify MPG limiting factors and sources of mortality or harm and implement best management practices to minimize impacts. (Priority 1b) Assessment of ecologically important limiting factors and evaluating the success of management measures that have been implemented is necessary for effective adaptive management. To minimize adverse effects of threats, best management practices should be implemented by all partners. • Evaluate the effects of vegetation management on MPGs and their habitat. • Determine if and how translocated populations within the range of TPG are affecting demographic and genetic characteristics of this subspecies; develop solutions if needed. • Identify landscape features that influence MPG dispersal and distribution. • Evaluate impacts of other anthropogenic stressors affecting MPGs (e.g., cats, dogs, recreational uses, etc.). • Evaluate natural factors affecting population health and distribution within and between sites. • Conduct demographic and genetic studies. • Revise population viability analysis every 10 years, or when new genetic or demographic information becomes available. • Implement measures to avoid, minimize, or mitigate impacts to individual RPPGs or YPGs as a result of military training. These include the activities described in the JBLM INRMP and the ESMC for MPGs; and the activities, reasonable and prudent measures, and terms and conditions included in the biological opinion(s) addressing training and related

activities at JBLM. • Develop and implement best management practices to avoid and minimize effects of activities in occupied MPG habitat, including: use of mechanical equipment, particularly heavy equipment operations; implementation and use of restoration tools and techniques (including use of prescribed fire); management of predation by domestic and feral dogs and cats; and minimizing incidental or intentional MPG mortality resulting from control of fossorial animals (such as moles) as pest species (i.e., by poisoning and trapping). 3. To achieve Reserve targets for each subspecies, evaluate the need to either create new local populations or increase the number of individuals in existing local populations within each Recovery Area or Recovery Unit. If needed, create new local populations or increase current (2020) local population sizes through habitat creation and population augmentation. Monitor Reserves/Reserve Complexes as needed to determine status and trend of populations prior to final monitoring requirements in Common Criterion 2. (Priority 2) • Evaluate the range-wide need to increase the number of populations. • Monitor local populations in individual Reserves as needed to determine status and trend prior to final monitoring requirements in Common Criterion 2. • Evaluate the range-wide need to augment existing populations. • If needed, evaluate and modify methods of captive breeding, handling, transport, and translocation. • If needed, develop and test best practices for habitat expansion. • If needed, evaluate sites for suitability and prioritize for habitat expansion. • If translocation or habitat expansion is justified, evaluate legal aspects and complete compliance analysis and documentation (permitting, National Environmental Policy Act, etc.) • If needed and appropriate, establish additional populations within unoccupied areas of the historical range. • If needed and appropriate, implement and monitor habitat expansion through vegetation manipulation (tree and shrub removal, mowing, restoration, etc.). 4. Strengthen outreach and cooperation with stakeholders and partner agencies. (Priority 2) Coordination with landowners, management agencies, and interested members of the public is necessary to effectively implement necessary recovery actions across a broad range of land ownership. • Facilitate coordination and information sharing. • Implement outreach and education. 5. Monitor Reserves to determine local population status and trend, sufficient to determine if population goals required in Common Criterion 2 have been met. (Priority 3) Population survey and monitoring with consistent and repeatable methodology is necessary to assess whether Reserves have met population targets in Common Criterion 2 and to provide baseline information for development of a post-delisting monitoring plan. • Verify existing comprehensive survey/monitoring scheme (Olson 2017). Implement survey/monitoring scheme at each Reserve to determine if local population goals required in Common Criteria 2 have been met. (USFWS, 2021)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Future research and management recommendations include: (1) Protect, conserve, and enhance Mazama pocket gopher habitat within the range of each subspecies through habitat acquisition, habitat easement, habitat conservation plans, habitat restoration, and other conservation tools. (2) Conduct research to identify limiting factors and sources of mortality or harm for Mazama pocket gophers and implement best management practices to minimize impacts across the range of each subspecies. (3) If needed, create new local populations or increase population sizes on conserved lands. Monitor each subspecies' population to determine status and trend. (4) Strengthen outreach and cooperation with stakeholders and partner agencies. (USFWS, 2020)

**References**

USFWS. 2016. Status of the Species: (Thomonys mazama ssp.) Mazama Pocket Gopher. U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016

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USFWS. 2021. Draft Recovery Plan for Four Subspecies of Mazama Pocket Gopher. Draft Recovery Plan for Four Subspecies of Mazama Pocket Gopher Roy Prairie pocket gopher (Thomomys mazama glacialis) Olympia pocket gopher (Thomomys mazama pugetensis) Tenino pocket gopher (Thomomys mazama tumuli) Yelm pocket gopher (Thomomys mazama yelmensis). 29 pp + Attachments.

USFWS. 2022. Recovery plan for four subspecies of Mazama pocket gopher. Portland, Oregon. xi +33 pp.+ appendices.

USFWS. 2022b. Recovery plan for four subspecies of Mazama pocket gopher. Portland, Oregon. xi +33 pp.+ appendices.

USFWS 2020. 5-YEAR REVIEW Mazama Pocket Gophers: Olympia, Roy Prairie, Tenino, and Yelm pocket gophers (Thomomys mazama pugetensis, T. m. glacialis, T. m. tumuli, and T. m. yelmensis). 9 pp.

# SPECIES ACCOUNT: *Thomomys mazama yelmensis* (Yelm pocket gopher)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; Pacific Region (R1) (USFWS, 2016)

**Physical Description**

Adult Mazama pocket gophers are reddish brown to black above, and the underparts are lead-colored with buff-colored tips. The lips, nose, and patches behind the ears are black; the wrists are white. Adults range from 7 to 9 inches (189 to 220 millimeters (mm)) in total length, with tails that range from 2 to 3 inches (45 to 85 mm)(Verts and Carraway 2000, p.2). Mazama pocket gophers are morphologically similar to other species of pocket gophers that exploit a subterranean existence. They are stocky and tubular in shape, with short necks, powerful limbs, long claws, and tiny ears and eyes. Their short, nearly hairless tails are highly sensitive and probably assist when navigating tunnels. The “pockets” are external, fur-lined cheek pouches on either side of the mouth that are used to transport nesting material and plant cuttings. Mazama pocket gophers reach reproductive age in the spring of the year after their birth and produce litters between spring and early summer. Litter size ranges from one to nine (Wight 1918, p. 14), with an average of five (Scheffer 1938, p. 222). They do not hibernate in winter; they remain active throughout the year (Case and Jasch 1994, p. B-20) (USFWS, 2016).

**Taxonomy**

Although the species Thomomys mazama, or Mazama pocket gopher, includes numerous subspecies that are found in the States of Washington, Oregon, and California, only the subspecies found in the State of Washington have recently been considered for listing. The Mazama pocket gopher complex consists of 15 subspecies, eight of which occur only in Washington, five of which occur only in Oregon, one that occurs only in California, and one subspecies with a distribution that spans the boundary between Oregon and California (Hall 1981, p. 467). The first pocket gophers collected in western Washington were considered subspecies of the northern pocket gopher (Thomomys talpoides)(Goldman 1939), until 1960 when the complex of pocket gophers found in western Washington was determined to be more similar to the western pocket gopher (T. mazama)(Johnson and Benson 1960, p. 20). Eight western Washington subspecies of Mazama pocket gopher (T. mazama, ssp. couchi, glacialis, louiei, melanops, pugetensis, tacomensis, tumuli, and yelmensis) have been identified (Hall 1981, p. 467). Thomomys mazama is recognized as a valid species by the Integrated Taxonomic Information System (ITIS 2012). Although there have been suggestions that potential changes to the classification of some of these subspecies should be considered, we have no information to suggest that any of the presently recognized subspecies are the subject of serious dispute. We follow the subspecies designations of Verts and Carraway (2000), as this text represents the currently accepted taxonomy for the species T. mazama. Verts and Carraway (2000, p.1) recognize T. m. glacialis, pugetensis, tumuli, and yelmensis as separate subspecies (the Roy Prairie, Olympia, Tenino, and Yelm pocket gophers, respectively) based on morphological characteristics, distribution, and differences in number of chromosomes. Due to the close proximity of the four subspecies located in Thurston and Pierce Counties, and the fact that at least three of them occur in the same clade, we refer to these four subspecies (T. m. glacialis, pugetensis, tumuli, and yelmensis) as “the four Thurston/Pierce subspecies” of the Mazama

pocket gopher (USFWS, 2016).

**Current Range**

In Washington, Mazama pocket gophers are found west of the Cascade Mountain Range, in the Olympic Mountains and in the Puget Sound trough, with an additional single locality known from Wahkiakum County (Verts and Carraway 2000, p.3). Their populations are concentrated in well-drained friable soils often associated with glacial outwash. Yelm pocket gophers (Thomomys mazama yelmensis) were originally found on prairies in the area of Grand Mound, Vail, and Rochester (Dalquest and Scheffer 1944, p. 446). Surveys conducted during 1993 and 1994 found no pocket gophers near the towns of Vail or Rochester (Steinberg 1995, p. 28). More recent surveys have reported pocket gophers near Grand Mound, Littlerock, Rainier, Rochester, and Vail (Krippner 2011, p. 31), though WDFW biologists question the validity of the reports near Littlerock and Vail (WDFW 2013b, enclosure 1, p. 3). Soil series and soil series complexes in and around these areas that may support pocket gophers include Alderwood, Everett, Godfrey, Kapowsin, McKenna, Nisqually, Norma, Spana, Spanaway, Spanaway-Nisqually complex, and Yelm.(USFWS, 2016).

**Critical Habitat Designated**

Yes; 4/9/2014.

**Legal Description**

On April 9, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat for three subspecies of the Mazama pocket gopher (the Olympia pocket gopher, Thomomys mazama pugetensis; the Tenino pocket gopher, T. m. tumuli; and the Yelm pocket gopher, T. m. yelmensis) under the Endangered Species Act of 1973, as amended (Act). In total, approximately 1,607 acres (650 hectares) in Thurston County, Washington, fall within the boundaries of the critical habitat designation for the Olympia, Tenino, and Yelm pocket gophers. The effect of this regulation was to designate critical habitat for the Olympia, Tenino, and Yelm subspecies of the Mazama pocket gopher found in Thurston County, Washington, under the Act.

**Critical Habitat Designation**

Yelm Pocket Gopher Critical Habitat—Tenalquot Prairie Subunit. This subunit consists of 289 ac (117 ha) and contains lands owned by one commercial landowner and The Nature Conservancy. This subunit is located northwest of the city of Rainier, Thurston County, Washington. As proposed, subunit 1–E (now the Tenalquot Prairie Subunit) included 1,505 ac (609 ha) of JBLM land, which has been exempted based on a completed ESMP. This 4(a)(3)(B)(i) exemption, based on this speciesspecific management plan, has been determined to provide a conservation benefit to the Yelm pocket gopher. The Tenalquot Prairie Subunit is occupied by the Yelm pocket gopher and contains the physical or biological features essential to the conservation of the species due to the underlying soil series (Spanaway), suitable forb and grass vegetation present onsite, and its large size. The physical or biological features in this subunit are threatened by: Loss of habitat through conversion to incompatible uses, such as development; the loss of natural disturbance processes and invasion by woody plants; inadequacy of existing regulatory mechanisms; and control as a pest species.

Yelm Pocket Gopher Critical Habitat—Rock Prairie Subunit. This subunit consists of 243 ac (98 ha) and contains lands owned by one private residential and commercial landowner. As proposed (subunit 1–H), this subunit included 378 ac (153 ha) of private ranch land, which has been excluded under section 4(b)(2) of the Act (see Exclusions for details). The Rock Prairie Subunit is likely occupied by the Yelm pocket gopher and contains the physical or biological features essential to the conservation of the species due to the underlying soil series or soil series complex (Spanaway and SpanawayNisqually complex), suitable forb and grass vegetation present onsite, and its size. The physical or biological features in this subunit are threatened by: Loss of habitat through conversion to incompatible uses, such as development; the loss of natural disturbance processes and invasion by woody plants; predation; inadequacy of existing regulatory mechanisms; and control as a pest species. We additionally evaluated this area as if it were presently unoccupied by the Yelm pocket gopher, and have determined that it is nonetheless essential to the conservation of the species.

**Primary Constituent Elements/Physical or Biological Features**

Critical habitat for the Yelm pocket gopher is designated in Thurston County, Washington. Within these areas, the primary constituent elements of the physical or biological features essential to the conservation of the Yelm pocket gopher consist of two components:

(i) Friable, loamy, and deep soils, some with relatively greater content of sand, gravel, or silt, all generally on slopes less than 15 percent in the following soil series or soils series complex: (A) Alderwood; (B) Cagey; (C) Everett; (D) Godfrey; (E) Indianola; (F) Kapowsin; (G) McKenna; (H) Nisqually; (I) Norma; (J) Spanaway; (K) Spanaway-Nisqually complex; and (L) Yelm.

(ii) Areas equal to or larger than 50 ac (20 ha) in size that provide for breeding, foraging, and dispersal activities, found in the soil series listed in paragraph (2)(i) of this entry that have: (A) Less than 10 percent woody vegetation cover; (B) Vegetative cover suitable for foraging by gophers. Pocket gophers' diets include a wide variety of plant material, including leafy vegetation, succulent roots, shoots, tubers, and grasses. Forbs and grasses that Mazama pocket gophers are known to eat include, but are not limited to: Achillea millefolium (common yarrow), Agoseris spp. (agoseris), Cirsium spp. (thistle), Bromus spp. (brome), Camassia spp. (camas), Collomia linearis (tiny trumpet), Epilobium spp. (several willowherb spp.), Eriophyllum lanatum (woolly sunflower), Gayophytum diffusum (groundsmoke), Hypochaeris radicata (hairy cat's ear), Lathyrus spp. (peavine), Lupinus spp. (lupine), Microsteris gracilis (slender phlox), Penstemon spp. (penstemon), Perideridia gairdneri (Gairdner's yampah), Phacelia heterophylla (varileaf phacelia), Polygonum douglasii (knotweed), Potentilla spp. (cinquefoil), Pteridium aquilinum (bracken fern), Taraxacum officinale (common dandelion), Trifolium spp. (clover), and Viola spp. (violet); and (C) Few, if any, barriers to dispersal. Barriers to dispersal may include, but are not limited to, forest edges, roads (paved and unpaved), abrupt elevation changes, Scot's broom thickets, highly cultivated lawns, inhospitable soil types or substrates, development and buildings, slopes greater than 35 percent, and open water.

**Special Management Considerations or Protections**

Critical habitat does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas) and the land on which they are located existing within the legal boundaries on May 9, 2014.

The physical or biological features essential to the conservation of each subspecies may require special management considerations or protection to restore, protect, and maintain the essential features found there.

The physical or biological features essential to the conservation of the four Thurston/Pierce subspecies of the Mazama pocket gopher may require special management considerations or protection to control or prevent the establishment of invasive woody plants, which create shade and compete for light, food and nutrients otherwise utilized by the forb, bulb, and grass species that the gophers require for forage. Management may be implemented using hand tools or mechanical methods, prescribed fire, and the judicious use of herbicides. Although several management techniques are being implemented on public lands, we may need to improve our outreach to educate private landowners on controlling their pets and appropriately managing grazing on their properties, as well as to developing incentives for landowners who agree to conserve habitat. Incentives would create protected areas, through agreements or acquisitions. These would include corridors between existing protected habitat areas that may require management, enhancement actions, and long-term maintenance.

***Life History***

**Feeding Narrative**

Adult: Pocket gophers are generalist herbivores and their diet includes a wide variety of plant material, including leafy vegetation, succulent roots, shoots, and tubers. In natural settings pocket gophers play a key ecological role by aerating soils, activating the seed bank, and stimulating plant growth, though they can be considered pests in agricultural systems. In prairie and meadow ecosystems, pocket gopher activity plays an important role in maintaining species richness and diversity. Foraging primarily takes place below the surface of the soil, where pocket gophers snip off roots of plants before occasionally pulling the whole plant below ground to eat or store in caches. If above-ground foraging occurs, it's usually within a few feet of an opening and forage plants are quickly cut into small pieces and carried back to the nest or cache (Wight 1918, p. 12). Any water they need is obtained from their food (Gettinger 1984, pp. 749-750; Wight 1918, p. 13). The probability of pocket gopher occupancy is much higher in areas with less than 10 percent woody vegetation cover (Olson 2011a, p. 16), presumably because such vegetation will shade out the forbs, bulbs, and grasses that pocket gophers prefer to eat, and high densities of woody plants make travel both below and above the ground difficult (USFWS, 2016).

**Reproduction Narrative**

Adult: Pocket gophers reach sexual maturity during the spring of the year following their birth, and generally produce one litter per year (Case and Jasch 1994, p. B-20), though timing of sexual maturity has been shown to vary with habitat quality (Patton and Brylski 1987, p. 502; Patton and Smith 1990, p. 76). Gestation lasts approximately 18 days (Andersen 1978, p. 421; Schramm 1961, p. 169). Young are born in the spring to early summer (Wight 1918, p. 13), and are reared by the female. Aside from the breeding season, males and females remain segregated in their own tunnel systems. There are 1-9 pups per litter (averaging 5), born without hair, pockets, or teeth, and they must be kept warm by the mother or "packed" in dried vegetation (Case and Jasch 1994, p. B-20; Wight 1918, p. 14). Juvenile pelage starts growing in at just over a week (Andersen 1978, p. 420). The young eat vegetation in the nest within three weeks of birth, with eyes and ears opening and pockets developing at about a month (Andersen 1978, p. 420; Wight 1918, p. 14). At six weeks they are weaned, fighting with siblings, and nearly ready to disperse (Andersen 1978, p. 420; Wight 1918, p. 15), which usually occurs at about two months of age (Stinson 2005, p. 26). They attain their adult weight between four and five months of age (Andersen 1978, pp. 419, 421). Most pocket gophers live only a year or two, with few living to three or four years of age (Hansen 1962, pp. 152, 153; Livezey and Verts 1979, p. 39) (USFWS, 2016).

**Spatial Arrangements of the Population**

Adult: Clumped (USFWS, 2016)

**Habitat Narrative**

Adult: The Mazama pocket gopher (pocket gopher) is associated with glacial outwash prairies in western Washington, an ecosystem of conservation concern (Hartway and Steinberg 1997, p. 1), as well as alpine and subalpine meadows and other meadow-like openings at lower elevations. Steinberg and Heller (1997, p. 46) found that pocket gophers are even more patchily distributed than are prairies, as there are some seemingly high quality prairies within the species' range that lack pocket gophers; e.g., Mima Mounds Natural Area Preserve (NAP), and 13th Division Prairie on Joint Base Lewis-McChord (JBLM). Pocket gopher distribution is affected by the rock content of soils, drainage, forage availability, and climate (Case and Jasch 1994, p. B-21; Hafner et al. 1998, p. 279; Reichman 2007, pp. 273-274; Steinberg and Heller 1997, p. 45; Stinson 2005, p. 31; WDFW 2009). Prairie and meadow habitats used by pocket gophers have a naturally patchy distribution. In their prairie habitats, there is an even patchier distribution of soil rockiness which may further restrict the total area that pocket gophers can utilize (Steinberg and Heller 1997, p. 45; WDFW 2009). We assume that meadow soils have a similarly patchy distribution of rockiness, though the soil surveys to support this are, at this time, incomplete. In western Washington, pocket gophers currently occupy the following soils series: Alderwood, Cagey, Carstairs, Everett, Everett-Spanaway complex, Everett-Spanaway-Spana complex, Godfrey, Grove, Indianola, Kapowsin, McKenna, Murnen, Nisqually, Norma, Shelton, Spana, Spana-Spanaway-Nisqually complex, Spanaway, Spanaway-Nisqually complex, and Yelm. No soil survey information is currently available for occupied sites in the Olympic National Park, so the soils occupied there are unknown. We purposely avoid using specific map unit names, because we know that there are imperfections in soil mapping. Maps are based on the technology, standards, and tools available at the time soil surveys were conducted, sometimes up to 50 years ago. We recognize that soil survey boundaries may be adjusted in the future, and that soil series names may be added or removed to soil survey maps and databases. As a result, the overlap of pocket gopher locations with soil series names may be different in the future. The soils information presented here is based on best scientific data available at the time of listing. We also recognize that some of these soil series or soil series complexes are not typically either deep or well-drained. For a variety of reasons, mapped soil types may or may not have all of the characteristics described by the U.S. Department of Agriculture, Natural Resources Conservation Service, and the actual soils that occur on sites may have characteristics that make them more or less habitable by pocket gophers. These reasons may include: map boundary or transcription errors, map projection errors or differences, map identification or typing errors, soil or hydrological manipulations that have occurred since mapping took place, and small-scale inclusions that are different from the mapped soil. Because soils are mapped at large scales, mapped soils may not identify smaller inclusions. Any of the soil series or soil series complexes listed above could potentially be suitable for the four Thurston/Pierce subspecies of the Mazama pocket gopher. And, the four Thurston/Pierce subspecies of the Mazama pocket gopher may also inhabit soil series not included in the above list. Although some soils are sandier, more gravelly, or may have more or less silt than described, most all soils used by pocket gophers are friable (easily pulverized or crumbled), loamy, and deep, and generally have slopes less than 15 percent. There have been reports of pocket gophers (subspecies unknown) occurring on other types of soils, on managed forest lands in Capitol State Forest (owned by the Washington State Department of Natural Resources, WDNR) and Vail Forest (owned by Weyerhaeuser) in Thurston County. These were subsequently determined to be moles (Scapanus spp.), based on trapping conducted in these areas by the Washington State Department of Fish and Wildlife (WDFW) during 2012 (Thompson, pers. comm. 2012b). A study of the relationship between soil rockiness and pocket gopher distribution revealed a strong negative correlation between the proportion of medium-sized rocks in the soil, and the presence of pocket gophers (eight of nine prairies sampled); medium sized rocks were considered greater than 0.5 inch (12.7 mm), but less than 2 inches (50.8 mm) in diameter (Steinberg 1996, p. 32). In observations of pocket gopher distribution on JBLM, pocket gophers did not occur in areas with a high percentage of Scot's broom cover (Cytisus scoparius), or where mole populations were particularly dense (Steinberg 1995, p. 26). A more recent study on JBLM also found that pocket gopher presence was negatively associated with Scot's broom; however, the researcher found no relationship between pocket gopher presence and mole density (Olson 2011a, pp. 12, 13). Pocket gopher burrows consist of a series of main runways, off which lateral tunnels lead to the surface of the ground (Wight 1918, p. 7). Pocket gophers dig their burrows using their sharp teeth and claws and then push the soil out through the lateral tunnels (Case and Jasch 1994, p. B-20; Wight 1918, p. 8). Nests containing dried vegetation are generally located near the center of each pocket gopher's home tunnel system (Wight 1918, p. 10). Food caches and store piles are usually placed near the nest, and excrement is piled into blind tunnels or loop tunnels, and then covered with dirt, leaving the nest and main runways clean (Wight 1918, p. 11). (USFWS, 2016).

***Dispersal/Migration***

**Motility/Mobility**

Adult: High (USFWS, 2016)

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: Non-migratory (USFWS, 2016)

**Dispersal**

Adult: Low (USFWS, 2016)

**Immigration/Emigration**

Adult: Unlikely (USFWS, 2016)

**Dispersal/Migration Narrative**

Adult: Pocket gophers have limited dispersal capabilities (Williams and Baker 1976, p. 303). Mazama pocket gophers are smaller in size than other sympatric or peripatric Thomomys species (Verts and Carraway 2000, p. 1). Both dispersal distance and home range size are therefore likely to be smaller than for other Thomomys species. Dispersal distances may vary based on surface or soil conditions and size of the animal. For other, larger, Thomomys species, dispersal distances average about 131 feet (40 meters) (Barnes Jr. 1973, pp. 168, 169; Daly and Patton 1990, pp. 1286, 1288; Williams and Baker 1976, p. 306). Initial results from research being conducted on JBLM indicate that juvenile pocket gophers usually make movements from 13.1 to 32.8 feet (4-10 meters), though these may not be dispersal movements. One juvenile made a distinct dispersal movement of 525 feet (160 meters) in a single day (Olson 2012, p. 5).

Suitable dispersal habitat is free of barriers to movement, and may need to contain foraging habitat if an animal is required to make a long-distance dispersal movement. Potential barriers include, but are not limited to, forest edges, roads (paved and unpaved), abrupt elevation changes, Scot's broom thickets (Olson 2012, p. 3), highly cultivated lawns, inhospitable soil types or substrates (Olson 2008, p. 4), development and buildings, slopes greater than 35 percent, and open water. Barriers may be permeable, meaning that they impede movement from place to place without completely blocking it, or they may be impermeable, meaning they cannot be crossed. Permeable barriers, as well as lower quality dispersal habitats, may present a risk of mortality for animals that use them (e.g., open areas where predation risk is increased, or a paved area where vehicular mortality is high). The WDFW conducted a study to determine dispersal distances of juvenile pocket gophers on JBLM. Twenty-eight juveniles were radio-collared and tracked for 17 to 56 days, with all but three animals tracked for more than 30 days. Of these, only nine gophers moved more than 32.8 feet (10 meters), and 10 gophers were never found more than 13.1 feet (4 meters) from any previous location (Olson 2012, p. 5). Only one animal dispersed what would be considered a larger distance, moving 525 feet (160 meters) in a single day.

***Population Information and Trends***

**Population Trends:**

Decreasing (USFWS, 2016)

**Population Narrative:**

There are few data on historical or current population sizes of Mazama pocket gopher (pocket gopher) populations in Washington, although several local populations and one subspecies are believed to be extinct. Knowledge of the past status of the pocket gopher is limited to distributional information. Recent surveys have focused on determining current distribution, primarily in response to development applications. In addition, in 2012, WDFW initiated a five county-wide distribution survey. Because the object of all of these surveys has mainly been presence/absence only, total population numbers for each subspecies are unknown. And, the precise boundaries of each subspecies' range are not currently known. Local population estimates have been reported but are based on using apparent gopher mounds to delineate the number of territories, a method that has not been validated (Stinson 2005, pp. 40, 41). Olson (2011a, p. 2) evaluated this methodology on pocket gopher populations at the Olympia Airport and Wolf Haven International. Although there was a positive relationship between the number of mounds and number of pocket gophers, the relationship varies spatially, temporally, and demographically (Olson 2011a, pp. 2, 39). Based on the results of Olson's 2011 study, we believe past population estimates (Stinson 2005) may have been too high. As there is no generally accepted standard survey protocol to determine population size for pocket gophers, it is not currently possible to obtain an estimate of subspecies population sizes or trends. Overall habitat availability has declined, however, and habitat has a finite ability to support pocket gophers. For these reasons, the Service concludes that the overall population trend of each of the four Thurston/Pierce subspecies of the Mazama pocket gopher is negative. Increased survey effort since 2007 has resulted in the identification of numerous additional occupied sites located on private lands, especially in Thurston County (WDFW 2013a). Some of these new detections are adjacent to other known occupied sites, such as the population at the Olympia Airport. The full extent of these smaller discontiguous sites is currently unknown, and no research has been done to determine whether or not these aggregations are "stepping stone" sites that may facilitate dispersal into nearby unoccupied suitable habitat, or if they are population sinks (sites that do not add to the overall population through recruitment). Others of these additional occupied sites are separate locations, seemingly unassociated (physically) with known populations (Tirhi, in litt. 2008). The largest known expanse of areas occupied by any subspecies in Washington occur on JBLM (Roy Prairie and Yelm pocket gophers), and at the Olympia and Shelton airports (Olympia and Shelton pocket gophers, respectively). A translocated population occurs on Wolf Haven International's land near Tenino, Washington. Between 2005 and 2008, over 200 gophers from a variety of areas in Thurston County (some from around Olympia Airport (Olympia pocket gopher, T. m. pugetensis)) and some from near the intersection of Rich Road and Yelm Highway (assumed to be Olympia pocket gophers) were released into the 38 acres (15 ha) mounded prairie site. Based on the best available information, we do not believe the property previously supported pocket gophers. Today pocket gophers continue to occupy the site (Tirhi, in litt. 2011); however, current population estimates are not available. Another site, West Rocky Prairie Wildlife Area, has received a total of 560 translocated pocket gophers (T. m. pugetensis) from the Olympia Airport between 2009 and 2011. Initial translocation efforts were unsuccessful; a majority of the pocket gophers died within three days due to predation (Olson 2009, p. 3). Modified release techniques used in 2010 and 2011 resulted in improved survival rates (Olson 2011b, p. 4). It is too soon to know if the population will become self-sustaining, or if additional translocations of gophers will be necessary.

