Hawaii and Pacific Animals

This section includes all animal taxa addressed in this biological opinion that are found in the Pacific Islands, including Hawai'i and the territories. Our analysis and rationales are presented by the following main taxa groupings: birds, mammals, reptiles, and invertebrates. Within each taxa section, species may be grouped according to commonalities (e.g., similar geographic areas, or assumptions related to vulnerability, risk, or usage), or in some cases, will be presented individually. However, for each species, we considered the following when determining our conclusion: 1) their vulnerability (i.e., status, environmental baseline, cumulative effects); 2) risk if exposed to malathion either directly or indirectly through food resources, habitat, or other species on which they depend; 3) anticipated usage that influenced their likelihood of exposure; and 4) any relevant general or species-specific conservation measures. Our conclusions and rationales are described below.

Birds – Effect Analysis

The Pacific Islands contain 45 species of birds that are Federally listed as endangered or threatened, the majority of which are in Hawai'i (33 endangered and 3 threatened). Guam and the Commonwealth of the Northern Marianas Islands (CNMI) contain all but one of the remaining (eight endangered) species, with the final species restricted to American Samoa (endangered). The below analysis examines these species in groups based on their occurrence and life history.

Hawai'i

The listed bird species in Hawai'i can be broken into three main groups for analysis based on life histories: seabirds (three species), waterbirds (five species) and forest birds (15 species).

Integration and Synthesis Summary: Hawaiian Seabirds

Scientific Name	Common Name	Entity ID
Oceanodroma castro	Band-rumped storm petrel	2859
Pterodroma sandwichensis	Hawaiian petrel	82
Puffinus newelli (=Puffinus auricularis newelli)	Newell's shearwater	114

As these species are piscivores and all feeding is done far out at sea, indirect impacts from affected food resources are not an issue. Low levels of malathion may occur for these species while on their nesting grounds, but the levels are such that we would expect the effects to be limited.

Species: Band-rumped storm petrel

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: Multiple populations (few)

Species Trends: Declining population(s) – one or more populations declining

Pesticides noted ☐

According to the 2014 Final Rule, the band-rumped storm-petrel is a small seabird that is found in several areas of the subtropical Pacific and Atlantic Oceans (USFWS 2014). In the Pacific, there are three widely separated breeding populations, one in Japan, one in Hawaii, and one in the Galapagos (USFWS 2014). The Hawaiian birds represent a small, remnant population of possibly only a few hundred pairs (USFWS 2014). The three populations in the Pacific are separated by long distances across the ocean where birds are not found (USFWS 2014). Extensive at-sea surveys of the Pacific have revealed a broad gap in distribution of the band-rumped storm-petrel to the east and west of the Hawaiian Islands, indicating that the distribution of birds in the central Pacific around Hawaii is disjunct from other nesting areas. The available information indicates that distinct populations of band-rumped storm-petrels are definable and that the Hawaiian population is largely distinct based on geographic and distributional isolation from other band-rumped storm-petrel populations in Japan, the Galapagos, and the Atlantic Ocean. Loss of the Hawaiian population would cause a significant gap in the distribution of the band-rumped storm-petrel in the Pacific and could result in the complete isolation of the Galapagos and Japan populations without even occasional genetic exchange (USFWS 2014).

The band-rumped storm-petrel was probably common on all of the main Hawaiian Islands when Polynesians arrived about 1,500 years ago, based on storm-petrel bones found in middens on the island of Hawaii and in excavations on Oahu and Molokai (USFWS 2014). In Hawaii, band-rumped storm-petrels are known to nest in remote cliff locations on Kauai and Lehua Island, in steep open to vegetated cliffs, and in little vegetated, high-elevation lava fields on Hawaii Island (Wood et al. 2002, p. 17-18; Wanderer et al. 2007, pp. 1, 5; Joyce and Holmes 2010, p. 3; Banko 2015 in litt.; Raine 2015, in litt.; as cited in USFWS 2016). Vocalizations were heard in Haleakala Crater on Maui in 1992 (Johnston 1992, in Wood et al. 2002, p. 2), on Lanai (Penniman 2015, in litt.), and in Hawaii Volcanoes National Park (Orlando 2015, in litt., as cited in USFWS 2016).

Band-rumped storm petrels are regularly observed in coastal waters around Kauai, Niihau, and Hawaii Island (Harrison et al. 1990, p. 49; Holmes and Joyce 2009, 4 p.), and in “rafts” (regular concentrations) of a few birds to as many as 100, possibly awaiting nightfall before coming ashore to breeding colonies (USFWS 2016). Kauai likely has the largest population, with an estimated 221 nesting pairs in cliffs along the north shore of the island in 2002, and additional observations on the north and south side of the island in 2010 (Harrison et al. 1990, p. 49; Wood et al. 2002, pp. 2-3; Holmes and Joyce 2010, pp. 1-3; as cited in USFWS 2016). Audio detections on the Na Pali coast and Waimea Canyon, with a very small number in Winyah Valley (Raine 2015, in litt.; as cited in USFWS 2016). The band-rumped petrel is also known from Lehua Island (as detected there by auditory surveys) (VanderWerf et al. 2007, p. 1; Raine 2015, in litt.), Maui (Mitchell et al. 2005, in litt.), Kahoolawe (Olson 1992, pp. 38, 112), Lanai

(Penniman 2015, in litt.) and Hawaii Island (Mitchell et al. 2005, in litt.; Orlando 2015, in litt.; as cited in USFWS 2016).

The significant reduction in numbers and range of the band-rumped storm-petrel is due primarily to predation by nonnative species introduced by humans, including the domestic cat (*Felis catus*), small Indian mongoose (*Herpestes auropunctatus*), common barn owl (*Tyto alba*), black rat (*Rattus rattus*), Polynesian rat (*Rattus exulans*), and Norway rat (*Rattus norvegicus*) (USFWS 2014). Attraction of fledglings to artificial lights, which disrupt their night-time navigation, resulting in collisions with buildings and other objects, and collisions with artificial structures such as communication towers and utility lines, are also threats (USFWS 2014).

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2014. Endangered and Threatened Wildlife and Plants; Review of Native Species that are Candidates for Listing as Endangered or Threatened; Annual Notice of Findings Resubmitted Petitions; Annual Description of Progress on Listing Actions; Proposed Rule. *Federal Register* 79 FR 72449 - 72497. 49 pp.

U.S. Fish and Wildlife Service (USFWS). 2016. Endangered and Threatened Wildlife and Plants; Endangered Status for 49 Species from the Hawaiian Islands Final Rule. 81 FR 67786 67860 U.S. Fish and Wildlife 2013. 75 pp.

U.S. Fish and Wildlife Service (USFWS). 2021. Band-Rumped Storm-Petrel Hawaii DPS 5-Year Review. Honolulu, Hawaii. 33 pp.

Species: Hawaiian petrel

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: Multiple populations (few)

Species Trends: Declining population(s) – one or more populations declining

Pesticides noted ☐

According to the 2017 5-Year Review, since the publication of the last 5-year review in 2011, results from analysis of at-sea surveys conducted between 1998 and 2011 estimated the Hawaiian petrel population to be 52,186 (95% CI 29,823-67,379) individuals, including juveniles and subadults (Joyce 2013, as cited in USFWS 2017). The previous at-sea population estimate from surveys conducted between 1980 and 1994 estimated 19,000 (95% CI 11,000-34,000) birds, including subadults and juveniles (Spear et al. 1995, as cited in USFWS 2017). The two studies are not directly comparable and differences in abundance estimates may reflect either changes in the population size or the proportion of the population sampled because the portion of the species' range that was surveyed differed between the two studies, as did the time of year and survey and analytical methodology (Joyce 2013). Croxall et al. (2012) estimated a population of 9,000 to 16,000 adult Hawaiian petrels, based on data from the International Union for the Conservation of Nature (USFWS 2017).

The Hawaiian petrel was once abundant on all southern islands of the Hawaiian Archipelago including Hawaii, Maui, Lanai, Kahoolawe, Molokai, Oahu, and Kauai (USFWS 2017). By the 1980's, the Hawaiian population had experienced significant range contractions and today breeding colonies are found only in remote or high elevation areas on the islands of Hawaii, Maui, Lanai and Kauai (USFWS 2017). Recent surveys in 2011 undertaken by Deringer and VanZandt (as cited in USFWS 2017) documented Hawaiian Petrels calling in the Kohala Mountains of Hawaii Island. Young and VanderWerf (2016, as cited in USFWS 2017) used acoustic monitors to survey for Hawaiian petrels on Hawaii Island, Maui, Molokai, and Oahu. They detected birds at Hapai Mamo, a previously known nesting colony within Hawaii Volcanoes National Park's Kahuku Unit on Hawaii Island, in Waimanu Valley in the Kohala Mountains of Hawaii Island, and low calling rates in the West Maui Mountains. Follow-up ground surveys in Kohala did not locate nesting burrows, but further effort is warranted. No Hawaiian Petrels were detected on Molokai or Oahu during these surveys. Hawaii Volcanoes National Park began systematic surveys in 2012 (Hu et al. 2015, as cited in USFWS 2017) to establish baseline nest density and track trends in density over time in two primary colonies on Mauna Loa (USFWS 2017)

Nesting habitat has been lost from lowland areas due to urbanization and degraded by feral goats and pigs. Nest burrows are trampled by feral goats, sheep, and potentially axis deer (BirdLife International 2011, as cited in USFWS 2011). In addition, suitable nesting habitat is threatened by invasion of non-native plant species, such as strawberry guava (*Psidium cattleianum*), that fundamentally alter the vegetation structure so that petrels cannot excavate burrows or even reach the ground. Habitat degradation by strawberry guava is a major threat to the Lānai Hawaiian petrel colony (BirdLife International 2011, as cited in USFWS 2011).

EB/CE Sources:

U.S. Fish and Wildlife (USFWS). 2011. Hawaiian Petrel (*Pterodroma sandwichensis*) 5-Year Review Summary and Evaluation. Honolulu, Hawaii. 11 pp.

U.S. Fish and Wildlife (USFWS). 2017. Hawaiian Petrel (*Pterodroma sandwichensis*) 5-Year Review Short Form Summary. Honolulu, Hawaii. 11 pp.

Species: Newell's shearwater

Status: Threatened

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: Multiple populations (few)

Species Trends: Declining population(s) – one or more populations declining

Pesticides noted ☐

The Newell's Shearwater's historical range is thought to include Hawaii, Maui, Molokai, Oahu, and Kauai, and recent surveys suggest birds may still be extant throughout its historical range, albeit in low numbers (Service 1983, Pyle and Pyle 2009; as cited in USFWS 2017). Few colonies have been monitored for nesting success, primarily because this work creates trails that increase predator ingress. Thus, predator control is inherent in any monitoring program. Results from analysis of at-sea surveys conducted between 1998 and 2011 estimated the Newell's Shearwater population to be 27,011 (95 percent confidence interval (CI) 18,254-37,125) individuals, including 14 juveniles and subadults (Joyce 2013, as cited in USFWS 2017). The previous at-sea population estimate from surveys conducted between 1980 and 1994 estimated 84,000 (95 percent CI 57,000-115,000) birds, including subadults and juveniles (Spear et al. 1995, as cited it USFWS 2017).

An estimated 90 percent occurs on Kauai (Ainley et al. 1997, Service unpublished; as cited in USFWS 2017). Research and management by the Kauai Endangered Seabird Recovery Project (KESRP) have increased our understanding of the status of the population on Kauai, and surveys on the other main Hawaiian Islands have provided some information about the species' distribution on those islands (USFWS 2017).

Predators (particularly cats and feral pigs) take adults as well as eggs and juveniles, which is especially devastating to this long-lived species which does not reach reproductive maturity until about age 6 years and has a high proportion of nonbreeding adults. As none of the predator control sites are surrounded by predator-proof fences, predator ingress is constant (USFWS 2017).

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2017. Newell's Shearwater (*Puffinus auricularis newelli*) 5-Year Review Short Form Summary. Honolulu, Hawaii. 14 pp.

VULNERABILITY and RISK

(Summary of status, environmental baseline and cumulative effects)

The three listed seabirds in the main Hawaiian Islands (Newell's shearwater [*Puffinus auricularis newelli*], Hawaiian petrel [*Pterodroma sandwiches*], and band-rumped storm-petrel [*Oceanodroma castro*]) are all burrow-nesting species that spend the majority of their lives at sea; the birds only come to land to nest seasonally in the summer and fall. Critical habitat is not designated for any of the species. Nesting sites generally fall into two distinct types: (1) high-elevation cinder and lava rock fields and cliffs on Maui and Hawaii (Hawaiian petrel and band-rumped storm-petrel), above the deposition zone of these three pesticides (where we anticipate very low likelihood of exposure, if any); and (2) areas of thick forest within the deposition zone on Kauai, Lanai, Molokai, Maui, and Hawaii (all species). While nesting at these latter sites, they may come into contact with low levels of the pesticide primarily through volatilization and deposition effects, but also through direct exposure from mosquito adulticide if malathion is used. Exposure pathways would most likely come through direct inhalation or preening contaminated feathers. Although we would expect species within high-level elevation to be exposed to malathion via volatilization, we conclude, based on the best information available, that species in high elevations would not be exposed to concentration levels that would affect them (see *General Effects* for further information on volatilization). As these species are all piscivores and all feeding is done far out at sea, indirect impacts from affected food resources would not be an issue. So, while the low levels of malathion may affect these species while on their nesting grounds, the levels are such that we would not expect these effects to be significant.

Overall Vulnerability Band-rumped storm petrel: ☒ High ☐ Medium ☐ Low

Overall Vulnerability Hawaiian petrel: ☒ High ☐ Medium ☐ Low

Overall Vulnerability Newell's shearwater: ☐ High ☒ Medium ☐ Low

Overall Risk for Band-rumped storm petrel: ☐ High ☐ Medium ☒ Low

Overall Risk for Hawaiian petrel: ☐ High ☐ Medium ☒ Low

Overall Risk for Newell's shearwater: ☐ High ☐ Medium ☒ Low

USAGE

(Anticipated usage within the range based on past usage data)

Information regarding past usage of malathion in Hawaii is not available, however prior survey data has indicated that 4.8% of agricultural crops were treated with insecticides, with malathion being only a subset of this use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the Approach to Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in Hawaii; future use cannot be ruled out but is not expected to increase significantly.

Overall Usage for Band-rumped storm petrel: ☐ High ☒ Medium ☐ Low

Overall Usage for Hawaiian petrel: ☐ High ☒ Medium ☐ Low

Overall Usage for Newell's shearwater: ☐ High ☒ Medium ☐ Low

CONCLUSION

After reviewing the current status of the species, the environmental baseline for the Action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the Band-rumped storm petrel, Hawaiian petrel, and Newell's shearwater.

As these species are all piscivores and all feeding is done far out at sea, indirect impacts from affected food resources would not be expected to result in measurable effects to these species or their prey. So, while the low levels of malathion may affect these species while on their nesting grounds, the levels are such that we would not expect these effects to be significant. These seabirds nest in high-elevation cinder and lava rock fields and cliffs or in thick forest, where we anticipate any exposure would primarily be through volatilization deposition. Although, we would expect species within high-level elevation areas to be exposed to malathion via volatilization, we conclude, based on the best information available, that species in high elevations would not be exposed to concentration levels that would result in mortality, or effects to growth or reproduction (see *General Effects*). In addition, we would expect that malathion is unlikely to be applied within these high altitude areas. Also, the available information indicates that malathion is not being used as a mosquito control agent in Hawaii, and, although future use cannot be ruled out, it is not expected to increase significantly, further decreasing the likelihood of exposure. Thus, we expect exposure of individual band-rumped storm petrels, Hawaiian petrels, and Newell's shearwater and their prey to occur only at very low levels over the duration of the Action and would likely not result in mortality, sublethal effects, or measurable impacts to their prey base. Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of these seabirds in the wild.

Conclusion for band-rumped storm petrel:	**Not likely to jeopardize**
Conclusion for Hawaiian petrel:	**Not likely to jeopardize**
Conclusion for Newell's shearwater:	**Not likely to jeopardize**

Integration and Synthesis Summary: Hawaiian Water birds

Scientific Name	Common Name	Entity ID
Anas wyllivianа	Hawaiian (koloa) duck	69
Branta (Nesochen) sandwicensis	Hawaiian goose	73
Fulica americana alai	Hawaiian coot	108
Gallinula chloropus sandvicensis	Hawaiian common gallinule	76
Himantopus mexicanus knudseni	Hawaiian stilt	104

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Overall threats to these listed waterbirds include loss of their wetland habitat, as well as predation by introduced animals, particularly mongooses, rats, and feral cats. Additional threats include habitat changes through modified hydrology, non-native plants and grazing, and environmental contaminants in the water features that the species prefer (USFWS 2011).

Species: Hawaiian (=koloa) duck

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Unknown (USFWS 2011)

Species Trends: Not Available (USFWS 2011)

Pesticides noted ☒

Environmental Baseline/Cumulative Effects (EB/CE) Summary Hawaiian (koloa) duck:

Historically, the Hawaiian duck was known on all of the main Hawaiian Islands except Lāna`i and Kaho`olawe (USFWS 2011). Currently, the Hawaiian duck is found on the islands of Ni`ihau, Kaua`i, O`ahu, Maui, and Hawai`i. The status of the Hawaiian duck is difficult to judge due to the difficulty of distinguishing between the Hawaiian duck, feral mallard (*Anas platyrhynchos*), and hybrids. There are no population estimates prior to 1940, but in the 1800s it was fairly common in natural and farmed wetland habitats (Engilis et al. 2002, as cited in USFWS 2011). The Hawaiian duck was noted to occur on the hottest coasts with suitable ponds as well as in the mountains as high as 2,100 meters (7,000 feet) (Perkins 1903, cited in Banko 1987b, as cited in USFWS 2011). The arrival of the Polynesian people in Hawai`i about 1,600 years ago (Kirch 1982) and their cultivation of kalo or taro (*Colocasia esculenta*), an agricultural crop grown in a pond-like environment, considerably changed wetland habitat in the islands, including plant composition, water levels, and human disturbance (B. Zaun, USFWS, in litt. 2005, as cited in USFWS 2011). Engilis et al. (2002, as cited in USFWS 2011) estimated the statewide population of pure Hawaiian ducks to be 2,200 birds, with 2,000 on Kaua`i and 200 on Hawai`i. Biannual waterbird counts have yielded lower numbers (averaging 360 based on winter counts from 2000 through 2007), primarily because this survey currently does not include montane streams that are believed to harbor much of the Hawaiian duck population on Kaua`i and Hawai`i (Swedberg 1967, Paton 1981, as cited in USFWS 2011). There are believed to be fewer than 2,000 pure koloa maoli remaining statewide, with most of these occurring on Kauai (Wells et al. 2019, as cited in USFWS 2021). These endangered Hawaiian waterbirds are currently found in a variety of wetland habitats including freshwater marshes and ponds, coastal estuaries and ponds, artificial reservoirs, kalo or taro (*Colocasia esculenta*) lo`i or patches, irrigation ditches, sewage treatment ponds, and montane streams and marshlands (USFWS 2011). The most important causes of decline for this species were loss and degradation of wetland habitat and predation by introduced animals. Other factors that have contributed to waterbird population declines, and that continue to be detrimental, include modification of hydrology, alteration of habitat structure and vegetation composition by invasive non-native plants, loss of riparian vegetation, water quality degradation due to grazing, disease, and possibly environmental contaminants (USFWS 2011). Contamination of wetlands with toxic substances from human development or from agricultural/aquacultural practices (e.g., oil, pesticides, and herbicides) is also a potential threat (USFWS 2011). In addition, hunting in the late 1800s and early 1900s took a heavy toll on Hawaiian duck populations (Swedberg 1967, as cited in USFWS 2011). Currently, hybridization with feral mallards is the most serious threat to the Hawaiian duck (USFWS 2011).

The Hawaiian duck is an opportunistic feeder. Foods consumed include snails, insect larvae, earthworms, tadpoles, crayfish, mosquito larvae, mosquito fish (*Gambusia affinis*), aquatic invertebrates (including water boatmen, family Corixiae), grass seeds and leaf parts of wetland plants (Swedberg 1967; B. Zaun, in litt. 2005, as cited in USFWS 2011).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2011. Recovery Plan for Hawaiian Waterbirds, Second Revision. Portland, Oregon. 233 pp.

BirdLife International. 2016. *Anas wyvilliana*. The IUCN Red List of Threatened Species 2016: e.T22680199A92848719. http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22680199A92848719.en. Downloaded on 05 March 2017.

U.S. Fish and Wildlife Service (USFWS). 2021. Hawaiian Duck 5-Year Review Short Form Summary. Honolulu, Hawaii. 10 pp.

Species: Hawaiian coot

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: 21 - 80 (NatureServe 2015)

Species Trends: Stable or slightly increasing (USFWS 2010, 2015)

Pesticides noted ☒

Environmental Baseline/Cumulative Effects (EB/CE) Summary Hawaiian coot:

The Hawaiian coot, or ‘alae ke‘oke‘o occurs statewide although Kauai, Oahu, and Maui collectively support 80 percent of birds detected during the annual waterbird surveys (Hawaii Division of Forestry and Wildlife [HDODFAW] 1976-2008, USFWS 2011). The survey data do show some variability, but because ‘alae ke‘oke‘o are fairly conspicuous, the waterbird count data are considered fairly accurate minimum population estimates for this species (USFWS 2011). The most recent minimum population estimate of ‘alae ke‘oke‘o is 1,815 (1,248 – 2,577) individuals (Paxton et al. 2021, p. 12, as cited in USFWS 2021). In addition, this species disperses readily, exploits seasonally flooded wetlands, and their populations naturally fluctuate according to climactic and hydrologic conditions (Engilis and Pratt 1993). Threats to the species continue and include predation, degradation of wetlands, and avian disease. Contamination of wetlands with toxic substances from human development or from agricultural/aquacultural practices (e.g., oil, pesticides, and herbicides) is also a potential threat (USFWS 2011). This species may be close to being recovered if some additional recovery actions are taken as per the 2011 Recovery Plan (USFWS 2011). There are no new threats known at this time, although avian botulism impacts are increasing (USFWS 2011).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2010. Hawaiian Coot (*Fulia alai*) 5-Year Review. Honolulu, Hawaii. 11 pp.

U.S. Fish and Wildlife Service (USFWS). 2011. Recovery Plan for Hawaiian Waterbirds, Second Revision. U.S. Fish and Wildlife Service, Portland, Oregon. xx + 233 pp.

U.S. Fish and Wildlife Service (USFWS). 2015. Hawaiian Coot (*Fulia alai*) 5-Year Review. Honolulu, Hawaii. 7 pp.

U.S. Fish and Wildlife Service (USFWS). 2021. Hawaiian Coot (*Fulia alai*) 5-Year Review Short Form Summary. Honolulu, Hawaii. 9 pp.

Species: Hawaiian goose

Status: Threatened

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: 25 (NatureServe 2015)

Species Trends: Most islands: stable; Kauai: increasing (USFWS 2011)

Pesticides noted ☒

Environmental Baseline/Cumulative Effects (EB/CE) Summary Hawaiian goose:

Predation is believed to be the main threat to this species at this time (USFWS 2004). Mongooses are believed to be the most serious egg predator (Banko 1988, 1992, Black and Banko 1994, Stone et al. 1983; as cited in USFWS 2004). Rats and pigs also take eggs and cats have been observed moving eggs in nests, so they may also predate eggs (Baker and Baker 1995; Zaun in litt. 2008; as cited in USFWS 2011). Goslings are taken by mongooses, rats, pigs, and cats (Banko 1992, Hoshide et al. 1990; K. Misjon, NPS, pers. comm. 2011; as cited in USFWS 2011). Dogs and mongooses have been cited as being responsible for most known cases of predation on adult birds, but cats and probably pigs are known to be significant predators of adults as well (Banko and Elder 1990, Kear and Berger 1980; K. Misjon, NPS, pers. comm. 2011; as cited in USFWS 2011). Nēnē may also be impacted by human activities through the application of pesticides and other contaminants, ingestion of plastics and lead, collisions with stationary or moving structures or objects, entanglement in fishing nets, habitat degradation, disturbance at nest and roost sites, attraction to hazardous areas through human feeding and other activities, and mortality or disruption of family groups through direct and indirect human activities (Banko et al. 1999, as cited in USFWS 2004). Nēnē populations are currently stable on most islands and increasing on Kauai. However, predation and the potential for sustained drought remain important threats. It is likely that without predator control, populations would not fare as well. If mongoose ever become established on Kauai, it will likely have a major impact on the Kauai nēnē population. In addition, we lack resources to deal with nutritional concerns on Hawaii and Maui Islands, including managing pastures, restoring habitat, and developing alternative breeding sites. Finding lowland sites for breeding on those islands is also proving difficult. Habituation to humans results in direct harm to birds such as road kills and being struck by golf balls. A common cause of known mortality in adults at Hawaii Volcanoes National Park during 1989-1999 was roadkill (Rave et al. 2005, as cited in USFWS 2011). Vehicle-related mortality also occurs where roads pass though nēnē habitat, such as location where roads bisect nesting and rearing habitat, roosting and day-use sites, or a historic flocking area. This forces birds, including families with unfledged goslings, to cross dangerous roads. Studies have shown that parent reared birds are more dominant, more vigilant, and have greater reproductive success than goslings reared in ‘sibling groups’ (Marshall and Black 1992, Woog 1993; as cited in USFWS 2004). Low genetic variation may limit reproductive success and survival (USFWS 2004). Studies have shown that nēnē went through a prehistoric population bottleneck and have very low genetic diversity (Paxinos et al. 2002, Rave 1994, Rave et al. 1999, Veillet et al. 2008; as cited in USFWS 2011). Veillet et al. (2008, as cited in USFWS 2011) looked at polymorphic satellites in nēnē and their data corroborates previous studies showing high levels of inbreeding in wild nēnē populations that may impact breeding success and juvenile survival (Paxinos et al. 2002, Rave 1994; as cited in USFWS 2004). Some studies indicate that inadequate nutrition is a factor limiting nēnē reproduction and gosling survival, especially on Hawaii and Maui, and especially in harsh conditions (Baker and Baker 1995, Hu 1998, Rave et al. 2005, Tamayose 2006, as cited in USFWS 2004, 2011). Wind farms are a new threat to nēnē. Section 7 consultation and Habitat Conservation Plans (HCPs) are approved or being planned and are likely to affect nēnē on Maui, Molokai, and Hawaii Island. To date, at least six nēnē have been killed at the West Maui wind farm site. In 2017, the statewide population was estimated from the Hawaii Department of Land and Natural Resources at 3,252 individuals, comprised of 1,104 individuals on Hawaii, 1,482 individuals on Kauai, 627 individuals on Maui, 37 individuals on Molokai, and 2 individuals on Oahu. These estimates include the 646 translocations made from Kauai to Hawaii (598) and Maui (48), between 2011 and 2016.

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2004. Draft Revised Recovery Plan for the nēnē or Hawaiian Goose (*Branta sandvicensis*). Portland, Oregon. 148 + xi pp

U.S. Fish and Wildlife Service (USFWS). 2011. Nēnē or Hawaiian Goose (*Branta sandvicensis*) 5-Year Review Summary and Evaluation. Honolulu, Hawaii. 16 pp.

U.S. Fish and Wildlife Service (USFWS). 2019. Endangered and Threatened Wildlife and Plants s; Reclassifying the Hawaiian Goose From Endangered to Threatened With a Section 4(d) Rule. *Federal Register* 50 CFR 69918 - 69947.

Species: Hawaiian common gallinule

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: 6 - 20 (NatureServe 2015)

Species Trends: Unknown (USFWS 2015)

Pesticides noted ☒

Environmental Baseline/Cumulative Effects (EB/CE) Summary Hawaiian common gallinule:

The Hawaiian Common Gallinule or `alae `ula currently occurs only on the islands of Kauai and Oahu, having been extirpated from Molokai (sometime after the 1940s), Maui (after the late 1940s) and Hawaii in 1887 (USFWS 2011 p. 35, as cited in USFWS 2021). One of the main priorities in the revised recovery plan is to reintroduce this species to at least two additional islands (USFWS 2011, p. 133, as cited in USFWS 2021). Because this species is so secretive and difficult to census, current survey data are considered inadequate (USFWS 2021). The state-wide biannual waterbird counts provide a rough idea of recent population trends, but an accurate population estimate is not available (Hawaii Division of Forestry and Wildlife 1976-2008, entire; USFWS 2011, p. 37 as cited in USFWS 2021). Survey data from the State of Hawaii Department of Land and Natural Resources 2017 – 2021 was unavailable. The most recent minimum population estimate of `alae `ula is a 5-yr average of 927 (678 – 1,235) individuals from surveys between 2012 to 2016 (Paxton et al. 2021, p. 12 as cited in USFWS 2021). Threats to the species continue, including predation, degradation of wetlands, and avian disease. Contamination of wetlands with toxic substances from human development or from agricultural/aquacultural practices (e.g., oil, pesticides, and herbicides) is also a potential threat (USFWS 2011). Counts of `alae `ula have been stable, but remain low, with average totals of 287 birds over 10 years from

1998 to 2007 (HDOFAW 1976-2008, USFWS 2011, 2015). The inaccuracy of current methodology used in the statewide waterbird counts for this species is demonstrated by the extreme differences in numbers between summer and winter counts of lotus fields on Oahu. Updating and increasing the accuracy of surveys for this species is an important action in the recovery plan (USFWS 2011, 2015).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2011. Recovery Plan for Hawaiian Waterbirds, Second Revision. U.S. Fish and Wildlife Service, Portland, Oregon. xx + 233 pp.

U. S. Fish and Wildlife Service (USFWS). 2015. Hawaiian Common Gallinule (Moorhen, *Gallinula chloropus sandvicensis*) 5-Year Review, Honolulu, Hawaii. 8 pp.

U. S. Fish and Wildlife Service (USFWS). 2021. Hawaiian Common Gallinule (Moorhen, *Gallinula chloropus sandvicensis*) 5-Year Review Short Form Summary, Honolulu, Hawaii. 10 pp.

Species: Hawaiian stilt

Status: Endangered

Distribution: Species/Populations neither constrained nor widespread

Number of Populations: Multiple populations (occurs on all main islands, except Kahoolawe (USFWS 2020)

Species Trends: Stable or slightly increasing (USFWS 2011, 2020)

Pesticides noted ☒

Environmental Baseline/Cumulative Effects (EB/CE) Summary Hawaiian stilt:

The Hawaiian stilt was a popular game bird, and hunting contributed to local population declines until waterbird hunting was prohibited in 1939 (Henshaw 1902; Schwartz and Schwartz 1949; as cited in USFWS 2011). Hawaiian stilts are currently found on all of the main Hawaiian Islands except Kaho`olawe. Based on biannual Hawaiian waterbird surveys from 1998 through 2007, the Hawaiian stilt population averaged 1,484 birds, but fluctuated between approximately 1,100 and 2,100 birds (HDOFAW 1976-2008; Figure 26; as cited in USFWS 2011). Long-term census data indicate statewide populations have been relatively stable or slightly increasing for the last 30 years (Reed and Oring 1993; Figures 26 and 27; as cited in USFWS 2011). While the number of ae‘o counted on the surveys has not consistently exceeded 2,000 individuals during either the winter or summer counts (DOFAW 2017−Hawai‘i Waterbird Survey Site Database) for at least 5 consecutive years, as indicated in Downlisting Criterion 3 in the recovery plan (USFWS 2011, p. 124), the population has remained relatively stable over the years (USFWS 2020).

Considerable movement of Hawaiian stilts occur between the Kaua`i and Ni`ihau populations, apparently in response to rainfall patterns and the flooding and drying of Ni`ihau's ephemeral lakes (Engilis and Pratt 1993; as cited in USFWS 2011). On Kaua`i, Hawaiian stilts are numerous in large river valleys such as Hanalei, Wailua, and Lumaha`i, and on the Mānā Plain. Hawaiian stilts also frequent Kaua`i's reservoirs, particularly during drawdown periods, as well as sugarcane effluent ponds in Līhu`e and Waimea. The O`ahu population supports the largest number of Hawaiian stilts in the Hawaiian Islands (Engilis 1988; HDOFAW 1976-2008; as cited in USFWS 2011). Large concentrations of Hawaiian stilts can be found at the James Campbell National Wildlife Refuge, the Kahuku aquaculture ponds, the Honouliuli and Waiawa units of the Pearl Harbor National Wildlife Refuge, and on Nu`upia Ponds in Kāne`ohe. Populations also exist at the Chevron Refinery, the fishponds at Kualoa Beach Park, at Salt Lake District Park, and at scattered locations along the northern and eastern coasts. Over the past 5 years, O`ahu accounted for 35 to 50 percent of the State's Hawaiian stilt population, with approximately 450 to 700 birds counted during any single year (HDOFAW 1976-2008; Figure 29; as cited in USFWS 2011). The Maui, Moloka`i, and Lāna`i (Maui Nui) populations, support a significant number of Hawaiian stilts, with important nesting habitat at Keālia. Monthly counts indicate that birds freely move between these two wetlands, apparently in search of optimal foraging habitat (Ueoka 1979; as cited in USFWS 2011). Moloka`i's south coastal wetlands and playa lakes are, at times, important habitats for Hawaiian stilts, with large concentrations at the Kaunakakai Wastewater Reclamation Facility. There is some evidence of periodic movements of birds between Maui and Moloka`i, again probably in response to available foraging habitat (Engilis and Pratt 1993; as cited in USFWS 2011). Since 1968, statewide waterbird surveys have shown a significant increase in Hawaiian stilts on Moloka`i (Reed and Oring 1993; as cited in USFWS 2011). Hawaiian stilts are now permanent residents at the Lāna`i City wastewater treatment pond. They have been recorded there annually since the ponds became operational in 1989, and numbers sometimes exceed 100 birds (HDOFAW 1976-2008; as cited in USFWS 2011). The Hawai`i population from the Kona Coast from Kawaihae Harbor south to Kailua supports the largest number of Hawaiian stilts on Hawai`i Island, with `Ōpae`ula and `Aimakapā Ponds being key breeding areas. These two ponds anchor the continuous network of wetlands along the Kona Coast and together have maintained 95 percent of the Hawaiian stilts and 90 percent of the Hawaiian coots for Hawai`i Island (Paton et al. 1985; M, Morin, in litt. 2005; as cited in USFWS 2011). Until 2003, the Cyanotech Ponds were a key breeding area because management focused on providing adequate breeding habitat for Hawaiian stilts to minimize nesting attempts in hazardous areas (Evans and Uyehara 2001; Waddington 2003; as cited in USFWS 2011). For a variety of reasons, these ponds are no longer managed as breeding habitat for Hawaiian stilts. However, we are working with Cyanotech and the State to provide suitable nesting habitats for Hawaiian stilts displaced from the site, and Cyanotech is funding predator control actions at `Ōpae`ula Pond (J. Kwon, pers. comm. 2008, Waddington 2010; as cited in USFWS 2011). The anchialine pools north of the harbor in Kona are also important Hawaiian stilt as well as Hawaiian coot habitat (M. Morin, in litt. 2005; as cited in USFWS 2011). Hawaiian stilts can also be found along the Hāmākua Coast and in the Kohala River valleys of Waipi`o, Waimanu, and Pololū. The scattered anchialine ponds along the Kona Coast are important feeding sites.

Predators of Hawaiian stilts include mongooses, black rats (*Rattus rattus*), feral cats, feral dogs, black-crowned night herons, cattle egrets, Hawaiian short-eared owl or pueo (*Asio flammeus sandwichensis*), and common mynas (*Acridotheres tristis*) (Coleman 1981, Robinson et al. 1999; as cited in USFWS 2011). Because of their exposed nest sites, Hawaiian stilts appear to be more susceptible to avian predators than are other Hawaiian waterbirds.

Hawaiian stilts are opportunistic feeders. They eat a wide variety of invertebrates and other aquatic organisms as available in shallow water and mudflats. Specific organisms taken include water boatmen (insects in the family Corixidae), beetles (order Coleoptera), possibly brine fly (*Ephydra riparia*) larvae, polychaete worms, small crabs, fish (e.g., Mozambique tilapia (*Oreochromis mossambica*) and mosquito fish (*Gambusia affinis*)), and tadpoles (*Bufo* spp.) (Shallenberger 1977; Robinson et al. 1999; as cited in USFWS 2011). Midges are an important food source for Hawaiian stilts; in taro patches at Hanalei National Wildlife Refuge, silt and midge abundance were positively related and Hawaiian stilt and mosquito fish abundance were negatively related; mosquito fish, not Hawaiian stilts, were limiting midge populations (Broshears 1979; as cited in USFWS 2011). Feeding typically occurs in shallow flooded wetlands. These types of wetlands are ephemeral in nature and may appear at any time of year but are primarily available in winter. Hawaiian stilts require specific conditions (water depths of 13 centimeters [5 inches] or less) for optimal foraging (Telfer 1973; Gee 2007; as cited in USFWS 2011). Thus, intra- and inter-island movement is an important strategy for exploiting food resources; movement between O`ahu and Maui has been documented by statewide waterbird survey data and banding studies (Ueoka 1979; Engilis and Pratt 1993; Reed et al. 1994; 1998b; as cited in USFWS 2011).

Little is known about the lifespan or survivorship of the Hawaiian stilt. From two Hawaiian stilt cohorts, Reed et al. (1998a; as cited in USFWS 2011) determined first-year survival to be 0.53 and 0.6, Based on the 2011 Recovery Plan for Hawaiian Waterbirds, the trend data collected over the past three decades show that Hawaiian coot, Hawaiian common moorhen, and Hawaiian stilt populations are either stable or increasing. The most important causes of decline for all four species were loss and degradation of wetland habitat and predation by introduced animals. Other factors that have contributed to waterbird population declines, and that continue to be detrimental, include modification of hydrology, alteration of habitat structure and vegetation composition by invasive non-native plants, loss of riparian vegetation and water quality degradation due to grazing, disease, and possibly environmental contaminants. Contamination of wetlands with toxic substances from human development or from agricultural/aquacultural practices (e.g., oil, pesticides, herbicides) is also a potential threat (USFWS 2011).

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2011. Recovery Plan for Hawaiian Waterbirds, Second Revision. Portland, Oregon. xx + 233 pp.

U.S. Fish and Wildlife Service (USFWS). 2020. Hawaiian stilt (*Himantopus mexicanus knudseni*) 5-Year Review. Honolulu, Hawaii. 26 pp.

Overall Vulnerability Hawaiian (koloa) duck:	☒ **High**	☐ **Medium**	☐ **Low**
Overall Vulnerability Hawaiian goose:	☐ **High**	☒ **Medium**	☐ **Low**
Overall Vulnerability Hawaiian coot:	☒ **High**	☐ **Medium**	☐ **Low**
Overall Vulnerability Hawaiian common gallinule:	☒ **High**	☐ **Medium**	☐ **Low**
Overall Vulnerability Hawaiian stilt:	☒ **High**	☐ **Medium**	☐ **Low**

RISK

(Risk is based on species exposure and response from labelled uses across the range)

Risk to individuals if exposed:

Effects to Hawaiian waterbirds birds from use sites:

- The Hawaiian stilt is unlikely to experience mortality or sublethal effects from consumption of contaminated dietary items exposed on use sites or via spray drift.
- Other waterbird species may experience mortality or sublethal effects from consumption of food items such as grass, leaves, or terrestrial arthropods exposed on use sites with higher allowable application rates, such as developed, developed open space, and orchards and vineyards. However, direct effects are not expected from exposure to these food items via spray drift. Exposure to malathion from contaminated food items from usage on pasture is not expected to result in effects to any of these species.

Effects to Hawaiian waterbirds birds from mosquito control

- Exposure to malathion from contaminated food items from usage for mosquito control is not expected to result in effects to any of these species.

Risk to the species from labelled uses across the range

DIRECT (all uses except mosquito adulticide)	
Use areas – mortality and sublethal effects	No effects to the Hawaiian common gallinule, Hawaiian duck, and Hawaiian coot are expected from exposure to aquatic invertebrates and fish. A chance of mortality or sublethal effects exists for individuals that stop to forage in wetland areas within certain agricultural use sites (orchards and vineyards, developed, open space developed, and vegetables and ground fruit) if consuming terrestrial food items such as arthropods, grass or

	leaves on these use sites. However, we expect this behavior to occur on malathion use sites infrequently. Hawaiian geese could experience mortality or sublethal effects from foraging on treated areas in developed, developed open space, and orchards and vineyards use sites. No effects expected to the Hawaiian stilt from consumption of contaminated dietary items exposed on use sites or via spray drift.
Spray drift areas – mortality	No effects expected
Direct spray or contact with contaminated media	No effects expected
Volatilization	Could contribute to exposure for Hawaiian goose and Hawaiian duck
INDIRECT (all uses except mosquito adulticide)	
Use areas - Prey item mortality	Mortality to aquatic and terrestrial invertebrates via direct exposure and spray drift
MOSQUITO ADULTICIDE	
Direct (mortality and sublethal)	No effects expected
Indirect	Mortality to aquatic and terrestrial invertebrates if use occurs

Risk modifiers: Four of the five waterbird species (Hawaiian Common Gallinule, Hawaiian Stilt, Hawaiian Duck, and Hawaiian Coot) are associated almost exclusively with wetlands, ponds, and other water features in the Hawaiian Islands, which occur predominately at low elevation. Hawaiian ducks also rely on montane streams extensively for breeding as well. The fifth species, Hawaiian Goose, has a wider distribution from high-elevation dry scrub and grasslands on Maui and Hawai'i to pastures and golf courses on these two islands, as well as Molokai and Kauai; although they are also found in wetlands as well. Agricultural wetlands (i.e., taro fields) are key habitat for many of these waterbird species. The Hawaiian goose and the Hawaiian duck can be found in upland areas where volatilization of malathion into the fog layer could increase exposure. Notably, a significant percentage of the Hawaiian duck population breeds in upland streams on Kauai, where volatilization would be particularly acute. Although we would expect species within high-level elevation area to be exposed to malathion via volatilization, we conclude, based on the best information available, that species in high elevations would not be exposed to concentration levels that would affect them (see *General Effects* for further information on volatilization). Other species are found predominantly at lower elevations where volatilization is less likely to increase exposure.

Range maps for Hawaiian waterbirds include the entirety of the islands where these species can be found. Therefore, an overlap analysis of malathion use sites would simply be indicative of the extent of use sites on the islands, and not the true overlap where the species is likely to be found. Thus, exposure is better assessed by the degree to which these species are likely to be within or adjacent to malathion use sites. Malathion is not registered for use on taro, which form the agricultural wetlands where these species are often found. The waterbird species restricted to wetland areas are not expected to be exposed to malathion directly in other agricultural crops or developed areas but could be found in suitable wetland areas that are adjacent to or traverse to these sites. The Hawaiian goose could be exposed directly to malathion from usage on pasture; however, effects to this species on pasture are not anticipated. Malathion is not registered for use on golf courses.

Contamination of wetlands with toxic substances from human development or from agricultural/aquacultural practices (e.g., oil, pesticides, herbicides) is a potential threat. Because waterbirds are often concentrated in small areas, the localized contamination of water or food can affect a large number of birds (USFWS 2011). In the case of malathion use, the main threat from this type of exposure would likely be loss of prey and foraging items.

Allowable uses driving effects/other considerations: Direct effects to these species are only expected to occur if individuals consume terrestrial food items on use sites with higher application rates. As species are not expected to regularly inhabit these areas, exposure would likely occur if individuals stopped in wetlands associated with these use sites associated with regular movements and consumed terrestrial food items from agricultural areas.

Indirect effects to the aquatic and terrestrial prey base could occur on all use sites and in wetland areas adjacent to use sites. Because species taken as food items exhibit a range of sensitivities to malathion, we expect exposure to reduce the abundance in these areas, but not completely eliminate the prey base in these portions of the range. We anticipate this reduction to be greater on use sites, where estimated environmental concentrations are higher than would be anticipated from spray drift. These reductions are likely temporary (based on application frequency) with community recovery over a short period of time.

Overall Risk for Hawaiian (koloa) duck: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Risk for Hawaiian goose: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Risk for Hawaiian coot: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Risk for Hawaiian common gallinule: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Risk for Hawaiian stilt: ☐ **High** ☐ **Medium** ☒ **Low**

USAGE

(Anticipated usage within the range based on past usage data)

Information regarding past usage of malathion in Hawaii is not available, however prior survey data has indicated that 4.8% of agricultural crops were treated with insecticides, with malathion being only a subset of this use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the Approach to Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in Hawaii; future use cannot be ruled out but is not expected to increase significantly.

Overall Usage for Hawaiian (koloa) duck: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Usage for Hawaiian goose: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Usage for Hawaiian coot: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Usage for Hawaiian common gallinule: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Usage for Hawaiian stilt: ☐ **High** ☒ **Medium** ☐ **Low**

CONSERVATION MEASURES

Rain restriction and aquatic habitat buffers: These Hawaiian water birds are known to rely on aquatic habitat for food resources or is otherwise closely associated with aquatic habitats and may experience effects of malathion through effects to the aquatic system. Label language has been added restricting malathion application to periods where rain is not forecasted for at least 48 hours for agriculture and 24 hours for residential use or when the soil is not saturated. Rain restrictions (which allow for malathion to degrade before runoff events can occur as malathion has a relatively short half-life and rapid degradation that occurs via hydrolysis and other processes) and aquatic habitat buffers (which specify on the label a distance from water bodies where pesticides are not to be applied) required of all agricultural and residential uses will likely reduce the level of effects impacting these species by substantially reducing the amount of malathion that would reach the habitats in which these species reside. We anticipate that, in many cases, these buffers will significantly reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

Residential use label changes: New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely), reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from “repeat as necessary” to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted for within 24 hours or when the soil is not saturated.

Reduced application number and rate: New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop, previous allowable number of applications ranged from 3 to 13 applications per year). We anticipate that this measure will reduce the amount of malathion used and decrease potential exposure to these species, thus decreasing the risk of both indirect and direct effects to these species.

CONCLUSION

After reviewing the current status of the species, the environmental baseline for the Action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service’s biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of these species. We discuss each of the species in the following paragraphs:

Hawaiian Stilt

For the Hawaiian stilt, the vulnerability is high, the risk is low, and the usage is medium for this species, and the general conservation measures described above are expected to further reduce the likelihood of exposure to malathion. We do not anticipate the Action will result in species-level effects.

The Hawaiian stilt has a high vulnerability based on its status, distribution, and trends. The risk to this species posed by the labeled uses across the range is low, with a medium amount of estimated usage within the range of this species. Usage is not expected on all use sites at the maximum rates allowed by the year as prior survey data indicated that 4.8% of agricultural crops were treated with insecticides (malathion use being a subset of this) and based on CONUS species information. We estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. While usage is not expected on all use sites and at the maximum rates allowed by the labels wherever used each year, we anticipate that some usage will occur. While we do anticipate that adverse effects to prey items will occur, we do not expect species-level effects because if prey items in a particular area are impacted, Hawaiian stilts have the ability to move to untreated areas within their range to forage. As such, mortality or sublethal effects are not anticipated. Furthermore, we anticipate the additional conservation measures above, including rain restrictions and aquatic habitat buffers, residential use label changes, and reduced numbers of applications and application rates on certain use sites would further reduce the likelihood of exposure to the species, its prey, and its habitat. The Hawaiian stilt depends on mudflats and shallow water habitats for foraging and breeding, and as with most species that use wetlands, the rain (restricting applications when rain is forecasted) and residential restrictions (using only spot treatment in residential areas including open space developed areas) are anticipated to reduce the runoff exposure to waterbodies and aquatic organisms. In addition, the aquatic habitat buffers (anticipated to reduce spray drift) and reduction in number of applications and application rates for certain agricultural crops are anticipated to reduce the amount of malathion used and limit exposure to the species and its habitat. Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of the Hawaiian stilt in the wild.

Hawaiian Duck, Goose, Coot, and Common Gallinule

After reviewing the current status of the species, the environmental baseline for the Action area, the effects of the proposed registration of malathion, and cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the Hawaiian (koloa) duck, Hawaiian goose, Hawaiian coot, and Hawaiian common gallinule. As discussed below, even though the vulnerability is high for the Hawaiian (koloa) duck, Hawaiian coot, and Hawaiian common gallinule and the vulnerability is medium for the Hawaiian goose, the risk and usage are both medium for all of these species. Moreover, we anticipate the implementation of the general conservation measures described above are expected to further reduce the likelihood of exposure. While we anticipate that very small numbers of individuals of these species will be affected over the duration of the proposed Action, we do not expect species-level effects to occur.

The Hawaiian (koloa) duck, Hawaiian coot, and the Hawaiian common gallinule have high vulnerability based on their status, distribution, and trends. The Hawaiian goose has medium vulnerability based on its status, distribution, and trends. The risk to the species posed by the labeled uses across the range is medium, with a medium amount of estimated usage within the range of this species based on prior survey data that indicated 4.8% of agricultural crops were treated with insecticides (malathion use being a subset of this). Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. While usage is not expected on all use sites at the maximum rates allowed by the maximum rate allowed by the label wherever used each year, we anticipate that usage could occur. Contamination of wetlands with toxic substances from human development or from agricultural/aquacultural practices (e.g., oil, pesticides, and herbicides) is a potential threat. In addition, the Hawaiian goose and Hawaiian duck have wider distributions and can be found in upland areas where volatilization of malathion into the fog layer would increase exposure. Notably, a significant percentage of the Hawaiian duck population breeds in upland streams on Kauai, where volatilization would be particularly acute. Although we would expect species within high-level elevation areas to be exposed to malathion via volatilization, we conclude, based on the best information available, that species in high elevations would not be exposed to concentration levels that would affect them (see *General Effects* for further information on volatilization). In addition, in the event that prey items in a particular area were reduced, the Hawaiian (koloa) duck, Hawaiian coot, Hawaiian common gallinule, and Hawaiian goose would all likely respond by moving elsewhere within their range to forage.

Furthermore, we anticipate that the additional conservation measures above, including rain restrictions and aquatic habitat buffers, residential use label changes, and reduced numbers of applications and application rates on certain use sites would further reduce the likelihood of exposure of these species, their prey, and their habitats. Each of these species use a variety of wetland areas for nesting and feeding, and we anticipate that the rain (restricting application when rain is forecasted) and residential restrictions (spot treatment only including in open space developed areas) will reduce runoff of malathion to the waterbodies and aquatic organisms these species use. Similarly, we expect the aquatic habitat buffers will reduce spray drift and runoff into these habitats. The reduction in number of applications and application rates for certain agricultural crops are anticipated to further reduce exposure to the malathion.

Together, these measures are anticipated to substantially reduce the likelihood of exposure to these species and their habitat. Thus, we anticipate only small numbers of individuals of these species will experience mortality, effects to growth and reproduction, and small reductions in the forage base for the species over the duration of the Action. However, we do not anticipate the loss of small numbers of individuals, or the low levels of expected sublethal take and reductions in the forage base would result in species-level effects.

Therefore, we anticipate that the proposed Action would not appreciably reduce survival and recovery of the Hawaiian (koloa) duck, Hawaiian goose, Hawaiian coot, and Hawaiian common gallinule.

Conclusion for Hawaiian (koloa) duck: **Not likely to jeopardize**

Conclusion for Hawaiian goose: **Not likely to jeopardize**

Conclusion for Hawaiian coot: **Not likely to jeopardize**

Conclusion for Hawaiian common gallinule: **Not likely to jeopardize**

Conclusion for Hawaiian stilt: **Not likely to jeopardize**

***ADDITIONAL REFERENCES*:**

U.S. Fish and Wildlife Service (USFWS). 2011. Recovery Plan for Waterbirds Second Edition. Portland, Oregon. xx + 233 pp.

U.S. Fish and Wildlife Service (USFWS). 2014. (*Gallirallus owstoni*) 5-year review summary and evaluation; Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii. 11 pp.

U.S. Fish and Wildlife Service (USFWS). 2014. Guam rail (*Gallirallus owstoni*) 5-year review Short Form Summary; Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii. 6 pp.

U.S. Fish and Wildlife Service (USFWS). 2020. Hawaiian Stilt 5-year review; Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii. 26 pp.