***Threats and Stressors***

**Stressor:** Destruction, Modification, or Curtailment of Habitat and Range (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** The primary long term threats to the pocket gopher are the loss, conversion, and degradation of habitat, particularly to urban development, successional changes to grassland habitat, and the spread of invasive plants. The threats also include increased predation pressure, which is closely linked to habitat degradation. The prairies of south Puget Sound are one of the rarest ecosystems in the United States (Dunn and Ewing 1997b, p. v; Noss et al. 1995, p. I-2). Dramatic changes have occurred on the landscape over the last 150 years, including a 90 to 95 percent reduction in the extent of the prairie ecosystem. In the south Puget Sound region, where most of western Washington's prairies historically occurred, less than 10 percent of the original prairie persists, and only three percent remains dominated by native vegetation (Crawford and Hall 1997, pp. 13, 14). Development: Native prairies and grasslands have been severely reduced throughout the range of the four Thurston/Pierce subspecies of Mazama pocket gopher, especially as a result of conversion to residential and commercial development and agriculture. Prairie habitat continues to be lost, particularly to residential development (Stinson 2005, p. 70), by removal and fragmentation of native vegetation, and the excavation, and/or heavy equipment-caused compaction of surfaces and conversion to non-habitat (e.g., buildings, pavement, other infrastructure), rendering soils unsuitable for burrowing. Residential development is associated with increased infrastructure, such as new road construction, which is one of the primary causes of landscape fragmentation (Watts et al. 2007, p. 736). Activities that accompany low-density development are correlated with decreased levels of biodiversity, mortality to wildlife, and facilitated introduction of nonnative invasive species (Trombulak and Frissell 2001; Watts et al. 2007, p. 736). In the south Puget Sound lowlands, the glacial outwash soils and gravels underlying the prairies are deep and valued for use in construction and road

building, which leads to their degradation and destruction. In the south Puget Sound, Nisqually loamy soils appear to support high densities of pocket gophers (Stinson, in litt. 2010a Olson 2008, p. 6), the vast majority of which occur in developed areas of Thurston County, or within the Urban Growth Areas for the cities of Olympia, Tumwater, and Lacey (WDFW 2009), where future development is most likely to occur. Where pocket gopher populations presumably extended across an undeveloped expanse of open prairie (Dalquest and Scheffer 1942, pp. 95, 96), areas currently occupied by the four Thurston/Pierce subspecies of the Mazama pocket gopher are now isolated to small fragmented patches due to development and conversion of suitable habitat to incompatible uses. The presumed extinction of the Tacoma pocket gopher is likely linked directly to residential and commercial development, which has replaced nearly all pocket gopher habitats in the historical range of the subspecies (Stinson 2005, pp. 18, 34, 46). One of the historical Tacoma pocket gopher sites was converted to a large gravel pit and golf course (Steinberg 1996, pp. 24, 27; Stinson 2005, pp. 47, 120). In addition, two gravel pits are now operating on part of the site recognized as the type locality for the Roy Prairie pocket gopher (Stinson 2005, p. 42), and another is in operation near Tenino (Stinson, in litt. 2010b) in the vicinity of the type locality for the Tenino pocket gopher. Multiple pocket gopher sites in Pierce and Thurston Counties may be, or have been, lost to gravel pit development, golf course development, or residential and commercial development (Stinson, in litt. 2005; Stinson 2005, pp. 26, 42; Stinson, in litt. 2010b). Multiple prairies that used to contain uninterrupted expanses of prairie habitat suitable for pocket gophers within the range of the four Thurston/Pierce subspecies have been developed to cities, neighborhoods, agricultural lands, or military bases, and/or negatively impacted by such development, including Baker Prairie, Bush Prairie, Chambers Prairie, Frost Prairie, Grand Mound Prairie, Little Chambers Prairie, Marion Prairie, Roy Prairie, Ruth Prairie, Woods Prairie, Violet Prairie, and Yelm Prairie. Some of these prairie areas still contain smaller areas that support pocket gophers, and some appear to no longer support pocket gophers at all (WDFW 2012). Where their properties coincide with pocket gopher occupancy, many private lands developers and landowners in Thurston County have agreed to create set-asides or agree to other mitigation activities in order to obtain development permits from the County (Tirhi, in litt. 2008). However, it is unknown if any pocket gophers will remain on these sites due to the small size of the set-asides, extensive grading in some areas adjacent to set-asides, lack of dedicated funding for enforcement or monitoring of set-aside maintenance (Thurston County Long Range Planning and Resource Stewardship, in litt. 2011, p. 2), and lack of control of predation by domestic or feral cats and dogs. In addition, some landowners have received variances from Thurston County that allowed development to occur without a requirement to set aside areas for pocket gophers. A population of Olympia pocket gophers is located at and around the Port of Olympia's Olympia Airport, which is sited on the historical Bush Prairie. Gophers on Bush Prairie are currently vulnerable to negative impacts from proposed future development by the Port of Olympia and ongoing development by adjacent landowners. The Port of Olympia has plans to develop large portions of the existing grassland that likely supports the largest population of the Olympia pocket gopher in Washington (Stinson 2007, in litt.; Port of Olympia and WDFW 2008, p.1; Port of Olympia 2012). The Olympia Airport is realigning the airport runway, which is in known occupied habitat. They continue to work with the Service and WDFW on mitigating airport expansion activities that may negatively impact gophers (Tirhi, in litt. 2010). The Olympia pocket gopher has a population at the Olympia Airport that spans several hundred acres, and there are two translocated populations: one at West Rocky Prairie Wildlife Area (some individuals from the Olympia Airport) and one at Wolf Haven (individuals from the Olympia Airport and some from near the intersection of Rich Road and Yelm Highway). The population centered on the Olympia Airport could be negatively impacted by plans for development both on and off the airport, while the two translocated populations are currently secure from intense commercial and residential development pressures as they occur on conserved lands. The Roy Prairie pocket gopher is known to occur across a large expanse of prairie on JBLM, which is currently secure from the threat of development. The Tenino pocket gopher has a single known population, which has been detected during surveys on the Rocky Prairie NAP, although the intermittent nature of these detections suggests it must be part of a larger metapopulation that occurs across nearby areas that have not been accessible for surveys. No known development poses a threat to the NAP, but any future conversion of the surrounding area to incompatible land use would likely hinder the recovery of this subspecies. The Yelm pocket gophers on Tenalquot prairie (which is owned in large part by JBLM) and Scatter Creek Wildlife Area are also secure from such residential and commercial development, but the Yelm pocket gopher habitat on Rock Prairie north of Old Highway 99 is in an area that is likely to be developed soon, which may negatively affect any local populations in the vicinity. Loss or Curtailment of Natural Disturbance Processes: The suppression and loss of ecological disturbance regimes across vast portions of the landscape, such as fire, has resulted in altered vegetation structure in the prairies and meadows and has facilitated invasion by native and nonnative woody vegetation, rendering habitat unusable for the four Thurston/Pierce subspecies of Mazama pocket gopher. The basic ecological processes that maintain prairies and meadows have disappeared from, or have been altered on, all but a few protected and managed sites. Historically, the prairies and meadows of the south Puget Sound region are thought to have been actively maintained by native peoples, who lived here for at least 10,000 years before the arrival of Euro-American settlers (Boyd 1986; Christy and Alverson 2011, p. 93). Frequent burning reduced the encroachment and spread of shrubs and trees (Boyd 1986; Chappell and Kagan 2001, p. 42), favoring open grasslands with a variety of native plants and animals. Following Euro-American settlement of the region in the mid-19th century, fire was actively suppressed on grasslands, allowing encroachment by woody vegetation into the remaining prairie habitat and oak woodlands (Agee 1993, p. 360; Altman et al. 2001, p. 262; Boyd 1986; Franklin and Dyrness 1973, p. 122; Kruckeberg 1991, p. 287)Fires on the prairie create a mosaic of vegetation conditions, which serve to maintain native prairie plant communities. In some prairie patches fires will kill encroaching woody vegetation and reset succession back to bare ground, creating early successional vegetation conditions suitable for many native prairie species. Early succession forbs and grasses are favored by pocket gophers. The historical fire frequency on prairies has been estimated to be 3 to 5 years (Foster 2005, p. 8). On sites where regular fires occur, there is a high complement of native plants and fewer invasive species. These types of fires maintain the native short-statured plant communities favored by pocket gophers. The result of fire suppression has been the invasion of the prairies and oak woodlands by native and nonnative plant species (Dunn and Ewing 1997a, p. v; Tveten and Fonda 1999, p. 146), notably woody plants such as the native Douglas-fir (Pseudotsuga menziesii) and the nonnative Scot’s broom. On tallgrass prairies in midwestern North America, fire suppression has led to degradation and the loss of native grasslands (Curtis 1959, pp. 296, 298; Panzer 2002, p. 1297). On northwestern prairies, fire suppression has allowed Douglas-fir to encroach on and outcompete native prairie vegetation for light, water, and nutrients (Stinson 2005, p. 7). This increase in woody vegetation and nonnative plant species has resulted in less available prairie habitat overall and habitat that is unsuitable for and avoided by many native prairie species, including pocket gophers (Olson 2011a, pp. 12, 16; Pearson et al. 2005, pp. 2, 27; Tveten and Fonda 1999, p. 155). Pocket gophers prefer early successional vegetation as forage. Woody plants shade out the forbs and grasses that pocket gophers prefer to eat, and high densities of woody plants make travel both below and above the ground difficult. In locations with poor forage, pocket gophers tend to have larger territories, which may be difficult or impossible to establish in densely forested areas. The probability of pocket gopher occupancy is much higher in areas with less than 10 percent woody vegetation cover (Olson 2011a, p. 16). On JBLM alone, over 16,000 acres (6,477 ha) of prairie has converted to Douglas-fir forest since the mid-19th century (Foster and Shaff 2003, p. 284). Where controlled burns or direct tree removal are not used as a management tool, this encroachment will continue to cause the loss of open grassland habitats for pocket gophers and is an ongoing threat to the species. Restoration in some of the south Puget Sound grasslands has resulted in temporary control of Scot's broom and other invasive plants through the careful and judicious use of herbicides, mowing, grazing, and fire. Fire has been used as a management tool to maintain native prairie composition and structure and is generally acknowledged to improve the health and composition of grassland habitat by providing a short-term nitrogen addition, which results in a fertilizer effect to vegetation, thus aiding grasses and forbs to sprout. Unintentional fires ignited by military training burn patches of prairie grasses and forbs on JBLM on an annual basis. These light ground fires create a mosaic of conditions within the grassland, maintaining a low vegetative structure of native and nonnative plant composition, and patches of bare soil. Because of the topography of the landscape, fires create a patchy mosaic of areas that burn completely, some areas that do not burn, and areas where consumption of the vegetation is mixed in its effects to the habitat. One of the benefits of fire in grasslands is that it tends to kill regenerating conifers, and reduces the cover of nonnative shrubs such as Scot's broom, although Scot's broom seed stored in the soil can be stimulated by fire (Agee 1993, p. 367). Fire also improves conditions for many native bulb-forming plants, such as Camassia spp. (Agee and Dunwiddie 1984). On sites where regular fires occur, such as on JBLM, there is a high complement of native plants and fewer invasive species. These types of fires maintain the native, short-statured plant communities favored by pocket gophers. Management practices such as intentional burning and mowing require expertise in timing and technique to achieve desired results. If applied at the wrong season, frequency, or scale, fire and mowing can be detrimental to the restoration of native prairie species. Excessive and high-intensity burning can result in a lack of vegetation or encourage regrowth of nonnative grasses. Where such burning has occurred over a period of more than 50 years on the artillery ranges of JBLM, prairies are covered by nonnative forbs and grasses instead of native perennial bunchgrasses (Tveten and Fonda 1999, pp. 154, 155). Pocket gophers are not commonly found in areas colonized by Douglas-fir trees because pocket gophers require forbs and grasses of an early successional stage for food (Witmer et al. 1996a, p. 96). Pocket gophers observed on JBLM did not occur in areas with high cover of Scot's broom (Steinberg 1995, p. 26). A more recent study on JBLM also found that pocket gopher presence was negatively associated with Scot's broom (Olson 2011a, pp. 12, 13, 16). Some subspecies may disperse through forested areas or may temporarily establish territories on forest edges, but there is currently not enough data available to determine how common this behavior may be or which subspecies employ it. The four Thurston/Pierce subspecies of the Mazama pocket gopher occur on prairie-type habitats, many of which, if not actively managed to maintain vegetation in an early-successional state, have been invaded by shrubs and trees that either preclude pocket gophers or limit their ability to fully occupy the landscape. Typical management at civilian airports prevents woody vegetation from encroaching onto surrounding areas for flight safety reasons. Woody vegetation encroachment is therefore not a threat at civilian airports. Military Training: Pocket gopher populations occurring on JBLM are exposed to differing levels of training activities on the base. The Department of Defense's (DOD) proposed actions under their "Grow the Army" initiative include stationing 5,700 new soldiers, new combat service support units, a combat aviation brigade, facility demolition and construction to support the increased troop levels, and additional aviation, maneuver, and live fire training (75 FR 55313, September 10, 2010). The increased training activities will affect nearly all training areas at JBLM, resulting in an increased risk of accidental fires, and habitat destruction and degradation attributable to vehicle use in occupied areas, mounted and dismounted training, bivouac activities, and digging. Even though the training areas on the base are degraded, with implementation of agreed-upon conservation measures, these areas still provide habitat for the Roy Prairie and Yelm pocket gopher. JBLM's recently signed Endangered Species Management Plan (ESMP) for the Mazama pocket gopher will serve to minimize threats across the base by redirecting some training activities to areas outside of occupied habitat, designating areas where no vehicles are permitted, designating areas where vehicles will remain on roads only, and designating areas where no digging is allowed, among other conservation measures. JBLM has further committed to enhancing and expanding suitable habitat for the Roy Prairie and Yelm pocket gophers in "priority habitat" areas on base (areas that were proposed as critical habitat); enforcing restrictions on recreational use of occupied habitat by dog owners and horseback riders; and continuing to support the off-base recovery of the four Thurston/Pierce subspecies of the Mazama pocket gopher. Several moderate- to large-sized areas supporting pocket gophers have been identified on JBLM. These areas are within the historical ranges of the Roy Prairie (Pierce County) and Yelm (Thurston County) pocket gophers. Their absence from some sites of what is presumed to have been formerly suitable habitat may be related to compaction of the soil due to years of mechanized vehicle training (Steinberg 1995, p. 36). Training infrastructure (e.g., roads, firing ranges, bunkers) also degrades pocket gopher habitat and may lead to reduced use of these areas by pocket gophers. For example, JBLM has plans to add a third rifle range on the south impact area where it overlaps with a densely occupied pocket gopher site. The area may be usable by pocket gophers when the project is completed; however, construction of the rifle range may result in removal of forage and direct mortality of pocket gophers through crushing of burrows (Stinson, in litt. 2011). Recent survey access to the center of the artillery impact area on 91st Division Prairie, where bombardment is presumably of the highest intensity, did detect some unspecified level of occupancy by the Roy Prairie pocket gopher (WDFW 2013b, enclosure 1, p. 6). This apparently suitable central portion of the 91st Division Prairie is subject to repeated and ongoing bombardment, which may create an ecological trap for dispersing juveniles. JBLM training areas have varying levels of use; some allow excavation and off-road vehicle use, while other areas have restrictions that limit off-road vehicle use. The ESMP specifically requires coordination between the JBLM Fish and Wildlife personnel and the JBLM entities responsible for training activities (e.g., Range Support, battalion commanders, and/or first field grade officers) to ensure all parties are aware of where occupied areas occur in relation to training activities, the effects of training, and the potential ramifications of habitat destruction or animal mortality. Since military training has the potential to directly or indirectly harm or harass pocket gophers, we conclude that these activities will negatively impact the Roy Prairie and Yelm pocket gophers. JBLM has committed to operational restrictions on portions of the base in order to avoid and minimize potential impacts to Roy Prairie and Yelm pocket gophers. Currently-occupied areas will be buffered from training activities, with an emphasis on occupied habitat in "priority habitat" areas. Regular surveys will be conducted with the goals of determining distribution, protecting pocket gophers and their habitat from disturbance or destruction, and determining population status. Where possible, JBLM will alleviate training pressure by transferring activities to unoccupied areas where encroaching forest has been removed. This strategy has the effect of both releasing large areas of land that were historically prairie and providing unoccupied areas where training is free of the risk of negatively impacting Roy Prairie or Yelm pocket gophers. While the Service fully supports the implementation of these impact minimization efforts and will continue to collaborate with DOD to address all aspects of training impacts on the species, not all adverse impacts on pocket gophers can be fully avoided. Military training continues to pose a threat to the Roy Prairie and Yelm subspecies at this time. No military training occurs in the ranges of the Olympia or Tenino subspecies of the Mazama pocket gopher (USFWS, 2016).

**Stressor:** Poor Connectivity Between Small and Isolated Populations (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Isolated genetics
**Narrative:** Most species' populations fluctuate naturally, responding to various factors such as weather events, disease, and predation. Populations that are small, fragmented, or isolated by habitat loss or modification of naturally patchy habitat, and other human-related factors, are more vulnerable to extirpation by natural randomly occurring events, cumulative effects, and to genetic effect (collectively known as small population effects). These effects can include genetic drift (loss of recessive alleles), founder effects (over time, an increasing percentage of the population inheriting a narrow range of traits), and genetic bottlenecks leading to increasingly lower genetic diversity, with consequent negative effects on evolutionary potential. To date, of the eight subspecies of Mazama pocket gopher in Washington, only the Olympic pocket gopher has been documented as having low genetic diversity (Welch and Kenagy 2008, p. 7), although the six other extant subspecies have local populations that are small, fragmented, and physically isolated from one another. The four Thurston/Pierce subspecies of the Mazama pocket gopher face threats from loss or fragmentation of habitat. Historically, pocket gophers probably persisted by continually recolonizing habitat patches after local extinctions. However, widespread development and conversion of habitat has resulted in widely separated populations, and intervening habitat corridors are now gone, with the effect of impeding or stopping much of the natural recolonization that historically occurred (Stinson 2005, p. 46). Although pocket gophers are not known to have low genetic diversity, small population sizes at most sites, coupled with disjunct and fragmented habitat, may contribute to further population declines. Little is known about the local or rangewide reproductive success of pocket gophers found in Washington State (USFWS, 2016).

**Stressor:** Predation and Pest Control (USFWS, 2016)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Predation: Predation influences the distribution, abundance, and diversity of species in ecological communities. Generally, predation leads to changes in both the population size of the predator and that of the prey. In unfavorable environments, prey species are stressed or living at low population densities such that predation is likely to have negative effects on all prey species, thus lowering species richness. In addition, when a nonnative predator is introduced to the ecosystem, negative effects on the prey population may be higher than those from co-evolved native predators. The effect of predation may be magnified when populations are small, and the disproportionate effect of predation on declining populations has been shown to drive rare species even further towards extinction (Woodworth 1999, pp. 74, 75). Predation has an impact on populations of the four Thurston/Pierce subspecies of Mazama pocket gopher. Urbanization, particularly in the south Puget Sound region, has resulted in not only habitat loss, but also increased exposure to feral and domestic cats and dogs. Domestic cats are known to have serious impacts on small mammals and birds and have been implicated in the decline of

several endangered and threatened mammals, including marsh rabbits (Sylvilagus palustris) in Florida and the salt-marsh harvest mouse (Reithrodontomys raviventris) in California (Ogan and Jurek 1997, p. 89). Domestic cats and dogs have been specifically identified as common predators of pocket gophers (Case and Jasch 1994, p. B-21; Henderson 1981, p. 233; Wight 1918, p. 21) and at least two pocket gopher locations were found as a result of house cats bringing home pocket gopher carcasses (WDFW 2001). Informal interviews with area biologists document multiple incidents of domestic pet predation on pocket gophers (Chan, in litt. 2013; Clouse, in litt. 2012 Skriletz 2013 in litt., Wood 2013 in litt.). There is also one recorded instance of a WDFW biologist being presented with a dead Mazama pocket gopher by a dog during an east Olympia, Washington, site visit in 2006 (Burke Museum 2012 McAllister 2013 in litt.). Some local populations of the pocket gopher occur in areas where people recreate with their dogs, bringing these potential predators into environments that may otherwise be relatively free of them, consequently increasing the risks to individual pocket gophers and populations that may be small and isolated The four Thurston/Pierce subspecies of Mazama pocket gopher occur in rapidly developing areas. Local populations that survive commercial and residential development (adjacent to and within habitat) are potentially vulnerable to extirpation by domestic and feral cats and dogs (Case and Jasch 1994, p. B-21; Henderson 1981, p. 233). As stated previously, predation is a natural part of the pocket gopher's life history; however, the effect of predation may be magnified when populations are small and habitat is fragmented. The disproportionate effect of additional predation on declining populations has been shown to drive rare species even further towards extinction (Woodworth 1999, pp. 74, 75). Predation, particularly from nonnative species, will likely continue to be a threat to the four Thurston/Pierce subspecies of the Mazama pocket gopher now and in the future. This is particularly likely where development abuts gopher habitat, resulting in increased numbers of cats and dogs in the vicinity, and in areas where people recreate with their dogs – particularly if dogs are off-leash and not prevented from harassing wildlife. In such areas, where local populations of pocket gophers are already small, this additional predation pressure (above natural levels of predation) is expected to further negatively impact population numbers. Pest Control: Pocket gophers are often considered a pest because they sometimes damage crops and seedling trees, and their mounds can create a nuisance. Several site locations were found as a result of trapping conducted on Christmas tree farms, a nursery, and in a livestock pasture (WDFW 2001). The type locality for the Cathlamet pocket gopher is on a commercial tree farm. Pocket gophers from Thurston County were used in a rodenticide experiment as recently as 1995 (Witmer et al. 1996a, p. 97). In Washington State it is currently illegal to trap or poison Mazama pocket gophers, or to trap or poison moles where they overlap with Mazama pocket gopher populations, but not all property owners are cognizant of these laws, nor are most citizens capable of differentiating between moles, pocket gophers, or the signs of their habitation (e.g., soil disturbance). In light of this, it is reasonable to believe that mole trapping or poisoning still has the potential to adversely affect pocket gopher populations. Local populations that survive commercial and residential development (adjacent to and within habitat) may be subsequently extirpated by trapping or poisoning. Lethal control by trapping or poisoning is most likely to be a threat to the four Thurston/Pierce subspecies where their ranges overlap residential properties (USFWS, 2016).

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 6C

**Delisting Criteria:**
Common Criterion 1: Reserve Establishment. Multiple discrete Reserves (Reserve Cores, Reserve Complexes, or both) are established for each of the four MPG subspecies (see subspecies-specific criteria below for Reserve numbers and distribution (USFWS, 2022b)

Common Criterion 2: Demographic Viability. Each Reserve supports a self-sustaining population with a minimum of 1,000 individuals of the target subspecies. A minimum of 5 years of monitoring utilizing Service-approved protocols across a 10-year period have been conducted and demonstrate the self-sustaining nature of local MPG populations on each Reserve (USFWS, 2022b).

Common Criterion 3: Habitat Area. Each Reserve Core provides approximately 250 to 500 acres (about 100 to 200 ha), or more, of medium- and high-quality habitat (see Appendix A for a description of medium- and high-quality habitat). Each Reserve Complex provides a comparable amount of medium- and high-quality habitat (i.e., approximately 250 to 500 acres (100 to 200 ha), located on functionally connected Reserve Satellites. Each Reserve Satellite contains at least 10 acres (approximately 4 ha) of contiguous medium- or high-quality habitat (USFWS, 2022b).

YPG Criterion 1 There are a total minimum of seven (7) Reserves (as defined and described in Common Criterion 1) across the range of the subspecies. Each of the three RUs for YPG has its own requirements under this criterion: YPG Criterion 1a - YPG-North Recovery Unit: There are a minimum of two (2) Reserves in the YPG-North RU. YPG Criterion 1b - YPG-East Recovery Unit: There are a minimum of two (2) Reserves in the YPG-East RU, with at least one on Johnson/Weir/Tenalquot Prairie and at least one on Yelm Prairie. YPG Criterion 1c - YPG-South Recovery Unit: There are a minimum of three (3) Reserves in the YPG-South RU, with at least one on each side of I-5 and one representing Frost Prairie (USFWS, 2022b).