Integration and Synthesis Summary: Hawaii Forest Birds

This section describes our analysis for Hawaii Forest Birds. The analysis for these species will be presented together according to the following groups, although each species was considered independently based on its life history and vulnerability, risk, and usage, as well as any applicable conservation measures. Each species has a separate conclusion listed after the narrative. Groups:

- Species that are presumed extinct or extirpated with recommendations for delisting
- Species status "Unknown" rather than "presumed extinct"
- Extant Forest Birds

Scientific Name	Common Name	Entity ID
Chasiempis ibidis	O'ahu 'Elepaio	150
Corvus hawaiiensis	Hawaiian (`alalā) crow	68
Drepanis coccinea	I'iwi	10073
Hemignathus affinis	Maui nukupuu (honeycreeper)	11333
Hemignathus wilsoni	Akiapola'au	65
Loxioides balleui	Palila	79
Loxops caeruleirostris	Akekee	6522
Loxops coccineus	Hawai'i akepa	97
Loxops ochraceus	Maui akepa (honeycreeper)	98
Myadestes lanaiensis rutha	Molokai'i thrush	106
Melamprosops phaeosoma	Po'ouli (honeycreeper)	113
Myadestes palmeri	Small Kauai (puaiohi) thrush	86
Oreomystis bairdi	Akikiki	4136
Oreomystis mana	Hawai'i creeper	112
Palmeria dolei	Crested (akohekohe) honeycreeper	74
Paroreomyza maculata	O'ahu creeper	99
Pseudonestor xanthrophyrys	Maui parrotbill	81
Psittirostra psittacea	O'u	78

In Hawai'i, there are 15 species of listed forest birds that are extant. One of these species, the Hawaiian (`alalā) crow (*Corvus Hawaiiensis*), exists only in captivity, but a reintroduction program is ongoing with birds to be released back into the forests of Hawai'i annually from 2017 and is thus included in this analysis. In addition, there are three forest birds that after additional evaluation, the FWS determined the Action "may affect, but is not likely to adversely affect" the species, because the species are presumed extirpated or extinct (i.e., recommended for delisting in a recent [within the last 5 years] FWS 5-year review or other USFWS status review). These species are the Maui nukupu'u (*Hemignathus affinis*), Maui akepa (*Loxops ocharaceus*), and Po'ouli (*Melamprosops phaeosoma*). Six species have designated critical habitat: akikiki (*Oreomystis bairdi*), akekee (*Loxops caeruleirostris*), and Oahu `elepaio (*Chasiempis ibidis*) on Oahu, Maui parrotbill (*Pseudonestor xanthrophrys*) and akohekohe *(Palmeria dolei*) on Maui, and palila (*Loxioides balleui*) on Hawai'i. Nine species do not have critical habitat: `alalā

(*Corvus hawaiiensis*), akiapolaau (*Hemignathus wilsoni*), Hawai'i creeper (*Oreomystis mana*), and Hawai'i akepa (*Loxops coccineus*) on Hawai'i; and puaiohi (*Myadestes palmeri*) on Kauai and o'u (*Psittirostra psittacea*) on Kauai; Molokai thrush (*Myadestes lanaiensis rutha*) on Moloka'i and O'ahu creeper (*Paroreomyza maculata*) on O'ahu. Finally, the i'iwi (*Vestiaria coccinea*), which is found on all of the Hawaiian Islands.

VULNERABILITY.

(Summary of status, environmental baseline and cumulative effects)

Primary threats to forest birds in Hawai'i are habitat loss and degradation due to agriculture, urbanization, cattle grazing, browsing by feral ungulate species, timber harvesting, and invasion of non-native plants into native-dominated plant communities; predation by alien mammals, and diseases carried by alien mosquitoes. Small populations and the associated threats from inbreeding depression, as well as demographic and environmental stochastic events are also a problem for many species (USFWS 2006). Emergent threats include introduced diseases and non-native insects that threaten the remaining native forest habitats where they live, particularly rapid ohia death caused by a *Ceratosystis* sp. fungus on Hawai'i (Friday et al. 2015). Changes to distribution of habitats and disease vectors due to climate change is also anticipated to drive population declines in the future, particularly as avian malaria spreads to upper elevation refugia (Fortini et al. 2015).

Populations of all of these species are very small, with some species existing in single populations of less than 500 individuals. None of the species exist in more than three populations.

Species that are presumed extinct or extirpated with recommendations for delisting

Species: Maui nukupuu (honeycreeper)

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Unknown

Species Trends: USFWS recommendation in species population status from "unknown' to "presumed extinct" (USFWS 2018)

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary Maui Nukupuu:

The Maui nukupu`u is one of three subspecies. The Maui and Kaua`i subspecies may still survive, *but Hemignathus lucidus lucidus* of O`ahu is extinct. Evidence is mounting that the Kaua`i, O`ahu, and Maui forms of nukupu`u are distinct species (Pratt 2005; R. Fleischer, unpublished data; as cited in USFWS 2006). The historical record provides little information on the life history of the Maui nukupu`u (Rothschild 1893 to 1900, Perkins 1903; as cited in USFWS 2006). Nothing is known of its breeding biology, which likely was similar to its closest relative, the `akiapōlā`au. Maui nukupu`u tap and probe bark, lichen, and branches to extract insects, and thus their foraging behaviors resemble those of `akiapōlā`au. Diet of the Maui nukupu`u was reported by Perkins (1903; as cited in USFWS 2006) to be small weevils and larvae of Coleoptera (beetles) and Lepidoptera (butterflies and moths). Apparently, they seldom forage for larvae and adults of longhorn beetles (Cerambycidae) and thereby compete little with Maui parrotbills. The first historical records, at the turn of the last century, indicate that the Maui nukupu`u inhabited mixed koa/`ōhi`a (*Acacia koa*/*Metrosideros polymorpha*) forest from 1,220 meters (4,000 feet) to timberline (Perkins 1903, Banko 1984; as cited in USFWS 2006) on the northwestern slope of Haleakalā. Sightings since the 1967 rediscovery of the Maui nukupu`u have been in mixed shrub montane wet forest (Jacobi 1985; as cited in USFWS 2006) in Kīpahulu Valley and the northeast slope of Haleakalā at 1,100 to 2,100 meters (3,600 to 6,720 feet), though most have been above 1,700 meters (5,500 feet; Banko 1984b; as cited in USFWS 2006). Discovery of subfossil nukupu`u on Moloka`i and Maui show that the species once inhabited dry forests (James and Olson 1991; as cited in USFWS 2006). As Reynolds and Snetsinger (2001; as cited in USFWS 2006) describe, there are instances where rare Hawaiian birds have been rediscovered after they were presumed extinct or have been found in larger populations than expected. The large areas on East Maui (approximately 50,000 hectares; USFWS 1984, as cited in USFWS 2006) and Kaua`i (7,800 hectares) with suitable habitat, and many sites that are remote and only rarely visited by qualified observers, increase the potential that a small population of nukupu`u still exists in Hawai`i. In addition, the rough terrain on Kaua`i and Maui and frequent wet weather make surveys difficult, and numerous steep valleys create many small pockets of habitat where the species could potentially persist. In 1967, W. Banko rediscovered Maui nukupu`u in the upper reaches of Kīpahulu Valley on the eastern slope of Haleakalā (Banko 1968; as cited in USFWS 2006). Since then, isolated sightings have been reported on the northern and eastern slopes of Haleakalā from below Pu`u `Alaea east to Kīpahulu Valley (Pratt and Pyle 2000). Because most of these sightings were uncorroborated by behavioral information or follow-up sightings, the recent status of the Maui nukupu`u is difficult to evaluate. Scott et al. (1986; as cited in USFWS 2006) estimated a population of 28 ± 56 birds based on a single sighting. One bird was detected in 1994 and was resighted in 1995 and a second time in 1996, on the northeast slope of Haleakalā (Reynolds and Snetsinger 2001; as cited in USFWS 2006). However, most recent intensive surveys (1995 to 1999) did not detect nukupu`u at locations of previous sightings (Baker 2001; Hawai`i Department of Land and Natural Resources, unpublished data; as cited in USFWS 2006). Although it is possible the Maui subspecies may be extinct (Pratt and Pyle 2000; as cited in USFWS 2006), the relatively recent sightings of nukupu`u on Haleakalā and extensive habitat area that still exists for nukupu`u led Reynolds and Snetsinger (2001; as cited in USFWS 2006) to conclude that the nukupu`u is still extant on Maui. Further targeted surveys will be required to confirm the status of this species.

The USFWS believes the population status of Maui nukupu'u should be considered "presumed extinct" rather than "unknown" (USFWS 2018). This recommendation is based on 1) the lack of detections during extensive searches conducted throughout the species range, in particular Hanawī NAR where Maui nukupu'u was last reported in 1996; and 2) the extremely small population at the end of the 20th Century and its vulnerability to the negative effects of small population size. Although neither an estimate of species extinction date nor a quantitative confidence bound were available for this species (Elphick et al. 2010), we conclude based on the failure to detect Maui nukupuʻu despite extensive search by qualified observers of over 10,000 person hours in the area of the species' last reported sighting (Pratt and Pyle 2000, p. 37; as cited in USFWS 2018), and many hours of subsequent field presence by qualified observers in Hanawī NAR and other high elevation native forest on east Maui (H. Mounce, Hawaiʻi Division of Forestry and Wildlife, pers. comm., 2018, p. 1; as cited in USFWS 2018), that there is strong confidence (equivalent to at least 95 percent) that the species is extinct (USFWS 2018).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2006. Revised Recovery Plan for Hawaiian Forest Birds. Portland, Oregon. 622 pp.

U.S. Fish and Wildlife Service (USFWS). 2018. Maui Nukupu'u (*Hemignathus affinis*) 5-year Review Short Form Summary 2018. U.S. Fish and Wildlife Service, Honolulu, Hawaii. 11 pp.

Species that are presumed extinct or extirpated with recommendations for delisting

Species: Maui akepa (honeycreeper)

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Unknown

Species Trends: USFWS recommendation in species population status from "unknown' to "presumed extinct" (USFWS 2018)

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary Maui akepa:

The primary threats to Hawaiian forest birds are habitat loss and degradation due to agriculture, urbanization, cattle grazing, browsing by feral ungulate species, timber harvesting, and invasion of nonnative plant species into native-dominated plant communities; predation by alien mammals; and diseases carried by alien mosquitoes. In addition, rats may have played an especially important role as nest predators of akepa. While the only nest of Maui akepa ever reported was built in tree foliage, the birds may also have selected tree cavities like the very similar Hawaii akepa. In Maui forests, nest trees are of shorter stature than where akepa survive on Hawaii Island. Suitable cavity sites on Maui are low in the vegetation, some near or at ground level, and thus more accessible to rats. High densities of both black and Polynesian rats (*Rattus and Rattus exulans*) infest akepa habitat on Maui (Sugihara 1997; as cited in USFWS 2006). Almost nothing about the life history of the Maui akepa appears in the historical record (Perkins 1903, Rothschild 1893 to 1900, Henshaw 1902, Banko 1984a; as cited in USFWS 2006). No effort has been initiated in the field specifically for Maui `ākepa. However, this species has, or could have, benefited in the long-term from habitat restoration to assist other endangered birds on Maui. All specimens of Maui akepa were collected in ohia/koa (*Acacia koa*) rainforest at 1,200 to 1,800 meters (4,000 to 6,000 feet) elevation on the northwest rift of Haleakalā. Rothschild (1893 to 1990; as cited in USFWS 2006) found Maui `ākepa foraging in `ōhi`a. Perkins (1903; as cited in USFWS 2006) noted that the birds were "often seen in koa trees but more often in `ōhi`a." Henshaw (1902; as cited in USFWS 2006) commented that they much preferred koa to `ōhi`a for foraging. Palmer also found `ākepa in mid-elevation `ōhi`a forest, and all likely sightings this century have been in `ōhi`a forest at 1,700 to 2,100 meters (5,500 to 7,000 feet; as described in Rothschild 1893 to 1900; as cited in USFWS 2006). The past distribution of the Hawai`i `ākepa once encompassed a wide range of habitats from 600 meters (2,000 feet) to timberline, and the Maui subspecies may also have once occupied all forests within its range. The current habitat of the Maui `ākepa is mixed shrub montane wet forest (Jacobi 1985; as cited in USFWS 2006) above 1,500 meters (5,000 feet), the same as for other endangered birds on Maui. In the absence of early historical surveys, the extent of the geographical range of the Maui `ākepa cannot be reconstructed. All historical records of the Maui `ākepa were from high elevation forests most accessible to naturalists, near Olinda and Ukulele Camp on the northwest rift of Haleakalā, and from mid-elevation forests in Kīpahulu Valley (see Figure 14 on page 2-94; as cited in USFWS 2006). This range suggests that the birds were missing from forests at lower Revised Recovery Plan for Hawaiian Forest Birds 2-136 elevations, perhaps due to the introduction of disease-transmitting mosquitoes to Lahaina in 1826 (Hardy 1960; as cited in USFWS 2006). However, it may be that the Maui `ākepa originally occupied all forests on Maui. Complete destruction of habitat was not extensive during the 20th century, but ecological changes in the forests probably have caused the species to decline to its restricted geographic range. Reports by naturalists at the turn of the century varied in their estimates of abundance of the Maui `ākepa, ranging from rare to locally abundant (Banko 1984a; as cited in USFWS 2006). From 1970 to 1995, there have been few credible sightings of Maui `ākepa (Banko 1984a, Engilis 1990; as cited in USFWS 2006). Scott et al. (1986; as cited in USFWS 2006) estimated a total population of 230 ± 290 birds, in 2 populations on northwestern and eastern Haleakalā. However, this estimate was based on potentially confusing auditory detections, not on visual observations. Songs of the Maui `ākepa were reportedly heard in 1994 and 1995 during the Hawai`i Rare Bird Search, but visual confirmation of the species was not obtained, and it is possible there was some confusion with similar songs or mimicry of the Maui parrotbill (*Pseudonestor xanthophrys*) (Reynolds and Snetsinger 2001; as cited in USFWS 2006). The current population, if any, therefore, remains undetected and most likely survives in the vicinity of the northeastern rift of Haleakalā, the location of the last reports. Thorough surveys from 1995 through 1999 turned up no `ākepa in this area (Reynolds and Snetsinger 2001; Hawai`i Department of Land and Natural Resources, unpublished data; as cited in USFWS 2006), but the conclusion of the Hawai`i Rare Bird Search was that based on the available evidence, it is not possible to either confirm or disprove that the Maui `ākepa is extant (Reynolds and Snetsinger 2001; as cited in USFWS 2006). Pratt (2014, p. 10; as cited in USFWS 2006) found that the Hawaii, Maui, and Oahu populations of the akepa were distinct at the species level based on molecular data and differences in plumage and nest placement. Based on this research, the AOU (Chesser et al. 2015, p. 760; as cited in USFWS 2006) accepts the Hawaii akepa *(Loxops coccineus*), the Maui akepa (*Loxops ochraceus*), and the Oahu akepa (*Loxops wolstenholmei*) as distinct species. The taxonomic change does not affect the range or endangered status of either the Hawaii akepa or the Maui akepa (81 FR 8004 8007; as cited in USFWS 2006).

The USFWS recommends a change in species population status from "unknown' to "presumed extinct" (USFWS 2018). The USFWS recommends a change in species population status from "unknown" to "presumed extinct". The last confirmed sighting of Maui `ākepa was in 1988 from Hanawī Natural Area Reserve (NAR) (Engilis 1990, p. 69; as cited in USFWS 2018). The last audio detections of Maui `ākepa were in 1994 from Maui `ākepa from Hanawī NAR and 1995 from upper Kīpahulu Valley (Reynolds and Snetsinger 2001, p. 140; as cited in USFWS 2018). Over 10,000-person search hours in Hanawī NAR and nearby areas including Kīpahulu Valley from October 1995 through June 1999 failed to confirm presence of Maui 'ākepa (Pratt and Pyle 2000, p. 37; as cited in USFWS 2018). Field presence by qualified observers from 2006 to 2011 in the area Maui `ākepa was last known failed to detect this species. This recommendation is based on 1) lack of detections during surveys and searches conducted throughout the species' range since the Maui 'ākepa was last sighted in 1988; the species' estimated small population when last detected in the 1980s and its vulnerability to the negative effects of small population size; and 3) the conclusion by Elphick et al. 2010 (p. 620) estimating the extinction date of the species as 1987, with 95% confidence of extinction by 2004 (USFWS 2018).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2006. Revised Recovery Plan for Hawaiian Forest Birds. Portland, OR. 622 pp.

U.S. Fish and Wildlife Service (USFWS). 2018. Maui Akepa 5-year Review Short Form Summary 2018. U.S. Fish and Wildlife Service, Honolulu, Hawaii. 10 pp.

Species that are presumed extinct or extirpated with recommendations for delisting

Species: Po'ouli

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Unknown (USFWS 2018)

Species Trends: USFWS recommendation in species population status from "unknown' to "presumed extinct" (USFWS 2018)

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary Po'ouli:

The po'ouli is a medium sized, stocky Hawaiian honeycreeper recognized by its brown plumage and characteristic black mask framed by a gray crown and white cheek patch (USFWS 2006). Surveys for Hawaiian forest birds using the variable circular-plot method as previously conducted by Scott et al. (1986; as cited in USFWS 2006) were conducted in forest areas on east and west Maui from 2010-2012 in areas with historical occurrence of po'ouli (R. Camp, U.S. Geological Survey, pers. Comm. 2015; as cited in USFWS 2015). Po'ouli were not detected during these surveys. Elphick et al. (2010; as cited in USFWS 2015) estimated the extinction of the po'ouli to have occurred in 2005 using a method by which the predicted probability of extinction increases as a function of the time since a species was last observed. Using 2004 as the last reliable observation record for po'ouli, the authors determined the year 2008 as the upper 95% confidence bound for species extinction. This approach for establishing extinction probability however is problematic when applied to extremely rare species such as po'ouli that are potentially distributed over a large area because the absence of observation records may be the result of inadequate survey effort and the few if any visits by qualified observers to remote areas where rare and potentially extinct species may still exist. Hawaiian honeycreepers are known to be highly susceptible to introduced avian disease, particularly avian malaria (*Plasmodium relictum*) (Atkinson et al. 1995; Atkinson et al. 2000; Yorinks and Atkinson 2000; Banko and Banko 2009; as cited in USFWS 2015). According to some climate change projections, temperature increases could present an additional threat specific to Hawaiian forest birds by causing an increase in the elevation below which regular transmission of avian malaria occurs, potentially reducing the remaining suitable habitat for these species. In Hawaii, the threshold temperature for transmission of avian malaria has been estimated to be 13 degrees Celsius (55 degrees Fahrenheit), whereas peak *P. relictum* prevalence in wild mosquitoes occurs in mid-elevation forest where the mean ambient summer temperature is 17 degrees Celsius (64 degrees Fahrenheit) (Benning et al. 2002; as cited in USFWS 2015). Benning et al. (2002; as cited in USFWS 2015) used GIS simulation to show that an increase in temperature of 2 degrees Celsius (3.6 degrees Fahrenheit), which is within the range predicted by some climate models (e.g., IPCC 2013; ICAP 2010; as cited in USFWS 2015), would result in 100 years in a 50 percent decrease in the land area for po'ouli where malaria transmission currently is only periodic. Lia et al. (2015; as cited in USFWS 2015) assessed how global climate change will affect future malaria risk for native Hawaiian bird populations and expect high elevation areas to remain mosquito free only to midcentury due to combined factors of increased rainfall and increasing temperatures. If climate change were to reduce the remaining suitable habitat for po'ouli as predicted, it would likely contribute to the extinction of this species over time. Forest bird surveys were conducted on Maui in 2010-2012, but no birds were detected (USFWS 2006, 2015).

In 2018, the USFWS recommended a change in species population status from "unknown" to "presumed extinct" (USFWS 2018). The last confirmed sighting of poʻouli was in 2004 from Hanawī NAR (USFWS 2006, p. 2-154). Extensive field presence by qualified observers from 2006 to 2011 in Hanawī NAR where poʻouli was last known failed to detect this species and searches of Kīpahulu Valley near Hanawī Natural Area Reserve (NAR) from 1997 to 1999 also failed to detect poʻouli (USFWS 2006, p. 2-94). We therefore believe the population status of the poʻouli should be considered "presumed extinct" rather than "unknown." This recommendation is based on 1) lack of detections since the po'ouli was last sighted in 2004; 2) the extremely small population of the species when last detected in 2004 and its vulnerability to the negative effects of small population size; and 3) the conclusion by Elphick et al. 2010 (p. 620; as cited in USFWS 2018) estimating the extinction date of the species as 2005, with a 95% confidence of extinction by 2008 (USFWS 2018).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2006. Revised Recovery Plan for Hawaiian Forest Birds. Portland, Oregon. 622 pp.

U.S. Fish and Wildlife Service (USFWS). 2015. Po'ouli (*Melamprosops phaeosoma*), 5-Year Review: Short Form Summary. U.S. Fish and Wildlife Service, Region 1, Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii. 8 pp.

U.S. Fish and Wildlife Service (USFWS). 2018. Po'ouli (*Melamprosops phaesoma*) 5-year Review Short Form Summary 2018. U.S. Fish and Wildlife Service, Honolulu, Hawaii. 10 pp.

Species status "Unknown" rather than "presumed extinct"

Species: O'ahu Creeper

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Population: Population size/location(s) unknown (USFWS 2019)

Species Trends: Unknown population trends (USFWS 2019)

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary O'ahu creeper:

The O'ahu creeper is a small sexually dichromatic Hawaiian honeycreeper endemic to the island of O'ahu. Female and immature birds are gray to grayish green above and yellowish white below, and usually have two prominent white wing bars. Males are olive-green above and golden yellow below, with a yellow forehead and superciliary line, a dark eye line and do not have wing bars (USFWS 2010). The downlisting goals for this species have not been met, since it is not yet known whether the O'ahu creeper still exists and all threats within known and potential suitable habitat are not being sufficiently managed. We cannot assume that it is extinct since no monitoring efforts have been done to determine a population. Small populations of `i`iwi have been rediscovered recently on O`ahu in both the Wai`anae and Ko`olau Mountains (VanderWerf and Rohrer 1996; as cited in USFWS 2019), and it is possible that isolated populations of the O`ahu creeper also still exist in remote areas of the island (USFWS 2019).

Lack of survey effort indicates that the species status is best described as "unknown" rather than "presumed extinct." The last well-documented observation of the O`ahu creeper was of two birds on December 12, 1985, during the Waipi`o Christmas Bird Count (Bremer 1986; as cited in USFWS 2010). There have been several reports from different areas since 1985; however, details of the observations have been inconclusive and the birds were never relocated (Baker and Baker 2000, USFWS 2006; as cited in USFWS 2010). Based on an evaluation of the survey effort required to detect small populations of other rare Hawaiian forest birds (Scott et al. 1986, pp. 69-71; as cited in USFWS 2010), there is likely a low probability of detecting a small remaining population of this species using variable circular-plot point count methodology.

The preferred habitat of the O'ahu creeper is thought to be mid-elevation koa/`ōhi`a (*Acacia koa/Metrosideros polymorpha*) forests in valleys or on sideridges at elevations from 300 to 600 meters (1,000 to 2,000 feet) (Shallenberger and Pratt 1978; as cited in USFWS 2019). Small populations of `i`iwi have been rediscovered recently on O`ahu in both the Wai`anae and Ko`olau Mountains (VanderWerf and Rohrer 1996; as cited in USFWS 2019), and it is possible that isolated populations of the O`ahu creeper also still exist in remote areas of the island (USFWS 2019).

Habitat loss and degradation by agriculture, urbanization, cattle grazing, browsing by feral ungulate species, timber harvesting, and invasion of nonnative plant species into native-dominated plant communities have been some of the primary threats to this species (USFWS 2006). Feral pigs, and goats to a lesser degree, have had a long-term damaging effect upon native forests in the remaining O`ahu creeper range by consuming and damaging understory vegetation, creating openings on the forest floor for weeds, transporting weed seeds into the forest, and causing soil erosion and disruption of seedling regeneration of native plants. Predation by alien mammals such as black rats (*Rattus rattus*) and Polynesian rats (*Rattus exulans*) and diseases such as avian malaria (*Plasmodium relictum*) and avian pox (Poxvirus avium) carried by alien mosquitoes have also been primary threats to this species (USFWS 2006). This species now occurs in such low numbers and in such restricted ranges, if it exists at all, that it is threatened by natural processes, such as inbreeding depression and demographic stochasticity, and by natural and man-made factors such as hurricanes, wildfires, and periodic vegetation die-back (USFWS 2006). Impacts of alien birds are not well understood, but include aggressive behavior towards native bird species, possible competition for food, nest sites, and roosting sites, and possibly supporting elevated predator population levels. Hawaii honeycreepers are known to be highly susceptible to introduced avian disease, particularly avian malaria (*Plasmodium relictum*) (Atkinson et al. 1995; Atkinson et al. 2000; Yorinks and Atkinson 2000; Banko and Banko 2009; as cited in USFWS 2010). According to some climate change projections, temperature increases could present an additional threat specific to Hawaiian forest birds by causing an increase in the elevation below which regular transmission of avian malaria occurs, potentially reducing the remaining suitable habitat for these species. Lia et al. (2015, as cited in USFWS 2019) assessed how global climate change will affect future malaria risk for native Hawaiian bird populations and expect high elevation areas to remain mosquito free only to mid-century due to combined factors of increased rainfall and increasing temperatures.

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2006. Revised Recovery Plan for Hawaiian Forest Birds. Region 1, Portland, Oregon. 622 pp.

U.S. Fish and Wildlife Service (USFWS). 2010. O'ahu creeper (*Paroreomyza maculate*) 5-Year Summary and Evaluation. U.S. Fish and Wildlife Service, Honolulu, Hawaii. 12 pp.

U.S. Fish and Wildlife Service (USFWS). 2019. O'ahu creeper (*Paroreomyza maculata*) 5-Year Review Short Form Summary. U.S. Fish and Wildlife Service, Honolulu, Hawaii. 9 pp.

Species status "Unknown"

Species: Moloka'i thrush

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Population size/location(s) unknown (USFWS 2018)

Species Trends: Unknown population trends (USFWS 2018)

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary Molokai thrush:

The breeding biology of the oloma`o is largely unknown but may be similar to that of the closely related `ōma`o. Oloma`o consume a variety of small fruits that they swallow whole and insects are taken at all levels in the forest (Rothschild 1893 to 1900, Perkins 1903, Bryan 1908; as cited in USFWS 2006). The diet of the `ōma`o is essentially the same, and these foods are also fed to nestlings (Perkins 1903, van Riper and Scott 1979, Wakelee et al. 1999; as cited in USFWS 2006). Oloma`o prefer closed forest; if in open forest, they stay close to cover (Bryan 1908; as cited in USFWS 2006). Originally, they were ubiquitous throughout wet and dry forests on Moloka`i and Lāna`i, in the lowlands as well as at the highest elevations (Rothschild 1893 to 1900, Perkins 1903; as cited in USFWS 2006). The most recent records have all been from dense rainforest above 1,000 meters (3,300 feet) elevation adjacent to the steep pali (cliff) of Pelekunu (Scott et al. 1986; as cited in USFWS 2006). Currently, there are no known oloma`o populations, and whether the species remains extant is unknown. Survey efforts for this species have been relatively low, due in part to the difficulty of accessing some of its best remaining habitat. An unconfirmed sighting in 2005 provided some hope that the species may still survive (G. Hughes, in litt. 2005; as cited in USFWS 2006). Additional searches are needed to ascertain the current status of the oloma`o with greater confidence, particularly of the Oloku`i Plateau.

The last confirmed detection of oloma'o was in 1980 (Reynolds and Snetsinger 2001, p. 136; as cited in USFWS 2006). However, during biological survey of the Oloku'i Plateau in 2015 there were several unconfirmed sightings of oloma'o near 'Ōhi'alele in The Nature Conservancy Pelekunu Preserve (Oppenheimer et al. 2015, p. 8; as cited in USFWS 2018). We believe the status of the oloma'o is "unknown," based on conclusion of the Hawai'i Rare Bird Search 1994-

1996 the species could still be potentially extant (Reynolds and Snetsinger, 2001, pp. 141-142; as cited in USFWS 2006), the low survey effort for olomaʻo subsequent to this (see Table 1), and the recent unconfirmed sightings of olomaʻo in 2015. There are instances where rare Hawaiian birds have been rediscovered after they were presumed extinct or have been found in larger populations than expected (Reynolds and Snetsinger 2001, p. 142; as cited in USFWS 2006). The large area of the Olokuʻi Plateau, an area of 656 hectares (1,616 aces) that was not surveyed during the Hawaiʻi Rare Bird Search, and the many remote areas within this that are only rarely visited by qualified observers, increase the potential that a small population of olomaʻo could still exist on Molokaʻi. The extremely rough terrain on Molokaʻi and frequent wet weather make surveys difficult, and numerous steep valleys create small pockets of habitat where the species could still persist**.**

Hawaiian honeycreepers are known to be highly susceptible to introduced avian disease, particularly avian malaria (*Plasmodium relictum*) (Atkinson et al. 1995; Atkinson et al. 2000; Yorinks and Atkinson 2000; Banko and Banko 2009; as cited in USFWS 2018). According to some climate change projections, temperature increases could present an additional threat specific to Hawaiian forest birds by causing an increase in the elevation below which regular transmission of avian malaria occurs, potentially reducing the remaining suitable habitat for these species.

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2006. Revised Recovery Plan for Hawaiian Forest Birds. Portland, Oregon. 622 pp.

U.S. Fish and Wildlife Service (USFWS). 2018. 5-year review for the olomaʻo or Molokaʻi thrush (*Myadestes lanaiensis rutha*). Honolulu, Hawaii. 8 pp.

Extant Forest Birds

Species: O’ahu ‘Elepaio

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: Single population with 4 larger, sub-populations and 12 smaller sub-populations (USFWS 2019)

Species Trends: Declining/stable (USFWS 2019)

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary O’ahu ‘Elepaio:

Much of the historical decline of the O`ahu `elepaio can be attributed to habitat loss, especially at low elevations. Fifty-six percent of the original prehistoric range has been developed for urban or agricultural use, and no `elepaio remain in these developed areas (USFWS 2006, page 2-10). Habitat loss thus has been a major cause of decline, but `elepaio are adaptable, and moderate habitat alteration in the form of gradual replacement of native forest with alien forest has not limited their distribution. Moreover, several areas of O`ahu that recently supported large `elepaio populations and still contain suitable native forest habitat are unoccupied, demonstrating that habitat loss is not the only threat. `Elepaio were observed regularly into the 1970s or early 1980s at Poamoho, Schofield-Waikāne, Mānana, and other areas, but they have disappeared from all these areas even though the forest is still largely intact (VanderWerf *et al.* 2001, page15; as cited in USFWS 2006).

Habitat loss and modification and avian disease and predation by introduced animals continue to limit populations of the Oʻahu ʻelepaio. The remaining `elepaio populations are small and isolated, comprising 6 core populations that contain between 100 and 500 birds, and numerous small remnants, most of which contain fewer than 10 birds (USFWS 2006, page 2-12). Even if the threats responsible for their decline were controlled, the existing populations would still be threatened with extinction because their small sizes and restricted distributions make them vulnerable to a variety of natural processes, including reduced reproductive vigor caused by inbreeding depression, loss of genetic variability and evolutionary potential over time due to random genetic drift, stochastic fluctuations in population size and sex ratio, and natural disasters such as hurricanes and fires (USFWS 2006, pp. 2-12).

O`ahu `elepaio also are threatened by human actions, such as the potential introduction of the brown tree-snake (*Boiga irregularis*) from the Mariana Islands, which has devastated the avifauna on Guam (USFWS 2006, page 2-13). A study of the effects of noise from military training showed that O`ahu `elepaio at U.S. Army Schofield Barracks are not affected by noise from military training (USFWS 2006, page 2-13). However, fires ignited by military training activities are a serious long-term threat to `elepaio and have reduced the amount of suitable habitat for `elepaio, including areas designated as critical habitat for the O`ahu `elepaio at Schofield Barracks and Mākua Military Reservation (USFWS 2003, page 162; as cited in USFWS 2006). Firebreak roads exist to help prevent the spread of fires into mesic forest occupied by `elepaio, but fires regularly start beyond the firebreaks, and each fire removes additional habitat, which is replaced by non-native fire-adapted plants that are not used by `elepaio, such as *Eucalyptus robusta* and *Melaleuca quinquenervia*.

Recent surveys confirm the continued population decline of O`ahu `elepaio despite efforts to minimize threats, primarily rodent control, needed to reduce rodent predation on nesting females. Over the past six years, the overall trend of the Oʻahu ʻelepaio in the Oʻahu Army Natural Resources Program (OANRP) recovery areas and in Wailupe Valley has remained somewhat stable (USFWS 2019). This could be due to effective predator control. The decrease in numbers for OANRP in 2018 is due to limited access at Schofield Barracks Military Reservation during the entire breeding season of the Oʻahu ʻelepaio due to threats of and OANRP's response to unexploded ordnance and no access to Moanalua Valley due to road construction that occurred during the breeding season (Army Natural Resources Program (ANRP) 2013, 2014, 2015, 2016, 2017, 2018; as cited in USFWS 2019). The current geographic range of the Oʻahu ʻelepaio encompasses about 5,187 hectares, declining by about 75 percent since 1975, and becoming fragmented into four larger subpopulations with 100 or more birds each and twelve smaller subpopulations, many of which are isolated by urban and agricultural development (VanderWerf et al. 2001, 2013; Dittmar and VanderWerf, 2018; as cited in USFWS 2019). Habitat loss and modification, avian disease, and predation by introduced mammals are thought to have caused the O`ahu `elepaio population to become endangered, and these factors continue to limit `elepaio today.

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2006. Revised Recovery Plan for Hawaiian Forest Birds. U.S. Fish and Wildlife Service, Portland, Oregon. 622 pp.

U.S. Fish and Wildlife Service (USFWS). 2019. 5-year Status review for Oahu `Elepaio. U.S. Fish and Wildlife Service, Honolulu, Hawaii. 9 pp.

Species: Hawaiian (`alalā) crow

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: Population size/location(s) unknown (USFWS 2015, 2020)

Species Trends: Unknown population trends (USFWS 2015, 2020)

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary Hawaiian (`alalā) crow:

The `alalā is endemic to the island of Hawaii (USFWS 2009a). Historically, the species was restricted to the dry and mesic forests in the western and southern portions of the island, from Pu`uanahulu in the North Kona District to the vicinity of Kīlauea Crater in the Ka`ū District. The species is associated with `ōhi`a (*Metrosideros polymorpha*) and `ōhi`a-koa (*Acacia koa*) forests with an understory of native fruit-bearing trees, vines, and shrubs (USFWS 2009b). The `alalā feeds on native and introduced fruits, invertebrates gleaned from tree bark and other sites, and eggs and nestlings of other forest birds. Nectar, flowers, and carrion are minor diet components.

Many factors contributed to the decline of ’alala in the wild (USFWS 2003). Destruction of most of the lowland forests restricted the bird’s ability to follow seasonal fruiting up and down the mountains. The upland forests have been thinned and fragmented, and many fruiting plants lost, due to logging, ranching, and the effects of grazing by feral pigs, cattle, and sheep. Mongooses, cats, and rats prey on ’Alala eggs and fledglings. Diseases carried by introduced mosquitoes may have caused the mortality of many ’alala, as they did other forest birds. The role of ’io (Hawaiian hawk) in this decline, however, is unknown, despite their known effect on released birds. However, ’io densities are higher, and vulnerability of ’alala may be greater, in areas where ungulate grazing has reduced understory cover.

The `alalā was extirpated from the wild by 2003 (USFWS 2009a). Between 1993 and 1998, twenty-seven juvenile `alalā, originating from both captive and wild parents, were raised in captivity and released in South Kona at the McCandless Ranch, near where wild `alalā were still known to exist. Twenty-one of the 27 released birds died from disease, were depredated, or disappeared. The remaining six were returned to captivity in 1998 and 1999. Released birds did not integrate into the wild population, and no reproduction occurred. Only limited reproductive behavior was observed in the released birds. The wild population of 12 birds in 1992 dwindled to zero in 2002. The last observation of `alalā in the wild was in 2002 (USFWS 2009b). Since then, there have been reported sightings of `alalā, however, none have been confirmed. The entire historical range of the `alalā has been modified by alien species and human activities with negative effects on the `alalā's survival and/or reproduction (USFWS 2009b).

The captive population has increased steadily since its initial inception in 1978 (USFWS 2015). As of August 2020, there are 114 `alalā in captivity in Hawaii: 76 at the Keauhou Bird Conservation Center, Hawaii Island, and 38 at the Maui Bird Conservation Center. The Hawaiian Crow is not currently found in the wild, although the USFWS is working with the State of Hawaii, Department of Land and Natural Resources Division to establish a self-sustaining, wild population. Since the `alalā is endemic to the island of Hawaii, reintroduction efforts have focused releasing captive-reared birds on this island. For the most recent reintroduction efforts, thirty `alalā were released at Pu'u Maka'ala Natural Area Reserve from 2016 through 2019. Three 'alalā pairs formed in the wild. One pair built a nest, and the female appeared to incubate eggs. However, no young were produced. By 2019, only five `alalā were known to survive (USFWS 2020). In response to mortalities of released Alalā, including predation by the 'io, conservationists captured the remaining five surviving birds from Pu'u Maka'ala Natural Area Reserve and brought them back into captivity. While in the wild, these five birds gained valuable knowledge about foraging, predator avoidance, pair bonding, and other social behaviors that could be passed on to the birds residing within the conservation breeding program and aid with future recovery efforts (State of Hawaii 2021). As efforts to improve success of Hawaii Island reintroductions continues, the Project has begun preliminary work to explore the potential of Maui Nui to serve as an additional release site for `alalā. There is subfossil evidence that alala or a similar species once existed in Maui Nui and predation by 'io has been a challenge (State of Hawaii 2021).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2003. Federal Register. Vol. 68, No. 245, 71128-71129. December 22, 2003. Draft Revised Recovery Plan for the 'Alala (*Corvus hawaiiensis*).

U.S. Fish and Wildlife Service (USFWS). 2009a. `Alala (*Corvus hawaiiensis*) 5-Year Review, Honolulu, Hawaii. 14 pp.

U.S. Fish and Wildlife Service (USFWS). 2009b. Revised Recovery Plan for the `Alala (*Corvus hawaiiensis*), Honolulu, Hawaii. 120 pp.

U.S. Fish and Wildlife Service (USFWS). 2015. `Alala (*Corvus hawaiiensis*) 5-Year Review, Honolulu, Hawaii. 7 pp.

U.S. Fish and Wildlife Service (USFWS). 2020. `Alala (*Corvus hawaiiensis*) 5-Year Review, Honolulu, Hawaii. 9 pp.

State of Hawaii. 2021. Press release: next steps in ‘alalā recovery include Maui Nui and ‘io research. March 31, 2021. Electronic source access on January 3, 2022, at: https://dlnr.hawaii.gov/alalaproject/2021/03/31/press-release-next-steps-in-%ca%bbalala-recovery-include-maui-nui-%ca%bbio-research/.

Species: I'iwi

Status: Threatened

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: approximately 14 (9 regions) (USFWS 2016)

Species Trends: Kauai: declining; Oahu: may occur as a small remnant population; Molokai: may occur as relict population; Maui: declining; Hawaii: stable/declining to increasing (USFWS, 2016)

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary I’iwi:

The I’iwi is a Hawaiian forest bird in the endemic honeycreeper subfamily of the Fringillidae (finch family). It is found primarily in closed canopy, montane wet or montane mesic forests of tall stature, dominated by native ohia trees (Metrosideros polymorpha) or both ohia and koa trees (*Acadia koa*). I’iwi are nectarivorous; their diet consists predominantly of nectar from the flowers of ohia*,* but they may also feed on *Sophora chrysophylla* (mamane) and plants in the lobelia family (Campanulaceae) (Pratt *et al*. 2009, p. 193; as cited in USFWS 2016), as well as opportunistic feeding upon insects and spiders (Fancy and Ralph 1998, pp. 4–5; ; Pratt *et al*. 2009, p. 193; as cited in USFWS 2016). Ohia trees are also used for nesting.

I’iwi are strong fliers that move long distances to locate nectar sources and are well known for their seasonal movements in response to the availability of flowering ohia and mamane for feeding (Fancy and Ralph 1998, p. 3; Kuntz 2008, p. 1; Guillamet *et al*. 2016, p. 192; as cited in USFWS 2016). Such movements generally occur after the breeding season. This seasonal movement to lower elevation areas in search of nectar sources is an important factor in the exposure of I’iwi to avian diseases, particularly malaria.

Although historical abundance estimates are not available, the I’iwi was considered one of the most common of the native forest birds in Hawaii by early naturalists, described as “ubiquitous” and found from sea level to the tree line across all the major islands (USFWS 2016). In the late 1800s, Iiwi began to disappear from low elevation forests, and by the mid-1990s, the species was largely absent from sea level to mid-elevation forest across all the major islands. Today, I ‘iwi are no longer found on Lanai and only a few individuals may be found on Oahu, Molokai, and

West Maui. Remaining populations of I'iwi are restricted to high-elevation forests on Hawaii Island, East Maui, and Kauai. The current population size of I'iwi rangewide is estimated as a mean of 605,418 individuals (range 550,972 - 659,864) (USFWS 2016). The population on Kauai is in steep decline. Trends on Maui are mixed but generally appear to be in decline. On Hawaii Island, there is evidence for stable or declining populations on the windward size of the island. Ninety percent of all I'iwi now occur on Hawaii Island, followed by East Maui (~10%). Of the nine regions for which sufficient information is available for quantitative inference, five show strong or very strong evidence of declining populations; one, a stable to declining population; one, a stable to increasing population; and two, strong evidence for increasing populations. Four of the nine regions show evidence of range contraction.

Rapid ohia death (ROD) has been identified as stressor, a type of *Ceratosystis* wilt fungal disease, as a potentially significant emerging habitat stressor (USFWS 2016). Based upon the most recent research, ROD-infected stands of ohia often show greater than 50 percent mortality initially and nearly 100 percent of trees in a stand succumb to the disease within 2 to 3 years. Rapid ohia death is presently reported only from the island of Hawaii; however, over roughly the last 5 years it has spread across the island, which is home to 90 percent of the I'iwi population, and in some areas, affected trees have been observed within the range of I'iwi. As of January 2016, ROD is estimated to have infected approximately 34,000 ac (13,759 ha), which is a 100 percent increase in affected area since 2015. Introduced mosquito-borne disease, specifically avian pox and avian malaria, has been a primary driver in the declines and extinctions of many native Hawaiian forest birds since the late 1800s. I'iwi are known to be especially vulnerable, suffering particularly high mortality from avian malaria compared to other native bird species. The transmission of avian malaria is currently limited or absent at higher elevations, where temperatures are too cool for the development of the malaria parasite. With increasing temperature at high elevations resulting from global climate change, avian malaria is projected to continue moving upward into high- elevation forests that currently provide refuge from disease for I'iwi. Modeling of future conditions consistently predicts a significant loss of disease-free habitat for I'iwi, with consequent severe reductions in population size and distribution by the year 2100, although significant changes are likely to be observed as early as 2040. Within the Hakalau Forest National Wildlife Refuge (NWR) closed-forest study area, sampled only after 1999, densities of both the Hawaii creeper (*Oreomystis mana*) and Hawaii Akepa (*Loxops coccineus coccineus*) showed evidence of increased populations following management of lower elevation forested areas. Hawaii creeper and Hawaii Akepa are insectivorous and maintain year-round residence in a local area, and unlike I'iwi, do not move seasonally to lower elevations where they might be exposed to mosquitoes.

As the I'iwi's numbers and distribution continue to decline, small, isolated populations may become increasingly vulnerable to the additional stressor of loss of their ohia forest habitat from rapid ohia death, as well as other environmental catastrophes and demographic stochasticity; this will particularly be the case should all remaining I'iwi become restricted to a single island (Hawaii Island), as some scenarios suggest (USFWS 2016).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2016. I'iwi (*Drepanis coccinea*) Species Status Report. Honolulu, HI. 133 pp.

Species: `Akiapōlā`au (honeycreeper)

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: 2 (USFWS 2015)

Species Trends: Decline of > 90% (NatureServe 2015); Hakalau Forest NWR: increasing; Kau: stable; central Hawaii: decreasing (USFWS 2015)

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary Akiapola'au:

The `akiapōlā`au is a medium-sized (14 cm, 28 g), stocky, short-tailed Hawaiian honeycreeper endemic to Hawai`i island. Its most remarkable feature is the extraordinary bill, which has a long, sickle-shaped upper mandible and a short, straight lower mandible that is only half as long as the upper. In the 1970s, `akiapōlā`au were found in five disjunct populations with a total estimated population size of 1,500 ± 400 birds (Scott et al. 1986, as cited in USFWS 2010 ). Four of these populations inhabited koa-dominated montane forests in Hāmākua south to the upper Waiākea kīpuka, Kūlani, and Keauhou, in Ka`ū and Kapāpala, in southern Kona, and in central Kona. A fifth population occupied subalpine dry forest on Mauna Kea. Originally these populations were all connected, but they have been isolated by loss of forest mainly to grazing. The ʻakiapōlāʻau currently occurs as two disjunct populations in the windward Hawaiʻi and Kaʻū regions on Hawaiʻi and total population is approximately 1,900 birds (Gorresen et al. 2009, as cited in USFWS 2020). Trend analysis indicates density is increasing in Hakalau Forest National Wildlife Refuge (Hakalau Forest NWR) in north windward Hawaiʻi (Camp et al. 2010b; Camp et al. 2016a; as cited in USFWS 2020). Trend analysis for density is unclear for central windward Hawaiʻi and Kaʻū region (Gorresen et al. 2009; Camp et al. 2010a; as cited in USFWS 2020). The species is extirpated from subalpine Mauna Kea and likely Kona districts (Gorresen et al. 2009, as cited in USFWS 2020). ʻAkiapōlāʻau were detected at 1,280 meters (4,200 feet) elevation in the Hakalau Forest NWR during surveys for Hawaiian forest birds in 2012, which is 300 meters (1,000 feet) lower in elevation than previous sightings in the 1970s, suggesting possible range expansion into middle elevation native forests on Hakalau Forest NWR (Kendall and Gordon 2012, as cited in USFWS 2020). Analysis of population trends suggest the species is benefiting from over two decades of habitat restoration in the Hakalau Forest NWR (Camp et al. 2010b, as cited in USFWS 2020). ʻAkiapōlāʻau are reliant on old-growth, intact native forests for breeding. Goldsmith et al. (2005, as cited in USFWS 2020) noted that wood-boring beetles, an important prey, were abundant in young Acacia koa (koa) trees in the reforested pastures in Hakalau Forest NWR. ʻAkiapōlāʻau is regularly seen foraging in planted koa tree groves at upper elevations of the refuge several kilometers above old growth forest areas and highest ʻakiapōlāʻau densities reported are in upper elevation koa forest plantations on the refuge

(Pejchar et al. 2005, as cited in USFWS 2020). Highest densities of ‘akiapōlā‘au in central windward Hawai‘i were detected in altered forest stratum, which included koa silviculture areas (Camp et al. 2010b, as cited in USFWS 2020).

The `akiapōlā`au is subject to the same threats that negatively impact other forest birds on Hawai`i, including habitat loss and degradation, predation, and introduced diseases, but due to its low reproductive rate (see Life History), this species may be particularly vulnerable to these threats and slow to recover. Other factors, such as competition from introduced avian and arthropod insectivores, have not been documented, but purposeful and accidental introduction of alien species remains a constant threat. Destruction and degradation of forest habitat from development, logging, and ranching has greatly reduced the range of the `akiapōlā`au and has been particularly severe in mesic and dry forest areas. Dry, high-elevation māmane-naio forest habitat on the slopes of Mauna Kea has been severely degraded by decades of browsing by feral goats and sheep. Designation of critical habitat for the endangered palila (*Loxioides bailleui*), and subsequent court orders to remove ungulates, has resulted in some regeneration of this habitat, but `akiapōlā`au have already been extirpated from this area. Widespread loss and alteration of forest habitats also has led to fragmentation of the remaining suitable forest. The dispersal behavior of `akiapōlā`au is poorly known, but habitat fragmentation may isolate the remaining populations, decrease the effective population size, and hinder recolonization of formerly occupied areas. Most Hawaiian forest birds are susceptible to introduced mosquito-borne diseases, and the `akiapōlā`au may be limited to its current high-elevation distribution by these diseases (Scott *et al.* 1986, van Riper *et al.* 1986, Atkinson *et al.* 1995; as cited in USFWS 2010). Despite the availability of apparently suitable habitat, `akiapōlā`au are absent from most areas below 4,500 feet (1,350 meters) where mosquitoes are common. This pattern contrasts with that of species not listed as threatened or endangered, such as `apapane (*Himatione sanguinea*) and Hawai`i `amakihi (*Hemignathus virens*), suggesting that `akiapōlā`au and other endangered species are especially susceptible to disease. The `akiapōlā`au is threatened with extinction because of its small total population size and restricted distribution (USFWS 2010. These characteristics make the species vulnerable to a variety of natural processes, including reduced reproductive vigor caused by inbreeding depression, loss of genetic variability and evolutionary potential over time due to random genetic drift, stochastic fluctuations in population size and sex ratio, and natural disasters such as hurricanes and fires.

Climate change may also pose a threat to the `akiapōlā`au. However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species (USFWS 2010).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2010. Akiapolaau 5-year Review Summary and Evaluation, short form. U.S. Fish and Wildlife Service, Honolulu, Hawaii. 17 pp.

U.S. Fish and Wildlife Service (USFWS). 2020. ‘Akiapōlā‘au (*Hemignathus wilsoni*). 5-year Review Short Form Summary. U.S. Fish and Wildlife Service, Honolulu, Hawaii. 8 pp.

Species: Palila (honeycreeper)

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Single population (USFWS 2015)

Species Trends: Declining (USFWS 2015)

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary Palila:

The palila is an extreme food specialist, preferring unhardened māmane (*Sophora chrysophylla*) seeds in green pods or in pods that are just beginning to turn brown (Banko et al. 2002, as cited in USFWS 2006). Palila also eat māmane flowers, buds, and leaves, and naio (*Myoporum sandwicense*) berries, especially when other foods are in short supply. Seeds, fruits, flowers, and leaves of other species are rarely eaten (U.S. Geological Survey, unpublished data; as cited in USFWS 2006). Caterpillars and other insects are important in the diet of nestlings and are eaten frequently by adults (Perkins 1903; U.S. Geological Survey, unpublished data; as cited in USFWS 2006). Palila move in response to the availability of māmane seeds, and fledglings and hatch-year birds sometimes disperse widely in search of food (Hess et al. 2001; U.S. Geological Survey, unpublished data; as cited in USFWS 2006). Nevertheless, there is no evidence that birds move more than about a third of the way around Mauna Kea during their entire lives, and those hatched on the western slope may travel even less (U.S. Geological Survey, unpublished data, as cited in USFWS 2006). Palila are dependent on the māmane and māmane/naio forests for all their needs. Up to 96 percent of the current palila population and nearly all of the successful breeding occurs on the southwestern slope of Mauna Kea, where the elevation range of the forest and habitat quality is greatest (Scott et al. 1984, 1986; Jacobi et al. 1996; Banko et al. 1998; Gray et al. 1999; as cited in USFWS 2006).

Palila currently occur only on the island of Hawaiʻi, in one core population in subalpine, dry forest habitat on the southwestern slope of Mauna Kea (Banko and Farmer 2014; as cited in USFWS 2020). The palila population has been surveyed annually from 1998 to 2020 to determine abundance, population trends, and spatial distribution. The 2019 and 2020 count data has not yet been analyzed, so the most recent analysis in 2018 is included here. Within the core survey area, the number of palila detected decreased by 22% between 2016 and 2017 (319 in 2016 and 248 in 2017), and a further 60% decrease in palila detections occurred between 2017 and 2018 (248 in 2017 and 99 in 2018) (Genz et al. 2018, as cited in USFWS 2020). These observations corresponded to population estimates of 1,861 in 2016, 1,461 in 2017, and 1,051 in 2018 (Genz et al. 2018, as cited in USFWS 2020). In addition to the population in the core, palila were also detected below the core in the Kaʻohe Restoration Area in 2017 and 2018, and on the north slope of Mauna Kea in 2017 (Genz et al. 2018, as cited in USFWS 2020). These sightings indicate that the population is either expanding into newly restored areas or that some birds are transient outside of the core. Between 1998 and 2003, palila numbers have fluctuated annually and after a peak in 2003, palila populations declined steadily through 2011 (Genz et al. 2018, as cited in USFWS 2020). From 2011- 2018, population estimates fluctuated at about the 2011 level with a peak in 2012 (Genz et al. 2018, as cited in USFWS 2020). Overall, the average rate of decline during the 20-year monitoring period (1998-2018) has been around 168 birds per year, equating to a 76% decline in the palila population (Genz et al. 2018, as cited in USFWS 2020).