**Recovery Actions:**
- 1. Protect, conserve, and enhance MPG habitat. (Priority 1a) • Identify and prioritize creation and protection of Reserves. • Purchase occupied and highly suitable lands in Reserve areas. • Implement other short- and long-term strategies to protect Reserves and other important MPG sites from development pressure (e.g., mitigation lands, interim permitting strategy, in lieu fee, programmatic HCPs; municipal HCPs). • Develop and cooperatively implement programs for the protection and conservation of MPGs, south Puget Sound prairies, oak savanna, and other prairie-dependent species. This can include, but is not limited to, grant funding, habitat acquisition, habitat restoration, regulatory reform programs and policies, management plans, zoning, mitigation, research, and monitoring for each subspecies. • Implement conservation programs to avoid, minimize, or offset effects of RPPG and YPG habitat impacts resulting from military training. • Monitor implementation of habitat protection activities for MPG conservation (e.g., set-asides, mitigation banks). • 2. Identify MPG limiting factors and sources of mortality or harm and implement best management practices to minimize impacts. (Priority 1b) Assessment of ecologically important limiting factors and evaluating the success of management measures that have been implemented is necessary for effective adaptive management. To minimize adverse effects of threats, best management practices should be implemented by all partners. • Evaluate the effects of vegetation management on MPGs and their habitat. • Determine if and how translocated populations within the range of TPG are affecting demographic and genetic characteristics of this subspecies; develop solutions if needed. •

Identify landscape features that influence MPG dispersal and distribution. • Evaluate impacts of other anthropogenic stressors affecting MPGs (e.g., cats, dogs, recreational uses, etc.). • Evaluate natural factors affecting population health and distribution within and between sites. • Conduct demographic and genetic studies. • Revise population viability analysis every 10 years, or when new genetic or demographic information becomes available. • Implement measures to avoid, minimize, or mitigate impacts to individual RPPGs or YPGs as a result of military training. These include the activities described in the JBLM INRMP and the ESMC for MPGs; and the activities, reasonable and prudent measures, and terms and conditions included in the biological opinion(s) addressing training and related activities at JBLM. • Develop and implement best management practices to avoid and minimize effects of activities in occupied MPG habitat, including: use of mechanical equipment, particularly heavy equipment operations; implementation and use of restoration tools and techniques (including use of prescribed fire); management of predation by domestic and feral dogs and cats; and minimizing incidental or intentional MPG mortality resulting from control of fossorial animals (such as moles) as pest species (i.e., by poisoning and trapping). 3. To achieve Reserve targets for each subspecies, evaluate the need to either create new local populations or increase the number of individuals in existing local populations within each Recovery Area or Recovery Unit. If needed, create new local populations or increase current (2020) local population sizes through habitat creation and population augmentation. Monitor Reserves/Reserve Complexes as needed to determine status and trend of populations prior to final monitoring requirements in Common Criterion 2. (Priority 2) • Evaluate the range-wide need to increase the number of populations. • Monitor local populations in individual Reserves as needed to determine status and trend prior to final monitoring requirements in Common Criterion 2. • Evaluate the range-wide need to augment existing populations. • If needed, evaluate and modify methods of captive breeding, handling, transport, and translocation. • If needed, develop and test best practices for habitat expansion. • If needed, evaluate sites for suitability and prioritize for habitat expansion. • If translocation or habitat expansion is justified, evaluate legal aspects and complete compliance analysis and documentation (permitting, National Environmental Policy Act, etc.) • If needed and appropriate, establish additional populations within unoccupied areas of the historical range. • If needed and appropriate, implement and monitor habitat expansion through vegetation manipulation (tree and shrub removal, mowing, restoration, etc.). 4. Strengthen outreach and cooperation with stakeholders and partner agencies. (Priority 2) Coordination with landowners, management agencies, and interested members of the public is necessary to effectively implement necessary recovery actions across a broad range of land ownership. • Facilitate coordination and information sharing. • Implement outreach and education. 5. Monitor Reserves to determine local population status and trend, sufficient to determine if population goals required in Common Criterion 2 have been met. (Priority 3) Population survey and monitoring with consistent and repeatable methodology is necessary to assess whether Reserves have met population targets in Common Criterion 2 and to provide baseline information for development of a post-delisting monitoring plan. • Verify existing comprehensive survey/monitoring scheme (Olson 2017). Implement survey/monitoring scheme at each Reserve to determine if local population goals required in Common Criteria 2 have been met. (USFWS, 2021)

- Yelm pocket gopher 1. Protect, conserve, and enhance OPG habitat. $86,074,000 Priority 1a 2. Identify MPG limiting factors and sources of mortality or harm and implement best management practices to minimize impacts. $1,240,000 Priority 1b 3. To achieve Reserve targets for each subspecies, evaluate the need to either create new local populations or increase the number of individuals in existing local populations in the RPPG Recovery Area (Costs for this TBD). Monitor Reserves as needed to determine status and trend of populations prior to final monitoring requirements in Common Criterion 2. $9,289,000 Priority 2 4. Strengthen outreach and cooperation with stakeholders and partner agencies. $1,384,000 Priority 2 5. Monitor population status, trend, and distribution, sufficient to determine if population goals required in Common Criterion 2 have been met. $3,059,000 Priority 3 (USFWS, 2021)

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: Future research and management recommendations include: (1) Protect, conserve, and enhance Mazama pocket gopher habitat within the range of each subspecies through habitat acquisition, habitat easement, habitat conservation plans, habitat restoration, and other conservation tools. (2) Conduct research to identify limiting factors and sources of mortality or harm for Mazama pocket gophers and implement best management practices to minimize impacts across the range of each subspecies. (3) If needed, create new local populations or increase population sizes on conserved lands. Monitor each subspecies' population to determine status and trend. (4) Strengthen outreach and cooperation with stakeholders and partner agencies. (USFWS, 2020)

**References**

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USFWS 2016. Status of the Species: (Thomonys mazama ssp.) Mazama Pocket Gopher. U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

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USFWS. 2021. Draft Recovery Plan for Four Subspecies of Mazama Pocket Gopher. Draft Recovery Plan for Four Subspecies of Mazama Pocket Gopher Roy Prairie pocket gopher (Thomomys mazama glacialis) Olympia pocket gopher (Thomomys mazama pugetensis) Tenino pocket gopher (Thomomys mazama tumuli) Yelm pocket gopher (Thomomys mazama yelmensis). 29 pp + Attachments.

USFWS. 2022b. Recovery plan for four subspecies of Mazama pocket gopher. Portland, Oregon. xi +33 pp.+ appendices.

USFWS 2020. 5-YEAR REVIEW Mazama Pocket Gophers: Olympia, Roy Prairie, Tenino, and Yelm pocket gophers (Thomomys mazama pugetensis, T. m. glacialis, T. m. tumuli, and T. m. yelmensis). 9 pp.

# SPECIES ACCOUNT: *Trichechus manatus* (West Indian Manatee)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 04/05/2017 Southeast Region (R4) (82 FR 16668).

**Physical Description**

West Indian manatees are massive fusiform-shaped animals with skin that is uniformly dark grey, wrinkled, sparsely haired, and rubber-like. Manatees possess paddle-like forelimbs, no hind limbs, and a spatulate, horizontally flattened tail. Females have two axillary mammae, one at the posterior base of each forelimb (Fig. 2). Their bones are massive and heavy with no marrow cavities in the ribs or long bones of the forearms (Odell 1982). Adults average about 3.0 m (9.8 ft) in length and 1,000 kg (2,200 lbs) in weight, but may reach lengths of up to 4.6 m (15 ft) (Gunter 1941) and weigh as much as 1,620 kg (3,570 lbs) (Rathbun et al. 1990). Newborns average 1.2 to 1.4 m (4 to 4.5 ft) in length and about 30 kg (66 lbs) (Odell 1981). The nostrils, located on the upper snout, open and close by means of muscular valves as the animals surface and dive (Husar 1977; Hartman 1979). A muscular flexible upper lip is used with the forelimbs to manipulate food into the mouth (Odell 1982). Bristles are located on the upper and lower lip pads. Molars designed to crush vegetation form continuously at the back of the jaw and move forward as older ones wear down (Domning and Hayek 1986). The eyes are very small, close with sphincter action, and are equipped with inner membranes that can be drawn across the eyeball for protection. Externally, the ears are minute with no pinnae (USFWS, 2001).

**Taxonomy**

Domning and Hayek (1986) identified separate subspecies of the West Indian manatee in Florida (Trichechus manatus latirostris) and the Caribbean (Trichechus manatus manatus), based on cranial measurements. The distinctive morphological features are generally thought to be the result of and reflective of population isolation, where certain anatomical features are favored by adaptation. These subspecies will continue to be recognized and used unless future analyses prove otherwise (USFWS, 2001).

**Historical Range**

Range encompasses rivers, estuaries, and coastal areas of subtropical and tropical areas of northern South America, West Indies/Caribbean region (but apparently never very abundant in the Greater Antilles, except perhaps Cuba, Lefebvre 1989), Gulf of Mexico (now mainly western and southwestern portions), and southeastern North America (mainly Florida). U.S. populations occur primarily in Florida (e.g., see Van Meter 1987), where they are effectively isolated from other populations by the cooler waters of the northern Gulf of Mexico and the deeper waters of the Straits of Florida (Domning and Hayek 1986). In the southeastern United States, manatees are more or less retricted to the vicinity of warm-water sites in peninsular Florida during the winter, although a few may remain year-round in Cumberland Sound, southeastern Georgia, where factory warm-water outfalls allow survival of colder winter months (Reeves et al. 1992). Occasional manatees occur in summer from Texas to North Carolina (e.g., see Schwartz 1995, Brimleyana 22:53-60, for North Carolina records). Those in Texas may be wanderers from Mexican population, but DNA analysis of an individual captured linked it to the Florida population (T. Ettel, pers. comm.). Manatees range along most of the Gulf coast of Florida but infrequently occur north of the Suwannee River and between the Chassahowitzka River and Tampa Bay. They inhabit the Atlantic coast of Florida from the Georgia coast to Biscayne Bay and the Florida Keys, including the St. Johns River, the Indian River lagoon system, and various other waterways (O'Shea and Ludlow 1992). In Florida, the most well-used wintering areas are at Crystal River, Homosassa River, Tampa Bay, Ft. Myers, Port Everglades, Riviera Beach, near Titusville, and Blue Spring (O'Shea and Ludlow 1992) (NatureServe, 2015).

**Current Range**

Present range limits are similar to those known historically, but the distribution is fragmented due to areas of local extirpation (O'Shea and Ludlow 1992). Area of occupancy and abundance are apparently greatly reduced in Central and South America compared to the historical situation. Small numbers exist in the Greater Antilles but the species has not been documented in the Lesser Antilles south of the Virgin Islands since the 1700s. Sightings are rare in the Bahamas. Manatees remain relatively abundant in Belize (compared to elsewhere in Central America) and in Guyana, and they are still reasonably abundant in some areas of Mexico and on both coasts of Florida (Lefebvre et al. 1989). In Puerto Rico, manatees are most often observed in coastal areas from San Juan eastward to the east coast, (and including Vieques Island) and then south and west, past Jobos Bay, to the west coast, and about as far to the northwest as Rincon; they are concentrated in several areas, including Ceiba, Vieques Island, Jobos Bay, and Boquerón Bay, and are less abundant along the north coast, between Rincón and Dorado (USFWS 2007). Manatees are very rare (transient) in the U.S. Virgin Islands (USFWS 2007). See Fairbairn and Haynes (1982) and Hurst (1986) for information on status and distribution in Jamaica. See Lefebvre et al. (1989) for a fairly detailed overview of country by country status (USFWS, 2015).

**Distinct Population Segments Defined**

No

**Critical Habitat Designated**

Yes; 9/24/1976.

**Legal Description**

On September 24, 1976, the Director, U.S. Fish and Wildlife Service (hereinafter, the “Director” and the “Service ” respectively) hereby issues a Rulemaking pursuant to Section 7 of the Endangered- Species Act of 1973 (16 U.&C. 1531-1543; 87 Stat. 884; hereinafter, the “Act”) which determines Critical Habitat for the American Crocodile(Crocodylus acutus), California Condor (Gymnogyps californianus), Indiana Bat (Myotis sodalis), and Florida Manatee (Trichechus manatus).

**Critical Habitat Designation**

The following areas (exclusive of those existing manmade structures or settlements which are not necessary to the normal needs or survival of the species) are Critical Habitat for the Species indicated. Pursuant to Section 7 of the Act, all Federal agencies must insure that actions authorized, funded, or carried out by them do not result-in the destruction or adverse modification of these areas:

Florida. Crystal River and its headwaters known as King’s Bay, Citrus County: the Little Manatee River downstream from the U.S. Highway 301 bridge. Hillsborough County; the Manatee River downstream from the Lake Manatee Dam, Manatee County; the Myakka River downstream from Myakka River State Park. Sarasota and Charlotte Counties: the Peace River downstream from the

Florida State Highway 760 bridge, De Soto and Charlotte Counties: Charlotte Harbor north of. the Charlotte-Lee county line, Charlotte County: Caloosahatchee River downstream from the Florida State Highway 31 bridge, Lee County; all U.S. territorial waters adjoining the coast and islands of Lee County; all U.S. territorial waters adjoining the coast and Islands and all connected bays, estuaries, and rivers from Gordon's Pass, near Naples. Collier County, southward to and including Whitewater Bay, Monroe County; all waters of Card, Barnes, Blackwater, Little Blackwater, Manatee, and Buttonwood sounds between Key Large, Monroe County, and the mainland of Dade County: Biscayne Bay, and all adjoining and connected lakes, rivers, canals, and waterways from the southern tin of Kev Biscayne northward to and including Maule Lake, Dade County; all of Lake Worth, from its northernmost point immediately south of the intersection of U.S. Highway 1 and Florida State Highway AIA -southward to its southernmost point immediately north of the town of Boynton Beach, Palm Beach County: the Loxahatchee River and its headwaters, Martin and West Palm Beach Counties; that section of the lntracoastal waterway from the town of Sewalls Point, Martin County to Jupiter Inlet, Palm Beach County: the entire inland section of water known as the Indian River, from its northernmost point immediately south of the intersection of VS. Highway 1 and Florida State Highway 3. Volusia County, southward to its southernmost point near the town of Seawalls Point, Martin County, and the entire inland section of water known as the Banana River and all waterways between Indian and Banana rivers, Brevard County: the St. Johns River including Lake George, and including Blue Springs and Silver Glen Springs from their points of origin to their confluences with the St. Johns River; that section of the Intracoastal Waterway from its confluence with the St. Marys River on the Georgla-Florida border to the Florida State Highway A1A bridge south of Coastal City, Nassau and Duval Counties.

**Primary Constituent Elements/Physical or Biological Features**

With respect to the Florida manatee,. the areas delineated below contain the largest concentrations in the United States. and are the only areas that presently can be defined as having major dependent populations. The Crystal River and Its King's Bay headwaters form one of the largest natural warm water resources for Manatees. Up to 60 Manatees possibly representing six to ten percent of the total population of the species in the United States utilize this refugium during cold weather periods. The Little Manatee, Manatee, Myakka, and Peace rivers, and Charlotte Harbor all support large Manatee concentrations. Manatees also utilize the Caloosahatchee River and associated coastal areas. The warm water discharge of the Florida Power and Light Company Ft. Meyers power plant into the Orange River on the south bank of the Caloosahatchee River at Tice is known to attract as many as 75 manatees during cold periods. The area off the coast of Collier and Monroe Counties, southwestern Florida is the center of a large, but uncounted Manatee population. This population Is at least partially resident and is dependent on the extensive local growths of Thalassia and Diplanthera as a primary food resource. Concentrations of as many as 75 manatees are observed in Whitewater Bay. The waterway formed by Card, Barnes, Blackwater, and Buttonwood sounds may constitute the Manatee's essential thoroughfare between Miami-Biscayne Bay and the lower Keys and Florida Bay. Seaward movement along the upper Keys is very rare. Biscayne Bay, with its adjoining waterways are of central importance to the large Manatee populations of southeastern Florida, Abundant food resources exist in the area, and the warm water flow from the Florida Power and Light Company Miami River plant provides an important refugium. Lake Worth supports a large Manatee population year-round and also serves as a warm water refugium for additional wintering manatees. The outfall from the Florida Power and Light Company Miami River plant supports up to 75 manatees during cold weather. The Indian and Banana rivers may contain the largest manatee population in Florida. These areas provide warm, quiet waters and abundant food resources. The St. Johns River also provides ample food resources to a significant manatees population, and several of its spring-fed tributaries provide warm warm water during cold spells. In Lake Monroe, two power plants provide warm water outfalls which are used by manatees during cold periods. The Intracoastal Waterway frown the St. Marys River to Highway A1A is a major concentration area and thoroughfare for manatees.

PCEs not specifically described. From the text above, it can be presumed that the following are primary constituent elements:

(1) Warm water during cold periods.

(2) Thalassia and Diplanthera as a primary food resource.

**Special Management Considerations or Protections**

Not available

***Life History***

**Feeding Narrative**

Adult: Manatees are herbivores that feed opportunistically on a wide variety of submerged, floating, and emergent vegetation. Because of their broad distribution and migratory patterns, Florida manatees utilize a wider diversity of food items and are possibly less specialized in their feeding strategies than manatees in tropical regions (Lefebvre et al. 2000). Feeding rates and food preferences depend, in part, on the season and available plant species. Bengtson (1981, 1983) reported that the time manatees spent feeding in the upper St. Johns River was greatest (6 to 7 hrs/day) before winter (August to November), least (3 to 4 hrs/day) in spring and summer (April to July), and intermediate (about 5 hrs/day) in winter (January to March). He estimated annual mean consumption rates at 33.2 kg/day/manatee or about 4 to 9% of their body weight per day depending on season (Bengtson 1983). At Crystal River, Etheridge et al. (1985) reported cumulative daily winter feeding times from 0 to 6 hrs. 10 min. based on observations of three radio-tagged animals over seven 24-hour periods. The estimated daily consumption rates by adults, juveniles, and calves eating hydrilla (Hydrilla verticillata) were 7.1, 9.6, and 15.7% of body weight per day, respectively. Seagrasses appear to be a staple of the manatee diet in coastal areas (Ledder 1986; Provancha and Hall 1991; Kadel and Patton 1992; Koelsch 1997; Lefebvre et al. 2000). Packard (1984) noted two feeding methods in coastal seagrass beds: (1) rooting, where virtually the entire plant is consumed; and (2) grazing, where exposed grass blades are eaten without disturbing the roots or sediment. Manatees may return to specific seagrass beds to graze on new growth (Koelsch 1997; Lefebvre et al. 2000).In the upper Banana River, Provancha and Hall (1991) found spring concentrations of manatees grazing in beds dominated by manatee grass (Syringodium filiforme). They also reported an apparent preference for manatee grass and shoalgrass (Halodule wrightii) over the macroalga Caulerpa spp. Along the Florida-Georgia border, manatees feed in salt marshes on smooth cordgrass (Spartina alterniflora) by timing feeding periods with high tide (Baugh et al. 1989; Zoodsma 1991) (USFWS, 2001).

**Reproduction Narrative**

Adult: Breeding takes place when one or more males (ranging from 5 to 22) are attracted to an estrous female to form an ephemeral mating herd (Rathbun et al. 1995). Mating herds can last up to 4 weeks, with different males joining and leaving the herd daily (Hartman 1979; Bengtson 1981; Rathbun et al. 1995. Cited in Rathbun 1999). Permanent bonds between males and females do not form. During peak activity, the males in mating herds compete intensely for access to the female (Fig. 9; Hartman 1979). Successive copulations involving different males have been reported. Some observations suggest that larger, presumably older, males dominate access to females early in the formation of mating herds and are responsible for most pregnancies (Rathbun et al. 1995), but males as young as three years old are spermatogenic (Hernandez et al. 1995). Although breeding has been reported in all seasons, Hernandez et al. (1995) reported that histological studies of reproductive organs from carcasses of males found evidence of sperm production in 94% of adult males recovered from March through November. Only 20% of adult males recovered from December through February showed similar production.Females appear to reach sexual maturity by about age five but have given birth as early as four (Marmontel 1995; Odell et al. 1995; O'Shea and Hartley 1995; Rathbun et al. 1995), and males may reach sexual maturity at 3 to 4 years of age (Hernandez et al. 1995). Manatees may live in excess of 50 years (Marmontel 1995), and evidence for reproductive senescence is unclear (Marmontel 1995; Rathbun et al. 1995). Catalogued Florida manatee CR 28, a wild manatee that overwinters in Crystal River, was last documented with a calf in 1998, at which time she was estimated to be at least 34 years of age (USGS-Sirenia, unpublished data). A captive animal, MSTm-5801, gave birth to a calf in 1990, at which time she was estimated to be 43 to 48 years of age (FWS, unpublished data). The length of the gestation period is uncertain but is thought to be between 11 and 14 months (Odell et al. 1995; Rathbun et al. 1995; Reid et al. 1995). The normal litter size is one, with twins reported rarely (Marmontel 1995; Odell et al. 1995; O'Shea and Hartley 1995; Rathbun et al. 1995). Calf dependency usually lasts one to two years after birth (Hartman 1979; O'Shea and Hartley 1995; Rathbun et al. 1995; Reid et al. 1995). Calving intervals vary greatly among individuals. They are probably often less than 2 to 2.5 years, but may be considerably longer depending on age and perhaps other factors (Marmontel 1995; Odell et al. 1995; Rathbun et al. 1995; Reid et al. 1995). Females that abort or lose a calf due to perinatal death may become pregnant again within a few months (Odell et al. 1995), or even weeks (Hartman 1979) (USFWS, 2001).

**Environmental Specificity**

Adult: Moderate (based on species habitat)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from USFWS, 2001)

**Habitat Narrative**

Adult: The Florida manatee lives in freshwater, brackish and marine habitats. Submerged, emergent, and floating vegetation are their preferred food. During the winter, cold temperatures keep the population concentrated in peninsular Florida and many manatees rely on the warm water from natural springs and power plant outfalls. During the summer they expand their range and on rare occasions are seen as far north as Rhode Island on the Atlantic coast and as far west as Texas on the Gulf coast. The most significant problem presently faced by manatees in Florida is death or injury from boat strikes. The long-term availability of warm-water refuges for manatees is uncertain if minimum flows and levels are not established for the natural springs on which many manatees depend, and as deregulation of the power industry in

Florida occurs. Their survival will depend on maintaining the integrity of ecosystems and habitat sufficient to support a viable manatee population (USFWS, 2001). Low tolerance ranges are inferred based on temperature requirements (USFWS, 2001).

***Dispersal/Migration***

**Motility/Mobility**

Adult: High

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: Yes (USFWS, 2001)

**Dispersal**

Adult: High (temperature dependant (USFWS, 2001)

**Immigration/Emigration**

Adult: Immigrates (USFWS, 2001)

**Dispersal/Migration Narrative**

Adult: This is a large aquatic mammal that is highly mobile. The species migrates to warm water ouflows (power plant outflow and warm springs) during cold weather (USFWS, 2001). In addition, USFWS (2001) notes that immigration of animals from other populations to Crystal River and Blue Springs. The species has the ability to disperse if water temperatures are warm enough and have been found as far North as Rhode Island during certain years)

***Population Information and Trends***

**Population Trends:**

Decreasing (NatureServe, 2015)

**Number of Populations:**

6-20 (NatureServe, 2015)

**Population Size:**

Total population size (2500 - 10,000 (NatureServe, 2015)

**Population Narrative:**

NatureServe, 2015) notes that the number of populations is between 6 and 20 and the overall population numbers are between 2,500 and 10,000. In addition long -term and short term population trends are declining.Moderate resiliency is inferred based on low number of offspring and gestation period and widespread populations (USFWS, 2001 and NatureServe, 2015). Low representation is inferred based on long gestation period, low number of offspring produced and relatively long parental care (USFWS, 2001). Low redundancy is inferred based on limited number of populations (USFWs, 2001).

***Threats and Stressors***

**Stressor:** Boat strikes (USFWS, 2001)

**Exposure:**
**Response:**
**Consequence:** Death/Injury
**Narrative:** The most significant problem presently faced by manatees in Florida is death or serious injury from boat strikes (USFWS, 2001).

**Stressor:** Lack of warm water refuge (USFWS, 2001)
**Exposure:**
**Response:**
**Consequence:** Habitat Loss/Death
**Narrative:** The availability of warm-water refuges for manatees is uncertain if minimum flows and levels are not established for the natural springs on which many manatees depend, and as deregulation of the power industry in Florida occurs (USFWS, 2001).

**Stressor:** Human development (USFWS, 2001)
**Exposure:**
**Response:**
**Consequence:** Habitat Loss
**Narrative:** Consequences of an increasing human population and intensive coastal development are long-term threats to the Florida manatee. Their survival will depend on maintaining the integrity of ecosystems and habitat sufficient to support a viable manatee population (USFWS, 2001).

**Stressor:** Red tide (USFWS, 2001)
**Exposure:**
**Response:**
**Consequence:** Death
**Narrative:** Although the exact mechanism of manatee exposure to the red tide brevetoxin is unknown in the 1982 and 1996 outbreaks, ingestion, inhalation, or both are suspected (Bossart et al. 1998). The critical circumstances contributing to high red tide-related deaths are concentration and distribution of the red tide, timing and scale of manatee aggregations, salinity, and timing and persistence of the bloom (Landsberg and Steidinger 1998). It is difficult to manage for these rare but catastrophic causes of mortality (USFWS, 2001).

**Stressor:** Navigational Locks (USFWS, 2001)
**Exposure:**
**Response:**
**Consequence:** Death
**Narrative:** The next largest human-related cause of manatee deaths is entrapment or crushing in water control structures and navigational locks and accounts for 4% of the total mortality between 1976 and 2000 (Ackerman et al. 1995; FWC, unpublished data) (USFWS, 2001).

***Recovery***

**Reclassification Criteria:**
Identify minimum flow levels for important springs used by wintering manatees (82 FR 16668).

Protect a network of warm-water refuges as manatee sanctuaries, refuges, or safe havens (82 FR 16668).

Identify foraging sites associated with the network of warm-water sites for protection (82 FR 16668).

Identify for protection a network of migratory corridors, feeding areas, and calving and nursing areas (82 FR 16668).

Address harassment at wintering and other sites to achieve compliance with the Marine Mammal Protection Act (MMPA) and the Endangered Species Act and as a conservation benefit to the species (82 FR 16668).

Protect important manatee habitats (82 FR 16668).

Reduce or remove unauthorized take (82 FR 16668).

Create and enforce manatee safe havens and/or Federal manatee refuges (82 FR 16668).

Retrofit one half of all water control structures with devices to prevent manatee mortality (82 FR 16668).

Draft guidelines to reduce or remove threats of injury or mortality from fishery entanglements and entrapment in storm water pipes and structures (82 FR 16668).

Recovery Priority Number: 5C

**Delisting Criteria:**
Protect Habitat (USFWS, 2007)

Protect from 'take' (USFWS, 2007)

Resolve the inadequacy of existing regulatory mechanisms (USFWS, 2007)

Protect from human related mortality (USFWS, 2007)

**Recovery Actions:**
- In order to ensure the long-term recovery needs of the manatee and provide adequate assurance of population stability (i.e., achieving the demographic criteria), threats to the manatee’s habitat or range must be reduced or removed. This can be accomplished through Federal, State or local regulations to establish and maintain minimum spring flows and protect the following areas of important manatee habitat:   a. Minimum flow levels to support manatees at the Crystal River Spring Complex, Homosassa Springs, Blue Springs, Warm Mineral Spring, and other spring systems as appropriate, in terms of quality (including thermal) and quantity have been adopted by regulation and are being maintained.(Task 3.2.4.3) 9   b. A network of level 1 (Primary), 2(Secondary) and 3 (Tertiary) warm-water refuge sites have been protected as either manatee sanctuaries, refuges or safe havens. (Task 1.2.3, 1.3, 3.2.2, 3.2.3, 3.2.4, 3.3.1)   c. Adequate feeding habitat sites (extent, quantity

and quality) associated with the network warm-water refuge sites identified by the HWG and are protected. (Task 3.1(3), 3.3.8). d. The network of migratory corridors, feeding areas, calving and nursing areas identified by the HWG are protected as manatee sanctuaries, refuges or safe havens. (Task 1.3, 3.3.1) (USFWS, 2007).