New threats (USFWS 2020): 1) Increased predator presence. 2) Drought conditions on Mauna Kea occurred during 74 percent of the months from 2000 - 2010, with drought recorded in all but two months from 2006 to 2010 (Banko et al. 2013, as cited in USFWS 2020). 3) Naio thrips, *Klambothrips myopori*, a recently established insect pest which infests *Myoporum sandwicense* (naio), an important tree species in Mauna Kea dry forests and is especially prevalent in lower elevations of palila core habitat. 4) Climate change degradation of habitat - Hawaiian honeycreepers are known to be highly susceptible to introduced avian disease (particularly avian malaria), increased fire potential, habitat degradation, increased potential for avian malaria (*Plasmodium relictum*) (Atkinson et al. 1995; Atkinson et al. 2000; Yorinks and Atkinson 2000; Banko and Banko 2009; as cited in USFWS 2020). According to some climate change projections, temperature increases could present an additional threat specific to Hawaiian forest birds by causing an increase in the elevation below which regular transmission of avian malaria occurs, potentially reducing the remaining suitable habitat for these species (USFWS 2015, Pages 2 - 3).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2006. Revised Recovery Plan for Hawaiian Forest Birds. Portland, OR. 622 pp.

U.S. Fish and Wildlife Service (USFWS). 2015. Palila (*Loxioides bailleui*). 5-Year Review. Honolulu, Hawaii. 11 pp. U.S. Fish and Wildlife Service (USFWS). 2020. Palila (*Loxioides bailleui*). 5-Year Review. Honolulu, Hawaii. 13 pp.

Species: Akekee

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: Single population (USFWS 2019)

Species Trends: Declining; Akekee occupancy increases gradually from west to east (USFWS 2017)

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary Akekee:

The Kauai akepa (*Loxops caeruleirostris*), or akekee, is a small forest bird found only on the island of Kauai. The akekee occurs in the montane mesic and montane wet ecosystems in forests dominated by *Metrosideros polymorpha*, *Acacia koa*, *Cheirodendron trigynum*, and *C.*

platyphyllum (Lepson and Pratt 1997, p. 4; TNCH 2007; as cited in USFWS 2019). The akekee uses its bill to open flower and leaf buds while foraging for arthropod prey (insects, insect larvae, spiders), and is a specialist on the ohia tree (*M. polymorpha*) (Lepson and Pratt 1997, p. 4; as cited in USFWS 2019). Richardson and Bowles (1964, p. 30; as cited in USFWS 2019) reported that it was fairly common in higher elevation forests. Conant et al. (1998, p. 16; as cited in USFWS 2019) reported that the akekee was common in the area around Sincock's Bog in 1975 and observed it daily. The first quantitative information on population size and distribution was based on extensive surveys conducted from 1968 to 1973, which yielded an island-wide population estimate of 5,066 ± 840 birds, with most individuals found in the Alakai Plateau area, west to Kokee, and on Makaleha Mountain and in Wainiha Valley (Sincock et al. 1983, p.53; as cited in USFWS 2019). This was followed by population estimates of 7,839 ± 704 birds in 2000, and 5,669 ± 1,003 birds in 2005 (Hawaii Division of Forest and Wildlife and USGS, unpublished data 2007). Surveys in 2008 failed to find the species in many areas where it was previously observed, and its range was estimated to be 50 square kilometers (31 square miles) (Camp and Gorresen 2011, as cited in USFWS 2017). The population of akekee was estimated to be 3,100 birds, based on extrapolation of the density recorded across the Alakai Plateau in 2008 (62 per square kilometer [38 per square mile]) (Gorresen et al. 2009, as cited in USFWS 2017) and the species' 2008 estimated range. Paxton et al. (2016, as cited in USFWS 2017) documents the population decline and range contraction for akekee and other avifauna on Kauai. The study looked at the average change in density over a 25-year period for both the interior and exterior areas of the Alakai Plateau. Akekee has declined precipitously, with the 2012 population sizes estimated to be only 945 (95% Confidence Interval [CI], 460 to 1547) individuals. Unlike in previous surveys (2000, 2005, 2007, and 2008), akekee was not detected by systematic surveys in the periphery of its range in 2012, although incidental sightings indicate continued but limited occurrence. If current rates of decline continue, extinction is predicted in the coming decades.

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2017. Akekee (*Loxops caeruleirostris*). 5-Year Review. Honolulu, Hawaii. 20 pp.

U.S. Fish and Wildlife Service (USFWS). 2019. Draft Kauai Islandwide Recovery Plan. Portland, Oregon. 43 pp.

Species: Hawaii akepa (honeycreeper)

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: 4 (USFWS 2015)

Species Trends: Stable (USFWS 2015)

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary Hawaii Akepa:

Modification and loss of habitat and avian disease are the main factors that have contributed to the decline of Hawaii akepa (USFWS 2006). Predation by introduced mammals also may have played a role. Clearing of forest by logging and ranching has been extensive, greatly reducing the amount of suitable habitat for Hawaii akepa and other forest birds and resulting in fragmentation of the remaining forest habitat. Hawaii akepa are especially sensitive to the loss of old growth forest due to their dependence on large trees with cavities for nesting (Freed 2001, as cited in USFWS 2006). Much old-growth forest has been cleared for pasture at upper elevations (Tomonari-Tuggle 1996, as cited in USFWS 2006). New threats include climate change destruction or degradation of habitat. Hawaiian honeycreepers are known to be highly susceptible to introduced avian disease, particularly avian malaria (*Plasmodium relictum*) (Atkinson et al. 1995; Atkinson et al. 2000; Banko and Banko 2009; as cited in USFWS 2020). According to some climate change projections, temperature increases could present an additional threat specific to Hawaiian forest birds by causing an increase in the elevation below which regular transmission of avian malaria occurs, potentially reducing the remaining suitable habitat for these species.

The Hawaii akepa feeds primarily on small insects, spiders, and caterpillars throughout the year. It rarely feeds on nectar (USFWS 2006). The historical range of the Hawai`i `ākepa once included much of the island of Hawai`i, presumably wherever there were large trees that provided nest cavities (shown in Freed 1999; as cited in USFWS 2006). The major change in distribution has been the complete loss of birds from lower elevations, below 1,300 meters (4,300 feet). However, the range has also contracted somewhat at upper elevations as well (Freed 1999, Scott et al. 1986; as cited in USFWS 2006).

Pratt (2014, p. 10; as cited in USFWS 2016) found that the Hawaii, Maui, and Oahu populations of the akepa were distinct at the species level based on molecular data and differences in plumage and nest placement. Based on this research, the AOU (Chesser et al. 2015, p. 760; as cited in USFWS 2016) accepts the Hawaii akepa (*Loxops coccineus*), the Maui akepa (*Loxops ochraceus*), and the Oahu akepa (*Loxops wolstenholmei*) as distinct species. The taxonomic change does not affect the range or endangered status of either the Hawaii akepa or the Maui akepa (81 FR 8004 8007). The Hawaii akepa shares subspecific status with the Maui akepa (*Loxops c. ochraceus*) and the Oahu akepa (*Loxops c. rufus*). The Oahu subspecies is extinct and the Maui subspecies is probably extinct, meaning the Hawaii akepa now likely comprises the entire species.

The Hawaiʻi ʻākepa occurs as five disjunct populations in the north and central windward Hawaiʻi, Kaʻū, Kona, and Hualālai regions on Hawaiʻi (Gorresen et al. 2009, as cited in USFWS 2020). In 1977, the total population of Hawaiʻi ʻākepa was estimated 13,892 (95% CI + 1,825) birds (Scott et al. 1986, as cited in USFWS 2020). In 2016, total population was estimated 16,248 (95% CI 10,074 - 25,198) birds (Judge et al. 2018, as cited in USFWS 2020). Hawaiʻi ʻākepa is known for distributional anomalies across apparently suitable habitat particularly between open canopy montane woodland and old-growth closed-canopy *Metrosideros polymorpha* (ʻōhiʻa) forest, likely due to differences in nest-site and food availability (Judge et al. 2018, as cited in USFWS 2020). The recent population estimate of Hawai‘i ‘ākepa is encouraging because it suggests that numbers have remained stable for approximately 40 years since global surveys for this species were first conducted in the late 1970s and early 1980s (Scott et al. 1986; Judge et al. 2018; as cited in USFWS 2020). Hawai‘i ‘ākepa is likely increasing on Hakalau Forest NWR (Camp et al. 2016, as cited in USFWS 2020) and were detected at 1,280 meters (4,200 feet) elevation during surveys for Hawaiian forest birds in 2012, suggesting possible range expansion into middle elevation native forests on the refuge (Kendall and Gordon 2012, as cited in USFWS 2020). However, the species is likely decreasing in central windward Hawai‘i, decreasing at Hualālai and potentially extirpated from central Kona regions (Gorresen et al. 2009, as cited in USFWS 2020).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2006. Revised Recovery Plan for Hawaiian Forest Birds. Portland, OR. 622 pp.

U.S. Fish and Wildlife Service (USFWS). 2016. Endangered and Threatened Wildlife; Technical Corrections for Eight Wildlife Species on the List of Endangered and Threatened Wildlife. 81 FR 8004 8007, February 17, 2016.

U.S. Fish and Wildlife Service (USFWS). 2020. Hawai‘i ‘ākepa (*Loxops coccineus coccineus*). 5-Year Review. Honolulu, Hawaii. 7 pp.

Species: Small Kauai (puaiohi) thrush

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: Multiple populations (USFWS 2018)

Species Trends: Population is stable (USFWS 2018)

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary Small Kauai (Puaiohi) thrush:

The puaiohi, or Small Kaua‘i Thrush, is a medium-sized, slender, long-legged thrush endemic to Kaua‘i. Since 2009, the overall trend of puaiohi within its restricted range in the Alaka‘i Wilderness Preserve is stable. The 2009 5-year review estimated the total population of puaiohi to be approximately 300 to 500 individuals (USFWS 2006, page 2-35). Crampton et al. (2017, as cited in USFWS 2018) estimate the current population of puaiohi at approximately 494 (95% CI 414–580) individuals. The current breeding population is restricted to an area of < 20 km^2 and 75% occurs in 10 km^2. Puaiohi occur in high densities (up to 11 pairs / km of stream) in three adjacent drainages: the Upper Mōhihi, Upper Waiakoali, and the northeastern upper Kawaikōī, but density declines with elevation (Snetsinger et al. 1999, Crampton et al., 2017; as cited in

USFWS 2018). The upper reaches of the Halehaha and Halepāʻākai drainages support a medium-density population of about 5 pairs / km of stream and low-density populations occur in the lower Waiealae / unnamed drainage (1.25 pairs / km; Pratt et al. 2002; Crampton et al. 2017; as cited in USFWS 2018) and lower Kawaikōī / Kauaikinanā (0.5 pair / km). In 1994, two small, low-density populations were detected on private lands along the Halekua and Waiau streams at the southern edge of the species' range, but neither population was detected during surveys in March 2000 (Telfer pers. comm., as cited in USFWS 2018). Surveys in March 2000 and spring 2012 confirmed the existence of a small population along an upper tributary of the Koaiʻe Stream, although its size and extent are unknown (Foster, unpublished data; Crampton et al. 2017, as cited in USFWS 2018). The best predictor of puaiohi occupancy is the number and size of the cliffs along a stream (Crampton et al. 2017, as cited in USFWS 2018).

Feral pigs, and goats to a lesser degree, have had a long-term damaging effect upon native forests in the remaining puaiohi range, opening space for weeds and transporting weed seeds into the forest (USFWS 2006, page 2-39). Soil erosion and disruption of seedling regeneration of beneficial plants is one of many forest management problems within puaiohi range. Habitat degradation resulting from the invasion of many nonnative weeds has drastically changed the forest structure and integrity. Two hurricanes in 1982 and 1992 severely disturbed areas of native forest and made space for the germination and expansion of alien plants. Perhaps less obvious, but potentially detrimental to the health of remaining puaiohi habitat, are additions of new exotic invertebrates to the forest ecosystem. New insects, such as the two-spotted leaf hopper (*Sophonia rufofascia*) are causing serious damage to many native and non-native plants (USFWS 2006, page 2-39). Many of the food producing plants used by puaiohi could be negatively affected, reducing their range, fruit set, and even survival. Other introduced predatory insects may reduce or eliminate specialized native insects that are necessary for pollination of certain food plants. Introduced snails that prey on indigenous snails could reduce food resources of the puaiohi. On the other hand, the detrimental effects of some introduced insects could be offset if they are eaten by puaiohi.

Avian diseases, including both pox (*Poxvirus avium*) and malaria (*Plasmodium relictum*), almost certainly limit puaiohi from the lower reaches of stream drainages with suitable nesting cliffs. Mist-netting of forest birds from 1994 to 1997 at three locations, Pihea/Alaka`i Swamp Trail, Tom's Camp, and Sincock's bog, documented 2 to 5 percent of individuals of all bird species with active malaria infections and up to 12 percent with malarial antibodies (USFWS 2006, pages 2-37 and 2-38). Malarial infection rates were highest in the west, at Pihea, and lowest in Sincock's Bog. Mosquitoes are present to the highest elevations on Kaua`i (USFWS 2006, page 2-38). Furthermore, two captive-reared puaiohi likely died from avian malaria shortly after their release in the Kawaikōī drainage in fall of 2007 (Atkinson 2007).

Predators such as rats (*Rattus* spp.) may be serious limiting factors on puaiohi nesting success. Although their habit of nesting on steep cliff faces may provide some protection from nest predation, data from 1998 and 1999 showed that 14 percent and 22 percent of nests, respectively, failed due to confirmed rat predation including a total of three females taken on their nests (USFWS 2006, pp. 2-38). Moreover, the tendency of young puaiohi to remain close to the ground for several days after fledging probably makes them particularly vulnerable to predation by feral cats.

Climate change poses a threat to the puaiohi by causing an increase in elevation at which regular transmission of avian malaria occurs (Benning et al. 2002; Atkinson et al. 2014; Fortini et al. 2015; as cited in USFWS 2018). Experimental evidence has shown that the malarial parasite does not develop in birds below 13 degrees Celsius and field studies have found that maximum malaria transmission occurs where mean ambient summer temperature is 17 degrees Celsius (La Pointe 2000, as cited in USFWS 2018). Between 13 and 17 degrees Celsius, malaria transmission is limited and usually associated with warmer periods, such as El Niño events (Feldman et al. 1995, as cited in USFWS 2018). There are no forested areas on Kauaʻi where mean ambient temperature is below 13 degrees Celsius, meaning all areas are currently subject to malaria at least periodically. Downscaled end-of-century climate projections for Hawaiʻi based on a moderate A1B emission scenario (Intergovernmental Panel on Climate Change 2000, as cited in USFWS 2018) suggest an average 2.6 degrees Celsius warming in areas that Hawaiian forest birds currently inhabit (Zhang et al. 2011, as cited in USFWS 2018). Under this scenario and continued disease-driven distribution limitation, puaiohi are expected to lose all of their range by 2100 (Fortini et al. 2015, as cited in USFWS 2018).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2006. Revised Recovery Plan for Hawaiian Forest Birds. Portland, OR. 622 pp. U.S. Fish and Wildlife Service (USFWS). 2018. Puaiohi 5-year Review. Honolulu, HI. 9 pp.

Species: Akikiki

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: Single population (USFWS 2019)

Species Trends: Declining (USFWS 2017)

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary Akikiki:

The Kauai creeper (*Oreomystis bairdi*), or akikiki, is a small Hawaiian honeycreeper found only on the island of Kauai, currently in the montane wet ecosystem (TNCH 2007; as cited in USFWS 2010). The akikiki is most common in forests dominated by *Metrosideros polymorpha* with a diverse subcanopy (Scott et al. 1986, p. 139; as cited in USFWS 2010). Based on surveys conducted from 1968 through 1973, its distribution was thought to encompass 21,750 ac (88 sq. km) at elevations between 1,968 and 5,248 ft (600 and 1,600 m), but a survey in 2000 indicated its distribution had decreased to 8,896 ac (36 sq km) (Scott et al. 1986, p. 141; Tweed et al. 2005, pp. 3-4; as cited in USFWS 2010). Diet: The akikiki generally forages on trunks, branches, and twigs of live and dead trees, and occasionally forages in subcanopy shrubs. It feeds primarily on insects, insect larvae, and spiders gleaned and extracted from bark, lichens, and moss (Foster et al. 2000, p. 4; as cited in USFWS 2010). The 2007 population of the akikiki was estimated to be 1,312 ±530 birds, based on surveys conducted in April and May 2007 (Hawaii Division of Forestry and Wildlife and USGS, unpublished data 2007; as cited in USFWS 2010). The abundance of the akikiki has thus declined by approximately 80 percent in the last 40 years, and its distribution has been reduced to less than half of its former extent (USFWS 2008; as cited in USFWS 2010). Paxton et al. (2016, as cited in USFWS 2017) documents the population decline and range contraction for akikiki and other avifauna on Kauai. The study looked at the average change in density over a 25-year period for both the interior and exterior areas of the Alakai Plateau. Akikiki has declined precipitously, with the 2012 population sizes estimated to be only 468 (95% Confidence Interval, 231 to 916) individuals. This estimate was derived from only three detections of akikiki during the 2012 survey. Unlike in previous surveys (2000, 2005, 2007, and 2008), akikiki was not detected by systematic surveys in the periphery of its range in 2012, although incidental sightings indicate continued but limited occurrence. If current rates of decline continue, extinction is predicted in the coming decades (USFWS 2017).

Threats to akikiki include habitat loss and degradation, disease, predation, small population size and natural stochastic events. These factors interact in complex and dynamic ways that are only partly understood (USFWS 2017).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2010. Recovery Outline for the Kauai Ecosystem. Honolulu, Hawaii. 41 pp.

U.S. Fish and Wildlife Service (USFWS). 2017. Akikiki (*Oreomystis bairdi*) 5-Year Review. Honolulu, Hawaii. 19 pp.

Species: Hawaii creeper

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: 5 (USFWS 2015)

Species Trends: Stable (USFWS 2015)

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary Hawaii Creeper:

Surveys for Hawaiian forest birds using the variable circular-plot method as previously conducted by Scott et al. (1986; as cited in USFWS 2015) were conducted in forest areas on Hawaii from 2010-2012 in areas with current and historical occurrence of Hawaii creeper (Camp

2015; as cited in USFWS 2015). The total population of Hawaii creeper is approximately 14,000 birds in 4 populations (Gorresen et al. 2009, as cited in USFWS 2015, 2020). Density is increasing in Hakalau Forest National Wildlife Refuge (NWR) and possibly stable in Kau but is likely decreasing in central windward Hawaii and nearly extirpated from Hualalai and central Kona (Gorresen et al. 2009, as cited in USFWS 2015). Although the species is stable overall, its range is still contracting. Hawaii creepers were detected at 1,280 m elevation at the Hakalau Forest NWR during surveys for Hawaiian forest birds in 2012, within 1.6 km from where they were last observed by USFWS biologists during the 1977 Hawaii Forest Bird Survey, suggesting possible range expansion into middle elevation native forests on the refuge (Kendall and Gordon 2012, as cited in USFWS 2015). Analysis of population trends suggest the species is benefiting from over two decades of habitat restoration at the Hakalau Forest NWR (Camp et al. 2010, as cited in USFWS 2015). In addition, Hawaii creeper is regularly seen foraging in planted koa groves at upper elevations of the Hakalau Forest NWR several kilometers above old growth forest areas (Hakalau Forest NWR 2013, as cited in USFWS 2015).

Habitat loss and modification (ungulate grazing, non-native plants), avian disease, and predation by introduced mammals are thought to have caused the Hawai`i creeper to become endangered, and these factors continue to limit the Hawaii creeper today (USFWS 2010). Hawaii honeycreepers are known to be highly susceptible to introduced avian disease, particularly avian malaria (*Plasmodium relictum*) (Atkinson et al. 1995; Atkinson et al. 2000; Yorinks and Atkinson 2000; Banko and Banko 2009; as cited in USFWS 2020). According to some climate change projections, temperature increases could present an additional threat specific to Hawaiian forest birds by causing an increase in the elevation below which regular transmission of avian malaria occurs, potentially reducing the remaining suitable habitat for these species. Lia et al. (2015, as cited in USFWS 2020) assessed how global climate change will affect future malaria risk for native Hawaiian bird populations and expect high elevation areas to remain mosquito free only to mid-century due to combined factors of increased rainfall and increasing temperatures. If climate change were to reduce the remaining suitable habitat for Hawaii creeper as predicted, it would likely contribute to the extinction of this species over time.

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2010. Hawaii Creeper (*Oreomystis mana*), 5-Year Review: Summary and Evaluation. Honolulu, Hawaii. 16 pp.

U.S. Fish and Wildlife Service (USFWS). 2015. Hawaii Creeper (*Oreomystis mana*), 5-Year Review: Short Form Summary. Honolulu, Hawaii. 8 pp.

U.S. Fish and Wildlife Service (USFWS). 2020. Hawaii Creeper (*Oreomystis mana*), 5-Year Review: Short Form Summary. Honolulu, Hawaii. 7 pp.

Species: Crested honeycreeper

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: Single population (USFWS 2018)

Species Trends: Declining (USFWS 2018)

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary Crested (Akohekohe) honeycreeper:

The ‘ākohekohe, or crested honeycreeper, is the largest (24 to 29 gram) (0.8 to 1.0 ounce) honeycreeper remaining on Maui Nui (USFWS 2011). The ‘ākohekohe is primarily nectarivorous, but also feeds on caterpillars (Lepidoptera), spiders, and dipterans (Berlin and VanGelder 1999, p. 4; as cited in USFWS 2011). Nectar is primarily sought from flowers of ‘ōhi‘a (*Metrosideros polymorpha*) trees, but also from several subcanopy tree and shrub species (Berlin et al. 2001, pp. 2007- 2008; as cited in USFWS 2011). Insects are taken mostly by gleaning ‘ōhi‘a foliage, buds, and flower clusters (Berlin and VanGelder 1999, p. 4; as cited in USFWS 2011).

Past population estimates were steady at about 3,800 from 1980 to 2011 (Scott et al. 1986 and USFWS 1984, 2006, 2011, and 2014; as cited in USFWS 2018) with Gorresen et al. (2009, as cited in USFWS 2018) postulating that the current population may be larger than previously estimated. However, current population estimates from Maui forest bird surveys conducted in 2016 show a decline from about 3,800 to less than 2,411 individuals (MFBRP 2017, as cited in USFWS 2018). Critical habitat for the `ākohekohe was designated in 2016 for the protection of existing population sites and unoccupied but suitable habitat locations for possible translocation and relocation essential to the conservation of the species (USFWS 2016, as cited in USFWS 2018). The `ākohekohe’s range has been contracting since the 1990’s, possibly the 1980’s. The new range size is 23 square kilometers compared to the previous range size of 58 square kilometers (USFWS 2014) making it the smallest range of all Maui honeycreepers (MFBRP 2017, as cited in USFWS 2018).

Modification and loss of habitat and avian disease are the main factors that have contributed to the decline of ‘ākohekohe and other Hawaiian forest birds (Warner 1968, pp. 101-102; as cited in USFWS 2011). Clearing of forest by logging and ranching has been extensive, greatly reducing the amount of suitable habitat for ‘ākohekohe and other forest birds and resulting in fragmentation of remaining forest habitat. Agricultural operations and forest fragmentation increase the abundance of mosquitoes and the distances mosquitoes disperse (Reitter and LaPointe 2007, p. 865; LaPointe 2008, p. 606; as cited in USFWS 2011). In addition, damage by feral pigs to understory vegetation provide mosquito breeding sites and may deplete nectar resources needed during times of year when ‘ōhi‘a bloom is less available (Lease et al. 1996, p. 1; Berlin et al. 2001, p. 212; as cited in USFWS 2011).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2011. Crested honeycreeper, akohekohe (*Palmeria dolei*) 5-Year Review. Honolulu, HI. 20 pp.

U.S. Fish and Wildlife Service (USFWS). 2014. Crested honeycreeper, akohekohe (*Palmeria dolei*) 5-Year Review. Honolulu, HI. 7 pp.

U.S. Fish and Wildlife Service (USFWS). 2018. Crested honeycreeper, akohekohe (*Palmeria dolei*) 5-Year Review. Honolulu, HI. 9 pp.

Species: Maui parrotbill (honeycreeper)

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: Single population (USFWS 2018)

Species Trends: Declining (USFWS 2018)

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary Maui Parrotbill:

The kiwikiu is insectivorous and often feeds in a deliberate manner, using its massive, hooked bill to dig, tear, crack, crush, and chisel the bark and softer woods on a variety of native shrubs and small- to medium-sized trees (USFWS 2011). Kiwikiu are associated with areas typified by large diameter trees and higher densities of understory, subcanopy, and canopy vegetation layers (Stein 2007, p. 3; as cited in USFWS 2011). Kiwikiu forage mainly on the woody portions of living native shrubs and small to medium-sized trees, especially koa (*Acacia koa*), ‘ōlapa (*Cheirodendron trigynum*) ‘alani (*Melicope* spp.) ‘ākala (*Rubus hawaiensis*) and kāwa‘u (*Ilex anomala*; Simon et al. 1997, p. 3; Stein 2007, pp. 3 and 28; as cited in USFWS 2011); historical accounts noted a preference for koa (Perkins 1903, p. 431; as cited in USFWS 2011). Kiwikiu also pluck and bite open fruit in search of insects, particularly kanawao (*Broussaisia arguta*), but do not eat the fruit. Especially preferred are larvae and pupae of various beetles and moths (Perkins 1903, p. 431; Mountainspring 1987, p. 32; Simon et al. 1997, p. 3; as cited in USFWS 2011).

Past population estimates were steady at approximately 500 from 1980 to 2011 (Scott et al. 1986, Gorresen et al. 2009, and USFWS 1984, 2006, 2011, and 2014; as cited in USFWS 2018). However, current population estimates of less than 312 from Maui forest bird surveys conducted in 2016 show a steep decline from previous population estimates (MFBRP 2017; as cited in USFWS 2018). Captive breeding of kiwikiu at the Maui Bird Conservation Center (MBCC) and Keauhou Bird Conservation Center (KBCC) was not successful over the past twenty years due to low reproductive success and low survivorship. According to staff at MBCC (2017, as cited in USFWS 2018), captive breeding is difficult for the species and on average, kiwikiu only live about 6 years in captivity. Currently there is no reproduction taking place and only10 kiwikiu remain in captivity (MBCC 2017, as cited in USFWS 2018). Critical habitat for the kiwikiu was designated in 2016 for the protection of existing population sites and unoccupied but suitable habitat locations for possible translocation and relocation essential to the conservation of the species (USFWS 2016; as cited in USFWS 2018). Recent kiwikiu range size of 30 square kilometers (11.6 square miles) was delineated based on habitat, elevation layers, and current surveys (MFBRP 2017, as cited in USFWS 2018) compared to the previously.

Global climate change in addition threatens *Pseudonestor xanthophrys* by increasing the elevation at which regular transmission of avian malaria (a protozoan parasite, *Plasmodium relictum*) and avian pox virus (*Avipoxvirus spp.*) occurs (Benning et al. 2002 as cited in USFWS).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2011. Maui parrotbill (*Pseudonestor xanthophyrys*) 5-year review. 19 pp.

U.S. Fish and Wildlife Service (USFWS). 2014. Maui parrotbill (*Pseudonestor xanthophyrys*) 5-year review. 7 pp.

U.S. Fish and Wildlife Service (USFWS). 2018. Maui parrotbill (*Pseudonestor xanthophyrys*) 5-year review. 9 pp.

Species: `O`u (honeycreeper)

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: Possibly extinct (NatureServe, 2015)

Species Trends: Decline of > 90%, possibly extinct (NatureServe 2015); unknown (USFWS, 2015); last sighted in 1989 (Kauai) and 1987 (Hawaii) (USFWS, 2009)

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary O'u:

The species has not been seen since 1989 on Kauai and 1987 on Hawaii (Pyle 1989, as cited in USFWS 2009). One of the primary threats to this species and to other Hawaiian forest birds is habitat loss and degradation by agriculture, urbanization, cattle (*Bos taurus*) grazing, browsing by feral ungulate species, timber harvesting, and invasion of nonnative plant species into native-dominated plant communities (USFWS 2006). New threats include climate change destruction or degradation of habitat (USFWS 2015). Hawaiian honeycreepers are known to be highly susceptible to introduced avian disease, particularly avian malaria (Plasmodium relictum) (Atkinson et al. 1995; Atkinson et al. 2000; Yorinks and Atkinson 2000; Banko and Banko 2009; as cited in USFWS 2015). According to some climate change projections, temperature increases could present an additional threat specific to Hawaiian forest birds by causing an increase in the elevation below which regular transmission of avian malaria occurs, potentially reducing the remaining suitable habitat for these species.

This species now occurs in such low numbers and in such restricted ranges, if it exists at all, that it is threatened by natural processes, such as inbreeding depression and demographic stochasticity, and by natural and man-made factors such as hurricanes, wildfires, and periodic vegetation die-back (USFWS 2006). Elphick et al. (2010, as cited in USFWS 2015) estimated the extinction of the `ō`ū to have occurred in 1990 on Hawaii and 1993 on Kauai using a method by which the predicted probability of extinction increases as a function of the time since a species was last observed. Using 1987 as the last reliable observation record for `ō`ū on Hawaii Island, and 1989 on Kauai, the authors determined the year 1998 for Hawaii Island and 2002 for Kauai as the upper 95% confidence bound for species extinction on the two islands. This approach for establishing extinction probability however is problematic when applied to extremely rare species such as `ō`ū that are potentially distributed over a large area because the absence of observation records may be the result of inadequate survey effort and the few if any visits by qualified observers to remote areas where rare and potentially extinct species may still exist.

Recent natural disasters may have affected some of the last remaining `ō`ū populations. On the Island of Hawai`i, a large portion of the Upper Waiākea Forest Reserve, location of some of the last observations of `ō`ū and considered prime habitat for the species, was inundated by the 1984 Mauna Loa lava flow, destroying thousands of acres of forest and creating a treeless corridor over a kilometer (0.62 mile) wide. On Kaua`i, two strong hurricanes, Iwa in 1982 and Iniki in 1992, had devastating effects on native forest habitat and native bird species. Habitat degradation resulting from the invasion of pernicious nonnative weeds has drastically changed the forest structure and integrity since the two hurricanes in 1982 and 1992, with the invasion and expansion of noxious weeds such as *Hedychium flavescens* (yellow ginger), *Erigeron karvinskianus* (daisy fleabane), *Tibouchina urvilleana* (glorybush), *Lonicera japonica* (Japanese honeysuckle), and others (USFWS 2006). If this species persists it is confined to remote forested area. These areas apparently receive little human traffic and are also unlikely to receive substantial pesticide usage. However, if this species persists it likely does so in such low numbers that any additional stressors may have substantial negative impacts on their survival and recovery.

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2006. Revised Recovery Plan for Hawaiian Forest Birds. Portland, OR. 622 pp.

U.S. Fish and Wildlife Service (USFWS). 2009. `Ō`ū (*Psittirostra psittacea*).5-year review summary and evaluation. Honolulu, Hawaii. 11 pp.

U.S. Fish and Wildlife Service (USFWS). 2015. `Ō`ū (*Psittirostra psittacea*). 5-year review summary and evaluation. U.S. Fish and Wildlife Service, Honolulu, Hawaii. 8 pp.

Overall Vulnerability Oahu `Elepaio: ☒ High ☐ Medium ☐ Low

Overall Vulnerability Hawaiian (`Alalā) crow: ☒ High ☐ Medium ☐ Low

Overall Vulnerability I'iwi: ☒ High ☐ Medium ☐ Low

Overall Vulnerability Akiapola'au: ☒ High ☐ Medium ☐ Low

Overall Vulnerability Palila: ☒ High ☐ Medium ☐ Low

Overall Vulnerability Akekee: ☒ High ☐ Medium ☐ Low

Overall Vulnerability Hawaii akepa: ☒ High ☐ Medium ☐ Low

Overall Vulnerability Molokai thrush: ☒ High ☐ Medium ☐ Low

Overall Vulnerability Small Kauai (puaiohi) thrush: ☒ High ☐ Medium ☐ Low

Overall Vulnerability Akikiki: ☒ High ☐ Medium ☐ Low

Overall Vulnerability Hawaii creeper: ☒ High ☐ Medium ☐ Low

Overall Vulnerability Crested (Akohekohe) honeycreeper: ☒ High ☐ Medium ☐ Low

Overall Vulnerability Oahu creeper: ☒ High ☐ Medium ☐ Low

Overall Vulnerability Maui parrotbill: ☒ High ☐ Medium ☐ Low

Overall Vulnerability O'u: ☒ High ☐ Medium ☐ Low

RISK

(Risk is based on species exposure and response from labelled uses across the range)

Risk to individuals if exposed:

Effects to Hawaiian forest birds from use sites:

All species could experience some degree of mortality or sublethal effects from exposure to malathion on use sites. However, forest birds are not expected to utilize malathion use sites. Exposure to malathion via spray drift is not expected to result in mortality or sublethal effects.

Effects to Hawaiian forest birds from mosquito control:

Malathion use for mosquito control, if applied, is not expected to result in mortality or sublethal effects to Hawaiian forest birds.

Risk to the species from labelled uses across the range:

DIRECT (all uses except mosquito adulticide)	
Use areas – mortality and sublethal effects	No effects expected, as species are not expected to enter use sites.
Spray drift areas – mortality	No effects expected
Direct spray or contact with contaminated media	No effects expected, as species are not expected to enter use sites.
Volatilization	Could contribute to exposure for all species
INDIRECT (all uses except mosquito adulticide)	
Use areas - Prey item mortality	Mortality to terrestrial invertebrates via spray drift from adjacent use sites. Effects to other prey species are not expected.
MOSQUITO ADULTICIDE	
Direct (mortality and sublethal)	No effects expected
Indirect	Mortality to terrestrial invertebrates if use occurs

Risk modifiers: All of these species are predominately restricted to mid- to upper-elevation forests on their respective islands, primarily due to avian disease (USFWS 2006; see Status of the Species for more details on each species). A notable exception is the Oahu `elepaio, which can be found within valleys lower in elevation, and much closer to developed areas than the other species. Due to the restricted nature of the habitats for these species of forest birds and their location primarily within the fog and cloud zones, volatilization is a source of exposure for these species. Inhalation of fog or exposure to malathion from preening feathers or through contact with plants in the environment with deposition residue could contribute to exposure for these species. Although we would expect species within high-level elevation area to be exposed to malathion via volatilization, we conclude, based on the best information available, that species in high elevations would not be exposed to concentration levels that would affect them (see *General Effects* for further information on volatilization).

All of these species rely on insects for a significant portion of the diet either exclusively or during certain times of the year, particularly as a key source of protein for nestlings during the breeding season. Seven of the species are obligate insectivores (Akikiki, Akekee, Oahu `Elepaio, Maui Parrotbill, Akiapolaau, Hawai'i Creeper, and Hawai'i Akepa).

Range maps for Hawaiian forest birds include the entirety of the islands where these species can be found. Therefore, an overlap analysis of malathion use sites would simply be indicative of the extent of use sites on the islands, and not the true overlap where the species is likely to be found. Thus, exposure is better assessed by the degree to which these species are likely to be within or adjacent to malathion use sites. These species are primarily restricted to forests, and therefore not expected to be exposed in agricultural areas. Species occurring in habitat that is adjacent to agriculture or pasture could be exposed via spray drift. In addition, the Oahu `elepaio could be exposed from via spray drift from use in developed or open space developed areas. However, no direct effects are anticipated for these species.

Allowable uses driving effects: Indirect effects to terrestrial invertebrates could occur from exposure to spray drift from use sites, particularly developed and open space developed sites for the Oahu `elepaio. Because invertebrates exhibit a range of sensitivities to malathion, exposure is expected to reduce the abundance in these areas, but not completely eliminate the prey base in these portions of the range. These reductions are likely temporary (based on application frequency) with community recovery over a short period of time.

Overall Risk Oahu `Elepaio: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Risk `Alalā: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk I'iwi: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk Akiapola'au ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk Palila: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk Akekee: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk Hawaii Akepa: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk Hawaii Moloka'i thrush: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk Puaiohi: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk Akikiki: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk Hawaii Creeper: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk Akohekohe: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk Oahu creeper: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk O'u: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk Maui Parrotbill: ☐ **High** ☐ **Medium** ☒ **Low**

USAGE

(Anticipated usage within the range based on past usage data)

Information regarding past usage of malathion in Hawaii is not available, however prior survey data has indicated that 4.8% of agricultural crops were treated with insecticides, with malathion being only a subset of this use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the Approach to Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in Hawaii; future use cannot be ruled out but is not expected to increase significantly.

Overall Usage Oahu `Elepaio: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Usage `Alalā: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Usage I’iwi: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Usage Akiapola’au ☐ **High** ☒ **Medium** ☐ **Low**

Overall Usage Palila: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Usage Akekee: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Usage Hawaii Akepa: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Usage Molokai thrush: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Usage Puaiohi: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Usage Akikiki: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Usage Hawaii Creeper: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Usage Akohekohe: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Usage Oahu creeper: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Usage O’u: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Usage Maui Parrotbill: ☐ **High** ☒ **Medium** ☐ **Low**

CONSERVATION MEASURES

Residential use label changes: New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely), reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from “repeat as necessary” to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application.

Reduced application number and rate: New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop, previous allowable number of applications ranged from 3 to 13 applications per year). We anticipate, this measure will help reduce the amount of malathion used and decrease potential exposure to these species, thus decreasing the risk of both indirect and direct effects to these species.

CONCLUSION

After reviewing the current status of the species, the environmental baseline for the Action area, and the effects of the proposed registration of malathion, it is the Service’s biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of these species. Our rationale for each of these species is provided in the following paragraphs.

Maui Akepa, Hawaii Nukupu’u, and the Po’ouli

These species have recommendations for a change in their species population statuses from “unknown” to “presumed extinct”. We do not anticipate the individuals of these species are likely to be exposed to malathion or experience mortality, or effects to growth or reproduction as a result of the Action. Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of these forest birds in the wild.

Molokai Thrush and the O’ahu Creeper.

The Molokai Thrush and the O’ahu Creeper could occur in remote or hard to access forested habitats, where malathion is not likely to be used. The last confirmed sightings of these two species were in the 1980’s, although we do not assume that these species are extinct; the status of these species are presently “unknown”. However, we do not anticipate the individuals of these species are likely to be exposed to malathion or experience mortality, or effects togrowth or reproduction as a result of the Action. Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of these forest birds in the wild.

The last confirmed detection of Molokai thrush was in 1980 (Reynolds and Snetsinger 2001, p. 136; as cited in USFWS 2006). However, during biological survey of the Oloku’i Plateau in 2015 there were several unconfirmed sighting of Molokai thrush near ‘Ōhi‘alele in The Nature Conservancy Pelekunu Preserve (Oppenheimer et al. 2015, p. 8; as cited in USFWS 2018). We believe the status of the oloma‘o is “unknown” based on conclusion of the Hawai‘i Rare Bird Search 1994-1996 that the species could still be potentially extant (Reynolds and Snetsinger, 2001, pp. 141-142), low survey efforts, and the unconfirmed sightings of this species in 2015. There is a potential that a small population of Molokai thrush still exist on Moloka'i. The extremely rough terrain on Moloka'i and frequent wet weather make surveys difficult, and numerous steep valleys create small pockets of habitat where the species could still persist.

The last well-documented observation of the O'ahu creeper was of two birds on December 12, 1985, during the Waipi'o Christmas Bird Count (Bremer 1986 as cited in USFWS 2019). The preferred habitat of this species is thought to be a mid-elevation koa/ohi'a (*Acacia koa*/*Metrosideros polymorpha*) forests in valleys or on sideridges at elevations 1,000 to 2,000 feet) (Shallenberger and Pratt 1978, as cited in USFWS 2019). We cannot assume that it is extinct since no monitoring efforts have been done to determine a population. Small populations of i'iwi have been rediscovered on O'ahu in both the Wai'anae and Ko'olau Mountains (VanderWerf and Rohrer 1996), and it is possible that isolated populations of the O'ahu creeper also still exist in remote areas of the island (USFWS 2019).

While we do anticipate that adverse effects to prey items could occur, we do not expect species-level effects, because these birds primarily inhabit remote forested habitats. Impacts to prey items would only occur along the edges of these forested habitats where they co-occur with malathion use sites. If there are areas where prey items are temporarily lost, birds have the ability to move to unaffected areas to forage. As discussed above, we anticipate the likelihood of exposure to malathion is low and the implementation of general conservations measures described above is expected to further reduce the likelihood of exposure. Since these two species rely on native forest for nesting and foraging, they are less likely to be exposed to malathion from agriculture or developed/open space developed applications, and the forest habitats in which these species occur are also likely to serve as a buffer to spray drift or runoff from these activities. Changes to residential labels limits applications to spot treatments and reduces the number of applications per year (2-4), are expected to decrease the overall amounts of malathion used in developed and open space developed areas and will further reduce runoff and drift. Additional reductions in the number of applications and rates allowed for certain crops will also reduce the amount of malathion used in agricultural settings, thereby decreasing potential exposure to the species through drift or runoff. Together, these measures are anticipated to further reduce the likelihood of exposure to these species and their habitat. Thus, we expect exposure of individuals of Molokai thrush and the O'ahu creeper and their prey to occur only at very low levels over the duration of the Action and would likely not result in mortality or sublethal effects to individuals of the species, or measurable impacts to their prey base.

Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of these forest birds in the wild.

Hawaiian (`Alalā) crow

As discussed below, even though the Hawaiian crow has high vulnerability, we anticipate the risk to malathion to be low and usage medium. The implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure to malathion when the species is reintroduced into the wild. Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of the `alalā in the wild.

The Hawaiian Crow is not currently found in the wild, although the USFWS is working with the State of Hawaii, Department of Land and Natural Resources Division to establish a self-sustaining, wild population. Since the `alalā is endemic to the island of Hawaii, reintroduction efforts have focused on releasing captive-reared birds to this island. From 2016–2019, `alalā were released, but in response to mortalities (including predation by the ‘io) conservationists captured the remaining birds and brought them back into captivity. As efforts to improve success of Hawaii Island reintroductions continue, the Project has begun preliminary work to explore the potential of Maui Nui to serve as an additional release site for `alalā.

As discussed above, we anticipate the likelihood of exposure to malathion is low. While usage is not expected on all use sites and at the maximum rates allowed by the labels where used each year, we anticipate that some use could occur based on information from a prior survey that estimated 4.8% of agricultural crops were treated with insecticides. Since, in the wild, the species relies on native forest for nesting and foraging, it is less likely to be exposed to malathion from agriculture or developed/open space developed applications, and the forest habitats in which this species occurs are also likely to serve as a buffer to spray drift or runoff from these activities. While we do anticipate that adverse effects to prey items could occur, we do not expect species-level effects because the Hawaiian crow primarily inhabits forested habitats. Impacts to prey items would only occur along the edges of these forested habitats where they co-occur with malathion use sites. If there are areas where prey items are temporarily lost, birds have the ability to move to unaffected areas to forage.

Additionally, we anticipate that the conservation measures above, including residential use label changes, and reduced numbers and application rates on certain use sites would further reduce the risk of exposure to these species and their prey. Since the Hawaiian crow relies on native forest for nesting and foraging, residential use restrictions for applications in developed and open space developed areas, such as spot treatments and reduced frequency of applications are anticipated to further limit exposure of malathion to these species and their habitats. In addition, the reduction in number of applications and application rates for certain agricultural crops are expected to further decrease the likelihood of exposure to this species, its prey, and its habitats. Together, these measures are anticipated to substantially reduce the likelihood of exposure to these species (i.e., when released into the wild), their prey, and their habitat. We expect exposure of Hawaiian crows and their prey to occur only at very low levels over the duration of the Action and would likely not result in mortality, sublethal effects, or measurable impacts to their prey base.

Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of the Hawaiian crow in the wild.

Oahu `Elepaio, Akiapola’au, Palila, Akekee, Hawaii Akepa, Molokai Thrush, Puaiohi, Akikiki, Hawaii Creeper, Akohekohe, O’u, and Maui Parrotbill.

As discussed below, even though these birds have high vulnerabilities, we anticipate risk to be low and usage medium. The implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure of individuals of these species to malathion, and we do not anticipate the Action will result in species-level effects.

These forest birds have high vulnerability based on their estimated status, distribution, and trends. The risk posed by the labeled uses across the range is medium for the Oahu `elepaio and low for the other forest birds in this group. There is also a medium amount of estimated usage within the range of these species. While usage is not expected on all use sites and at the maximum rates allowed by the labels where used each year, we anticipate that some use could occur based on information from a prior survey that estimated 4.8% of agricultural crops were treated with insecticides. Malathion is not registered for use in forest and these forest birds are not expected to utilize any of the malathion use sites. Exposure to malathion via spray drift is not expected to result in mortality or sublethal effects. While we do anticipate that adverse effects to prey items could occur, we do not expect species-level effects because these birds primarily inhabit forested habitats. Impacts to prey items would only occur along the edges of these forested habitats where they co-occur with malathion use sites. If there are areas where prey items are temporarily lost, birds have the ability to move to unaffected areas to forage. Furthermore, we expect the forested habitat in which these species occur also provide a buffer to runoff and spray drift from nearby use sites.

Additionally, we anticipate that the conservation measures above, including residential use label changes, and reduced numbers and application rates on certain use sites would further reduce the risk of exposure to these species and their prey. Since these forest birds rely on native forest for nesting and foraging, residential use restrictions for applications in developed and open space developed areas, such as spot treatments and reduced frequency of applications are anticipated to further limit exposure of malathion to these species and their habitats. In addition, the reduction in number of applications and application rates for certain agricultural crops are expected to further decrease the likelihood of exposure to these species, their prey, and their habitats. Together, these measures are anticipated to substantially reduce the likelihood of exposure to these species and their habitat. Due to the low risk and moderate usage, and the implementation of the conservation measures, we expect exposure of individuals of these species and their forage base will occur only at very low levels over the duration of the Action and would likely not result in mortality, sublethal effects, or measurable impacts to their prey base.

Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of these forest birds in the wild.

Conclusion for Maui akepa: **Not likely to jeopardize**

Conclusion for Maui nukupu'u: **Not likely to jeopardize**

Conclusion for Po'ouli: **Not likely to jeopardize**

Conclusion for Oahu `Elepaio: **Not likely to jeopardize**

Conclusion for `Alalā: **Not likely to jeopardize**

Conclusion for I'iwi: **Not likely to jeopardize**

Conclusion for Akiapola'au	**Not likely to jeopardize**
Conclusion for Palila:	**Not likely to jeopardize**
Conclusion for Akekee:	**Not likely to jeopardize**
Conclusion for Hawaii Akepa:	**Not likely to jeopardize**
Conclusion for Molokai thrush:	**Not likely to jeopardize**
Conclusion for Puaiohi:	**Not likely to jeopardize**
Conclusion for Akikiki:	**Not likely to jeopardize**
Conclusion for Hawaii Creeper:	**Not likely to jeopardize**
Conclusion for Akohekohe:	**Not likely to jeopardize**
Conclusion for Oahu creeper:	**Not likely to jeopardize**
Conclusion for Maui Parrotbill:	**Not likely to jeopardize**
Conclusion for O'u:	**Not likely to jeopardize**

***ADDITIONAL REFERENCES*:**

State of Hawaii. 2021. Next Steps in `Alalā Recovery Include Maui Nui & ʻIo Research. Press Release on March 31, 2021, accessed electronically on January 31, 2022 at: https://dlnr.hawaii.gov/alalaproject/2021/03/31/press-release-next-steps-in-%ca%bbalala-recovery-include-maui-nui-%ca%bbio-research/.

U.S. Fish and Wildlife Service (USFWS). 2006. Revised Recovery Plan for Hawaiian Forest Birds. Portland, OR. 622 pp.

U.S. Fish and Wildlife Service (USFWS). 2018. Olomaʻo or Molokaʻi Thrush (*Myadestes lanaiensis rutha*). 5-Year Review. Honolulu, Hawaii. 7 pp.

U.S. Fish and Wildlife Service (USFWS). 2009. Revised Recovery Plan for the `Alalā (Corvus hawaiiensis).

Guam and Commonwealth of Northern Mariana Islands

As noted in the 1990 Native Forest Birds of Guam and Rota of the Commonwealth of the Northern Mariana Islands Recovery Plan, pesticide use has a long history in the Mariana Islands, both for agricultural purposes and as a disease vector control. From World War II until it was banned in the early 1970s, DDT was regularly sprayed widely on Guam by the military and local farmers (Maben 1980; Anderson 1981). In addition, the insecticide malathion was applied by the military around beaches and buildings up to three times a week (Maben 1980). Malathion was also aerially applied over approximately a third of the island of Guam over 4 days in 1975 to prevent a potential outbreak of dengue fever (Haddock et al. 1979). While it is believed that this spraying played a role in the initial decline of forest birds in Guam, it is unclear how significant pesticide use was to this decline (Grue 1985; Drahos 2002). In addition, the widespread use of malathion on Rota in the 1960s and 1970s was thought to play a role in the extirpation of the Mariana swiftlet and sheath-tailed bat from the island (Engbring et al. 1986, Lemke 1986). It was again used widely on Rota in 1989 to control melon fly (Engbring 1989), which coincided with the decline and range restriction of the Rota bridled white-eye.

This section describes our analysis for birds in Commonwealth of Northern Mariana Islands and in Guam. The analysis for these species will be presented together according to their respective locations, although each species was considered independently based on its life history and vulnerability, risk, and usage, as well as any applicable conservation measures. Each species has a separate conclusion listed after the narrative.

Integration and Synthesis Summary: Northern Mariana Islands birds

Scientific Name:	Common Name:	Entity ID:
Acrocephalus luscinia	Nightingale reed warbler	1222
Aerodramus bartschi	Mariana gray swiftlet	148
Corvus kubaryi	Mariana (aga) crow	118
Gallinula chloropus guami	Mariana common moorhen	120
Megapodius laperouse	Micronesian megapode	87
Rallus owstoni	Guam rail	121
Todiramphus cinnamominus cinnamonminus	Guam Micronesian kingfisher	119
Zosterops rotensis	Rota bridled white-eye	1241

Birds on the Northern Mariana Islands vary in their life histories, but we believe we can analyze them together due to the small size of these islands and overlapping ranges for many of these species, creating similar threat and exposure risks. The Guam kingfisher is now extinct in the wild, but it is likely to be reintroduced back to the wild during the 15-year timeframe of this consultation, so is included in this analysis.

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Threats to these species vary, but all are heavily threatened by either reduction in range by the introduction of the brown tree snake (*Boiga irregularis*) to Guam or the potential for this threat to spread to other islands in the chain (Savidge 1987). Only the Mariana swiftlet and Mariana moorhen are extant in Guam, with both in very low numbers. Loss of habitat through urbanization and military expansion is another widespread threat that affects nearly all of these species. Other threats include disturbance of nest sites (Mariana crow, Micronesian megapode, Mariana gray swiftlet) and introduced mammalian predators, particularly feral cats (Guam rail, Mariana crow, Mariana common moorhen, Micronesian megapode) (USFWS 1990; USFWS 1991a, b; USFWS 1998a; USFWS 2005). As most of these species have been reduced to small populations separated on different islands, stochastic events, both environmental (typhoons) and demographic (small population effects) are serious threats to the long-term recovery of these species. In addition, pesticides and other contaminants are specifically called out as a serious threat to nightingale reed-warbler, Mariana crow, Mariana swiftlet, and Rota bridled white-eye (USFWS 1991a; USFWS 1998b; USFWS 2005; USFWS 2007).

Species: Nightingale reed warbler

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: 2 (USFWS 2015)

Species Trends: Saipan: declining; Alamagan: unknown; Overall declining/stable (USFWS 2010, 2015, 2020)

Pesticides noted ☒

Environmental Baseline/Cumulative Effects (EB/CE) Summary Nightingale Reed Warbler:

The nightingale reed-warbler, known locally as ga’ ga’ karisu (bird of the reeds) on Saipan, once occurred on Guam, Aguiguan, Tinian, Saipan, Alamagan, and Pagan (USFWS 1998, 2020). Nightingale reed-warblers now occur only on Saipan and Alamagan. Little management occurs within the species habitat on Saipan, and none occurs on Alamagan. The main two threats to the nightingale reed-warbled continue to be the loss and degradation of habitat, including wetlands, and predation by introduced species (predation and disease). Other threats to the species include predation by non-native species, fire, and human disturbance (USFWS 2010). The most recent estimates we have indicate the Saipan population has decreased by more than half between surveys in 1982 (1-6 birds on Aguiguan, 4,225 birds on Saipan, and 2000 birds on Alamagan) and 2007 (Camp et al. 2009, 946 birds on Alamagan and 2,742 birds on Saipan). Although there was no significant difference between the 2000 and 2010 population estimates of the Nightingale Reed-warbler on Alamagan, the native forest there is currently being overgrazed by feral ungulates and will eventually lead to habitat loss and a decline in the population there (Marshall et al. 2010). A population viability analysis was completed for the species in 2018, which found both the Saipan and Alamagan populations of reed-warblers will be severely decreased, and without management intervention, will likely go extinct within the next 100 years, or persist at population sizes that were so low as to signal a strong likelihood of future extinction (Fantle-Lepczyk et al. 2018, p. 5 as cited in USFWS 2020). In addition, Nightingale Reed-warblers remain on only two of the six islands in the Mariana Archipelago where they once occurred. The brown tree snake (*Boiga irregularis*), pesticides and major fires in the Agana Swamp during the 1960's were also likely significant problems and factors in the extinction of this species from the island of Guam (USFWS 1998).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 1998. Recovery Plan for the nightingale reed-warbler (*Acrocephalus Luscinia*), *Acrocephalus luscinia*. Portland, Oregon. 62 pp.