- “Take” in the form of harassment, is currently occurring at some of the winter refuge sites and other locations. This “take” is presently not authorized under the MMPA or ESA. However, there are no data at this time to indicate that this issue is limiting the recovery of the Florida manatee. The actions in this plan that address harassment are recommended in order to achieve compliance with the MMPA and ESA and as a conservation benefit to the species. Statutory mechanisms outlined in Factor D to protect and enact protection regulations for important manatee habitats identified in Factor A and enact regulations to address unauthorized “take” identified in Factor E, will also assist to reduce or remove these threats. Recovery actions and their subtasks specifically addressing this issue are 1.1, 1.11, 4.4 and those tasks identified in Factors A, D and E (USFWS, 2007).
- The current legal framework outlined below allows Federal and State government agencies to take both broad scale and highly protective action for the conservation of the manatee and its habitat. The FWS believes these regulatory mechanisms are adequate for recovery. However, additional specific actions under these laws such as those listed pursuant to Factor A and E must be accomplished (as well as meeting the demographic criteria) before the FWS will consider this species for removal from the List of Endangered and Threatened Wildlife. Factor A (a) Establish Minimum Flows (Task 3.2.4.3) STATE Florida Water Resources Act of 1972, Chapter 373, F.S. (specifically Minimum Flows and Levels, Sect. 370.42, F.S. and Establishment and Implementation of Minimum Flows and Levels, Sect. 370.421, F.S.) Factor A (b)(c) and (d) Protect Important Manatee Habitats (Task 1.2, 1.3.1, 1.3.2, 1.4, 3.2.2, 3.2.3, 3.2.4, 3.3.1, 3.3.8) FEDERAL Marine Mammal Protection Act; Clean Water Act, Sect. 401, 402 and 404; Rivers and Harbors Act, Sect. 10; National Environmental Policy Act; and Coastal Zone Management Act; STATE Florida Manatee Sanctuary Act, Sect. 370.12(2), F.S.; Florida Water Resources Act of 1972, Chapter 373, F.S.; Florida Air and Water Pollution Control Act, Chapter 403, F.S.; State Lands, Chapter 253, F.S.; and State Parks and Preserves, Chapter 258, F.S.; and LOCAL Florida Manatee Sanctuary Act, Sect. 370.12(o), F.S. which allows local governments to regulate by ordinance, motorboat speed and operations to protect manatees. Factor E (a)(b)(c) Reduce or Remove Unauthorized “take” (Task 1.1, 1.2, 1.3.1, 1.3.2, 1.4, 1.6, 1.7, 3.3.1) FEDERAL Marine Mammal Protection Act; and STATE Florida Manatee Sanctuary Act, 370.12(2), F.S. (USFWS, 2007).
- The most predictable and controllable threat to manatee recovery remains human-related mortality. In order to ensure the long-term recovery needs of the manatee and provide adequate assurance of population stability (i.e., achieving the demographic criteria), natural and manmade threats to manatees need to be reduced or removed. This can be accomplished through establishing the following Federal, State or local regulations, tasks and guidelines to reduce or remove human caused “take” of manatees: a. State, Federal and local government manatee conservation measures (such as, but not limited to speed zones, refuges, sanctuaries, safe havens, enforcement, education programs, county MPPs etc.) have been adopted and implemented to reduce or remove unauthorized watercraft-related “take” in the following Florida counties: Duval (including portions of Clay and St. Johns in the St. Johns River), Volusia, Brevard, Indian River, Martin, Palm Beach, Broward, Dade and Monroe on the Florida Atlantic Coast; Citrus, Pinellas, Hillsborough, Manatee, Sarasota, Charlotte, Lee and Collier on the Florida Gulf Coast; and Glades County on the Okeechobee Waterway. These measures are not only necessary to achieve recovery, but

may ultimately help to comply with the MMPA. (Task 1.3, 1.4, 1.5, 3.3.1). Stable or positive population benchmarks as outlined in the demographic criteria provide measurable population parameters that will assist in measuring the stabilization, reduction, or minimization of watercraft related “take.” Two other indices (weight of evidence) will assist in measuring success include: (1) watercraft-related deaths as a proportion of the total known mortality; and (2) watercraft-related deaths as a proportion of a corrected estimated population. These and other indices should be monitored. b. All water control structures and navigational locks listed as needing devices to prevent mortality have been retrofitted. (Task 1.6) c. Guidelines have been established and are being implemented to reduce or remove threats of injury or mortality from fishery entanglements and entrapment in storm water pipes and structures. (Task 1.7, 1.6.3) (USFWS, 2007).

- For Florida manatees: Establish minimum flow requirements to guarantee sufficient manatee winter habitat at key natural springs and restore access to springs in the St. Johns River watershed, Homosassa Springs, and other sites. Develop and implement a comprehensive management strategy to address manatee protection in the Ten Thousand Islands National Wildlife Refuge and Everglades National Park. Assess forage availability near wintering sites to determine the potential carrying capacity of these sites, assess the long-term effect of habitat modification on the population, and manage accordingly. Ensure that contingency plans and cooperative agreements with key industry and government partners are developed and utilized to mitigate the adverse effects of anticipated changes in artificial sources of warm water (USFWS, 2007).
- For Florida manatees: Propose regulations (in consultation with the Corps of Engineers and other Federal agencies) pursuant to section 112(a) of the MMPA to address direct, indirect, and cumulative threats from future development and resolve conflicts with the current consultation process under section 7 of the ESA. Ensure that the State of Florida’s manatee management plan will be sufficient to control watercraft injury and mortality. Ensure losses of power plant warm water effluents are adequately mitigated through coordination/consultation with EPA in association with Clean Water Act section 316 (b) requirements for once-through cooling systems (USFWS, 2007).
- For Florida manatees: Update the Florida Manatee Recovery Plan and, at a minimum, revise the demographic recovery criteria; as written, these criteria are considered inadequate (Section IIB2a). Consider restructuring the Florida Manatee Recovery Team. Continue to monitor the status of Florida manatees through surveys, photo identification and genetics research. New research on population genetics in Florida and in Puerto Rico is underway, and we will investigate whether manatees in each of these areas could be considered as distinct populations when that information becomes available. Use the results of new research to review and update the scientific information used in the manatee Core Biological Model, especially to gain a better understanding of manatee population dynamics in southwest Florida. Use updated demographic information to assess the effects of improved State and Federal management efforts since 2000 (USFWS, 2007).
- For Florida manatees: Expedite the next Federal status review and conduct it in 2009-2010, when updated adult survival rates will be available. If the above issues are satisfactorily addressed, it may be most appropriate to remove the manatee from the list of threatened and endangered species at the Federal level and provide protection under the MMPA only (USFWS, 2007).
- For Antillean Manatee in Puerto Rico and the U.S. Virgin Islands: In Puerto Rico, further discussions about State safe havens (manatee refuges and sanctuaries) and/or Federal manatee protection areas (including speed restricted and exclusion areas, as defined in 50

CFR 17 Subpart J) should be should be held between the Service and the Puerto Rico Department of Environment and Natural Resources regarding the following municipalities: Fajardo, Ceiba, Naguabo, Vieques, Arroyo, Patillas, Guayama, Lajas, and Cabo Rojo. More specifically, refuges should be established in Jobos Bay in Guayama; in Pelican Cove, Ensenada Honda and the Cape Hart Sewage Plant in the RRNS area; in that area west of Mosquito Pier to Punta Arenas in Vieques; in La Parguera and Bahía Montalva in Lajas; and in Laguna Rincón, Bahía Boquerón and Puerto Real in Cabo Rojo. Other areas may be included as information on distribution and use is further refined. The loss of habitat, including the loss of freshwater sources and seagrasses due to a variety of causes, should be monitored and prevented (USFWS, 2007).

- For Antillean Manatee in Puerto Rico and the U.S. Virgin Islands: If established, manatee protection areas should be adequately enforced to minimize unauthorized watercraft-related “takings.” An outreach program should be developed to reach younger generations who take “boat” training courses. Manatee conservation efforts should be properly marketed to target boating communities, developers, and non-users with the message of “losing one manatee is one too many.” Marina and other boating access development projects should be reviewed to address potential increases in the likelihood of manatee-boat collisions resulting from these projects. Construction of marinas and other boat access should be assessed to identify, quantify, avoid, and minimize threats to manatees. 6. Guidelines should be drafted to further reduce or remove threats of injury or mortality from fishery entanglements (USFWS, 2007).
- For Antillean Manatee in Puerto Rico and the U.S. Virgin Islands: Update the Recovery Plan and develop delisting criteria. Continue to monitor the status of manatees in Puerto Rico through improved (statistically-sound) survey methodology and genetics research. Continue to monitor and report on sources of manatee mortality through the carcass salvage effort, and statistically evaluate the fractions of mortality due to the various causes. Initiate demographic studies to better understand adult survival, juvenile recruitment and population growth. Initiate new research to investigate the importance of freshwater resources in Puerto Rico to the manatee population. Assess whether manatees in Puerto Rico can be considered as a DPS following advancements in genetics research (USFWS, 2007).

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# SPECIES ACCOUNT: *Urocitellus brunneus (=Spermophilus b.b.)* (Northern Idaho ground squirrel)

***Species Taxonomic and Listing Information***

**Commonly-used Acronym:** NIDGS

**Listing Status:** Threatened; 04/05/2000; Pacific Region (R1) (USFWS, 2016)

**Physical Description**

The northern Idaho ground squirrel (Urocitellus brunneus) is smaller than most ground squirrels at about 9 inches. The northern Idaho ground squirrel's fur is dark reddish-gray (due to a mixture of black unbanded and yellowish-red banded guard hairs), with reddish-brown spots on its coat. It has a short, narrow tail, tan feet and ears, grey-brown throat and a creamy white eye ring (USFWS, 2016).

**Taxonomy**

The first NIDGS specimens were collected in 1913 by L. E. Wyman, and described by A.H. Howell as a subspecies of the Washington ground squirrel (Citellus townsendii brunneus; Howell 1938, pp. 72-73). Subsequently, Howell (1938, pp. 72-73) reclassified the Idaho ground squirrel as a full species, Citellus brunneus. In 1949 (p. 300), Hershkovitz demonstrated that Spermophilus is the correct name for the genus. In 1991 (entire), Yensen determined that Spermophilus brunneus consisted of two taxonomically distinct subspecies based on morphology, pelage, and life history differences that also included biogeographical separation; the NIDGS and neighboring southern Idaho ground squirrel (SIDGS; Spermophilus brunneus endimicus; genus recognized as Urocitellus2 ; Helgen et al. 2009, p. 297). Yensen (1991, p. 583) suggested that the two subspecies were close to species-level separation, and subsequent genetic work has indicated that they could be validated as separate species (Gill and Yensen 1992, p. 155; Yensen and Sherman 1997, p. 1; Gavin et al. 1999, p. 163; Hoisington 2007, p. iii). In 2009, Helgen et al. (p. 297) revised the genus Spermophilus and placed the NIDGS into the genus Urocitellus2 . Given the NIDGS is threatened throughout its range, it is not considered a distinct population segment (USFWS, 2011).

**Current Range**

This species is endemic to a five-county area of west-central Idaho (Yensen and Sherman 1997). The northern subspecies (brunneus) presently is known only from Valley and Adams counties at elevations of 1,150-1,550 meters; most populations are small and often isolated by several kilometers (Yensen 1991). The southern subspecies (endemicus) has a patchy distribution at lower elevations (670-975 meters) north of the Payette River in Gem, Payette, and Washington counties. The species is apparently extirpated in the area between the extant populations of the northern and southern subspecies (Yensen 1984, 1991, Yensen et al. 1991, Yensen and Sherman 1997).

**Critical Habitat Designated**

No;

***Life History***

**Feeding Narrative**

Juvenile: Feeds on green vegetation, seeds.; Food Habits: Herbivore (Adult, Immature), Granivore (Adult, Immature) (NatureServe, 2015)

Adult: Feeds on green vegetation, seeds.; Food Habits: Herbivore (Adult, Immature), Granivore (Adult, Immature). Southern populations emerge in late January or early February and cease above-ground activity in late June or early July; northern populations are active above ground from late March or early April until late July or early August (Yensen 1991). Activity is constrained by time of snow melt and vegetation dessication. (NatureServe, 2015). Two studies were published on the diet of NIDGS since the last 5-year review. Yensen and others (Yensen et al. 2018, entire) analyzed fecal pellets from five study sites and found that NIDGS consumed a high diversity of plants but over 86% of their diet consisted of forbs. Likewise, Goldberg and others (Goldberg et al. 2020, entire) analyzed fecal pellets from 11 NIDGS sites and found that forbs dominated their diet followed by grasses, shrubs, trees, rushes, and sedges. Additionally, they found that one forb species, yampah (Perideridia spp.), was associated with overwinter survival in NIDGS (USFWS, 2022).

**Reproduction Narrative**

Adult: Mating occurs soon after spring emergence; males guard sexually receptive females from other males; after mating, female excludes male from female burrow; gestation lasts about 3 weeks; litter size is 2-10 (average around 6-7); young are weaned in 3 weeks (Yensen 1991, Spahr et al. 1991).; May be limited by competition from Columbian ground squirrel (Spahr et al. 1991). Badgers and prairie falcons are the primary predators.; (NatureServe, 2015). The northern Idaho ground squirrel emerges in late March or early April and remains active above ground until July or early August (Yensen 1991). Emergence during this period begins with adult males, followed by adult females, and then yearlings. The northern Idaho ground squirrel becomes reproductively active within the first 2 weeks of emergence (Yensen 1991). Females and males are sexually mature the first spring after birth. They produce one litter per year of between two and seven pups, depending on the fitness of the female. Females that survive the first winter live, on average, nearly twice as long as males (3.2 years for females and 1.7 years for males). Individual females have lived for as long as 8 years. Males normally die at a younger age due to behavior associated with reproductive activity. During the mating period, males move considerable distances in search of receptive females and often fight with other males for copulations, thereby exposing themselves to predation by raptors, such as prairie falcons (Falco mexicanus), goshawks (Accipiter gentilis), and red-tailed hawks (Buteo jamaicensis). Significantly more males die or disappear during the 2-week mating period than during the rest of the 12- to 14-week period of above-ground activity (Sherman and Yensen 1994). Seasonal torpor or hibernation generally occurs in early to mid-July for males and females, and late July to early August for juveniles (Yensen and Sherman 1997) (USFWS, 2003).

**Tolerance Ranges/Thresholds**

Adult: Moderate (inferred from NatureServe, 2015)

**Site Fidelity**

Adult: Moderate (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Northern populations are associated with shallow rocky soils in xeric meadows surrounded by ponderosa pine and Douglas-fir forest; southern populations inhabit low rolling hills and valleys now dominated by annual grassland with relict big sagebrush and bunch grasses (Yensen et al. 1991, Yensen 1991). This squirrel may occur on slopes and rarely on ridges (Yensen 1984). It burrows extensively in shallow rocky soils, but nest burrows are located in adjacent areas with deeper (>1 meter) well-drained soils (Yensen et al. 1991). Grassland/herbaceous. Burrowing in or using soil (NatureServe, 2015). Moderate ecological integrity of the community, site fidelity and tolerance ranges are inferred based on the specific habitat requirements of the species, relatively large geographic area it inhabits and the number of known populations.

***Dispersal/Migration***

**Motility/Mobility**

Adult: High (USFWS, 2011)

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: Non-migratory (Natureserve, 2015)

**Dispersal**

Adult: Moderate (USFWS, 2011)

**Dispersal/Migration Narrative**

Adult: Nonmigrant: Y; (NatureServe, 2015). Idaho ground squirrel dispersal corridors have been reduced or eliminated, further constricting the subspecies into smaller isolated areas (Yensen and Sherman 1997). Fire suppression has allowed conifers to invade once suitable meadow habitats, thereby shrinking the size of forb/grass meadows or closing grassy dispersal/migration corridors to nearby meadow sites. These changes have isolated the dry meadows with suitable shallow soils and preferred forage and burrow habitat where the northern Idaho ground squirrel finds refuge from the Columbian ground squirrel. Habitat fragmentation and reduced opportunities for dispersal among habitats prevents gene flow and results in considerable population differences (Yensen and Sherman 1997, Sherman and Runge 2002). The loss of dispersal corridors has caused some isolated population sites to become extirpated in recent years (Sherman and Yensen 1994; U.S. Fish and Wildlife Service 1996). Additionally, small populations at several remaining sites are likely to become extirpated (Sherman and Yensen 1994; Mangel and Tier 1994). The rate, timing, and age of dispersal of northern Idaho ground squirrels from their natal sites is unknown. However, in order to establish successfully functioning metapopulations, it is important to know how far northern Idaho ground squirrels disperse under a variety of conditions. Timing and age of dispersal is important for planning successful translocation, supplementation, and reintroduction programs. It may be possible to utilize information from surrogate ground squirrel species being studied (e.g., southern Idaho ground squirrels, Pauite ground squirrel, etc.) (USFWS, 2003). Data from studies of the southern Idaho ground squirrel (SIDGS; Spermophilus brunneus endimicus; genus recognized as Urocitellus1 ; Helgen et al. 2009, p. 297), which is classified as a candidate species (i.e. candidate for protection under the Endangered Species Act), indicates that dispersal is undertaken by young of the year midway through their active period (i.e. while they are above ground; Panek 2005, p. 39). While less is known regarding NIDGS dispersal timing, at one occupied location in 2011 it was determined that NIDGS pups were dispersing in mid July (Rautsaw in litt. 2011b, p.

13). Regarding dispersal distances, SIDGSs have been documented dispersing up to distances of 2.4 kilometers (km) (1.5 miles (mi); Panek 2005, p. 32). Caution should be used when comparing dispersal results from SIDGSs for NIDGSs given the different habitat requirements for each subspecies (NIDGSs are found in meadow/ forested habitats, while SIDGSs are found in shrub steppe habitats). These different habitats requirements may influence the dispersal distances for each subspecies (USFWS, 2011).

***Population Information and Trends***

**Population Trends:**

Decreasing (NatureServe, 2015); Increasing (USFWS, 2011)

**Number of Populations:**

21 - 80 (NatureServe, 2015)

**Population Size:**

2500 - 100,000 individuals (NatureServe, 2015)

**Population Narrative:**

A significant decline has occurred in area of occupancy, number of subpopulations, and population size (USFWS 2002, 2004). See information for subspecies brunneus and endemicus. Decline of 30-70%. Total adult population size appears to be at least several thousand individuals (Yensen 2001, USFWS 2002). See information for subspecies brunneus and endemicus. Based on locations mapped on a coarse scale (Yensen and Sherman 1997), this species occurs in at least few dozen distinct areas; these include at least a few hundred occupied sites. See information for subspecies brunneus and endemicus. (NatureServe, 2015). In 1985, the total NIDGS population was estimated to be 5,000 squirrels scattered among 18 known population sites (Yensen 1985, p. 29). In 2002, two years after listing, the population estimate for the NIDGS was 450 to 500 individuals (Haak 2002, p. 10). In 2010, NIDGSs occupied 56 sites, an increase of 34 sites compared to the 22 sites detected in 2002 (Evans Mack 2010a, p. ii). Modeled population results, combined with squirrels detected on surveys, estimate the minimum pre-pup population was 1,560 in 2010, down slightly from the 1,618 estimated in 2009 (Evans Mack 2010a, p. ii; Evans Mack in litt. 2010, p. 2; Evans Mack and Bond 2010, p. 6). The decrease in population from 2009 to 2010 is attributed to fewer sites surveyed in 2010 as opposed to a true population decrease (Evans Mack in litt. 2011b, p. 2). Overall, the 10-year NIDGS population trend is increasing while its distribution across the landscape continues to expand (Figure 1; Evans Mack in litt. 2011b, p. 2; Evans Mack 2010a, pp. 6, 10) (USFWS, 2011). Moderate resiliency, representation and redundancy are based on the number of use sites and their relatively wide ranging geography as well as the overall population size.

***Threats and Stressors***

**Stressor:** Meadow invasion (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat/increased predation
**Narrative:** Northern Idaho ground squirrels rely on meadow habitat connected within a matrix of ponderosa pine and/ or Douglas fir forested habitat. The primary threat to the NIDGS identified

in the 2000 listing rule and 2003 Recovery Plan was, and appears to continue to be, meadow invasion by conifers (Rautsaw in litt. 2011b, p. 1; Evans Mack in litt. 2010, p. 5; USFWS 2009a, p. 2; USFWS 2003, p. 11; USFWS 2000a, p. 17779; Yensen and Sherman 1997, p. 3). Once open stands of conifers with an herbaceous understory have been replaced by dense stands of trees lacking an understory as a result of logging and fire suppression in post-settlement times (USFWS 2003, pp. 11-12; Burns and Zborowski 1996, entire; Crane and Fischer 1986 and Steele et al. 1986 in Yensen and Sherman 1997, p. 3). This has reduced the amount of suitable NIDGS habitat, while at the same time further isolating populations and reducing genetic exchange among populations. With limited connectivity for dispersal opportunities, small and isolated NIDGS populations are also likely more susceptible to the effects of predation (USFWS, 2011).

**Stressor:** Land use changes (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Development and habitat conversion are historical and ongoing threats to NIDGS populations, especially on private lands (Evans Mack in litt. 2010, p. 5; USFWS 2003, p. 11; USFWS 2000a, pp. 17781-17782). Half of the currently known sites occupied by NIDGSs occur on private land, comprising an estimated 439 ha (1,085 ac) of occupied habitat (Evans Mack in litt. 2010, p. 5). The land incorporating the entire Round Valley NIDGS metapopulation is presently for sale, and a subdivision and private home have been developed in Round Valley in the last 6 years (Evans Mack in litt. 2010, p. 5). In addition, Potlatch Forest Holdings Inc. is advertising private timber land for sale in the Mud Creek drainage along Price Valley and Mud Creek roads where there are known occupied NIDGS locations (Evans Mack in litt. 2010, p. 5). This conversion of once open space occupied by NIDGSs to housing developments on private land is a continuous and expanding threat to the species (Evans Mack in litt. 2010, p. 5) (USFWS, 2011).

**Stressor:** Motorized recreation (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** A threat to NIDGS habitat not discussed in the 2000 Final Listing Rule, but that has materialized since then, is off highway vehicle (OHV) use. Cross-country OHV use can detrimentally impact NIDGS habitat through soil compaction, removal of vegetation, and physical disturbance or harm to individuals (USFS 2007, pp. 3-183). While this threat has not been quantified, anecdotal evidence exists of NIDGS habit disturbance by OHVs in certain areas (Rautsaw in litt. 2011c, entire). While it’s unlikely this threat is operating at the landscape level, isolated OHV cross-country use has the potential to negatively affect NIDGSs and their habitat through localized events, potentially threatening small and/ or isolated populations (USFWS, 2011).

**Stressor:** Recreational shooting (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Illegal recreational shooting continues to be a threat to the NIDGS, though quantification of take remains unknown; therefore population effects are unclear (Evans Mack 2010a, p. 6). In 2009, an illegal shooting case was documented and brought to trial in Adams

County, where the person charged pleaded guilty to illegally taking (shooting) a NIDGS (Evans Mack in litt. 2009, p. 1). In addition, NIDGSs are commonly mistaken for COGSs, which are still legal to shoot, both of which are often found occurring together in the same general vicinities. This potential confusion between the two species further increases the likelihood of continued illegal shooting of NIDGSs (USFWS, 2011).

**Stressor:** Scientific Collections and Translocations (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of indivduals
**Narrative:** While NIDGSs are actively monitored through live trapping, only 5 mortalities out of 2,490 trap events (<0.2%) have occurred in the past 8 years (Evans Mack in litt. 2010, p. 6). In 2005, a translocation attempt may have led to the loss of 9-13 NIDGSs (Evans Mack in litt. 2010, p. 6). Additional translocation attempts have not been carried out since then and concerns remain regarding the high mortality rate of translocated animals, low overall success, and diminished priority due to recent genetic findings (USFWS, 2011).

**Stressor:** Predation (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of indivduals
**Narrative:** At the time of listing, the threats to the NIDGS associated with Factor C include predation, especially at smaller and more isolated populations (USFWS 2000a, pp. 17782-17783). The state of knowledge on disease and predation has not changed significantly since listing or the completion of the 2003 Recovery Plan. While disease is not considered a threat, it is presently unknown if plague (Yersina pestis) occurs within any NIDGS populations (Evans Mack in litt. 2010, p. 6). Fleas have been documented at one NIDGS population, which has undergone population increases and decreases, though it's unknown if fleas are the source of the population changes (Evans Mack in litt., 2010a, p. 6). Domestic dogs have recently been identified as a localized threat at two NIDGS sites on private land (Evans Mack in litt. 2010, p. 6). Additional interactions between domestic dogs, feral cats, and NIDGSs are likely to continue as once open private lands near occupied NIDGS habitat are converted to residential developments. In addition, the closure of Slaughter Campground by the PNF at the Lost Valley metapopulation site was primarily due to the negative effects domestic dogs were having on NIDGSs (Rautsaw in litt. 2011b, p. 32). Badgers continue to be a predation concern, primarily to small and isolated populations that are more susceptible to the effects of localized predation events. To reduce the threat of predation on NIDGS populations, limited mammalian predator control, primarily for badgers (Taxidea taxus), has taken place periodically from 2003-2009. While quantification of control actions are reported annually, its effectiveness at reducing predation to NIDGSs is unknown because it never has been measured (Evans Mack in litt. 2010, p. 6). Other predators to NIDGSs include raptors and weasels (Mustela frenata) (USFWS, 2011).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Illegal Take or Possession Northern Idaho ground squirrels are a Federally threatened species, with illegal take regulated under Section 9(a)(1) of the Act. While hunting for several

other species of ground squirrels in Idaho is unregulated by the State, the NIDGS is considered a protected non-game species under State Law for which it is illegal to take: no person shall take or possess those species of wildlife classified as Protected Nongame, or Threatened or Endangered at any time or in any manner, except as provided in Sections 36- 106(e) and 36- 1107, Idaho Code, by Commission rule, or IDAPA 13.01.10, ?Rules Governing the Importation, Possession, Release, Sale or Salvage of Wildlife,? Subsection 100.06.b (IDFG 2005, p. B-5). Even though it is illegal to shoot NIDGSs, illegal take continues to pose a threat to the species. In 2009, a person was charged and sentenced with the illegal killing of a NIDGS. The sentencing was minimal due to the lack of knowledge by the defendant regarding the presence of NIDGSs in the vicinity of the infraction, and as a result, additional signage has been erected at key locations within their range warning of the presence of a threatened species. Additional public outreach regarding the illegality of shooting NIDGSs is needed to further reduce this threat since people commonly mistake NIDGSs for COGSs, which are legal to shoot (USFWS, 2011). While regulatory mechanisms for protecting NIDGS habitat are lacking on Idaho State lands, at this time we do not possess the information linking this lack of regulatory mechanisms as a threat to the species. We recommend the MOA between IDFG and IDL be continued and appropriately applied on State lands. Conservation measures may need to be better developed to address crosscountry OHV use through occupied NIDGS habitat on State of Idaho lands. We encourage the IDL to take advantage of opportunities to enhance NIDGS habitat on State endowment lands while adhering to the Idaho Constitution mandate to secure the maximum long term financial return for the State of Idaho (USFWS, 2011).

**Stressor:** Private land development (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** As is discussed under Factor A, the development of occupied NIDGS habitat on private lands continues to be a threat to the species. Comprehensive plans for Adams and Valley Counties, where all of the known NIDGS occupied habitat occurs, contain goals of protecting wildlife and their habitats (Valley County 2010, pp. 11-12; Adams County 2006, p. 37). Even with these goals in place, private lands containing occupied NIDGS habitat continue to be developed in those Counties (see 2.3.2.1, Present or threatened destruction, modification or curtailment of its habitat or range). While IDFG continues to provide technical comments to various agencies, including local Counties regarding the effects of land use changes on NIDGSs and their habitat (Evans Mack 2010b, p. 12), the inadequacy of existing regulatory mechanisms regarding private land development continues to be a threat to the species (USFWS, 2011).

**Stressor:** Columbian Ground Squirrel Competition (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** In 2010, it was found that COGSs occurred at 24 sites occupied by NIDGSs (Evans Mack 2010a, p. 6). It’s been noted by Evans Mack and Bond (2010, p. 7) that COGS expansion at certain NIDGS sites is likely a result of habitat treatments for the benefit of NIDGSs. As the PNF conducts habitat treatments for the benefit of NIDGSs, we expect COGSs to also favorably respond by expanding their range into once unsuitable habitat. In addition, COGSs may displace NIDGSs in other parts of their range where habitat treatments have not occurred. Therefore the threat still exists for COGSs displacing NIDGSs from occupied habitat (USFWS, 2011).

**Stressor:** Forage Competition Between NIDGSs and Livestock (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** While potential forage competition between NIDGSs and livestock (cattle) was not identified as a threat factor at the time of listing, it was identified as a research priority (USFWS 2003, p. 24). Given most occupied NIDGS sites are also grazed by cattle, a pilot study to document the diets of NIDGSs and cattle at 2 occupied sites was conducted. In the recent preliminary study, diet comparison results indicate that there is low dietary overlap between NIDGSs and cattle, with NIDGS diets consisting of a higher proportion of forbs (herbaceous flowering plant) compared to a higher proportion of graminoids (grasses) in cattle diets (Yensen et al. 2010, entire). Further study of these results is needed to answer additional questions raised in this preliminary study (Yensen et al. 2010, p. 6) such as season of use by cattle/NIDGS overlap and intensity of grazing. Domestic sheep grazing also occurs within portions of the range of NIDGSs. Domestic sheep have been known to alter the vegetation cover components in sagebrush ecosystems (Mueggler 1950, entire; Laycock 1967, entire). Spring grazing by domestic sheep has been shown to lead to a reduction of perennial forbs and grasses, while fall domestic sheep grazing has been shown to be less detrimental to the perennial forb and grass vegetation component (Mueggler 1950, pp. 314-315; Laycock 1967, p. 213; Bork et al. 1998, p. 299). Both perennial forbs and grasses are important diet components for NIDGSs. Given the likely dietary overlap between domestic sheep and NIDGSs, there is concern that domestic sheep grazing may negatively affect NIDGS habitat (Rautsaw in litt. 2011b, p. 35). Additional information is needed regarding the timing and extent of overlap of domestic sheep grazing in occupied and suitable NIDGS habitat to determine the extent of this potential threat (USFWS, 2011).

**Stressor:** Roadway mortality (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of individuals
**Narrative:** Mortality of NIDGSs from vehicles on roads has occurred near occupied sites on U.S. Forest Service and County roadways, and a U.S. highway, although total mortality has not been quantified (Evans Mack in litt. 2010, p. 7). Speed limits and timing restrictions have been identified as conservation measures, though they have not always been adhered to or implemented (Evans Mack in litt. 2010, p. 7). While vehicle induced NIDGS mortality is a potential threat, especially to smaller and isolated populations, additional study is needed to better quantify the amount of NIDGS mortality that occurs from vehicle collisions (USFWS, 2011).

**Stressor:** Idaho Department of Lands Land Exchange (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** In 2009, the Boy Scouts of America (BSA) approached the Service regarding entering into a safe harbor agreement, or similar agreement, related to a potential land swap between the BSA and IDL to establish a Boy Scott summer recreation camp (BSA in litt 2009, entire). The section of IDL land the BSA had proposed to acquire is adjacent to the large Lost Valley Reservoir NIDGS population. In 2010, this colony's population was estimated at 154 individuals (Evans Mack 2010a, p. 15). The proposed human access route from the identified section of IDL land to

the Reservoir would also cross through occupied NIDGS habitat, thereby greatly increasing human disturbance to NIDGSs. While the present status of this land swap is unknown, as it is currently proposed by the BSA it would constitute a threat to the relatively large and important Lost Valley Reservoir NIDGS population and impede NIDGS recovery (Womack in litt. 2010, entire) (USFWS, 2011).

**Stressor:** Small Populations and Naturally Occurring Events (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Extinction
**Narrative:** Due to the threats discussed in this 5-year review, along with the fact that small and isolated NIDGS populations remain throughout their range, the NIDGS still likely has little resilience to naturally occurring events (USFWS, 2011).

**Stressor:** Climate change (USFWS, 2011)
**Exposure:**
**Response:**
**Consequence:** Loss of habitat
**Narrative:** Predicted changes of climate could result in a wide-range of potential outcomes for NIDGSs and their habitat. The effects to the NIDGS in either the short or long-term in a focused geographic area cannot be reasonably discerned without a specific aspect of its ecology or physiology linked to a confidently predicted climate change variable (e.g., water temperature tolerance of fish, or early snowmelt reducing wolverine denning). Increasing temperatures and drought could affect fire frequency and intensity and the susceptibility of forest vegetation to disease. This rise in temperatures may also affect the timing of NIDGSs entering and exiting seasonal torpor in response to vegetative timing changes from climate change; or may cause a response by NIDGSs to move up in elevation as lower elevation habitats become less suitable. Additional information is needed to better determine the response of the NIDGS to a changing climate (USFWS, 2011).

**Stressor:** Plague (USFWS, 2022)
**Exposure:**
**Response:**
**Consequence:**
**Narrative:** From 2014 to 2018, researchers investigated whether sylvatic plague was present in NIDGS populations. Sylvatic plague is a flea-borne bacterial disease found in wild rodents. It is caused by the nonnative bacterium, Yersinia pestis. In our 2017 5-year status review, we described sylvatic plague research that was in progress and concluded that while preliminary results indicated that plague may be present in the range of NIDGS and could be reducing survival of the species, we were unable to determine whether this disease constituted a threat to NIDGS. The final study results were published in 2021 (Goldberg et al. 2021, entire). Similar to what was reported in the last status review, the final results suggest that NIDGS may be experiencing low levels of the disease in some individuals that could affect survival, but we cannot determine if this potential stressor rises to the level of a threat that could affect the species (USFWS, 2022).

***Recovery***

**Reclassification Criteria:**
Recovery Priority Number: 2C

**Delisting Criteria:**
Delisting may be considered when the following recovery criteria have been met: 1. Of the 17 potential metapopulations that have been identified within the probable historical distribution, there must be at least 10 metapopulations, each maintaining an average effective population size of greater than 500 individuals for 5 consecutive years (USFWS, 2003).

2. The area occupied by a minimum of 10 potential metapopulations must be protected. In order for an area to be deemed protected, it must be: (1) owned or managed by a government agency with appropriate management standards in place; (2) managed by a conservation organization that identifies maintenance of the subspecies as the primary objective for the area; or, (3) on private lands with a long-term conservation easement or covenant that commits present and future landowners to the perpetuation of the subspecies (USFWS, 2003).

3. Plans have been completed for the continued ecological management of habitats for a minimum of 10 potential metapopulation sites (USFWS, 2003).

4. A post-delisting monitoring plan covering a minimum of 10 potential metapopulation sites has been completed and is ready for implementation (USFWS, 2003).

**Recovery Actions:**
- Protect and increase all extant potential metapopulation sites (USFWS, 2003).
- Establish additional metapopulations and dispersal corridors (USFWS, 2003).
- Develop and execute a population and habitat management plan for each potential metapopulation site (USFWS, 2003).
- Accelerate and complete habitat enhancement projects on the Payette National Forest (USFWS, 2003).
- Develop and implement a transplantation effort to increase genetic diversity in each metapopulation (USFWS, 2003).
- Fully implement a long-term intensive and extensive metapopulation and habitat monitoring plan to evaluate success of recovery efforts (USFWS, 2003).
- Continue surveying efforts to locate new populations (USFWS, 2003).
- Conduct research to fill data gaps to ensure recovery (USFWS, 2003).
- Establish a captive propagation program as a hedge against extinction while wild populations are being reestablished, to provide an additional source for increasing genetic diversity of wild populations, provide a source for establishing new populations, provide research opportunities, and contribute to public education (USFWS, 2003).
- Increase efforts to enhance the outreach program for conservation of the northern Idaho ground squirrel (USFWS, 2003).
- Develop and maintain a comprehensive database to be used for monitoring the success of recovery (USFWS, 2003).
- Establish and maintain an interagency recovery coordinator and technical working group to coordinate recovery efforts (USFWS, 2003).
- Explore and initiate conservation options on private lands (USFWS 2017).

- Revise the Recovery Plan based on recommendations outlined in the 2011 5-year status review (USFWS 2017).
- Continue annual NIDGS population monitoring utilizing the long-term monitoring plan developed (USFWS 2017).
- Revise the existing suitable habitat model for the species, initially developed in 2007, utilizing recently collected annual monitoring and habitat data (USFWS 2017).
- 1. Continue and increase habitat treatments for NIDGSs Given the primary threat continues to be meadow invasion by conifers, additional work is still needed to enhance and maintain habitat for the NIDGS. We encourage the PNF to continue their existing and ongoing efforts to enhance and maintain suitable habitat conditions for NIDGSs on National Forest lands. In addition, we support additional habitat treatments to benefit NIDGSs on non-federal lands (USFWS, 2011).
- 2. Explore and initiate conservation options on private lands As mentioned in the inadequacy of existing regulatory mechanisms, the development of occupied NIDGS habitat on private lands continues to be a threat to the species. Approximately 50% of known occupied habitat occurs on private land (Evans Mack in litt. 2010, p. 5). Options for conservation may include outright acquisition, conservation easements, or long-term Safe Harbor Agreements, such as the 15-year agreement for the OX ranch, signed in 2009, that enrolls 3,150 ha (7,783 ac) of privately owned land (USFWS, 2011).
- 3. Revise the Recovery Plan The NIDGS Technical Working Group requested that the Service update the NIDGS Recovery Plan (NIDGS TWG in litt. 2010, entire). There are several aspects of the 2003 Recovery Plan for NIDGS that need revision that have been identified by the Technical Working Group, including: (1) Identify realistic population targets for recovery; (2) Clarify and/or redefine primary and secondary metapopulation areas; (3) Shift metapopulation site boundaries and re-assign occupied sites to better reflect recovery potential; (4) Provide an enhanced discussion of the role of private lands to recovery; (5) Discuss risks to squirrels that weren't identified initially (e.g. large vehicle traffic); (6) Discuss NIDGS suitable habitat and provide a copy of the suitable habitat model; (7) Expand the Probable Historic Distribution boundary based on new locations of squirrels; and (8) Acknowledge the diminished role of translocation as a recovery tool (NIDGS TWG in litt. 2010, p. 1) (USFWS, 2011).
- 4. Continue the NIDGS coordinator position As part of the 2003 Recovery Plan, recovery measure D (Coordinate the NIDGS Recovery Program), an interagency recovery coordinator position was established in 2003 (USFWS 2003, pp. 26-27). The primary responsibilities for the NIDGS recovery coordinator are to (1) coordinate and integrate ongoing interagency recovery programs, and (2) monitor NIDGS populations (Evans Mack 2010b, p. 1; Evans Mack 2011, p. 3). The coordinator is an IDFG employee, whose work is carried out through an agreement with, and partially funded by, the Service. From October 2008 through September 2010, coordinator accomplishments included; interagency program coordination; technical working group coordination and attendance; providing technical assistance regarding NIDGSs to 16 different agencies and private entities; providing information and education regarding NIDGSs through presentations and media outreach; securing funding for recovery actions; managing NIDGS tabular and spatial data; and, overseeing annual monitoring efforts (Evans Mack 2010b, entire) (USFWS, 2011).
- 5. Continue annual NIDGS population monitoring Since listing in 2000, annual NIDGS population monitoring has been conducted utilizing various methods. Beginning in 2002, population monitoring has been overseen by the NIDGS interagency program coordinator.

In 2004, standardized field protocols were developed for monitoring NIDGS populations (Evans Mack 2004, entire). Protocols are updated as needed, with the latest update occurring in January, 2011 (Evans Mack 2011, entire). Presently, annual population monitoring includes examining demography and population trends at 5 intensive monitoring sites (Evans Mack 2011, p. 3), surveying previously known NIDGS sites to assess NIDGS occupancy, and surveying areas identified as suitable habitat for new populations (Evans Mack 2010a, p. 1) (USFWS, 2011).

- 6. Address information gaps. In their January, 2010 letter to the Service, the NIDGS Technical Working Group identified gaps in knowledge (NIDGS TWG in litt. 2010, entire). They include: a. Diet of northern Idaho ground squirrels and potential effects of forage competition with livestock and Columbian ground squirrels b. Other potential impacts of livestock grazing c. Other potential effects of competition with Columbian ground squirrels d. Monitoring effectiveness of habitat treatments to squirrel recovery, including timing of habitat treatments and maintenance treatments e. The impacts of predators and illegal hunting on northern Idaho ground squirrel populations f. Dispersal patterns and the importance of open habitat corridors for dispersal (USFWS, 2011).
- 7. Develop an updated Population Viability Analysis (PVA) model In 1993, a computer population viability simulation program was constructed utilizing recruitment and death values recorded over 8 years from 1 intensively studied NIDGS population site (Gavin et al. 1999, entire; Sherman and Yensen 1994, entire). Utilizing the variables of no natural immigration, and beginning the population viability analysis with 50 individuals (30 less than the actual population size of 80) the model calculated that all but 1 of 100 population sites would become extinct in 20 years. In 1999, the Service contracted with the U.S. Geological Survey to develop a 2nd population model for NIDGS (Runge 1999, entire). Using the assumptions of a closed population and overwintering survival of the female and pups, this model predicted population extinction within 7 years (using 1999 demographic trend information) if no conservation measures were taken It’s been 12 years since a NIDGS population model was developed and the species has not gone extinct. Many recovery actions have been implemented by the agencies involved in recovery for the species. Information gathered from the annual interagency monitoring of NIDGS populations, demographics, and trends has been used to refine annual population estimates. Utilizing the data gathered from the annual monitoring of NIDGSs, an updated model, such as from a population viability analysis, could prove informative for future recovery planning and prioritization purposes (USFWS, 2011).

***Conservation Measures and Best Management Practices:***

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Continue habitat treatments for NIDGS to address the primary threat to the species – loss of meadow habitat due to conifer forest encroachment. Engage the NIDGS Technical Working Group to develop site-specific plans for these treatments to meet the habitat objectives of active season sites while considering overwintering habitat requirements. 2. Collect native plant seeds, primarily forbs, from NIDGS sites and adjacent areas and explore options to grow out these native seeds. These locally sourced native seeds can then be used to restore NIDGS sites, as needed. 3. Explore and initiate conservation options on private lands. 4. Revise the Recovery Plan based on the SSA and recommendations from the NIDGS Technical Working Group. 5. Develop an MOU with IDFG to outline the IDFG project coordinator and USFWS recovery coordinator roles. 6. Assist IDFG in securing funding for the NIDGS project coordinator position and annual NIDGS surveys (USFWS, 2022)

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# SPECIES ACCOUNT: *Urocyon littoralis catalinae* (Santa Catalina Island Fox)

***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 03/05/2004; California/Nevada Region (R8) (USFWS, 2016)

### Physical Description

The Santa Catalina Island fox (Urocyon littoralis catalinae) is the diminutive relative of the gray fox (U. cinereoargentea), weighing between 1.8 and 3.0 kilograms (kg) (3 and 6 pounds [lb.]), and stands approximately 30 centimeters (cm) (1 foot [ft.]) tall (USFWS 2015a). The island fox has dark pelage and a linear measurement about 25 percent smaller than that of the mainland gray fox. Body length, including head and tail, ranges from 59 to 79 cm (1.9 to 2.6 ft.). Tail length alone ranges from 11 to 29 cm (4.3 to 11.4 inches [in.]). Height at the shoulder is from 12 to 15 cm (4.7 to 5.9 in.) (USFWS 2015b). The dorsal coloration is grayish-white and black, and the base of the ears and sides of the neck and limbs are cinnamon-rufous in color (USFWS 2015a). The tail has a contrasting thin black stripe on the dorsal side, with a mane of stiff hairs. This is the smallest fox species known from the United States. Adult males weigh 2.00 kg (4.4 lb.) on average, and adult females weigh 1.88 kg (4.14 lb.). The chin, lips, nose, and areas around the eyes are lined in black, and the sides of the rostrum are grey. The ears, neck, and sides of the limbs are cinnamon colored. The underside of the tail is a rusty color. Fur color may differ among islands and be highly variable among individuals, ranging from overall greyish to honey brown and red. Island grey foxes molt once a year during the fall months from August to November. At that time, the fur coat fades in color and the fur tips curl at the ends. Young foxes tend to have a paler but thicker dorsal fur coat compared to adults. In addition, the ears are darker in color compared to adult foxes. The Santa Catalina Island fox display sexual dimorphism, with males being heavier and larger than their female counterparts (USFWS 2015a).

### Taxonomy

The island foxes (U. littoralis) are important members of the Urocyon family because they share similar genetic makeup to the mainland grey fox, but have rapidly evolved into a smaller, separate species (NPS 2003). The island fox is the largest of the Channel Islands native mammals, but one of the smallest canid species in the world (NPS 2003). The Santa Catalina Island fox is one of six subspecies of island fox. The other subspecies, all of which inhabit islands off the California coast, are the San Clemente Island fox (U. l. clementae), San Nicolas Island fox (U. l. dickeyi), San Miguel Island fox (U. l. littoralis), Santa Cruz Island fox (U. l. santacruzae), and Santa Rosa Island fox (U. l. santarosae) (USFWS 2015a). The Santa Catalina Island fox is differentiated from other island fox subspecies by morphologic, genetic, and geographic distinctions; each of the six subspecies are limited in range to a single island (69 FR 10335). Genetic information indicates that all island foxes are descended from one colonization event, and can be distinguished by snout size, number of vertebrae, and tail length (USFWS 2015a; NPS 2003).

### Historical Range

The Santa Catalina Island fox range is restricted to the Santa Catalina Island, Los Angeles County, California (USFWS 2015a). Archeological and geological evidence suggests that foxes arrived on the three northern islands about 10,400 to 16,000 years ago, and dispersed to the three southern islands (including Santa Catalina) 2,200 to 4,300 years ago (NatureServe 2015). It is also theorized that Native Americans may have translocated foxes from the northern islands to the southern islands (NatureServe 2015). Together with the fossil record, DNA restriction fragment evidence indicates that San Clemente Island was the first southern Channel Island colonized, probably by immigrants from San Miguel Island. Historically, the population of the Santa Catalina Island fox has been divided by a vertical isthmus, creating an eastern and western subpopulation (USFWS 2015a).

**Current Range**

Currently, Santa Catalina Island fox is endemic to Santa Catalina Island, where it occupies approximately 35 square kilometers (km2) (less than about 22 square miles [sq. mi.]) (NatureServe 2015). By 1994, Santa Catalina Island fox population had increased to an estimated 1,342 individuals. However, the population experienced catastrophic decline of more than 90 percent from 1999 to 2000, when it was estimated at fewer than 100 individuals. Recovery has occurred fairly quickly, with the total population in 2013 estimated at 1,852 individuals, of which 1,594 were adults (USFWS 2015a).

**Distinct Population Segments Defined**

No

**Critical Habitat Designated**

No;

***Life History***

**Feeding Narrative**

Adult: Island foxes consume a wide variety of insects, such as grasshoppers, katydid, and Jerusalem crickets (Stenopelmatus fuscus) when they are seasonally available. They have also been known to prey on deer mice (Peromyscus maniculatus), house mice (Mus musculus), and introduced rodent species like black rats (Rattus rattus). As a solitary hunter, the island fox depends on stealth and agility to apprehend its prey (CIPF 2006). Like other species of fox, adults will co-forage with pups until they are self-sufficient, at approximately 4 to 5 months of age (USFWS 2015). Deer mice (Peromyscus maniculatus) are an important food resource during the breeding season, because they are an energy-rich food source that adult foxes can bring back to their pups. In addition to insects and mammals, island foxes have been known to prey on ground-nesting birds, such as horned larks (Eremophila alpestris) and western meadowlarks (Sturnella neglecta). Less commonly in the island fox diet are amphibians, reptiles, and the carrion of marine mammals. In addition to insectivorous and carnivorous appetite, the island fox also forages on native plants such as that of the summer holly (Comarostaphylis sp.), toyon (Heteromeles sp.), beavertail cactus (Opuntia sp.), stone fruit (Prunus sp.), rose (Rosa sp.), nightshade (Solanum sp.), huckleberry (Vaccinium sp.), and manzanita (Arctostaphylos sp.) genera (USFWS 2015). Island foxes have been in direct competition with feral cats, who are known to be more ravenous and aggressive than island foxes (USFWS 2015).

**Reproduction Narrative**

Adult: Island fox courtship activities occur from late January to early March, and breeding occurs once per year between February and early March. Following gestation for 50 to 53 days, a litter of one to five pups (typically two) is born between late April and May (NatureServe 2015). In a captive breeding program, the observed average litter size was 2.4 (USFWS 2015). Island foxes give birth to their young under shrubs in dens, or in the side of ravines (USFWS 2015). Young foxes depend on their parents to provide shelter during the early stages of parental care. Both parents display a high level of parental care, foraging for their young and keeping them close throughout the summer months until August or September. Their shelters, commonly known as canid compounds, consist of multi-entrance tunnels, leading to intertwining chambers for quick entry and exit. Island foxes require habitat with dense topsoil to create dens (USFWS 2015).Deer mice (Peromyscus maniculatus) are important food items during the period of weaning and pup growth (NPS 2003). Some pups stay in their natal territory for up to 2 years, and others disperse earlier (USFWS 2015). Reproductive success is low for the species, reducing the chance for populations to recover following catastrophic decline (NPS 2003). In addition, the species lifespan is short, between 5 and 10 years. Most breeding involves older animals. On San Miguel Island, only 16 percent of juvenile females bred over a 5-year period, in contrast to 60 percent of older females (NPS 2003).

**Geographic or Habitat Restraints or Barriers**

Adult: Low vegetation types present less coverage and may render foxes more vulnerable to predation (USFWS 2015). They have also been known to avoid ravines and nonnative grasslands, because of difficult foraging conditions The Santa Catalina Island is surrounded by water, a geographical barrier. The distance between islands make it unlikely to access new quality habitat on neighboring islands (USFWS 2015).

**Spatial Arrangements of the Population**

Adult: Random (USFWS 2015).

**Environmental Specificity**

Adult: Broad/generalist; community with key requirements common.

**Tolerance Ranges/Thresholds**

Adult: Moderate

**Site Fidelity**

Adult: High

**Dependency on Other Individuals or Species for Habitat**

Adult: Observed territory configuration changes after the death and replacement of paired male foxes, but not after the death and replacement of paired females or juveniles, indicating that adult males are involved in territory formation and maintenance (USFWS 2015). Island foxes rely on the abandoned burrows of other species for shelter. These foxes often salvage pre dug holes (NPS 2003).

**Habitat Narrative**

Adult: Santa Catalina Island foxes are habitat generalists; they occupy a wide range of topography, with habitat preferences that include valley and foothill native grasslands, southern coastal dunes, coastal sage scrub, coastal bluff, island chaparral, maritime cactus scrub, southern coastal oak woodland, southern riparian woodland, pine forests, and coastal marsh habitat types. Other island fox subspecies have been known to avoid ravines and scrub oak patches. In addition, island foxes may use grasslands less than other habitats, even though insect prey is abundant in grasslands, because grasslands are denser and may be more difficult to forage in, and more vulnerable to aerial predation (USFWS 2015).Santa Catalina Island foxes require hollow structures, including ground holes, hollow trees, rock piles, shrubs, caves, and manmade structures for dens. If a fox is unable to find a suitable pre-hollowed area, it will dig a deep hole in the ground. These holes, called dens, serve as protection from predators, harsh weather conditions, and other dangers. Some dens start from burrows of other species, and some are created by the island foxes themselves (NPS 2003). The canid dens can consist of multi-entry complexes.Their designated territories are marked with feces and urine. Observed territory configuration changes after the death and replacement of paired male foxes, but not after the death and replacement of paired females or juveniles. This indicates that adult males play an important role in territory formation and maintenance (USFWS 2015).The USFWS did not designate any critical habitat for the island fox because: 1) the island fox is a habitat generalist and an opportunistic omnivore; 2) prior to predation by golden eagles and the outbreak of disease, habitat did not appear to be a limiting factor despite human-induced habitat changes; and 3) the primary reasons for the listing of the fox were predation and disease (USFWS 2015).

***Dispersal/Migration***

**Motility/Mobility**

Adult: Moderate

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: Nonmigratory (NatureServe 2015).

**Dispersal**

Adult: Low

**Immigration/Emigration**

Adult: No

**Dependency on Other Individuals or Species for Dispersal**

Adult: No

**Dispersal/Migration Narrative**

Adult: Santa Catalina foxes have moderate mobility and are nonmigratory canid species. They have been observed to have low dispersal and no immigration/emigration, due to their geographic isolation (USFWS 2015), with a home range of 0.80 to 1.6 kilometers (0.5 to 1.0 mile) (NPS 2003). The two subpopulations of Santa Catalina Island foxes are separated by an isthmus on the island, lessening potential dispersal and home range (NPS 2003). The island fox's territory is marked by feces and urine and can move location throughout the fox's lifetime (NPS 2003).Island foxes are known to have extended parental care, with the male fox playing an important role in the rearing of the young (NPS 2003). Some pups disperse at 7 months, while others remain on their natal territories into their second year (NPS 2003). Island foxes have small territories with high densities and shorter dispersal distances than the mainland gray fox (U. cinereoargentea). The home range and size configuration of the island fox is dependent on landscape features, fox population density, resource distribution, sex of the animal, habitat type, and season. Males are more involved in territory formation and maintenance than female foxes. Recorded home ranges of other subspecies of island fox varied from 0.15 to 0.87 km2 (0.06 to 0.34 sq. mi.), and averaged 0.55 km2 (0.21 sq. mi.) in size during a period of moderate to high fox density (equivalent to seven island foxes per km2 [18 per sq. mi.], from Santa Cruz Island and San Clemente Island) (USFWS 2015).

**Additional Life History Information**

Adult: Island foxes have small territories with high densities and shorter dispersal distances than the mainland gray fox (U. cinereoargentea). The home range and size configuration of the island fox is dependent on landscape features, fox population density, resource distribution, sex of the animal, habitat type, and season. Males are more involved in territory formation and maintenance than female foxes. Recorded home ranges of other subspecies of island fox varied from 0.15 to 0.87 km2 (0.06 to 0.34 sq. mi.), and averaged 0.55 km2 (0.21 sq. mi.) in size during a period of moderate to high fox density (equivalent to seven island foxes per km2 [18 per sq. mi.], from Santa Cruz Island and San Clemente Island) (USFWS 2015).

***Population Information and Trends***

**Population Trends:**

Decreasing (NatureServe 2015)

**Species Trends:**

Decreasing; due to the introduction of CDV (USFWS 2015).

**Population Growth Rate:**

Declining (USFWS 2015)

**Number of Populations:**

One extant population; two subpopulations (NPS 2003; NatureServe 2015).

**Population Size:**

Estimated at 1,665 individuals (USFWS 2022).

**Minimum Viable Population Size:**

The minimum viable population size is undescribed; however, the carrying capacity of Santa Catalina Island is approximately 1,500 foxes. Although not specified for the Southern Channel Islands, captive breeding programs modeled for the Northern Channel Islands required an on-island captive population of 20 breeding pairs (USFWS 2015).

**Resistance to Disease:**

Low

**Adaptability:**

Low

**Additional Population-level Information:**

The Santa Catalina Island fox population is composed of two subpopulations that are separated by an isthmus, with the eastern subpopulation at greater risk of extinction (due to CDV) than the western subpopulation (NPS 2003). Efficacy of CDV vaccines and application On June 24, 2022, USFWS and CIC biologists met with Deana Clifford, Senior Wildlife Veterinarian with the California Department of Fish and Wildlife to discuss vaccine efficacy and other CAIF related issues. Here are talking points from the working group discussion: 1. Estimates of the Purevax® efficacy in CAIF are based on resulting antibody titer levels; no challenge tests have been performed on Urocyon littoralis individuals. However, titer levels are considered a valid indicator of probable vaccine efficacy for island foxes, because efficacy has been demonstrated via challenge tests in ferrets and Siberian polecat (Mustela eversmanni) (Wimsat et al. 2003, entire). 2. Antibody titer levels produced by the Purevax® vaccine drop significantly after 1 year, necessitating annual boosters (Clifford 2022a, pers. comm.). 3. Wimsat et al. 2003 (p. 25) estimated efficacy of Purevax at 50 to 83 percent in Siberian polecats, a highly susceptible species. Given island foxes are also highly susceptible to morbidity and mortality from CDV, it is expected that efficacy would be similar (Clifford 2022b, pers. comm.). 4. The Purevax® vaccine is hypothesized to provide superior protection to foxes compared to Recombitek® vaccine, primarily because Purevax® contains a higher load of viral antigen material (Clifford 2022b, pers. comm.; see also Wright et al. 2022, entire). 5. The reason for assay results indicating low CDV antibody titer levels in some unvaccinated CAIF reported by the CIC are not certain. Other than loss of identification pit tags by vaccinated animals, hypothesized explanations include: (a) cross-reaction with non-distemper viral antibodies; (b) a testing artifact; and (c) presence of an endemic distemper virus strain with low pathogenicity. The assumption that CDV is not present on the island is based on lack of documented morbidities/mortalities due to CDV. The CAIF is very sensitive to CDV, so if the virus was present on the island, the CIC would likely be detecting mortalities from CDV (Clifford 2022b, pers. comm.). 6. A veterinary representative at the manufacturer spoke with veterinarians in the island fox health working group and noted that it is possible to freeze Purevax® vaccine doses for up to a year and retain viability (Clifford 2022b, pers. comm.; Island Fox Conservation Working Group 2016, slide 3). The CIC staff in attendance were not aware of that and said they would start freezing the leftover/extra doses to create an emergency stockpile (Hamblin 2022a, pers. comm.). 7. The CIC does not currently employ a vaccine "firewall" strategy, where all animals in a geographic area likely to be exposed (a site of likely vector arrival/disease introduction) are vaccinated to prevent disease spreading to the rest of the population. Basically, such a firewall strategy could increase the efficacy of vaccinations at the population level. They said they would consider this strategy (Hamblin 2022a, pers. comm.) (USFWS, 2022).