U.S. Fish and Wildlife Service (USFWS). 2010. Nightingale reed-warbler (old world warbler)(*Acrocephalus Luscinia*) 5-Year Review. Honolulu, Hawaii. 16 pp.

U.S. Fish and Wildlife Service (USFWS). 2015. Nightingale reed-warbler (old world warbler)(*Acrocephalus luscinia*) 5-Year Review. Honolulu, Hawaii. 6 pp.

U.S. Fish and Wildlife Service (USFWS). 2020. Nightingale reed-warbler (old world warbler)(*Acrocephalus Luscinia*) 5-Year Review Short Form Summary. Honolulu, Hawaii. 7 pp.

Species: Mariana gray swiftlet

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: 2 (USFWS 2015)

Species Trends: Stable/possibly increasing (USFWS 2015)

Pesticides noted ☒

Environmental Baseline/Cumulative Effects (EB/CE) Summary Mariana gray swiftlet:

The Mariana swiftlet is endemic to Guam, Rota, Aguiguan, Tinian, and Saipan, but has declined on all islands and is extirpated from Rota and Tinian (Cruz *et al*. 2008; USFWS 1991; Valdez *et al*. 2011 and references therein; as cited in USFWS 2020). The current range-wide population estimate for the Mariana gray swiftlet is approximately 5,704 individuals in the Mariana Islands, with 3,817 in 9 colonies on Saipan, 338 in 3 colonies on Aguiguan, and 1,549 in 3 colonies (Liske-Clark et al 2017a, 2017b; K.M. Brindock, Naval Facilities Engineering Command [NAVFAC] pers. comm. 2016 cited in Johnson et al. 2018). However, based on annual survey data, annual population average on Guam has dropped to around 1,000 over the last five years (Guam Division of Aquatic and Wildlife Resources [DAWR] unpublished data 2020, as cited in USFWS 2020). Recently, a suspected new naturally occurring population on Guam was discovered by DAWR near Talofofo in Balanos (USFWS 2020). Aguiguan has not been resampled since these 2016 estimates due to lack of funding and typhoon disruption. Similarly , no recent surveys have been conducted on Saipan. While no new life history has come from the Mariana populations, a number of publications have come from studies on the introduced population on Oahu from 2006-2010 (USFWS 2020).

Threats to the species continue, including human disturbance of caves, predation by the brown treesnake (*Boiga irregularis*), monitor lizards (*Varanus indicus*) and feral cats (*Felis cattus*), loss and degradation of foraging habitat, nest loss due to introduced insects, and more recently, climate change (Morton and Amidon 1996; USFWS 1991, 2010). Research conducted on Guam in 1981 indicates that pesticides have not affected the vertebrate fauna of Guam. However, significant declines in the flying insect fauna (swiftlet prey) due to large-scale aerial applications of malathion may have had an impact on the swiftlet population in the past (USFWS 1991). The black drongo (*Dicrurus macrocerucus*), a bird species introduced to Guam and Rota, was also observed preying on Mariana swiftlets on Guam (Perez 1968) and may have been a factor in their extirpation on Rota.

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 1991. Recovery Plan for the Mariana Islands Population of the Vanikoro Swiftlet, *Aerodramus vanikorensis bartschi*. Portland, OR. 49 pp.

U.S. Fish and Wildlife Service (USFWS). 2015. Mariana Gray Swiftlet (*Aerodramus vanikorensis bartschi*)5-Year Review. Honolulu, Hawaii. 7 pp.

U.S. Fish and Wildlife Service (USFWS). 2020. Mariana Gray Swiftlet (*Aerodramus vanikorensis bartschi*) 5-Year Review. Honolulu, Hawaii. 7 pp.

Species: Mariana (aga) crow

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: Single population (USFWS 2014, 2020)

Species Trends: Guam: in captivity; Rota: stable(USFWS 2020)

Pesticides noted ☒

Environmental Baseline/Cumulative Effects (EB/CE) Summary Mariana (aga) crow:

The Mariana crow population continued to decline on Guam from about 10 individuals in 2006, to three individuals in 2008, to one male in 2011 (SWCA 2012 as cited in USFWS 2020). The Mariana crow is now extirpated from Guam. The last known Mariana crow of Guam origin was observed in 2001, and the last known wild Mariana crow that was captive-reared from Rota and released on Guam was observed in 2012 (J. Quitugua, Guam Division of Aquatic and Wildlife Resources, pers. comm. 2014 as cited in USFWS 2020). The Mariana crow population on Rota has stabilized or slightly increased since the last review, from 46 breeding pairs documented in 2013 to 50 breeding pairs in 2019. During the 2019 breeding season, 24 of the 48 pairs that nested (50%) successfully fledged young (R. Ha, unpublished data), which is similar to the 48% average pair success rate from 1996 – 2009 (Zarones et al. 2015, as cited in USFWS 2020). Cat predation was recently identified as a mortality factor, but control efforts have just begun and plans to intensify the effort will begin by the end of 2014. Other unknown factors are suspected to contribute to Mariana crow mortality, but intensive monitoring and management actions are required to identify and control those threats. Researchers studying the impacts of pesticides on native forest birds in the 1980's did not believe that pesticides played a major role in the continuing decline of the aga and other endangered birds in the Mariana Islands (Grue 1985; Engbring 1989; as cited in USFWS 2005). However, Drahos (2002, as cited in USFWS 2005) believed that impacts of pesticides on native bird populations prior to the 1980's have been underestimated and that pesticide use may have played an important role in the decline of forest birds in Guam, especially southern Guam. Maben (1980, as cited in USFWS 1990) reported that the organophosphate insecticide malathion was applied by the military around beaches and buildings up to three times a week. Malathion was also aerially applied over approximately a third of the island of Guam over 4 days in 1975 to prevent the potential outbreak of dengue fever (Haddock et al. 1979, as cited in USFWS 2005). On Rota, malathion was used on to control insect pests in 1988 and 1989 (Engbring 1989, as cited in USFWS 2005).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 1990. Native Forest Birds of Guam and Rota of the Commonwealth of the Northern Mariana Islands Recovery Plan. U.S. Fish and Wildlife Service, Portland, OR. 86 pp.

U.S. Fish and Wildlife Service (USFWS). 2005. Draft Revised Recovery Plan for the Aga or Mariana Crow, *Corvus kubaryi*. Portland, Oregon. x + 147 pp.

U.S. Fish and Wildlife Service (USFWS). 2014. Mariana Crow 5-Year Review. Honolulu, Hawaii. 10 pp.

U.S. Fish and Wildlife Service (USFWS). 2020. Mariana Crow 5-Year Review. Honolulu, Hawaii.11 pp.

Species: Mariana common moorhen

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Multiple populations (few)

Species Trends: Declining (USFWS 2020)

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary Mariana common moorhen:

Mariana common moorhen populations currently occur on Guam, Rota, Tinian, and Saipan, having been extirpated from Pagan (USFWS 1991, 2020). The moorhen is an inhabitant of emergent vegetation of freshwater marshes, ponds, and placid rives. In the Mariana Islands its preferred habitat includes freshwater lakes, marshes, and swamps. Both man-made and natural wetlands are used (USFWS 1991). The most recent range-wide counts of the Mariana common moorhen estimated 133 birds on Saipan, 10 on Tinian, 3 on Rota, and 75 on Guam for a total of 221 in September 2018 (USFWS 2020). The main threat to the Mariana common moorhen currently is loss and degradation of wetland habitat, including filling, alteration of hydrology, invasion of habitat by nonnative plants, and unrestricted grazing. The second greatest threat to the species is predation by introduced species (USFWS 2009). The impacts of disease are not known at this time. Other natural or manmade factors that threaten the species are environmental contaminants and fires. Overutilization may have been a threat in the past in the form of hunting as the Mariana common moorhen was historically used as a food item by the local Chamorro people. Although hunting of the species is not currently allowed, poaching may be a problem (USFWS 1991). The inadequacy of existing regulatory mechanisms is not known to be a concern at this time.

EB/CE Source:

U.S. Fish and Wildlife (USFWS). 2020. Mariana common moorhen (*Gallinula chloropus guami*) 5-Year Review. Honolulu, Hawaii. 9 pp.

U.S. Fish and Wildlife (USFWS). 2009. Mariana common moorhen (*Gallinula chloropus guami*) 5-Year Review. Honolulu, Hawaii. 15 pp.

U.S. Fish and Wildlife (USFWS). 1991. Mariana common moorhen (*Gallinula choropus guami*). Portland, Oregon. 55 pp.

Species: Micronesian megapode

Status: Endangered

Distribution: Species/Populations neither constrained nor widespread

Number of Populations:12 (USFWS 2016)

Species Trends: Stable/increasing (USFWS 2010, 2016)

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary Micronesian megapode:

The Micronesian megapode once occurred throughout the Mariana archipelago, but was extirpated from Guam, Rota, and possibly Saipan in the 19th and early 20th centuries (USFWS

1998). Remnant populations were believed to persist on Aguiguan, Tinian, and Farallon de Medinilla (FDM), as well as a small, reintroduced population on Saipan (USFWS 1998). Larger numbers were believed to remain on the mostly, uninhabited northern islands of Anatahan, Sarigan, Guguan, Pagan Maug, Alamagan, Asuncion, and possibly Agrihan (USFWS 1998). Micronesian megapodes are generally dependent on native limestone forest but may occasionally use native and non-native secondary forest adjacent to limestone forest. Megapodes primarily select nest sites in sun-warmed cinder fields or areas warmed by geothermal heat, but secondarily will nest in the roots of rotting trees, logs, and in patches of rotting sword grass (USFWS 1998). The Mariana species may be able to fly the 4.6 kilometers (2.9 miles) between Saipan and Tinian, and the 8.9 kilometers (5.5 miles) between Tinian and Aguiguan, but they probably would not normally fly the 30 to 60 kilometers (18 to 37 miles) between adjacent northern islands (USFWS 2020). There were an estimated 1,440 to 1,975 individuals on 11 to 12 islands in the Mariana archipelago in 1998 (USFWS 1998). In 2009 and 2010, the USFWS Pacific Islands Fish and Wildlife Office coordinated surveys in the Commonwealth of the Northern Mariana Islands (Amidon *et al*. 2011, as cited in USFWS 2016). Based on these surveys, the current range-wide population estimate for the Micronesian Megapode is approximately 10,727 individuals (95% CI; 6,682-15,445) with the majority of birds on the islands of Sarigan, Guguan, and Asuncion (Amidon *et al*. 2011; as cited in USFWS 2016). During the surveys, megapodes were counted on Aguiguan, Saipan, Anatahan, Sarigan, Guguan, Alamagan, Pagan, Asuncion, and Maug.

Threats to the species include habitat loss and degradation, overgrazing by feral ungulates (goats, pigs, and cows), predation by introduced species (rats, feral dogs, cats, and pigs, and monitor lizards), the potential for the introduction of the brown treesnake (*Boiga irregularis*), human disturbance, possible competition from introduced Phasianidae (pheasants, quail, and francolins), poaching, stochastic events (volcanism, typhoons, and drought), and more recently, military activities, avian flu, West Nile virus, and climate change (USFWS 1998, 2010, 2020).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 1998. Recovery Plan for the Micronesian Megapode (*Megapodius laperouse laperouse*). Portland, Oregon. 90 pp.

U.S. Fish and Wildlife Service (USFWS). 2016. Micronesian Megapode or Sasangat (*Megapodius laperouse*). 5-Year Review. Short Form Summary. Honolulu, Hawaii. 8 pp.

U.S. Fish and Wildlife Service (USFWS). 2010. Micronesian Megapode or Sasangat (*Megapodius laperouse*). 5-Year Review. Short Form Summary. Honolulu, Hawaii. 12 pp.

U.S. Fish and Wildlife Service (USFWS). 2020. Micronesian Megapode or Sasangat (*Megapodius laperouse*). 5-Year Review. Short Form Summary. Honolulu, Hawaii. 18 pp.

Species: Guam rail

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: 3 (USFWS 2020)

Species Trends: Occurs in captivity and the wild (Rota and Cocos Islands); extirpated on Guam (USFWS 2020)

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary Guam rail:

As noted in the 1990 Recovery Plan, the Guam rail is endemic to the island of Guam and it was formerly distributed island wide (USFWS 1990, 2014). The Guam rail was distributed over much of Guam in all habitats except wetlands, although Jenkins (1979, as cited in USFWS 1990) considered both savanna and mature mixed forest marginal habitat. It is an omnivorous feeder but appears to prefer animal over vegetable food (Jenkins 1979, as cited in USFWS 1990). It is known to eat gastropods, skinks, geckos, insects, and carrion as well as seeds and palm leaves (Jenkins 1979, as cited in USFWS 1990). The Guam rail is a year-round ground nester laying 2-4 eggs with both parents sharing in the construction of a shallow nest of leaves and grass (Jenkins 1979, as cited in USFWS 1990). Incubation is 21 days (Beck 1985, unpublished data, as cited in USFWS 1990) with both sexes sharing in the nesting duties.

The Guam rail currently consists of three populations, one in captivity one experimental population Rota island, and a population on Cocos island established through a Safe Harbor Agreement (USFWS 2020). As of 2019, 116 birds were maintained in captivity by the Guam Department of Agriculture, Division of Aquatic & Wildlife (DAWR). The population on Cocos was estimated at 24 birds in 2018 and the population is actively breeding. Of 16 birds trapped in 2019, 10 were unbanded. The population appears to be stable, but not growing, as estimates in 2015 were 28-30 birds. On Rota, 200 birds were estimated based on call back surveys conducted in 2019, which is an increase over previous estimates, which ranged from 110 birds in 2016 and 2018 to 148 birds in 2015 (Laura Duenas DAWR, pers. comm.; DAWR 2016, 2017, 2018, 2019, 2020; as cited in USFWS 2020). The Guam rail has not yet been reestablished on Guam (USFWS 2020). Because population goals have not been met throughout its range, no new populations on Guam have been established, and the species is still threatened by human disturbance, predation, and other factors (USFWS 2020).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 1990. Native Forest Birds of Guam and Rota of the Commonwealth of the Northern Mariana Islands Recovery Plan. Portland, OR. 86 pp.

U.S. Fish and Wildlife Service (USFWS). 2014. Guam Rail; Ko'ko' (*Gallirallus owstoni*). 5-year review. Honolulu, Hawaii. 6 pp.

U.S. Fish and Wildlife Service (USFWS). 2020. Guam Rail; Ko'ko' (*Gallirallus owstoni*). 5-year review. Honolulu, Hawaii. 7 pp.

Species: Guam Micronesian Kingfisher

Status: Endangered

Distribution: Only in captivity; recovery strategy includes releasing birds back into the wild (USFWS 2014)

Number of Populations: extirpated in the wild and now only found in captivity (USFWS 2019)

Species Trends: Only in captivity (USFW 2014).

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary Guam kingfisher:

The Guam Micronesian kingfisher or sihek (*Halcyon cinnamomina cinnamomina*) was listed as an endangered subspecies in 1984 (USFWS 2008). By 1988 the sihek had been extirpated from the wild, and this subspecies is now found only in captivity. Between 1984 and 1986, 29 sihek were translocated to several zoological institutions in the mainland United States to begin a captive propagation program (USFWS 2020). By 1990, the captive population reached 61 individuals and hovered around this number of individuals until 2003 ($\lambda = 1.00$) due to high mortality and poor reproductive success. By 2014, the captive population reached the maximum population size of 157, more than doubling in size (mean $\lambda = 1.055$). Since 2014, space available has been limited resulting in a managed population decline of 3.4% and population growth rate of 0.976 (Newland and Ferrie 2020, as cited in USFWS 2020). There are currently 135 sihek in captivity distributed across 25 institutions (24 Association of Zoos and Aquariums accredited institutions in the mainland United States and a breeding facility on Guam) (Newland and Ferrie 2020, as cited in USFWS 2020).

Prior to its extirpation from the wild, the sihek was found only on the island of Guam. This kingfisher utilized a wide variety of habitats on the island including limestone forest, strand forest, ravine forest, agricultural forest, secondary forest, edge habitats, and forest openings (USFWS 2008). However, mature forests with appropriate nest sites may be an important component of sihek reproductive activities (USFWS 2008). The sihek is a cavity nester and apparently requires large, standing dead trees (nest trees were reported as averaging 43 cm in diameter) in which to excavate nests (Marshall 1989, as cited in USFWS 2008). Diverse vegetative structure providing a variety of both invertebrate and vertebrate prey, as well as exposed perches and areas of open ground for foraging, are also important components of suitable habitat. Habitat degradation and loss, human persecution, contaminants, and introduced species such as disease organisms, cats (*Felis catus*), rats (*Rattus* spp.), black drongos (*Dicrurus macrocercus*), monitor lizards (*Varanus indicus*), and brown treesnakes (*Boiga irregularis*) have all been suggested as factors in the population decline of this species (USFWS 2008). However, predation by the brown treesnake is believed to have been the overriding factor in the extirpation of sihek. Factors that continue to prevent the recovery of the sihek include poor reproductive success and high mortality in the captive population and the continued high density of brown treesnakes on Guam. Habitat loss and degradation were not considered a major threat due to the availability of suitable forest on Guam. However, this threat is increasing and may limit recovery as the island of Guam becomes further developed and additional forested areas are cleared or modified and feral ungulate populations remain high (USFWS 2008).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2008. Final Revised Recovery Plan for the Sihek or Guam Micronesian Kingfisher (*Halcyon cinnamomina cinnamomina*). Portland, Oregon. x + 117 pp.

U.S. Fish and Wildlife Service (USFWS). 2014. *Halcyon cinnamomina cinnamomina* (Sihek, Guam Micronesian kingfisher). 5-Year Review. Short Form Summary. Honolulu, Hawaii. 7 pp.

U.S. Fish and Wildlife Service (USFWS). 2020. *Halcyon cinnamomina cinnamomina* (Sihek, Guam Micronesian kingfisher). 5-Year Review. Short Form Summary. Honolulu, Hawaii. 6 pp

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Species: Rota bridled-eye

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: Single population (USFWS 2014)

Species Trends: Stable (USFWS 2014)

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary Rota bridled white-eye:

Among the factors believed to threaten the Rota bridled white-eye or nosa luta are: habitat loss or degradation (factor A); predation by introduced rats, black drongos, and other predators (factor C); the accidental introduction of new predators, such as brown treesnakes (factor C); avian disease (factor C); pesticides (factor E); and random catastrophic events, such as typhoons, which may affect the core range of the species and lead to its extinction (factor E) (USFWS 2007). Of these factors, habitat loss and degradation and predation by introduced species are currently believed to be the primary factors in the population decline and core range restriction of the nosa luta. Overutilization of nosa luta for commercial, recreational, scientific, or education purposes (factor B) is not known to be a threat, and existing regulatory mechanisms (factor D) appear adequate (USFWS, 2007 Final Recovery Plan, p. 25). Between 1982 and 2012, 12 point-transect distance sampling surveys were conducted to assess population status of avian species on Rota (Camp et al. 2014, as cited in USFWS 2020). The white-eye population declined and increased over the 30-year period, yielding weak evidence for increasing or decreasing trends, and moderate evidence for a stable, long-term trend. Population point estimates for 1982 and 2012 were similar (14,963 and 14,384, respectively), but the level of precision for both estimates was low (95% CI 8,741-18,487 and 5,620-20,961, respectively) suggesting more research is needed to understand the status of this population and whether it remains a conservation concern (USFWS 2020). There has been little progress toward determining threats to the species, and research is still needed to determine what factors are contributing to apparent fluctuations in population abundance. Insufficient data exists for assessing the following threats: predation by introduced rates, black drongos, and other predators; avian disease; and pesticides. Based on these results, Rota white-eye still warrants listing as endangered. Occupancy models and current distribution patterns indicated that Rota white-eyes are restricted to a small area of forest (approximately 300 hectares [741 acres]) at elevations above 150 meters (492 feet) (Zarones et al. 2013; Camp et al. 2014; as cited in USFWS 2020). Zarones et al. (2013) documented greater abundance of Rota white-eyes in wetter forests with more dense foliage and higher stem density. Some studies suggest that changes in the distribution of the Rota white-eye may be due to a decrease in suitable habitat as a result of changes in forest structure (Amidon 2000; Zarones et al. 2013; as cited in USFWS 2020).

EB/CE Sources:

U. S. Fish and Wildlife Service (USFWS). 2007. Recovery Plan for the Nosa Luta or Rota Bridled White-Eye (*Zosterops rotensis*). Portland, Oregon. 139 pp.

Overall Vulnerability Nightingale Reed Warbler: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability Mariana swiftlet: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability Mariana (aga) crow: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability Mariana common moorhen: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability Micronesian megapode: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability Guam rail: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability Guam kingfisher: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability Rota bridled white-eye: ☒ **High** ☐ **Medium** ☐ **Low**

RISK

(Risk is based on species exposure and response from labelled uses across the range)

Risk to individuals if exposed:

Effects to Northern Marianas islands birds from use sites:

All species could experience some degree of mortality or sublethal effects on use sites. Exposure to malathion from consuming dietary items exposed to spray drift only is not expected to cause effects to these birds.

- The two small-bodied obligate insectivores, the Rota bridled white-eye and Mariana swiftlet, are expected to experience mortality on all use sites from consumption of contaminated insects or from exposure via direct spray or contact with contaminated media.
- Approximately 30-90% of nightingale reed-warblers exposed on malathion use sites could experience mortality or sublethal effects from consumption of contaminated insects, and a smaller proportion (12%) from exposure to direct spray of contact with contaminated media.
- The Mariana common moorhen is not expected to experience mortality or sublethal effects from the consumption of aquatic dietary items, but may experience mortality or sublethal effects if grass, leaves, or terrestrial invertebrates are consumed on use sites with higher application rates (e.g., orchards and vineyards, developed, open space developed, vegetables, and ground fruit).
- The Guam rail and kingfisher could experience mortality or sublethal effects from consumption of terrestrial invertebrates on use sites with higher allowable application rates (e.g., orchards and vineyards, developed, open space developed, vegetables, and ground fruit), and has a lower chance of effects on other use sites.
- The Mariana crow is only expected to experience mortality or sublethal effects from exposure to contaminated food items on use sites with higher allowable application rates (i.e., orchards and vineyards, developed, open space developed, vegetables and ground fruit).

Effects to Northern Marianas islands birds from mosquito control:

- Rota bridled white-eyes and Mariana swiftlets have a low chance of mortality (<10%) if exposed to malathion as a result of mosquito control, if applied.
- No effects are expected to other Mariana Island bird species from this use.

Risk to the species from labelled uses across the range:

DIRECT (all uses except mosquito adulticide)	
Use areas – mortality and sublethal effects	The Mariana moorhen and the Rota bridled white-eye are unlikely to forage in malathion use sites and as such mortality and sublethal effects are not expected. A small proportion of Mariana swiftlets, nightingale reed-warblers, Guam rails, and Mariana crows could experience mortality or sublethal effects from foraging near malathion use sites. Guam kingfishers currently exist in captivity, but a small proportion could experience sublethal effects or mortality if released in the wild near agricultural or developed areas.
Spray drift areas – mortality	None

INDIRECT (all uses except mosquito adulticide)	
Use areas - Prey item mortality	Effects to prey are not expected for the Mariana moorhen and the Rota bridled white-eye which are unlikely to forage in malathion use sites. Mortality to prey, especially invertebrates, could occur over a small portion of foraging areas for Mariana swiftlets, nightingale reed-warblers, Guam rails, and Mariana crows from malathion exposure on use sites or via spray drift. Guam kingfishers currently exist in captivity, but a small portion of prey could experience mortality near agricultural or developed release areas.
MOSQUITO ADULTICIDE	
Direct (mortality and sublethal)	Effects to a small portion of individual Rota bridled white-eyes and Mariana swiftlets if exposed. No effects to other Northern Mariana Island birds.
Indirect	Effects to terrestrial invertebrates if exposed.

Risk modifiers:

Nightingale reed warbler - Nightingale reed warblers found on Saipan occur in thicket-meadow mosaics, forest edge, reed marshes, and forest openings, but are largely absent from mature native forest, beach strand, and swordgrass savannah. The population of nightingale reed-warblers on Alamagan inhabits forests with open overstory and brushy understory and wooded edges adjacent to open grassland (USFWS, 1998). Based on this information, reed warblers could have exposure to malathion via edge habitats if use sites were adjacent to their habitat.

Mariana swiftlet – The Mariana swiftlet nests and roosts in caves, often with entrances completely obscured by forest. The swiftlet, feeds by capturing small insects in flight. Forest habitat is preferred for feeding, but also can forage in grassland. Based on this information the swiftlet could have some exposure to malathion when feeding in non-forested habitats near or within use sites.

Rota bridled white-eye – The bridled white-eye is primarily restricted to mature forests above 150 meters (490 feet) in the Sabana region of Rota (USFWS, 2007). Its range is extremely limited, existing in approximately 740 acres of the 21,120-acre island. Based on this information, we do not expect the white-eye to be exposed to malathion on use sites.

Mariana (aga) crow – Mariana crows can utilize a variety of habitats, but only nest in the native limestone forests. The crow is an opportunistic omnivore and known dietary items include lizards, grasshoppers, crickets, praying mantis, earwigs, hermit crabs, foliage, fruits, seeds, and buds. Based on this information the crow could have some exposure to malathion when feeding in non-forested habitats near or within use sites.

Guam kingfisher - At present, the Guam kingfisher exists only in captivity. Historically, the kingfisher favored woodlands and limestone forest areas for feeding and nesting, and occurred island-wide in all habitats, except pure savannah and wetlands. Habitats utilized by the kingfisher were diverse and included limestone forests, coastal lowlands, coconut plantations and large woody gardens. In the wild, the Guam kingfisher was known to feed on grasshoppers, skinks, insects and small crustaceans captured from the ground. While the Guam kingfisher will not be exposed to malathion while in captivity, released individuals could be exposed to malathion if they foraged in agricultural or developed use sites.