**Population Narrative:**

The Santa Catalina Island fox population is composed of two subpopulations that are separated by a vertical isthmus, with the eastern subpopulation at greater risk of extinction, specifically from CDV, than the western subpopulation (NPS 2003). Although the risk of extinction is greater for the easternmost foxes, the entire population is steadily declining due to interactions with humans, disease, competition with feral cats, and loss of genetic diversity (USFWS 2015). With low resiliency, representation, and redundancy, the Santa Catalina Island fox is critically imperiled, facing the threat of near extinction (USFWS 2015).Densities between 1988 and 1991 ranged from 2.6 island foxes per km2 (6.7 per sq. mi.) in grassland to 12.7 island foxes per km2 (32.9 per sq. mi.) in scrub/dune habitats. By the mid-90s, Santa Catalina Island fox populations had increased to an estimated 1,342 individuals. However, the population experienced catastrophic decline of more than 90 percent from 1999 to 2000, when it was estimated at fewer than 100 individuals. Recovery has occurred fairly quickly, with the total population in 2013 estimated at 1,852 individuals, of which 1,594 were adults (USFWS 2015). If recovery criteria are met, the Santa Catalina Island fox could be recovered by 2024, with an estimated carrying capacity of 1,500 foxes, or 20 breeding pairs (USFWS 2015). The CIC used Program Mark to calculate annual survival over the 2020-2021 biological year (May–April) using data from radio-collared foxes. They estimated an island-wide population of foxes for 2021 at 1,665 that included all-ages and a density of 8.58 foxes/km2 (3.3 foxes/mi2 ); with adults only, the density was 7.14 foxes/km2 (2.8 foxes/mi2 ). Annual survival was estimated at 93 percent (standard error = 0.028, 95 percent confidence interval = 80–98 percent), up from the annual survival in 2019 and 2020 (87 and 92 percent). The 3-year average for survival between 2019–2021 was 91 percent (Hamblen and Henk 2022, pp. 15–17). The estimated population size decreased by 9 percent since the last status review, from 1,812 in 2015 (King and Duncan 2016, p. 10) to 1,665 in 2021 (Hamblen and Henk 2022, p. 16); however, there is no reason to believe the decrease in population size represents a trend. The “Island Fox Recovery Tracking Tool” is used to calculate a quasi-extinction risk estimate (USFWS 2015b, Appendix 2). The mean population size (adults only) estimated for 2020–2021 was 1,413, and the average mortality was estimated at 12 percent. The quasi-extinction risk estimate was slightly higher than it was in the last status review (per reduced population size). However, this was the 14th consecutive year where the 3-year average of mortality rate and population size (80 percent CI) fell below a 5 percent extinction risk over 50 years; see Figure 1 for different extinction risks over time based on varying adult mortality (Figure 1; Hamblen and Henk 2022, p. 18) (USFWS, 2022).

***Threats and Stressors***

**Stressor:** The threat of disease, such as that posed by ear tumors and canine distemper virus (CDT)
**Exposure:** Direct; potential for pathogen introduction from the movement of wild and domestic mammals.
**Response:** Reduced fitness; inability to compete for resources, find mates, and defend territory.
**Consequence:** High mortality rates.
**Narrative:** The threat of disease, such as ear tumors and canine distemper virus (CDV), is a continued concern for the Santa Catalina Island fox. The catastrophic decline on Santa Catalina was caused by CDV. The recent finding of ear tumors in Santa Catalina Island foxes, confirmed to be a source of mortality in wild foxes, is of high enough frequency to be considered a concern. The response to decreased fitness leads to an inability to compete for resources, find mates, and defend territory. Island foxes on all islands are vaccinated against CDV and rabies, the two diseases for which active mitigation measures could not be implemented in a timely manner once an outbreak was detected. The number of foxes vaccinated on each island is generally the number required to start a captive breeding program (75 to 100), were the population to be affected by an epidemic . Disease remains a concern for Santa Catalina Island foxes, because the island has high accessibility and a sizable human population (USFWS 2015).

**Stressor:** Competition with feral cats
**Exposure:** Direct
**Response:** Increased incidence of competition with feral cats leads to starvation and decreased viability.
**Consequence:** Death of individuals and greatly reduced populations.
**Narrative:** Competition with feral cats has led to starvation of juvenile foxes, increasing mortality rates, and a reduction in overall population numbers. The introduction of feral cats to the island has greatly disrupted the ecosystem for native predators (USFWS 2015).

**Stressor:** Mortality or injury from vehicular strikes
**Exposure:** Direct
**Response:** Reduced population size; less dispersal potential.
**Consequence:** Reduction in population numbers; decreased reproductive success; and higher susceptibility to mortality/extirpation.
**Narrative:** Death from vehicle collision on roads is the largest known source of mortality on San Clemente Islands, account for a minimum of 26 foxes per year between the years 1991 and 1995. Between 2003 and 2007, the annual average of foxes killed by vehicles was 4 per year, but the number of foxes killed has increased in the past several years as the fox numbers have increased: in 2011, 16 foxes were killed by vehicles, and in 2013, 12 foxes were killed by vehicles. It is likely that some foxes were hit and later succumbed to their injuries, or that there are juveniles who did not survive following the death of the mother. Because there is not have a method to document this type of mortality, the actual annual mortality due to vehicles is likely higher. Road mortality may impact island fox population dynamics (USFWS 2015).

**Stressor:** Inbreeding, loss of adaptive potential, loss of heterozygosity, and small population size
**Exposure:** Direct, indirect.
**Response:** Decrease in heterogeneity, population bottleneck.
**Consequence:** Reduction in population numbers, decreased reproductive success, increased genetic effects of population bottleneck, higher susceptibility to mortality/extirpation.
**Narrative:** Inbreeding and loss of heterozygosity have the potential to affect viability-related fitness traits in island foxes. Loss of genetic variation (adaptive potential) significantly affects the likelihood of persistence of the island fox over longer time frames (USFWS 2015).

**Stressor:** Habitat or range destruction, modification, or curtailment
**Exposure:** Indirect
**Response:** Decreased home range, increased interaction between foxes and humans.
**Consequence:** Increased mortality.
**Narrative:** Destruction, modification, or curtailment of habitat or range has a large effect on the success of island fox populations. The frequent interactions with domestic animals and humans has reduced home range and increased incidental mortalities of island foxes (USFWS 2015).

***Recovery***

**Reclassification Criteria:**
The following conditions would most likely result in a determination that downlisting of the Santa Catalina Island fox is warranted:

Santa Catalina Island fox exhibits demographic characteristics consistent with long-term viability, meaning it has no more than a 5 percent risk of quasi-extinction over a 50-year period. 1. Quasi-extinction is a population size of fewer than 30 individuals. 2. The risk of extinction is calculated based on a combined 90 percent confidence interval for a 3-year running average of population size estimates. 3. Five percent or less at risk is sustained for at least 5 years, during which time the population trend is not declining (USFWS 2015).

Recovery Priority Number: 9

**Delisting Criteria:**
In addition to the reclassification criteria, the following conditions would mostly likely result in a determination that delisting the Santa Catalina Island fox is warranted:

Land managers are able to respond in a timely fashion to potential or incipient disease outbreaks, and to other identified threats, using the best available technology. A disease management strategy is developed, approved, and implemented by the land manager(s) in collaboration with USFWS, including review by the appropriate Integrated Island Fox Recovery Team Technical Expertise Group or the equivalent. This strategy must include: 1. Identification of a portion of Santa Catalina Island fox that will be vaccinated against CDV and rabies, the diseases posing the greatest risk and for which vaccines are safe, effective, and available. Vaccinations to be provided and numbers vaccinated will be developed in consultation with appropriate subject-matter experts; 2. Identification of actual and potential pathogens of island foxes, and the means by which these can be prevented from decimating fox populations; 3. Measures to prevent diseases in island foxes; 4. A monitoring program that provides for timely detection of a disease outbreak, and an associated emergency response strategy as recommended by the appropriate subject-matter experts; and 5. A process for updating the disease management strategy as new information arises (USFWS 2015).

**Recovery Actions:**
- Reduce mortality for each subspecies of island fox to ensure that populations persist at sustainable levels (USFWS 2015).
- Conduct captive breeding and reintroduction of island foxes to increase population size (USFWS 2015).
- Establish island fox monitoring strategies (USFWS 2015).
- The long-term conservation strategy identifies actions that would further the conservation of the island fox. At this time, these activities are not essential for preventing extinction and are not required for downlisting or delisting a particular island fox subspecies; however, these activities could substantially enhance the long-term conservation of the species and may also increase our scientific understanding of the island fox. The USFWS has identified the following long-term conservation actions:
- Establish a mainland captive island fox population on which to conduct research to better understand fox behavior, ecology, reproduction, disease, and vaccine efficacy (USFWS 2015).
- Establish, expand, and continue island fox education and outreach programs (USFWS 2015).
- Assessing the demographic impact of other threats such as mortality from vehicle strikes, competition with feral cats, and emerging disease issues (USFWS 2015).
- Restoring island habitat (USFWS 2015).
- Establishment of conservation agreements (USFWS 2015).
-

***Conservation Measures and Best Management Practices:***
- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be initiated over the next 5 years. Successful implementation of these actions will reduce threats to CAIF and provide information to better understand the biological and physical factors limiting population growth and distribution. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current disease threats and

aid future restoration efforts. 1. Start freezing excess Purevax® vaccine doses annually and store in CIC facility to provide a stockpile to help reduce vaccine costs. Antibody titer levels in captive or freeranging island foxes administered previously frozen vaccine should be compared to existing titer data for vaccinated individuals. 2. Develop methods for enhancing public awareness and support for island fox recovery to reduce the potential for pathogen introduction to Santa Catalina Island from the movement of wild (i.e., racoons) and domestic mammals (i.e., dogs). This could be achieved via outreach and signage targeting the public who travel to Santa Catalina Island: through harbors, travel agencies, ferry companies, private airports, etc. 3. Initiate establishment of endowments or secure other sources of funding to (a) support adequate future vaccine purchases, (b) increase the number of monitored sentinel foxes, and (c) implement other protective measures as needed. 4. Optimize the frequency of sentinel monitoring and the number of radio-collared sentinel foxes to minimize the detection time of an epidemic and ensure a lower percentage of the CAIF population is infected at the time of detection. 5. Work to reduce the likelihood of introducing disease vectors at high-risk sites. Evaluate the use of one or more vaccination firewalls in areas where the likelihood of vector/pathogen entry and the CAIF density combined would remain relatively high. 6. Investigate combining regulation of possible wild and domestic vector introduction and a vaccine firewall at the isthmus to protect the west side of the island as a refugia from CDV infection. 7. Work with island partners to establish a Habitat Conservation Plan that will include minimization measures to reduce potential adverse effects to CAIF associated with tourism (e.g., pet transport), vehicle travel, habitat modification, construction activities, and recreational use of Santa Catalina Island. Also investigate the ability of establishing vaccination requirements, quarantine periods, or other guidelines that will reduce risk associated with pet travel to the island (USFWS, 2022).

***Additional Threshold Information:***

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# SPECIES ACCOUNT: *Vulpes macrotis mutica* (San Joaquin kit fox)

***Species Taxonomic and Listing Information***

**Commonly-used Acronym:** SJKF

**Listing Status:** Endangered; March 11, 1967 (32 FR 4001). Listed under the Endangered Species Preservation Act in 1967 (USFWS 2010).

**Physical Description**

The San Joaquin kit fox (Vulpes macrotis mutica), is the larger of two subspecies of the kit fox, the smallest canid species in North America. The San Joaquin kit fox, on average, stands about 30 centimeters (cm) (12 inches [in.]) high at the shoulder. The average weight of adult males is 2.3 kilograms (kg) (5 pounds [lbs.]), and of adult females is 2.1 kg (4.6 lbs.). It has a small slim body, large close-set ears, a narrow nose, and a long bushy tail that tapers at the tip. Depending on location and season, the fur coat of the kit fox varies in color and texture from buff to tan or yellowish-grey. The tail is distinctly black-tipped (USFWS 2010).

**Taxonomy**

The San Joaquin kit fox, V. m. mutica, was first described in 1902. Eight subspecies were recognized historically. Today, only V. m. macrotis and V. m. mutica are recognized subspecies (USFWS 1998). Recent genetic information supports the designation of swift (V. velox) and kit fox (V. macrotis) as separate species, while supporting the categorization of the San Joaquin kit fox as a subspecies (USFWS 2010). Because all three fox species that occur in the San Joaquin Valley are primarily nocturnal, identification of these free-living and often fast-moving animals can be a challenge. The black-tipped tail and coat color differences usually distinguish kit foxes from red foxes (V. vulpes). At 4 to 5 kg (8 to 11 lbs.), the red fox also is much heavier than the kit fox. Gray foxes (Urocyon cinereoargenteus), however, are sometimes misidentified as kit foxes, especially in winter when the kit fox coat is thicker and has more gray. Both species have a black tail tip, but gray foxes also have a distinctive black stripe running along the top of the tail. Gray foxes are more robust than kit foxes; they are heavier, with an average body weight of about 3.6 kg (8 lbs.). However, San Joaquin kit foxes have longer ears, averaging 8.6 cm (3.4 in.) compared with 7.8 cm (3 in.) for gray foxes (USFWS 1998).

**Historical Range**

The subspecies historically ranged in alkali scrub/shrub and arid grasslands throughout the level terrain of the San Joaquin Valley floor, from southern Kern County north to Tracy in San Joaquin County, on the western side of the valley, and up into more gradual slopes of the surrounding foothills and adjoining valleys of the interior Coast Range (USFWS 2010). On the eastern side of the valley, the historic range extended to La Grange, Stanislaus County. By 1930, it was estimated that the kit fox range had been reduced by more than half, with the largest portion of the range remaining in the southern and western parts of the valley (USFWS 1998).

**Current Range**

San Joaquin kit fox inhabited a portion, but not all, of the areas of suitable habitat remaining in the San Joaquin Valley and lower foothills of the coastal ranges and the Sierra Nevada and Tehachapi mountains. The boundaries of the kit fox’s range still extended from southern Kern County north to Contra Costa, Alameda, and San Joaquin counties on the western side of the valley; and to the La Grange area, Stanislaus County, on the eastern side of the valley. Populations have persisted throughout the western portion of the San Joaquin Valley south of San Luis Reservoir to the Buena Vista Valley, in the Panoche and Cuyama Valleys, and Carrizo Plain. Populations also continue to persist in the central portion of the Valley around Kern NWR and Semitropic Ecological Reserve, in Bakersfield, and in the southeastern portion of the Valley north to Porterville. The largest extant populations are known from western Kern County, on and around the Elk Hills area and Buena Vista Valley; and the nearby Carrizo Plain Natural Area, where relatively level terrain is separated by narrow rugged ranges (USFWS 1998; USFWS 2010; USFWS 2020).

**Distinct Population Segments Defined**

N/A; Distinct Population Segments are limited to species, and the San Joaquin kit fox is categorized as a subspecies (USFWS 2010).

**Critical Habitat Designated**

No;

***Life History***

**Feeding Narrative**

Adult: The kit fox was thought to subsist primarily on kangaroo rats (Dipodomys spp.), and historically populations appear to be most robust where kangaroo rats persist. Studies have shown that kangaroo rat remains comprised 80 to 90 percent of fecal material at most collecting sites throughout the range of the kit fox. During several years of drought, seed resources for granivorous rodents such as kangaroo rats become scarce, resulting in declining abundance of these kit fox prey species. Local extirpation of kit fox communities has also been linked to the previous loss of kangaroo rat populations. High rainfall events also are known to reduce prey abundance dramatically. The kit fox diet currently varies geographically, seasonally, and annually. It includes nocturnal rodents such as kangaroo rats, white-footed mice and pocket mice (Peromyscus spp.), California ground squirrels (Spermophilus beecheyi), rabbits (Sylvilagus spp.) and hares (Lepus spp.), San Joaquin antelope squirrels (Ammospermophilus nelsoni), and ground-nesting birds. Insects appear to be important seasonal prey items for at least some populations. California ground squirrels were found to be the most common prey item in the Bethany Reservoir area of Alameda County. No kangaroo rats were detected at this site; ground squirrels have also been important food items in some areas where kangaroo rats appeared to be abundant, although the relative density of kangaroo rats in these areas is not known. In eastern Contra Costa County, a crash in the kit fox population was associated with extirpation of the California ground squirrel due to a ground squirrel eradication program. In the Bakersfield vicinity, urban kit foxes have access to anthropogenic food resources to supplement available natural prey, so food is generally abundant and kit fox abundance shows little inter-annual variation (USFWS 2010).In addition, vegetation occurs frequently in feces. Grass is the most commonly ingested plant material (USFWS 1998). In some locations, coyotes only infrequently consume the kit fox they kill, suggesting that coyote attacks are competitive interactions that can include prey consumption rather than a strict predator-prey interaction. The diets and habitats selected by coyotes and kit fox often overlap. Increases in coyote abundance may be a causal factor in past local kit fox declines (USFWS 2010).

**Reproduction Narrative**

Adult: During September and October, adult females begin to clean and enlarge natal or pupping dens. Mating occurs in typically in late December or early January, but can occur as late as March, and young are typically born in February or March. Although some yearling female kit fox will produce young, most do not reproduce until 2 years of age. The median gestation period is estimated to range from 48 to 52 days. Typically, females give birth to two to six pups. The young are born in large natal dens; dens are essential for the survival and reproduction, because the kit fox use them year-round for temperature regulation, shelter from adverse environmental conditions, reproduction, rearing young, and escape from predators. The female is rarely seen hunting during the time she is lactating. During this period, the male provides most of the food for her and the pups. The pups emerge above ground at slightly more than 1 month of age. After 4 to 5 months, usually in August or September, the family bonds begin to dissolve and the young begin dispersing. Occasionally, a juvenile female will remain with the adult female for several more months. Offspring of both sexes sometimes remain with their parents through the following year and help raise a subsequent litter. Reproductive success appears to be correlated with prey abundance. Starvation, especially of pups, was noted to be a likely limiting factor for kit fox populations (USFWS 1998; USFWS 2010).Kit fox exhibit a perennial monogamous social system with generally life-long pair bonds. Kit foxes form pair-mates throughout the year, and the pair-mates continue to associate throughout the year, not just during breeding and pup raising. Pair-bond duration is therefore generally for more than a year; pair-mates that survive to the next breeding season generally remain together. Loss of pairs-mates to mortality, typically due to predation, accounted for dissolution of most pair bonds – due to high mortality rates, few pairs would be expected to last more than three breeding seasons. Red foxes live an average of 8 years; they are more fecund than kit foxes. Kit foxes live an average of 2 years, but may live for 7 or more years, and produce fewer offspring (USFWS 2010). Kit fox in natural habitats generally suffer from high mortality rates due to interference competition from coyote. This social system is determined to increase fitness by enhancing survival and reproductive success in these nonmigratory, territory-holding animals. Remaining on a well-known territory with familiar den locations has been shown to decrease predation risk (USFWS 2010).

**Geographic or Habitat Restraints or Barriers**

Adult: Loss, degradation, and fragmentation of habitat. Studies have shown that kit fox presence is generally negatively associated with ruggedness; kit fox are apparently excluded from steeper terrain by combined factors that influence detection of and increase kit fox susceptibility to predators, especially coyotes, that use these areas and that constitute a significant source of kit fox mortality (USFWS 2010).

**Spatial Arrangements of the Population**

Adult: Clumped

**Environmental Specificity**

Adult: Moderate

**Tolerance Ranges/Thresholds**

Adult: Moderate

**Site Fidelity**

Adult: High

**Dependency on Other Individuals or Species for Habitat**

Adult: San Joaquin kit foxes often enlarge burrows dug by other animals and can be found denning in manmade structures such as pipes and culverts (USFWS 1998, USFWS 2020).

**Habitat Narrative**

Adult: Kit fox are an arid-land-adapted species and typically occur in desert-like habitats in North America. Such areas have been characterized by sparse or absent shrub cover, sparse ground cover, and short vegetative structure. Kit foxes have been associated with areas having open, level, sandy ground that is relatively stone-free to depths of about 1 to 1.4 meters (m) (3 to 4.5 feet [ft.]). San Joaquin kit fox are absent or scarce in areas where soils are shallow due to high water tables, impenetrable hardpans, or proximity to parent material, such as bedrock (USFWS 2010). Studies have shown that kit fox presence is generally negatively associated with ruggedness; kit fox are apparently excluded from steeper terrain by combined factors that influence detection of and increase kit fox susceptibility to predators, especially coyotes, that use these areas and that constitute a significant source of kit fox mortality. Current understanding of kit fox habitat indicates that habitat with slopes of less than 5 percent is optimal for the kit fox, and habitat having slopes of greater than 15 percent is unsuitable. At one site, kit foxes were found to be more abundant, and to live the longest when they were located in relatively flat or rolling terrain, suggesting that such terrain likely has the most potential for sustaining viable populations of the species. Highly suitable habitat, consisting of arid scrub and grassland habitats with relatively sparse vegetative cover and slopes under 5 percent, was found to be highly fragmented, with many patches either too small or too isolated to support viable kit fox populations (USFWS 2010).San Joaquin kit foxes use dens for temperature regulation, shelter from adverse environmental conditions, reproduction, and escape from predators. Though kit foxes are reputed to be poor diggers, the complexity and depth of their dens do not support this assessment. Kit foxes also modify and use dens constructed by other animals, such as ground squirrels, badgers, and coyotes, and human-made structures (culverts, abandoned pipelines, and banks in sumps or roadbeds). Den characteristics vary across the San Joaquin kit fox's geographic range. In the southernmost portion, dens with two entrances are most frequently found. Natal and pupping dens, in which pups are born and raised, tend to be larger and have more entrances. Entrances are usually from 20 to 25 cm (8 to 10 in.) in diameter, and normally are higher than wide. Ramp-shaped mounds of dirt from 1 to 2 m (3 to 6 ft.) long are deposited at some den entrances. Kit foxes often change dens, and numerous dens may be used throughout the year (USFWS 1998).Kit foxes establish home ranges that are extensive, but home range sizes vary among locations. Home range size is thought to be related to prey abundance. In the Bakersfield vicinity, kit fox selection of den sites appears to be associated with areas of open space, or areas having light or infrequent disturbance, such as canal rights-of-way and detention basins. Urban kit foxes have access to anthropogenic food sources, and kit foxes in this urban area have smaller home ranges than those in nonurban areas. Kit foxes are also found in the arid and alkaline foothill areas along the western edge and southern part of the San Joaquin Valley, with dominant plant species including saltbush (Atriplex polycarpa), iodine bush (Allenrolfea occidentalis), tumbleweed (Amaranthus albus), alkali heath (Frankenia salina), and pickleweed (Salicornia subterminalis) widely spaced. Areas in which iodine bush was predominant were known to be poorly drained areas that did not support kangaroo rats and were not apparently used by the kit fox. In the period since listing, studies in various areas of the state have examined kit fox use of and persistence in other habitat types, including grasslands and altered habitat, although information on preferred vegetative types has not changed (USFWS 2010).A study of seven radio-collared kit fox that were radiotracked for up to 14 months has indicated that kit fox are unable to occupy farmland on a long-term basis. Agricultural lands do not provide suitable habitat for the kit fox for a variety of reasons. Lands producing row crops are subjected to weekly inundation during irrigation, which impedes kit fox foraging and precludes the establishment, maintenance, and use, of earthen dens. Prey abundance is relatively low in row crops, prey diversity is reduced, prey species composition changes, and favored prey species such as kangaroo rats disappear (USFWS 2010).

***Dispersal/Migration***

**Motility/Mobility**

Adult: High

**Migratory vs Non-migratory vs Seasonal Movements**

Adult: Nonmigratory (NatureServe 2015)

**Dispersal**

Adult: Young disperse from June to October. Average dispersal was 1.9 to 19.3 kilometers (km) (1.2 to 12 miles [mi.]) in one study; another found that the average dispersal was 7.7 km (4.8 mi.) (USFWS 2010, USFWS 2020).

**Immigration/Emigration**

Adult: Immigration/emigration.

**Dispersal/Migration Narrative**

Adult: San Joaquin kit fox are nonmigratory but appear to disperse readily throughout the range. Kit fox are highly reliant on successful dispersal from population strongholds into suitable habitat to sustain subpopulations. Young typically disperse from June through October , when they are 4 or 5 months old. Successful dispersal appears to be a key factor for the recovery and survival of kit fox, in large part because kit fox populations are becoming more fragmented and are thought to be approaching a metapopulation structure wherein local subpopulations occupy patches of suitable habitat and use the intervening habitat only for movement from one patch to another. Successful dispersal among subpopulations is often thought to maintain genetic diversity, and to rescue declining populations and prevent extinction. However, dispersal does have associated costs that may negatively affect species survival in fragmented landscapes. For the kit fox, animals traveling to unfamiliar areas are more vulnerable to predation, and dispersing juveniles have been shown to suffer high mortality when traveling outside their natal territory. During a 6-year study at the Elk Hills Naval Petroleum Reserves in California (NPRC), pups dispersed an average of 8 ± 1.4 km (5 ± 0.9 mi.), but the maximum reported distances can vary considerably. One individual traveled 40 km (25 mi.) from its whelping den (USFWS 1998; USFWS 2010).Home range size reflects prey abundance and varies with location and from year to year. Based on several studies, adult home ranges average around 400 to 2,340 hectares (ha) (988 to 5,782 acres [ac.]) (NatureServe 2015). Historically, there was high gene flow among San Joaquin kit fox populations, although additional studies are needed to determine levels of gene flow among subpopulations. Demographic research has suggested that some kit fox populations may be at considerable risk of loss of fitness due to inbreeding depression, even though they may be at greater risk of local extirpation due to either demographic or environmental stochasticity (USFWS 1998, USFWS 2020).

**Additional Life History Information**

Adult: For the kit fox, animals traveling to unfamiliar areas are more vulnerable to predation, and dispersing juveniles have been shown to suffer high mortality when traveling outside their natal territory (USFWS 1998).

***Population Information and Trends***

**Population Trends:**

Short-term trend: decline of 10 to 30 percent. Long-term trend: decline of 80 percent (NatureServe 2015).

**Species Trends:**

Declining (USFWS 2010)

**Resiliency:**

Throughout the latter half of the 20th century, large portions of the San Joaquin kit fox's habitat were converted to agriculture and urban areas. Populations decreased rapidly in response to habitat loss and fragmentation. While there are few data on habitat condition and population trends prior to land conversion, evidence suggests historical populations had high resiliency, and foxes were likely widespread throughout their historical range. Because there is no accurate, historical baseline to which we can compare, our analysis of the San Joaquin kit fox's current condition and resiliency is limited to current geographic analysis units which are fragmented, isolated, and increasingly small habitat patches throughout the range. Based on the relevant factors evaluated in our analysis, three of the current geographic analysis units are in overall high condition. These units have the highest probability of persistence. Demographically, three geographic analysis units currently are in high condition (Panoche/Western Merced, Carrizo Plain, and Western Kern County), but none of the units are in high condition based on habitat factors. It is important to note that populations of San Joaquin kit fox on the Carrizo Plain are likely in the best current condition, being found on the largest continuous patch of habitat within the range of the species that has species-specific management. Once habitat is protected, connectivity can be increased, and populations might no longer be isolated from one another. In this case, the many of the negative effects of demographic and environmental stochasticity can be mitigated and populations are more likely to be stable. Currently, only two geographic units (the Carrizo Plain and western Kern County) are well equipped to withstand stochastic variation, leaving the remaining analysis units vulnerable to the effects of continued land conversion and climate change. This reduces the overall resiliency of the species. Our predictions of future condition varied under our three condition scenarios. Under climate change scenarios and current land management trends, resiliency is likely to decrease in the future for two of our scenarios within all geographic units. However, if land is converted and managed for the species, it is possible future conditions could improve for the species (USFWS 2020).

**Representation:**

Historically, the San Joaquin kit fox was distributed throughout the southern end of the San Joaquin Valley and foothills of the Sierra Nevada and Coast Range. Within the range, San Joaquin kit fox occupied a variety of grassland, desert, scrub and upland habitats. Precipitation varies among these habitats, being more mesic in the northern, and western (coastal) portions of the range. All the northern and western portions of the range are in very low condition. This region represents a different ecological setting and possibly uniquely adapted kit foxes. The loss of these populations is a loss of representation and adaptive capacity from historic conditions. Additional loss of resiliency and extirpations forecast in the future are likely to further reduce this representation and adaptive capacity. Genetic diversity appears to remain high throughout the range of the San Joaquin kit fox. It is uncertain how much genetic diversity has already been lost, however. Gene flow appears to continue to occur across the southern portion of the range in spite of the increase in habitat fragmentation. However, San Joaquin kit fox do not likely occur in the densities or numbers they once did, and populations continue to fluctuate throughout climatic events. However, populations still exist in a variety of habitats throughout the range, showing a moderate amount of representation (USFWS 2020).

**Redundancy:**

Historically, populations of San Joaquin kit fox were distributed throughout the San Joaquin Valley. Although the current distribution of kit fox populations is like that known historically, the size of the populations has decreased. In addition, one population (Salinas Valley) may be extirpated and is in very low condition. Four additional populations in the northern portion of the range are currently in very low condition and three more populations are in low condition. Only three populations persist in high condition and two of these are adjacent to each other in the southwestern San Joaquin Valley. A catastrophic range-wide event, such as a long-term drought, has the potential to severely reduce viability of several units and lower the probability of persistence for several analysis units. In the most severe instance of a long-term drought, the three analysis units currently in high condition might be the only populations remaining. Under two of the future scenarios, many of the geographic units could exist in low condition. Should this happen, or should populations become locally extirpated, redundant variation throughout the range might no longer be possible. Land protections and restorations can mitigate the effects to populations from climatic change. This means persistence of many of the populations is more likely, even under climate change scenarios with an increase in adverse stochastic events (USFWS 2020).

**Number of Populations:**

16 historic and/or current subpopulations; composed of three core and 13 satellite areas: Western Kern County Core Area (inter-annual fluctuation, slow decline); Carrizo Plains Core Area (inter-annual fluctuation); Ciervo-Panoche Core Area (presumed declining); Alameda, Contra Costa, and San Joaquin counties (decline, no known breeding); Western Merced and Stanislaus counties (decline); Central Merced County (presumed extirpated); Western Madera County (presumed extirpated); Southwestern Fresno County (isolated); Southwestern Kings County (isolated); Southwestern Tulare County (isolated, Pixley National Wildlife Refuge [NWR] extirpated); Tulare County Foothills (unknown); Northwestern Kern County (unknown); Northeast Bakersfield (stable); Metropolitan Bakersfield (stable); Cuyama Valley (unknown, presumed extant); and Salina-Pajaro (Camp Roberts, potentially extirpated; Fort Hunter Liggett, extirpated) (USFWS 2010).

**Population Size:**

Unknown (USFWS 2010). 2,500 to 10,000 individuals (NatureServe 2015). Estimate of 7,000 was given in 1975 (USFWS 2010).

**Resistance to Disease:**

Low

**Adaptability:**

Moderate/high.

**Additional Population-level Information:**

Monitoring of kit fox subpopulations has indicated that the occupied range of the kit fox is contracting and increasingly fragmented, and that kit foxes have likely disappeared from areas of extant habitat in the central and northern portions of their historic range. In many areas, kit foxes appear to have decreased in abundance on a range-wide basis. In some cases, resident family groupings appear to have disappeared from more isolated areas of extant habitat. Kit fox populations are larger in the Bakersfield, Western Kern County, and Carrizo Plains areas than in other portions of the range, but both the western Kern County and Carrizo populations appear to be subject to marked population fluctuations that put them at risk of population loss in less than 10 years in unfavorable environmental and demographic situations. Of all known subpopulations of the kit fox, the Bakersfield animals appear to sustain the most stable population numbers, although the size of this subpopulation is not clear. To date, no comprehensive range-wide surveys have been completed to determine the status of kit fox populations throughout its historic range (USFWS 2010).

**Population Narrative:**

There are 16 subpopulations of the San Joaquin kit fox, consisting of three core areas and 13 satellite areas. Among the three core areas (Western Kern County, Carrizo Plain, and Ciervo-Panoche), distribution/abundance appears to be declining (slow overall decline in Western Kern County; inter-annual fluctuations in Carrizo Plain; and presumed declining in Ciervo-Panoche) (USFWS 2010). In the 13 satellite populations, the current trend is declining in two areas (Alameda, Contra Costa, and San Joaquin County; and Western Merced and Stanislaus counties), presumed/probably/potentially extirpated in three areas (Central Merced County, Western Madera County, and Salinas-Pajaro), isolated in three areas (Southwestern Fresno County, Southwestern Kings County, and Southwestern Tulare County), unknown in three areas (Tulare County Foothills, Northwest Kern County, and Cuyama Valley), and stable in two areas (Northeast Bakersfield and Metropolitan Bakersfield) (NatureServe 2015; USFWS 2010).Currently, the entire range of the kit fox appears to be similar to what it was at the time of the 1998 Recovery Plan. The largest extant population are known to occur in western Kern County on and around the Elk Hills and Buena Vista Valley areas, and in the Carrizo Plain Natural Area, San Luis Obispo County. Though monitoring was not continuous in the central and northern portions of the range, populations were recorded in the late 1980s at San Luis Reservoir, Merced County, North Grasslands, and Kesterson NWR area on the valley floor, Merced County, and in the Los Vaqueros watershed, Contra Costa County. Smaller populations and isolated sightings included other parts of the San Joaquin Valley floor, including Madera County and eastern Stanislaus County (USFWS 2010).However, current population structure has become more fragmented, and at least some of the resident satellite subpopulations, such as those at Camp Roberts, Fort Hunter Liggett, Pixley NWR, and the San Luis NWR, have apparently been locally extirpated. The populations are in the Western Kern County Core Area; Carrizo Plains Core Area; Ciervo-Panoche Core Area; Western Merced; Central Merced County; Western Madera County; Southwestern Fresno County; Southwestern Kings County; Southwestern Tulare County; Tulare County Foothills; Northwestern Kern County; Northeast Bakersfield; and Metropolitan Bakersfield, and is thought to be extant from Cuyama Valley (San Luis Obispo and Santa Barbara counties) and extirpated from Salinas-Pajaro (San Luis Obispo, Monterey, and San Benito counties (USFWS 2020).As of 1975, the remaining population was believed to include about 7,000 individuals. Subsequent survey data suggest that range-wide kit fox abundance has declined since then (USFWS 2010). The largest remaining population occurs in the Carrizo Plain; in 2000, that population was estimated at 251 to 610 individuals (NatureServe 2015; USFWS 2010). Monitoring of kit fox subpopulations has indicated that the occupied range of the kit fox is contracting and increasingly fragmented, and that kit foxes have likely disappeared from areas of extant habitat in the central and northern portions of their historic range. In many areas, kit foxes appear to have decreased in abundance on a range-wide basis. In some cases, resident family groupings appear to have disappeared from more isolated areas of extant habitat. Kit fox populations are larger in the Bakersfield, Western Kern County, and Carrizo Plains areas than in other portions of the range, but both the western Kern County and Carrizo populations appear to be subject to marked population fluctuations that put them at risk of population loss in less than 10 years in unfavorable environmental and demographic situations. Of all known subpopulations of the kit fox, the Bakersfield animals appear to sustain the most stable population numbers, although the size of this subpopulation is not clear. To date, no comprehensive range-wide surveys have been completed to determine the status of kit fox populations throughout its historic range (USFWS 2010).Serological surveys of the San Joaquin kit fox and co-occurring carnivores, including the coyote and red fox, have provided evidence of kit fox exposure to pathogens. In serological tests for disease antibodies, high numbers of kit fox test positive for CDV and CPV, indicating that they have been exposed to these diseases. CDV and CPV could be sources of mortality in kit fox populations, but population-level effects have not been studied. Infectious canine hepatitis virus, CDV, CPV, Leptospira interrogans, and Toxoplasma gondii were found in varying percentages of adult kit fox; however, only one of eight juveniles tested was positive for antibodies (to L. interrogans) (USFWS 2010).

***Threats and Stressors***

**Stressor:** Conversion of land to agricultural land
**Exposure:** Conversion of land to agricultural land.
**Response:** Burial, displacement, human disturbance, fire suppression, and pest control.
**Consequence:** Mortalities, displacement, reduction of prey populations and denning sites, changes in the distribution and abundance of larger canids that compete with kit fox for resources, and reduction in carrying capacity.
**Narrative:** Conversion of natural lands to agriculture has continued since the kit fox was listed. By 1979, most of the San Joaquin Valley floor had been developed, with approximately 150,000 ha (370,000 ac.) out of a total of approximately 3.4 million ha (8.5 million ac.) remaining undeveloped. Land conversions contribute to declines in kit fox abundance through direct and indirect means: mortalities, displacement, reduction of prey populations and denning sites, changes in the distribution and abundance of larger canids that compete with kit fox for resources, and reductions in carrying capacity. Kit fox may be buried in their dens during land conversion activities, or permanently displaced from areas where structures are erected or the land is intensively irrigated. In addition to the direct loss of habitat for denning and foraging by kit fox, land conversion and associated human-intensive uses can bring additional stressors, including human disturbance, fire suppression, and pest control (USFWS 2010).The conversion of natural lands to agriculture continues to be a threat on private lands on the western side of the San Joaquin valley floor in areas where agriculture has been extended west to the base of the foothills since the 1960s. Past agricultural conversion has removed most areas of the valley floor as kit fox habitat. However, conversion of natural habitat to intensive agriculture continues to be the primary cause of habitat loss for the San Joaquin kit fox in the San Joaquin, Salinas, and

associated valleys, and in adjacent foothill areas. Agricultural lands do not appear to be suitable habitat for long-term kit fox persistence due to practices including soil cultivation, frequent irrigation, and use of agricultural chemicals and pesticides, and due to altered prey and predator communities. Loss and modification of habitat due to agricultural use continues to be a primary threat to kit fox (USFWS 2010).

**Stressor:** Loss of habitat due to urbanization
**Exposure:** Population growth and urban development.
**Response:** Loss or degradation of habitat, and restriction of core habitat and movement corridors.
**Consequence:** Loss of habitat, fragmentation, and reduction in population numbers.
**Narrative:** The increasing human population of California, with the concomitant high demand for limited supplies of land, water, and other resources, has been identified as the primary underlying cause of habitat loss and degradation. Between 1970 and 2000, the human population of the San Joaquin Valley doubled in size; it is expected to more than double again by 2040. In the San Joaquin Valley, the continued increase in the human population has resulted in increased urban development. On the floor of the valley, urbanization occurs most often on previously cultivated lands, where natural habitat has been lost or degraded. However, urbanization is also occurring along all edges of the San Joaquin Valley in areas of extant natural habitat that is important to the kit fox. In these areas, cities that are undergoing substantial growth include but are not limited to: Livermore, Antioch, Tracy, and Los Baños, in the northwestern portion of the kit fox’s range; and Paso Robles, Tulare, and Bakersfield in the southern portion of the range. Development along the San Joaquin Valley periphery and in adjacent valleys, such as the Salinas Valley, continues to restrict both core habitat and movement corridors for the kit fox (USFWS 2010).

**Stressor:** Habitat loss and modification due to oil extraction and mining activities
**Exposure:** Oil exploration, and spills.
**Response:** Human disturbance, loss of habitat and den sites, entombment, entrapment in sumps or oil spills, exposure to contaminants, changes to remaining habitat, changes in predator and prey community composition and abundance, disruptions to migration and foraging.
**Consequence:** Reduction in habitat, mortality, reduction in prey, toxicity due to oil, and reduction in population numbers.
**Narrative:** Currently, oil extraction and gravel mining may pose both direct and indirect risks to the San Joaquin kit fox. Direct risks to kit fox from oil-field development include human disturbance, loss of habitat and den sites, entombment, entrapment in sumps or oil spills, and exposure to contaminants. San Joaquin kit fox appear to tolerate human activities; they have frequently been observed around facilities and are known to use manmade structures (pipe, culverts, and foundations) as dens, although with some mortality. Indirect effects of oil field development on kit fox include changes to remaining habitat, and changes in predator and prey community composition and abundance. Oil spills may create short-term disruptions of primary travel routes and foraging areas for kit fox. Short-term effects of oil spills have included a 67 percent decrease in abundance of Heermann’s kangaroo rats (Dipodomys heermanni) between spill areas and control areas. Similarly, oil field disturbances in western Kern County have been found to result in shifts in the small mammal community from the primarily granivorous (seed-eating) species (kangaroo rats) that are a staple prey of kit fox, to species adapted to disturbed areas (murid, or old world rodents). The effect of an altered prey community on the energetics of the kit fox is not currently known, but early studies suggest that such altered prey composition

may result in lower kit fox density (USFWS 2010).Currently, the southern half of the San Joaquin Valley continues to be an area of expansion and development activity for extraction of petroleum products. Recent and continuing oil and gas leases are being offered within the range of the kit fox in Kern, Kings, Fresno, San Benito, and Monterey counties, where they have the potential to affect kit fox habitat and dispersal corridors (USFWS 2010).

**Stressor:** Habitat loss, modification, and fragmentation due to construction of solar facilities
**Exposure:** Development of solar facilities.
**Response:** Fragmentation of habitat, significant restriction of the kit fox's range, and barriers to linkages/dispersal.
**Consequence:** Loss of habitat, reduction in population numbers, and reduction in dispersal.
**Narrative:** In the Carrizo Core Area, two solar farms totalling 5,250 acres were constructed on the northern end of the Carrizo Plain, San Luis Obispo County, just north of the Carrizo Plain National Monument. Another utility-scale solar facility covering 1,688 acres has been installed in the Cholame Valley in Monterey County. The most recently installed solar farm is a 2,154-acre facility in the Panoche Valley in San Benito County. Although these facilities have had impacts to San Joaquin kit foxes and their habitat, monitoring has shown that that solar development is not incompatible with kit fox presence. U.S. Fish and Wildlife Service (USFWS) expects that additional solar projects will be proposed on lands important to the kit fox at the southern extent of its range (USFWS 2010,USFWS 2020).

**Stressor:** Habitat loss, modification, and fragmentation due to construction of infrastructure
**Exposure:** Construction of roads, canals, reservoirs, water banks, sound walls, and similar facilities.
**Response:** Vehicle strikes, modification of land-use patterns, and barriers to movement.
**Consequence:** Reduction in habitat, mortality, and reduction in population numbers.
**Narrative:** Construction of infrastructure projects continues to result in the direct loss and indirect modification of remaining kit fox habitat throughout the range of the kit fox. Paved roads, canals, reservoirs, water banks, sound walls, and similar facilities present both permanent loss of habitat and potential barriers to kit fox movement that fragment habitat. Linear infrastructure features that accompany development, such as roads, freeways, and canals, have the potential to disrupt or stop the movement of a variety of mammals, including kit fox and their prey. This fragments the remaining suitable habitat into patches, where patch size affects the ability of the patch to support larger species and species that are less tolerant of human disturbance. Natural recovery following such declines can be difficult if community conditions have been altered. Overall, the effects of roadways on kit fox movement vary depending on the location, size, and volume of vehicle use. However, in urban areas such as Bakersfield, the effect of higher volume roads on kit fox dispersal is not clear, but does result in at least some mortality, thereby presenting at least a partial barrier to connectivity of kit fox. Four-lane highways with median barriers generally present impermeable barriers to movement of the kit fox compared to rural roadways. Road construction in the San Joaquin Valley has resulted in the loss of kit fox habitat since listing. Rough calculations of the acreage of land lost to road development indicate that by 2003, more than 3,800 ha (7,000 ac.) of land had been transferred to California Department of Transportation jurisdiction, including 1,500 ha (3,670 ac.) of land in Kern County, 240 ha (590 ac.) in Kings County, 431 ha (1,065 ac.) in Merced County, and 820 ha (2,020 ac.) in Fresno County (USFWS 2010).

**Stressor:** Habitat alteration due to fires

**Exposure:** Wildfire
**Response:** Changes in habitat, changes in foraging, and vulnerability to predation.
**Consequence:** Mortalities, displacement, and changes in the distribution.
**Narrative:** Wildfires have the potential to alter kit fox habitat, and could either negatively or positively affect kit fox persistence. Wildfires may increase under drought conditions or with increasing human populations and habitat change. In addition, prescribed burns may be used to control shrub growth. Fires may directly endanger individual kit fox, although the magnitude of this threat is expected to be relatively low in typical kit fox habitat, which is characterized by sparse vegetation. The threat to individual fox is expected to be higher in grassland habitats or where exotic grasses, or shrub overgrowth, carry fire into native habitat. However, kit fox that must relocate their areas of foraging within their home range in response to fires become more vulnerable to predation as they relocate. Wildfires are known to occur within the range of the kit fox. In 1998, a major wildfire burned through the Lokern Natural Area, destroying shrublands. Smaller repeated fires also occur on the landscape, resulting in expanded areas of grassland habitat due to the failure of saltbush scrub to regenerate. Wildfires commonly occur on the western hills of Kern and Kings counties, and into the Tumey, Ciervo, and Panoche Hills. The BLM uses prescribed fire on 160 to 810 ha (400 to 2,000 ac.) every 3 to 5 years in the Carrizo Plain. Military Reserves, such as Fort Hunter-Liggett, also use prescribed fire to control vegetation so that military operations do not ignite wildfires (USFWS 2010).

**Stressor:** Habitat alteration due to changes in vegetation structure from growth of nonnative vegetation, and altered grazing regimes
**Exposure:** Overgrazing and reduction or cessation of grazing.
**Response:** Coyote predation and reduced prey base.
**Consequence:** Mortality, starvation, reduction in population numbers, and reduction in habitat.
**Narrative:** In the period since the kit fox was listed, grazing practices that result in either overgrazed areas or in relatively high vegetative structure have been proposed as potential threats to kit fox by either reducing their prey base or increasing their vulnerability to predation. Kit fox are more vulnerable to coyotes in dense vegetation. Arid grassland habitat with low vegetative structure, common patches of bare ground, and abundant kangaroo rats is recognized as optimal habitat for the kit fox. In contrast, lands that develop dense stands of vegetation higher than approximately 46 cm (18 in.) are expected to result in increased predation risk for the kit fox. Nonnative grasses have become the dominant herbaceous component in many California habitats. In such grasslands, reduction or cessation of grazing has been demonstrated to result in conditions unsuitable for the kit fox under some conditions (e.g., where precipitation and soil conditions allow dense vegetative growth). In addition to nonnative grasslands, parcels of vacant or retired lands often harbor dense growths of weedy species (e.g., mustards [Brassica nigra and Sisymbrium irio], five-hook bassia [Bassia hyssopifolia], and silverscale [Atriplex argentea]) that render habitat unsuitable for kit fox. Altered vegetative structure can also affect the availability of the kit fox’s prey base, particularly for kangaroo rat species. Grazing effects on kangaroo rats appear to be mixed, and USFWS expects that grazing may either negatively or positively affect kangaroo rats, depending on the particular site conditions, grazing level, annual weather regime, and the particular species involved. Although kangaroo rats depend on open areas for burrow construction, they also consume seeds, and research on grazing effects suggests potential benefits to kangaroo rats of a mix of ungrazed and grazed habitats (USFWS 2010).

**Stressor:** Disease
**Exposure:** Rabies, canine parvovirus, mange, and canine distemper virus.

**Response:** See narrative.
**Consequence:** See narrative.
**Narrative:** Wildlife diseases (mange, rabies, canine parvovirus [CPV], canine distemper virus [CDV], etc.) can cause substantial mortality or contribute to reduced fertility in female kit foxes. Diseases may threaten long-term viability of small populations of wildlife. Although high numbers of kit fox test positive for CDV and CPV, indicating that they have been exposed to these diseases, past studies have not observed clinical indications of these diseases nor found evidence that disease was an important mortality factor where it was studied. Disease and predation may have both contributed to the catastrophic decline in the isolated population of San Joaquin kit fox at Camp Roberts, in San Luis Obispo County. Kit fox captures decreased from 103 in 1988 to 20 in 1991, and decreased further to only three in 1997. During this same period captures of striped skunks (Mephitis mephitis) also generally decreased, but the proportion of skunks that were found to be rabid increased. This correlation led biologists to propose that rabies was a factor in the kit fox decline (USFWS 2010). Currently an outbreak of sarcoptic mange (Sarcoptes scabei) is causing steep population declines in the Bakersfield kit fox population. The mange epidemic in Bakersfield was first observed in 2013, and, although mortality from this outbreak is high (70% overall and 100% without veterinary intervention), thus far it appears to be largely limited to Bakersfield. A few kit foxes with sarcoptic mange have been documented from Taft, but the outbreak does not appear to have spread into natural lands (USFWS 2020).

**Stressor:** Predation and competition
**Exposure:** Predation and competition from coyotes, red foxes, and domestic dogs.
**Response:** Predation, competition, and reduction in prey.
**Consequence:** Mortality, out-competed, reduction in useable habitat, and reduction in population numbers.
**Narrative:** Predation of kit fox by large canid predators, including the coyote (Canis latrans) and nonnative red fox (Vulpes vulpes), appears to be a major and increasing threat to the viability of kit fox populations. In most areas of the kit fox’s range, coyotes are a the primary cause of kit fox mortality, and survival rates of kit fox decrease significantly as coyote-caused mortality increases. Canid predators have increased both in distribution and abundance with the increased land conversion, presence of water sources, and related human activities in the San Joaquin Valley. Abundant coyote populations currently appear to be excluding kit fox from some protected kit fox habitat (USFWS 2010).In addition to direct mortality, coyotes and red fox also negatively affect kit fox by competing for prey resources, and by competing with kit fox for habitat and/or denning resources. Increased presence of wild and domestic canids that pose an increasing threat to kit fox may be due to human-associated changes in the natural environment. The diets and habitats selected by coyotes and kit fox often overlap. Coyotes apparently threaten kit fox on lands that are protected to provide natural habitat. In recent years, coyotes have increased in density at some conservation lands that have been protected for the kit fox and other listed upland species (USFWS 2010).Nonnative red fox are known to kill kit fox, displace kit fox from dens, and compete with them for habitat and prey resources. Nonnative red fox are close to kit fox both morphologically and taxonomically, which could result in more intense competitive interactions, including predation. Red foxes also live longer than kit foxes, with a lifespan of 8 years compared to an average of 2 years in kit fox. The predation threat posed by domestic canids is thought to be small, but has not been quantified (USFWS 2010).

**Stressor:** Inadequacy of existing regulatory mechanisms
**Exposure:** See narrative.

**Response:** See narrative.
**Consequence:** See narrative.
**Narrative:** The Endangered Species Act (ESA) is the primary federal law that provides protection for this species. The California ESA provides protection against take of the species, but the definition of take is more limited than that provided under ESA and does not protect the kit fox from significant modification of habitat. Other federal and state regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under ESA. There are several state and federal laws and regulations that are pertinent to federally listed species, each of which may contribute in varying degrees to the conservation of federally listed and nonlisted species. These laws, most of which have been enacted in the past 30 to 40 years, have greatly reduced or eliminated the threat of wholesale habitat destruction, although the extent to which they prevent the conversion of natural lands to agriculture is less clear Therefore, we continue to believe other laws and regulations have limited ability to protect the species in the absence of the ESA (USFWS 2010).

**Stressor:** Rodenticides and pesticides
**Exposure:** Consumption of rodenticides and pesticides, or exposure throughout their environments.
**Response:** Decline in rodent populations, and consumption of rodenticides and pesticides.
**Consequence:** Mortality, illness.
**Narrative:** At the time of listing, early generation poisons—such as compound 1080 and strychnine—were used as pesticides for predator and rodent control and were considered a threat to kit fox. Pesticides, and specifically rodenticides, pose a threat to kit fox through direct or secondary poisoning. For example, kit fox may be killed if they ingest rodenticide in a bait application, or if they consume rodents that have consumed bait. Kit fox may also be threatened by loss of prey if rodent prey populations decline due to rodent control programs, or if availability of insect prey is substantially reduced by insecticide treatments, especially if insect prey declines occur when overall prey resources are limited. There also is the potential that availability of den sites may be impacted by rodent control programs, because kit fox can depend on ground squirrels to create potential burrows in areas with hardpan soil layers. Although kit foxes have been excluded from large portions of agricultural lands, they currently use agricultural lands that border natural lands. In 1997, the California Department of Pesticide Regulation listed approximately 400 pesticides for which at least one use occurred within 1.6 km (1 mi.) of kit fox habitat, warranting further evaluation of potential effects to the kit fox. Pesticides used in close proximity to kit fox habitat include the following: Malathion, aldicarb, carbaryl, chlorpyrifos, lindane, parathion, and the anticoagulant rodenticides brodifacoum, chlorophacinone, and diphacinone. Currently, both first-generation anticoagulant rodenticides (FGARs) and second-generation anticoagulant rodenticides (SGARs) may be used as rodent control agents within the range of the kit fox, although the appropriate use of individual anticoagulants differs depending on the terms of their registration. FGARs include warfarin, chlorophacinone, and diphacinone, while brodifacoum, bromadiolone, difethialone, and difenacoum are considered SGARs. Both FGARs and SGARs interfere with blood clotting, leading to death from hemorrhaging. FGARs require several days of consecutive feedings to deliver a lethal dose to the target species, while SGARs can deliver a lethal dose in only one night of feeding (USFWS 2010).

**Stressor:** Selenium and other contaminants
**Exposure:** Selenium toxicity.

**Response:** Reduction in prey abundance, and bioaccumulation.
**Consequence:** Reduction in food source, and selenium toxicity.
**Narrative:** Selenium toxicity may pose a threat to the kit fox in some areas on the western side of the San Joaquin Valley where federal water is delivered to the San Luis Unit; and where local conditions result in elevated concentrations of selenium in soil and surface water, or in near-surface groundwater. In these areas, naturally occurring selenium has been concentrated in surface waters due to drainage from agricultural areas. These localities can include retired or fallowed seleniferous farm land, open ditches that convey subsurface drain water, and drain water reuse projects. Selenium has the potential to bio-accumulate in aquatic organisms, such as zooplankton and benthic invertebrates, and may then biomagnify as it reaches top level predators, including birds, mammals, and fish. Cover-cropping systems proposed for reuse areas include crops, such as grain crops and pasture lands, that may support substantial prey resources although some areas may be grazed, which would reduce prey abundance. The selenium applied to these reuse areas via agricultural drain water can enter the food chain through uptake by plants and soil invertebrates, where it may be bio-accumulated by the seed- and invertebrate-eating organisms that comprise typical kit fox prey (USFWS 2010).

**Stressor:** Prey availability
**Exposure:** Lack of prey availability, and use of rodenticides/insecticides.
**Response:** Prey scarcity.
**Consequence:** Decreased reproductive success, and extirpation.
**Narrative:** Kit foxes have been strongly linked ecologically to kangaroo rats, with kit fox densities and population stability highest in areas with abundant kangaroo rats. Abundance of prey species, particularly abundance of kangaroo rats, has been linked with successful recruitment of young kit foxes and increases in kit fox population numbers. Conversely, prey scarcity has been a primary factor contributing to decreased reproductive success during droughts, or to extirpation of kit fox in specific localities. Studies suggested that kangaroo rats were a preferred food for the kit fox throughout the range, and that kit fox densities were lower in areas like those near Bakersfield where plant associations changed and abundant ground squirrels replaced kangaroo rats. In addition to rodents, insects can be important prey for the San Joaquin kit fox, especially during periods of low prey availability. In the northern portion of the kit fox's range, insects, especially grasshoppers and crickets, currently provide the primary prey for kit foxes during the summer months, particularly July and August. Insecticides that target grasshoppers and crickets (Orthoptera spp.) may suppress kit fox populations, reduce juvenile survivorship, or inhibit successful dispersal (USFWS 2010).

**Stressor:** Inbreeding depression, genetic drift, and stochastic extinction.
**Exposure:** See narrative.
**Response:** See narrative.
**Consequence:** Extirpation
**Narrative:** Small populations may be subject to inbreeding depression and genetic drift, and also to chance extinction from stochastic environmental and demographic incidents. Demographic research has suggested that kit foxes may be susceptible to inbreeding depression, and that they are threatened by local extirpation due to stochastic events. It appears that at least several of these small and isolated resident subpopulations have recently "winked out" (become locally extinct), including subpopulations at the Fort Hunter Liggett military reserve, and at San Luis and Pixley (USFWS 2010).

**Stressor:** Vehicle strikes
**Exposure:** Kit foxes being hit by cars.
**Response:** See narrative.
**Consequence:** Mortality, injury, and population decline.
**Narrative:** Vehicle strikes are a consistent, but small source of kit fox mortality on natural lands. Although impacts of roads on kit fox ecology are generally thought to be low, mortality due to vehicle strikes may significantly affect small populations. Although vehicle strikes may not have population-level effects in natural lands where traffic volume is low, they appear to be a more substantial source of mortality in human-altered landscapes, including urban environments. In urban settings such as Bakersfield, vehicle strikes can be the largest source of kit fox mortality, and may impact urban kit fox populations (USFWS 2010).

**Stressor:** Accidental shooting
**Exposure:** Intentional or incidental shooting.
**Response:** See narrative.
**Consequence:** Reduction in population numbers; mortality and injury.
**Narrative:** In the past, state regulations, such as restrictions on night hunting and spotlighting, were promulgated to reduce the potential for intentional and incidental shooting of kit fox. Although threats have been reduced, it appears that kit fox are still subject to accidental and illegal shooting throughout most of their range. Kit fox may potentially be mistaken for other wild canids, especially coyotes (Canis latrans), but naïve hunters could also potentially mistake kit fox for gray fox or red fox (Vulpes vulpes). Kit fox superficially resemble juvenile coyotes, suggesting that kit fox may be particularly vulnerable to misidentification at particular times of the year. Both the coyote and the gray fox are nongame species that may be taken in any number. Although the coyote may be taken all year, hunting gray fox is restricted to a season that runs from November 24 through February. A closure on night hunting is in effect in those portions of the species' range in Monterey and San Benito counties lying east of Highway 101, but legal in the rest of the range. Coyote hunting by people using predator calls, and by sheepherders, has been reported in lands surrounding the former NPR-1. Documented kit fox mortality due to shooting occurs occasionally on both public and private lands, including protected lands. In addition, kit fox harassment in association with hunting has been reported (USFWS 2010).

**Stressor:** Off-road vehicle (ORV) use
**Exposure:** Use of ORVs.
**Response:** Disturbance of soil, reduction of herbaceous vegetation, destruction of burrow systems of prey species such as the kangaroo-rat, and damage to kit fox dens.
**Consequence:** See narrative.
**Narrative:** Use of ORVs poses an unquantified threat to the San Joaquin kit fox, primarily through the potential for off-road travel to disturb soil, reduce or destroy herbaceous vegetation, destroy burrow systems of prey species such as the kangaroo-rat, and damage kit fox dens. Off-road travel also increases access to areas that are otherwise remote and little used. Off-road travel is expected to increase impacts to animals on large expanses of natural lands, including both publicly and privately held lands. The increase in ORV use in this area appears to be an increasing threat to the kit fox in otherwise suitable habitat. Although effects on habitat have not been quantified in large portions of the western Kern County area, in specific areas the recent increased use of ORVs has substantially degraded soil and vegetation conditions on lands targeted for conservation (USFWS 2010).

**Stressor:** Climate change
**Exposure:** Change in climate.
**Response:** See narrative.
**Consequence:** See narrative.
**Narrative:** Climate researchers list three clear, observable connections between climate and terrestrial ecosystems, such as those inhabited by the kit fox: seasonal timing of life-cycle events (phenology), responses of plant growth, and biogeographic distributions of plant and animal species. Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying. Kit fox subpopulations are threatened by both droughts and high rainfall events. Kit fox subpopulations, including the relatively large subpopulations at the NPRC and Carrizo Plains areas, demonstrate large fluctuations in abundance in response to weather-mediated prey levels, which increases the potential for these groups to be extirpated. Weather conditions usually vary over larger landscape scales, leading to the general expectation that drought-mediated decreases in kit fox abundance, or local extirpation of some groups, should not affect persistence of the species as long as healthy core kit fox populations are not limited to one portion of the range. However, the loss and fragmentation of habitat documented herein has reduced the likelihood that lost sites will be recolonized. Because increased drying and droughts, and substantial precipitation events, are expected to negatively affect the native prey species on which the kit fox depends, USFWS expects climate change to pose a substantial threat to the species by further exacerbating interannual fluctuations in kit fox reproductive success and abundance (USFWS 2010).

**Stressor:** Research-related activities
**Exposure:** Research activities.
**Response:** See narrative.
**Consequence:** See narrative.
**Narrative:** A limited amount of mortality has been documented to occur due to research activities. During monitoring of 542 radio-collared kit fox at the NPRC between 1980 and 1991, seven suffered minor injuries, while one suffered a lethal injury when its front paw became trapped in the collar. Newly collared adults lost body mass compared to uncollared adults, consistent with collaring effects observed in other species, but the long-term effects of this difference have not been determined. In general, these research-related effects on kit fox appear to have few population-level consequences, but could potentially be important to dynamics of a small subpopulation (USFWS 2010).

***Recovery***

**Reclassification Criteria:**
Reclassification of the kit fox to threatened status may occur when the following criteria are met:

Secure and protect specified recovery areas from incompatible uses: a. The three core populations: Carrizo Natural Area, western Kern County, and Ciervo-Panoche Area; and b. Three satellite areas (USFWS 1998; USFWS 2010).

Management plans that include survival of the kit fox as an objective are approved and implemented for all protected areas identified as important to continued survival of the kit fox

(USFWS 1998; USFWS 2010).

Population monitoring in the specified recovery areas shows: a. Stable or increasing populations in the three core areas through one precipitation cycle;* and b. Population interchange between one or more core populations and the three satellite populations (USFWS 1998; USFWS 2010).

*A precipitation cycle is defined as "a period when annual rainfall includes average to 35 percent above average through greater than 35 percent below-average and back to average or greater. The direction of change (average to above or below average) is unimportant in this criterion." A stable population is one in which population size remains statistically the same during the average phase of a precipitation cycle (anticipated to be about 20 years). Increasing population size means that the population has increased over the previous or baseline year, measured during the specified portion of a precipitation cycle. Range-wide population monitoring programs would have to be established to measure progress in meeting recovery criteria (USFWS 1998; USFWS 2010).

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**Delisting Criteria:**
These criteria provide for delisting of the kit fox. The Recovery Plan states that delisting criteria include meeting all of the reclassification/downlisting criteria. It also specifies a protection level for the kit fox that provides an extinction probability of 5 percent for 300 years for the entire population of the San Joaquin kit fox (USFWS 1998; USFWS 2010).

In addition to the satellite areas protected under reclassification/downlisting criteria, secure and protect from incompatible uses several additional satellite populations (number dependent on the results of research), encompassing as much as possible of the environmental and geographic variation of the historic geographic range (USFWS 1998; USFWS 2010).

Management plans that include survival of the kit fox as an objective are approved and implemented for all protected areas identified as important to continued survival of the kit fox (USFWS 1998; USFWS 2010).

Population monitoring in the specified recovery areas shows stable or increasing populations in the three core areas and three or more of the satellite areas during one precipitation cycle* (USFWS 1998; USFWS 2010).

**Recovery Actions:**
- Develop and implement a regional cooperative program and participation plan (USFWS 1998).
- Protect and secure existing populations (USFWS 1998).
- Determine distributions and population status (USFWS 1998).
- Conduct important research and monitoring (USFWS 1998).
- Maintain and establish linkages in existing natural lands and between islands of habitat on the valley floor and natural lands around the fringe of the valley (USFWS 1998).
- Apply adaptive management in protected areas (USFWS 1998).

- The 1998 Recovery Plan identified core and satellite areas where subpopulations of kit fox occur. However, baseline mapping and quantification of the extant habitat remaining in each core and satellite area at the time of Recovery Planning has not yet been completed. Mapping efforts that quantify the acreage of suitable/native habitat and altered or degraded habitat in core, satellite, and linkage areas at 1) the time of the 1998 Recovery Plan; and 2) the current time will assist USFWS and other conservation entities in prioritizing conservation strategies and in determining progress in meeting recovery goals for protection of core and satellite areas. The locations, acreage, and quality (or characteristics) of protected habitat could also be compiled and mapped (USFWS 2010).
- Studies that assist in determining the population-level effects of contaminants, including FGARs and SGARs, on kit fox or surrogate species are needed. Studies that test correlations between rodenticide use and kit fox population parameters, measure sublethal effects on behavior, or quantify rodenticide/pesticide effects on availability of prey in relation to the energetic needs of the kit fox would provide information useful to recovery actions (USFWS 2010).
- Focus land acquisitions on the establishment of large blocks of land (at least 10,000 ac. in size) on the San Joaquin Valley floor and western fringes. Such large parcels are critical to supporting sustainable populations of kit fox for long-term conservation, and should be linked with protected broad dispersal corridors. These acquisitions are most likely to aid kit fox recovery if they build on existing protected lands to achieve larger expanses of protected land, if acquired lands possess the vegetative structure and native prey base that are associated with thriving kit fox populations, and if acquired lands are not isolated from extant populations of either the kit fox or its prey species. Large holdings of native habitat are also expected to be less suitable for coyotes and red fox that are responsible for high levels of kit fox mortality. Lands no longer suitable for agriculture, such as those targeted for land retirement, may be restored and conserved through fee title acquisition, conservation easement acquisition, or conservation banking arrangements from willing sellers or participants. However, on suboptimal habitat, conservation planning should recognize the lag times inherent in restoration of the ecological community needed to support the kit fox. Linkages will be most effective in contributing to kit fox recovery where they link to habitat that retains the characteristics needed to sustain resident populations (USFWS 2010).
- A range-wide census of kit fox should be conducted using a methodology that ensures statistically significant data collected for all areas. Collaboration with the U.S. Geological Service on methods that use occupancy models may be a promising approach, but additional consideration is needed. Some biologists have suggested that more northerly satellite areas and/or linkages have become population sinks for the kit fox, and this possibility merits further study to determine what factors contribute to population status in these areas, and how these factors may be altered to promote range-wide recovery. The amount of gene flow between subpopulations of the kit fox should be confirmed using appropriate methods, adequate sample size, and inclusion of subpopulations of interest, including isolated groupings in the valley center and subpopulations occurring along the western side of the valley (USFWS 2010).
- Consultations on the location of solar facilities may wish to consider lands that are drainage-impaired and that may not constitute suitable habitat for the kit fox due to level of groundwater present, condition of site vegetation, presence and density of preferred prey species, and isolation from other suitable habitat. These lands may be a potential alternative to development of solar facilities in areas north of the Carrizo Plain and Panoche Valley (USFWS 2010).

- The following measures are presented in the USFWS' Standardized Recommendations for Protection of the Endangered San Joaquin Kit Fox Prior to or During Ground Disturbance (USFWS 2011). This document contains additional recommendations for small projects, recommended exclusions zones, and destruction of dens that are not discussed below. Habitat subject to permanent and temporary construction disturbances and other types of ongoing project-related disturbance activities should be minimized by adhering to the following activities. Project designs should limit or cluster permanent project features to the smallest area possible, while still permitting achievement of project goals. To minimize temporary disturbances, all project-related vehicle traffic should be restricted to established roads, construction areas, and other designated areas. These areas should also be included in preconstruction surveys and, to the extent possible, should be established in locations disturbed by previous activities to prevent further impacts.
- 1. Project-related vehicles should observe a daytime speed limit of 20 miles per hour (mph) throughout the site in all project areas, except on county roads and state and federal highways; this is particularly important at night when kit foxes are most active. Night-time construction should be minimized to the extent possible. However, if it does occur, then the speed limit should be reduced to 10-mph. Off-road traffic outside of designated project areas should be prohibited (USFWS 2011).
- 2. To prevent inadvertent entrapment of kit foxes or other animals during the construction phase of a project, all excavated, steep-walled holes or trenches more than 2 ft. deep should be covered at the close of each working day by plywood or similar materials. If the trenches cannot be closed, one or more escape ramps constructed of earthen-fill or wooden planks shall be installed. Before such holes or trenches are filled, they should be thoroughly inspected for trapped animals. If at any time a trapped or injured kit fox is discovered, USFWS and the California Department of Fish and Wildlife (CDFW) shall be contacted as noted under measure 13, referenced below (USFWS 2011).
- 3. Kit foxes are attracted to den-like structures such as pipes, and may enter stored pipes and become trapped or injured. All construction pipes, culverts, or similar structures with a diameter of 4 in. or greater that are stored at a construction site for one or more overnight periods should be thoroughly inspected for kit foxes before the pipe is subsequently buried, capped, or otherwise used or moved in any way. If a kit fox is discovered inside a pipe, that section of pipe should not be moved until USFWS has been consulted. If necessary, and under the direct supervision of the biologist, the pipe may be moved only once to remove it from the path of construction activity, until the fox has escaped (USFWS 2011).
- 4. All food-related trash items such as wrappers, cans, bottles, and food scraps should be disposed of in securely closed containers and removed at least once a week from a construction or project site (USFWS 2011).
- 5. No firearms shall be allowed on the project site (USFWS 2011).
- 6. To prevent harassment, mortality of kit foxes, or destruction of dens, no pets, such as dogs or cats, should be permitted on the project site (USFWS 2011).
- 7. Use of rodenticides and herbicides in project areas should be restricted. This is necessary to prevent primary or secondary poisoning of kit foxes and the depletion of prey populations on which they depend. All uses of such compounds should observe label and other restrictions mandated by the U.S. Environmental Protection Agency, California Department of Food and Agriculture, and other state and federal legislation, as well as additional project-related restrictions deemed necessary by USFWS. If rodent control must be conducted, zinc phosphide should be used because of a proven lower risk to kit fox

(USFWS 2011).

- 8. A representative shall be appointed by the project proponent who will be the contact source for any employee or contractor who might inadvertently kill or injure a kit fox, or who finds a dead, injured, or entrapped kit fox. The representative will be identified during the employee education program, and their name and telephone number shall be provided to USFWS (USFWS 2011).
- 9. An employee education program should be conducted for any project that has anticipated impacts to kit fox or other endangered species. The program should consist of a brief presentation by persons knowledgeable in kit fox biology and legislative protection to explain endangered species concerns to contractors, their employees, and military and/or agency personnel involved in the project. The program should include the following: a description of the San Joaquin kit fox and its habitat needs; a report of the occurrence of kit fox in the project area; an explanation of the status of the species and its protection under ESA; and a list of measures being taken to reduce impacts to the species during project construction and implementation. A fact sheet conveying this information should be prepared for distribution to the previously referenced people and anyone else who may enter the project site (USFWS 2011).
- 10. Upon completion of the project, all areas subject to temporary ground disturbances, including storage and staging areas, temporary roads, and pipeline corridors, should be re-contoured if necessary, and revegetated to promote restoration of the area to pre-project conditions. An area subject to "temporary" disturbance means any area that is disturbed during the project, but which after project completion will not be subject to further disturbance and will have the potential to be revegetated. Appropriate methods and plant species used to revegetate such areas should be determined on a site-specific basis in consultation with USFWS, CDFW, and revegetation experts (USFWS 2011).
- 11. In the case of trapped animals, escape ramps or structures should be installed immediately to allow the animal(s) to escape, or USFWS should be contacted for guidance (USFWS 2011).
- 12. Any contractor, employee, or military or agency personnel who are responsible for inadvertently killing or injuring a San Joaquin kit fox shall immediately report the incident to their representative. This representative shall contact the CDFW immediately in the case of a dead, injured, or entrapped kit fox. The CDFW contact for immediate assistance is State Dispatch at (916) 445-0045. They will contact the local warden or Mr. Paul Hoffman, the wildlife biologist, at (530) 934-9309. USFWS should be contacted at the numbers below (USFWS 2011).
- 13. The Sacramento Fish and Wildlife Office and CDFW shall be notified in writing within 3 working days of the accidental death or injury to a San Joaquin kit fox during project-related activities. Notification must include the date, time, and location of the incident or of the finding of a dead or injured animal, and any other pertinent information (USFWS 2011). The USFWS contact is the Chief of the Division of Endangered Species, at the addresses and telephone numbers below. The CDFW contact is Mr. Paul Hoffman at 1701 Nimbus Road, Suite A, Rancho Cordova, California 95670, (530) 934-9309.
- 14. New sightings of kit fox shall be reported to the California Natural Diversity Database. A copy of the reporting form and a topographic map clearly marked to show where the kit fox was observed should also be provided to USFWS at the address below (USFWS 2011). Any project-related information required by USFWS, or questions concerning the above conditions or their implementation, may be directed in writing to USFWS at: Endangered

Species Division 2800 Cottage Way, Suite W2605 Sacramento, California 95825-1846 (916) 414-6620 or (916) 414-6600

***Conservation Measures and Best Management Practices:***

- Scenario 2 assumes that there will be hot and dry conditions (MIROC-ESM, RCP 8.5). We assume under this emission and global circulation scenario that decreased precipitation and increased extreme weather events will influence habitat for the species. We again assumed that increased drought years will limit reproduction for the species, however this may be offset by increases on overall habitat suitability and prey abundance. Although we expect an increase in fallowed agriculture lands, this has uncertain conservation value for the species and we do not expect this to contribute to habitat for the kit fox without specific recovery actions. Although a drier climate tends to point toward an increase in suitable habitat for the species, it is unlikely that the species will expand into any new areas without restoration and/or other recovery actions. Instead, we project in this scenario that development continues at its current rate, reducing habitat size and connectivity for populations in unprotected areas. (USFWS, 2020)
- Under the conditions described in this scenario, we projected that the species would have 3 populations in high condition, 4 in moderate condition, 4 in low condition, and 5 populations in very low condition. Under this scenario decreases in habitat due to development are somewhat offset by increasing habitat suitability and, thus, representation and redundancy remain similar to the current condition. (USFWS, 2020)
- Summary of impacts to the 3Rs Reduction in habitat quality and quantity due to human induced land use change can alter the local habitat composition of an area making populations of San Joaquin kit fox less resilient and more vulnerable to stochastic events. Habitat fragmentation can also reduce connectivity and prevent gene flow among populations, leading to a reduction in population resiliency and species redundancy. In some areas, land protections have been put in place to prevent further alterations to native habitat. In other areas, mitigation and restoration is being done to restore lands that were once habitat back to their native state. Protected lands may help offset effects to the 3R's that arise from land use changes. (USFWS, 2020)
- Conservation Banks A conservation bank is a site, or suite of sites (i.e., umbrella bank), that is conserved and managed in perpetuity, and provides ecological functions and services for specified listed species or resources. Conservation banks function to offset adverse impacts to these species that occurred elsewhere; therefore, the Service approves a specified number of credits that the bank owner may sell to developers or other project proponents for use as compensation for adverse impacts their projects have on those species. The bank owner then uses the money from the credit purchases to permanently protect and manage the land for those species and resources. More information about conservation banks within the Sacramento Fish and Wildlife Office's Service area can be found at: https://www.fws.gov/sacramento/es/Conservation-Banking/Banks/In-Area/. Currently, there are 16 banks covering 23,681 acres that conserve habitat for the kit fox. Conservation banks are found throughout the range of the species. Four banks totaling 9,953 acres have sold out of credits. The remaining 12 banks are currently active. Not all the land within each bank provides suitable habitat for the species. However, conservation banks provide permanent protection that can secure suitable habitat and link movement corridors. (USFWS, 2020)
- Permittee Responsible Mitigation Permittee-responsible mitigation includes activities or projects undertaken by a permittee (or authorized agent) to provide compensatory mitigation for which the permittee retains full responsibility. Permittee-responsible mitigation projects are typically not established in advance of the impacts they are offsetting and they do not have credits that can be used at a later time to offset different impacts, like conservation banks. (USFWS, 2020)

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- HCPs Habitat Conservation Plans (HCPs) are planning documents required as part of an application for an incidental take permit. They describe the anticipated effects of the proposed taking; how those impacts will be minimized, or mitigated; and how the HCP is to be funded. HCPs can apply to both listed and non-listed species, including those that are candidates or have been proposed for listing. Regional HCPs develop large-scale conservation strategies within a specific region that are designed to conserve functional ecological systems and the covered species that depend on them. Such HCPs aim to avoid a fragmented conservation landscape by working with local land use authorities and a designated implementing entity to conserve, enhance, and manage a preserve system. Project-level HCPs are designed to fully offset the impacts associated with the permitted activity by contributing to a larger conservation design. (USFWS, 2020)
- Habitat modification and destruction via housing or commercial development is expected to continue in the future. As the population in the San Joaquin Valley increases, housing/commercial development continues to threaten San Joaquin kit fox habitat, albeit at a lower level than the threat posed by other types of development. The total number of households in the San Joaquin Valley is projected to increase by just over 1 percent per year from 2010 to 2050, with the highest annual growth rates in Merced and Madera Counties (The Planning Center 2012, pp. 13–14). The population is projected to increase on average by an annual rate of 1.27 percent, increasing from approximately 4 million people in 2010 to over 6.5 million in 2050, with the highest expected increase in Merced County and the lowest increases predicted for Tulare and Fresno Counties (The Planning Center 2012, pp. 17–18). Direct or indirect impacts to the species due to energy or development projects is expected to be somewhat offset through mitigation or other measures.
- Summer precipitation is also difficult to predict, and similar assumptions were necessary. Under scenario 1, all summer precipitation is likely to increase, which may decrease the overall suitability of habitat during the summer largely due to negative impacts to prey species such as giant kangaroo rats or other small mammal species. This reduction in prey base may negatively affect San Joaquin kit fox survival (particularly the pups) and could depress reproduction. Under future scenarios 2 and 3, summer precipitation would decrease, meaning summers would be hotter and dryer. Because San Joaquin kit fox are already adapted for hot, dry summers, it is not likely that they would be severely, negatively impacted by these changes during the summer months. Habitat suitability models confirm, that under RCP 8.5 emission scenarios, the suitable range of the giant kangaroo rat is expected to remain similar or even expand (Widick and Bean 2019, pp. 7–9). Based on this data, it is expected that the San Joaquin kit fox may experience increased population growth under scenarios where a primary prey species does well. This positive effect of increasing suitable habitat for the fox (and its prey), may help offset the effects of more frequent or longer droughts. As a result, we predicted no overall change in demographic or prey base factors under this scenario. (USFWS, 2020)
- We made changes to demographic factors in relation to expected changes to habitat factors. We assumed that under scenarios 1 and 2, frequency of occupancy would decrease across much of the range in response to continued habitat fragmentation and land conversion. These land use changes would also impact survival and reproduction by reducing the available prey base and increasing exposure to rodenticides. Conversely, under scenario 3, the long-term effects of changes in climate are likely to be offset by increasing land protection and habitat availability. In this scenario, the combined effects of increases in habitat suitability (with presumed increased prey abundance) and land protection would lead to increases in kit fox populations despite potential negative effects from

increased drought frequency. (USFWS, 2020)

- RECOMMENDATIONS FOR FUTURE ACTIONS x The 1998 Recovery Plan identified core and satellite areas where subpopulations of San Joaquin kit fox occur. However, baseline mapping and quantification of the extant habitat remaining in each core and satellite area at the time of Recovery Planning has not yet been completed. Mapping efforts that quantify the acreage of suitable/native habitat and altered or degraded habitat in core, satellite, and linkage areas at 1) the time of the 1998 Recovery Plan, and 2) the current time, will assist the Service and other conservation entities in prioritizing conservation strategies and in determining progress in meeting recovery goals for protection of core and satellite areas. The locations, acreage, and quality (or characteristics) of protected habitat could also be compiled and mapped. x Studies that assist in determining the population-level effects of contaminants, including first and second generation anticoagulant rodenticides, on San Joaquin kit fox or surrogate species are needed. Studies that test correlations between rodenticide use and San Joaquin kit fox population parameters, measure sublethal effects on behavior, or quantify rodenticide/pesticide effects on availability of prey in relation to the energetic needs of the San Joaquin kit fox would provide information useful to recovery actions. x Focus land acquisitions on the establishment of large blocks of land (at least 10,000 acres in size) on the San Joaquin Valley floor and western fringes. Such large parcels are critical to supporting sustainable populations of San Joaquin kit fox for long-term conservation, and should be linked with protected broad dispersal corridors. These acquisitions are most likely to aid San Joaquin kit fox recovery if they build on existing protected lands to achieve larger expanses of protected land, if acquired lands possess the vegetative structure and native prey base that are associated with thriving San Joaquin kit fox populations, and if acquired lands are not isolated from extant populations of either the San Joaquin kit fox or its prey species. Large holdings of native habitat are also expected to be less suitable for coyotes and red fox that are responsible for high levels of San Joaquin kit fox mortality. In limited circumstances, lands no longer suitable for agriculture, such as those targeted for land retirement, may be restored and conserved through fee title acquisition, conservation easement acquisition, or conservation banking arrangements from willing sellers or participants. However, on suboptimal habitat, conservation planning should recognize the lag times inherent in restoration of the ecological community needed to support the San Joaquin kit fox. Linkages will be most effective in contributing to San Joaquin kit fox recovery where they link to habitat that retains the characteristics needed to sustain resident populations. x A rangewide census of San Joaquin kit fox should be conducted using a statistically robust methodology. Collaboration with U.S. Geological Service on methods that utilize occupancy models may be a promising approach, but needs additional consideration. Some biologists have suggested that more northerly satellite areas and/or linkages have become population sinks for the San Joaquin kit fox and this possibility merits further study to determine what factors contribute to population status in these areas, and how these factors may be altered to promote range-wide recovery. x Sarcoptic mange (Sarcoptes scabei) has been documented in the Bakersfield kit fox population and a recent outbreak is currently causing a population decline (Deatherage 2020). Current efforts to control and contain sarcoptic mange should continue to be implemented to limit the effect of the outbreak and suppress the spread of the disease within and outside of the Bakersfield population. In addition, research on more effective treatment options and mite control techniques are needed. (USFWS, 2020a)

***Additional Threshold Information:***

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