Mariana common moorhen - The moorhen is an inhabitant of emergent vegetation of freshwater marshes, ponds and placid rivers. The key characteristics of moorhen habitat appear to be a combination of deep (greater than 60 cm) marshes with robust emergent vegetation and equal areas of cover and open water. Man-made as well as natural wetlands are used, and moorhen have been observed at commercial fishponds, taro patches, rice paddies, sewage treatment plants, and reservoirs (Guam DAWR unpublished data). Although the moorhen favors freshwater areas, it occasionally uses brackish water sites such as tidal channels or mangrove wetlands for limited periods of time (Guam DAWR unpublished report; USFWS, 1991). Based on this information, the moorhen has a low likelihood of exposure to malathion on or near use sites.

Guam rail – The Guam rail formally occurred in most habitat types in Guam, including forest, savanna, secondary grassland, agricultural areas, mown grass bordering scrub communities, mixed woodland and scrub, and fern thickets. Guam rails have been released on Rota and Cocos Islands. On Rota Island, there are approximately 200 rails; on Cocos there are approximately 60-80 rails. Releases back into the wild in Guam are anticipated in the future. The Guam rail is an omnivorous species that forages along field edges and roadsides for snails, slugs, insects, geckos, vegetable matter, seeds and flowers from low grasses and shrubs. Based on this information, the rail could be exposed to malathion if agricultural or developed use sites occur within the rail's current distribution.

The Micronesian megapode is predominately restricted to remote islands in the north of the island chain, most of which is difficult to access, and/or restricted. The only potential malathion use on these remote islands is mosquito adulticide applications; however, the use of adulticides on remote islands is likely rare to nonexistent.

Information relevant to all Northern Mariana Island birds:

Range maps for birds in Guam and the Mariana Islands include the entirety of the islands where these species can be found. Therefore, an overlap analysis of malathion use sites would simply be indicative of the extent of use sites on the islands, and not the true overlap where the species is likely to be found. Thus, exposure is better assessed by the degree to which these species are likely to be within or adjacent to malathion use sites.

For the Marianas, we do not anticipate volatilization to be as great of a source of exposure as it is in Hawai'i due to the lack of a predictable fog layer and trade wind pattern. The distribution of these species on islands near the equator and the associated higher temperatures would cause some volatilization of malathion, although we would expect based on the best information available, that species in high elevations would not be exposed to concentration levels that would affect them (see *General Effects* for further information on volatilization).

The effects to the prey base are anticipated from malathion exposure on or near use sites for some Northern Mariana Island birds. Because species taken as food items exhibit a range of sensitivities to malathion, we expect exposure will reduce the abundance in these areas, but not completely eliminate the prey base in these portions of the range. We anticipated this reduction will be greater on use sites, where estimated environmental concentrations are higher would be anticipated from spray drift. These reductions are likely temporary (based on application frequency) with community recovery over a short period of time.

Overall Risk Nightingale reed warbler:	☐ **High**	☒ **Medium**	☐ **Low**
Overall Risk Mariana swiftlet:	☐ **High**	☒ **Medium**	☐ **Low**
Overall Risk Mariana (aga) crow:	☐ **High**	☒ **Medium**	☐ **Low**
Overall Risk Mariana common moorhen:	☐ **High**	☐ **Medium**	☒ **Low**
Overall Risk Micronesian megapode:	☐ **High**	☐ **Medium**	☒ **Low**
Overall Risk Guam rail:	☐ **High**	☒ **Medium**	☐ **Low**
Overall Risk Guam kingfisher:	☐ **High**	☒ **Medium**	☐ **Low**
Overall Risk Rota bridled white-eye:	☐ **High**	☐ **Medium**	☒ **Low**

USAGE

(Anticipated usage within the range based on past usage data)

Information regarding past usage of malathion is not available for either Guam or the Mariana Islands. Based on survey data collected in Hawaii, we estimate that 4.8% of agricultural crops were treated with insecticides, with malathion being only a subset of this use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the Approach to Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in Guam or the Mariana Islands; future use cannot be ruled out but is not expected to increase significantly.

Overall Usage: ☐ High ☒ Medium ☐ Low

CONSERVATION MEASURES

Rain restriction and aquatic habitat buffers: The Mariana common moorhen are known to rely on aquatic habitat for food resources or is otherwise closely associated with aquatic habitats and may experience effects of malathion through effects to the aquatic system. Label language includes restricting malathion application to periods where rain is not forecasted for at least 48 hours for agriculture and 24 hours for residential or when the soil is not saturated. Rain restrictions (which allow for malathion to degrade before runoff events can occur as malathion has a relatively short half-life and rapid degradation that occurs via hydrolysis and other processes) and aquatic habitat buffers (which specify on the label a distance from water bodies where pesticides are not to be applied) required of all agricultural and residential uses will likely reduce the level of effects impacting these species by substantially reducing the amount of malathion that would reach the habitats in which these species reside. We anticipate that, in many cases, these buffers will significantly reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

Residential use label changes: New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely), reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application.

Reduced application number and rate: New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop, previous allowable number of applications ranged from 3 to 13 applications per year). We anticipate this measure will help reduce the amount of malathion used and decrease potential exposure to the species.

CONCLUSION

After reviewing the current status of the species, the environmental baseline for the Action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of these species. Although all of the species in this group have high vulnerability and medium anticipated usage, their risk of exposure is either moderate or low. In the following paragraphs, we describe our rationales for each of these species.

Guam Micronesian Kingfisher (sihek)

The Guam Micronesian kingfisher is believed to have been extirpated in the wild by 1988 (Wiles et al. 2003, as cited in USFWS 2020) and is now only found in captivity (Bahner and Bier 2007, as cited in USFWS 2020). There are currently 135 Guam Micronesian kingfishers in captivity distributed across 25 institutions (24 Association of Zoos and Aquariums accredited institutions in the mainland United States and a breeding facility on Guam (Newland and Ferrie 2020, as cited in USFWS 2020)). Planning for release of this species from captivity is ongoing (USFWS 2020). As discussed below, even though the Guam Micronesian kingfisher has high vulnerability, we anticipate the likelihood of exposure to malathion to be low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure to malathion when they are released into the wild. Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of this species when released into the wild.

As discussed above, we anticipate the likelihood of exposure to malathion is low. While usage is not expected on all use sites and at the maximum rates allowed by the labels where used each year, we anticipate that some use could occur based on information from a prior survey that estimated 4.8% of agricultural crops were treated with insecticides. The kingfisher utilized a wide variety of habitats on the island of Guam including limestone forest, strand forest, ravine forest, agricultural forest, secondary forest, edge habitats, and forest openings (USFWS 2008). However, mature forests with appropriate nest sites may be an important component of sihek reproductive activities (USFWS 2008). Since the species may rely on mature forest for nesting, it may be less likely to be exposed to malathion from agriculture or developed/open space developed applications, and the forest habitats in which this species occurs are also likely to serve as a buffer to spray drift or runoff from these activities. While we do anticipate that adverse effects to prey items could occur, we do not expect species-level effects, because the kingfisher primarily inhabits forested habitats. Impacts to prey items would only occur along the edges of these forested habitats where they co-occur with malathion use sites. If there are areas where prey items are temporarily lost, birds have the ability to move to unaffected areas to forage.

Additionally, we anticipate that the conservation measures above, including residential use label changes, and reduced numbers and application rates on certain use sites would further reduce the risk of exposure to this species and its prey. The kingfisher relies on forests for foraging and mature forest for nesting but can also be found in edge habitat where residential use restrictions (spot treatments only make offsite spray drift unlikely) and reduced frequency of applications are anticipated to further limit exposure of malathion. In addition, the reduction in number of applications and application rates for certain agricultural crops are expected to further decrease the likelihood of exposure to this species, its prey, and its habitats. Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of the Guam Micronesian kingfisher when it is reintroduced into the wild.

Species with Medium Risk

The Nightingale reed warbler, Mariana gray swiftlet, Mariana (aga) crow, Micronesian megapode, and Guam rail, have high vulnerabilities based on their status, distributions, and trends. All of these birds rely on forests for nesting and foraging, and some species may use other habitats for other purposes as well. The risk to these species posed by the labeled uses across the range is medium or low, with a medium amount of estimated usage within their ranges. While usage is not expected on all use sites at the maximum rates allowed by the label, we anticipate that usage could occur. Moreover, we anticipate the general conservation measures described above are expected to reduce the likelihood of exposure. While we anticipate that very small numbers of individuals for some of these species will be affected over the duration of the proposed Action, we do not expect species-level effects to occur. We describe our assumptions about potential exposure for each species below.

The Micronesian megapode is predominately restricted to remote islands in the Northern Mariana Islands where malathion use sites do not typically occur. We do not expect that the Micronesian megapod would be exposed to malathion, due to the remote areas it inhabit, as described above. While we cannot rule out that individuals of the species could be subjected to mortality or sublethal effects, we expect that the likelihood of exposure is low. Mosquito adulticide application could potentially occur but is unlikely due to the remoteness of the islands the species occurs on. Further, mosquito adulticide applications are likely restricted to areas that have higher human populations, and developed and open spaced developed uses are largely targeted to home gardens and landscape maintenance. Thus, we do not anticipate individuals of this species would be exposed to malathion or experience mortality, effects to growth or reproduction, or impacts to their food base.

Nightingale reed warblers could have exposure to malathion via edge habitats where use sites are adjacent to their habitats, and thus could experience mortality or sublethal effects. The Mariana gray swiftlet feeds on insects and although forest habitat is preferred for feeding, they can also forage in grassland. Based on this information the swiftlet will have some exposure to malathion when feeding in non-forested habitats near or within use sites where mosquito applications occur. However, since this species feeds by capturing small insects in flight, we do not anticipate it would be exposed to malathion via its prey (i.e., through contaminated prey items), as treated insects are likely to die relatively quickly and not be available to swiftlets in the air. We expect that only small numbers of individuals will experience mortality, sublethal effects, or small reductions in prey availability.

The Mariana (aga) crow can utilize a variety of habitats, but only nests in the native limestone forest. They are opportunistic omnivores and known dietary items include lizards, grasshoppers, crickets, praying mantis, earwigs, hermit crabs, foliage, fruits, seeds, and buds. Based on this information, the crow is likely to have some exposure to malathion when feeding in non-forested habitats near or within use sites, but we anticipate forest habitat will likely serve as a buffer for spray drift or runoff from pesticide applications any nearby use sites, and only small numbers of individuals will experience mortality, sublethal effects, or small reductions in prey availability.

The Guam rail is an omnivorous species that forages along field edges and roadsides for snails, slugs, insects, geckos, vegetable matter, seeds and flowers from low grasses and shrubs. Based on this information, the rail could be exposed to malathion if agricultural or developed use sites occur within the rail's current distribution. The rails current distribution includes Cocos Island, just south of Guam and Rota Island. Cocos Island is a small uninhabited island but does have a day resort for Guam residents and visitors. Pesticide use is likely limited, but mosquito applications could occur. Rota is inhabited but does not appear to have much of an agricultural footprint. We expect exposure of individual Guam rails and their food items to occur only at very low levels over the duration of the Action and would likely not result in mortality, sublethal effects, or measurable impacts to their food resources.

For all of the species above, we expect that the likelihood of exposure is low due to the species affinity for their preferred natural habitats, where exposure is generally much less likely to occur. Mosquito adulticide applications are likely restricted to areas that have higher human populations and developed and open-spaced developed uses are largely targeted to home gardens and landscape maintenance where large broadcast treatments are not the norm. In addition, loss of prey resources may occur, but not in areas preferred by these species for foraging. Many of these species primarily occur in forested habitats.

Moreover, we anticipate that the conservation measures above, including rain restrictions (48 hours for agriculture and 24 hours for residential) and aquatic habitat buffers (specify on the label a distance from waterbodies where pesticides are not to be applied), residential use label changes (limits use to spot treatment only, rendering spray drift offsite unlikely), and reduced numbers and application rates on certain use sites would further reduce the risk of exposure to these species and their habitats.

Together, these measures are anticipated to substantially reduce the likelihood of exposure to these species and their habitats. Thus, we anticipate only small numbers of individuals of these species, as described above, will experience mortality, effects to growth and reproduction, and small reductions in the forage base over the duration of the Action. However, we do not anticipate the loss of small numbers of individuals, or the low levels of expected sublethal take and reductions in the forage base would result in species-level effects. While we anticipate that very small numbers of individuals will be affected over the duration of the proposed Action, we do not expect species-level effects to occur.

Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of these species in the wild.

Species with Low Risk

After reviewing the current status of the species, the environmental baseline for the Action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the

Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the Mariana common moorhen and Rota bridled white-eye. As discussed below, even though the vulnerability is high, the risk to these species is low and usage is medium ,and the general conservation measures described above are expected to further reduce the likelihood of exposure to malathion. We do not anticipate the Action will result in species-level effects.

The Mariana common moorhen and Rota bridled white-eye have high vulnerability based on their estimated status, distributions, and trends. The risk to these species posed by the labeled uses across the range is low, and there is a medium amount of estimated usage within the range of this species. While usage is not expected on all use sites and at the maximum rates allowed by the labels where used each year, we anticipate that some use could occur based on based on information from a prior survey that estimated 4.8% of agricultural crops were treated with insecticides, but we do not expect that the Mariana moorhen and Rota bridled white eye, would be exposed to malathion, due to the areas they inhabit, as described above.

We expect that the likelihood of exposure is low due to the species affinity for their preferred natural habitats, where exposure is generally much less likely to occur. Mosquito adulticide applications are likely restricted to areas that have higher human populations and developed and open-spaced developed areas. In addition, loss of prey resources will likely occur, but not in areas that we anticipate are preferred by these species for foraging

Additionally, we anticipate that the conservation measures above, including rain restrictions and aquatic habitat buffers, residential use label changes, and reduced numbers and application rates on certain use sites would further reduce the risk of exposure to these species and their prey. Since the Mariana common moorhen uses natural and artificial freshwater and occasionally brackish water bodies and the Rota bridled white-eye uses forest, the rain restrictions are anticipated to reduce the likelihood of exposure to these species (directly or in runoff) following a precipitation event. We anticipate that the aquatic habitat buffers will reduce the likelihood of spray drift exposure to aquatic organisms and waterbodies which waterbirds like the Mariana common moorhen resides. The residential restrictions and the reduction of number of applications and application rates for certain crops reduces the amount of malathion used and further limits the exposure to both species, their prey, and their habitats.

Together, these measures are anticipated to substantially reduce the likelihood of exposure to these species and their habitat. Thus, we anticipate only small numbers of individuals of these species will experience mortality, effects to growthand reproduction, and small reductions in the forage base for the species over the duration of the Action. However, we do not anticipate the loss of small numbers of individuals, or the low levels of expected sublethal take and reductions in the forage base would result in species-level effects.

Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of these two species in the wild.

Conclusion Nightingale reed warbler: Not likely to jeopardize

Conclusion Mariana gray swiftlet:	**Not likely to jeopardize**
Conclusion Mariana (aga) crow:	**Not likely to jeopardize**
Conclusion Mariana common moorhen:	**Not likely to jeopardize**
Conclusion Micronesian megapode:	**Not likely to jeopardize**
Conclusion Guam rail:	**Not likely to jeopardize**
Conclusion Guam kingfisher:	**Not likely to jeopardize**
Conclusion Rota bridled white-eye:	**Not likely to jeopardize**

***REFERENCES*:**

U.S. Fish and Wildlife (USFWS). 1991. Mariana common moorhen (*Gallinula choropus guami*). Portland, Oregon. 55 pp.

U. S. Fish and Wildlife Service (USFWS). 2007. Recovery Plan for the Nosa Luta or Rota Bridled White-Eye (*Zosterops rotensis*). Portland, Oregon. 139 pp.

U.S. Fish and Wildlife Service (USFWS). 2008. Final Revised Recovery Plan for the Sihek or Guam Micronesian Kingfisher (*Halcyon cinnamomina cinnamomina*). Portland, Oregon. x + 117 pp.

U.S. Fish and Wildlife Service (USFWS). 2020. *Halcyon cinnamomina cinnamomina* (Sihek, Guam Micronesian kingfisher). 5-Year Review. Short Form Summary. Honolulu, Hawaii. 6 pp

American Samoa Birds

In American Samoa and Samoa, current levels of pesticide use are likely lower than several decades ago when their use, particularly during the years in which taro was grown on large scales for export (1975-1985), coincided with the decline of bats in both places and has been implicated as the cause (Tarburton 2002, p. 107; USFWS 2016).

Integration and Synthesis Summary: American Samoa

Scientific Name:	Common Name:	Entity ID:
Gallicolumba stairi	Friendly ground dove	5170

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

The American Samoa DPS for the friendly ground-dove is threatened by predation, habitat loss, and stochastic events due to small population size, such as hurricanes (USFWS 2015).

Species: *Gallicolumba stairi*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: Single population in American Samoa, <100 individuals (2015) (USFWS 2016, 2019)

Species Trends: Unknown population trends (USFWS 2016)

Habitat: Forest (lowland and montane) (USFWS 2019)

Pesticides noted ☐

Environmental Baseline/Cumulative Effects Summary:

In American Sāmoa, the friendly ground-dove is reported to occur primarily in shaded forests or thickets on or near steep, forested slopes, sometimes with an open understory and fine scree or exposed soil (Kayano et al. 2019, p. 19; Tulafono 2006, in litt., entire; as cited in USFWS 2021). They utilize littoral forest and scrub, lowland rainforest, and agroforest and have been observed foraging in forested areas disturbed by human activity (Pyle et al. 2018, p. 18; Kayano et al. 2019, p. 19; as cited in USFWS 2021). Outside American Sāmoa, the species is known to inhabit brushy vegetation or native forest on offshore islands, native forest on limestone (Tonga), and forest habitats on large, high islands (Steadman and Freifeld 1998, p. 617; Clunie 1999, pp. 42–43; Freifeld et al. 2001, p. 79; Watling 2001, p. 118; as cited in USFWS 2021). The friendly ground-dove forages on the ground and in the forest understory on seeds, fruit, buds, snails, and insects (Clunie 1999, p. 42; Craig 2009, p. 125; as cited in USFWS 2021). Amerson et al. (1982a, p. 69; as cited in USFWS 2021) reports observing the species foraging on fallen fruits from a Macaranga harveyana tree. The friendly ground-dove typically builds a nest of twigs several feet from the ground or in a tree fern crown and lays one or two white eggs (Clunie 1999, p. 43; as cited in USFWS 2016).

The friendly ground-dove is uncommon or rare throughout its range in Fiji, Tonga, Wallis and Futuna, Samoa, and American Samoa (Steadman and Freifeld 1998, p. 626; Schuster et al. 1999, pp. 13, 70; Freifeld et al. 2001, pp. 78–79; Watling 2001, p. 118; Steadman 1997, pp. 745, 747; as cited in USFWS 2016), except for on some small islands in Fiji (Watling 2001, p. 118; as cited in USFWS 2016). The status of the species as a whole is not monitored closely throughout its range, but based on available information, the friendly ground-dove persists in very small numbers in Samoa (Schuster et al. 1999, pp. 13, 70; Freifeld et al. 2001, pp. 78– 79; as cited in USFWS 2016) and is considered to be among the most endangered of native Samoan bird species (Watling 2001, p. 118; as cited in USFWS 2016). In Tonga, the species occurs primarily on small, uninhabited islands and in one small area of a larger island (Steadman and Freifeld 1998, pp. 617–618; Watling 2001, p. 118; as cited in USFWS 2016). In Fiji, the friendly ground-dove is thought to be widely distributed but uncommon on large islands and relatively common on some small islands (Watling 2001, p. 118 as cited in USFWS 2016). Birdlife International (2016, entire; as cited by USFWS 2021) estimated that total population size for the species was between 2,500 and 9,999 individuals. Kayano et al. (2019, p. 21; as cited in USFWS 2921) gave a preliminary population estimate of 249 individuals for the American Sāmoa DPS of the species in 2018; with more birds estimated for Ofu then Olosega, 145 and 104 individuals, respectively. The habitat of the American Sāmoa DPS of the friendly ground-dove remains degraded and destroyed by past land-clearing for agriculture, and hurricanes exacerbate the poor status of this habitat, a threat that is likely to continue in the future and worsen under the projected effects of climate change (USFWS 2021). The threat of predation by nonnative mammals such as rats and cats are a current threat and likely to continue in the future (USFWS 2021). The DPS of the friendly ground-dove persists in low numbers of individuals and in few and disjunct populations on two small islands, a threat that interacts synergistically with other threats (USFWS 2021).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2016. 81 FR 65465 65508, Endangered Status for Five Species from American Samoa; Final Rule, September 22, 2016.

U.S. Fish and Wildlife Service (USFWS). 2021. Friendly Ground-Dove (*Gallicolumba stairi*). 5-year review. Honolulu, Hawaii. 27 pp.

Overall Vulnerability Friendly ground dove: ☒ High ☐ Medium ☐ Low

RISK

(Risk is based on species exposure and response from labelled uses across the range)

Risk to individuals if exposed:

Effects to friendly ground-doves from use sites:

The friendly ground-dove is expected to experience mortality or sublethal effects if consuming food items such as terrestrial invertebrates or leaves on use sites with higher allowable application rates (i.e., developed, developed open space, orchards and vineyards, and vegetables and ground fruit). Ground doves have a smaller chance of effects (~10-20%) from exposure on other use sites, such as pasture. Consumption of food items exposed via spray drift is not expected to result in effects.

Effects to friendly ground-doves from mosquito control:

The friendly ground-dove is not expected to experience mortality or sublethal effects if exposed to malathion from mosquito control, if applied.

Risk to the species from labelled uses across the range:

DIRECT (all uses except mosquito adulticide)	
Use areas – mortality and sublethal effects	Friendly ground-doves are not generally expected to enter malathion use sites, but it is possible that one or more friendly ground-doves could experience mortality or sublethal effects from foraging on or near malathion use sites.
Spray drift areas – mortality	No effects expected
INDIRECT (all uses except mosquito adulticide)	
Use areas - Prey item mortality	No effects are expected to prey species in forests, which represent the typical habitat for friendly ground-doves. Effects to terrestrial invertebrates could occur in adjacent areas.
MOSQUITO ADULTICIDE	
Direct (mortality and sublethal)	No effects expected
Indirect	Effects to terrestrial invertebrates if exposed

Risk modifiers: This species is widespread, but localized across islands of the southern Pacific, with the American Samoa population representing the easternmost distribution of the species. The friendly ground dove feeds on seeds, fruit, buds, snails, and insects (Clunie 1999, p. 42; Craig 2009, p. 125, USFWS, 2016). In American Samoa, the friendly ground-dove is typically found on or near steep, forested slopes, particularly those with an open understory and fine scree or exposed soil (Tulafono 2006, in litt.). Several thousand years of subsistence agriculture and more recent, larger-scale agriculture have resulted in the alteration and great reduction in area of forests at lower elevations in American Samoa (Friendly ground dove SOS). On Ofu, the coastal forest where the ground-dove has been recorded, and which may be the preferred habitat for this species range-wide (Watling 2001, p. 118), largely has been converted to villages, grasslands, or coconut plantations (Whistler 1994, p. 127; USFWS 2016). These conversions have likely pushed this species into more disturbed areas or forested habitat at higher elevations.

The conversion of ground-dove habitat to agricultural and developed areas suggests use sites where malathion could potentially be applied. While there is some indication that conversion to these areas has pushed the species from forests to more disturbed areas, habitat descriptions indicate that ground-doves tend to frequent forests, increasingly at higher elevations. Because of this, exposure of friendly ground-doves to malathion is anticipated to be low, though possible.

The range map for the friend ground-dove includes the entirety of the islands where these species can be found. Therefore, an overlap analysis of malathion use sites would simply be indicative of the extent of use sites on the islands, and not the true overlap where the species is likely to be found. Thus, exposure is better assessed by the degree to which this species is likely to be within or adjacent to malathion use sites.

The effects to the invertebrate prey base are anticipated from malathion exposure on or near use sites, or from mosquito control applications. Because invertebrates exhibit a range of sensitivities to malathion, we expect exposure will reduce the abundance in these areas, but not completely eliminate the prey base in these portions of the range. We anticipate this reduction will be greater on use sites, where estimated environmental concentrations are higher than would be anticipated from spray drift. These reductions are likely temporary (based on application frequency) with community recovery over a short period of time.

Overall Risk Friendly ground dove: ☐ High ☒ Medium ☐ Low

USAGE

(Anticipated usage within the range based on past usage data)

Information regarding past usage of malathion in American Samoa is not available, however prior survey data has indicated that 0.9% of agricultural crops were treated with insecticides, with malathion only being a subset of this, assuming its use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the Approach to Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in American Samoa; future use cannot be ruled out but is not expected to increase significantly.

Overall Usage Friendly ground dove: ☐ High ☐ Medium ☒ Low

CONSERVATION MEASURES

Residential use label changes: New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely), reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application.

Reduced application number and rate: New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop, previous allowable number of applications ranged from 3 to 13 applications per year). We anticipate this measure will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

CONCLUSION

After reviewing the current status of the species, the environmental baseline for the Action area, and the effects of the proposed registration of malathion, as proposed, is not likely to jeopardize the continued existence of the friendly ground dove. As discussed below, even though the vulnerability is high, the risk is medium, and we anticipate the likelihood of exposure to malathion is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure to malathion. We do not anticipate the Action will result in species-level effects.

Although the friendly ground dove has high vulnerability, and there is a potential of medium overall usage of malathion, this species has low risk of exposure as habitat descriptions indicate that ground-doves tend to frequent forests at increasingly higher elevations. Because of this and as prior survey data indicated that only 0.9% of agricultural crops are treated with insecticides, exposure to malathion is expected to be low. In addition, spray drift that enters the species habitat from adjacent uses is not expected to be at concentrations that would directly cause mortality, effects to growth or reproduction or reductions in food resources. Although we expect insect prey will be reduced as ar result of spray drift should it enter the species habitat, effects to terrestrial invertebrates within the forested habitat is expected to be low, even if applied adjacent to use sites.

Additionally, we anticipate that the conservation measures above, including residential use label changes, and reduced numbers and application rates on certain use sites would further reduce the risk of exposure to this species. Since the species utilizes littoral forest and scrub, lowland rainforest, and agroforest and have been observed foraging in forested areas disturbed by human activity, the residential restrictions are anticipated to reduce the likelihood of exposure to the ground dove (directly and in runoff). We anticipate that the reduction in number or applications and application rates for certain crops will help to reduce the amount of malathion used and decrease the exposure to the species and its habitat. Together, these measures are anticipated to substantially reduce the likelihood of exposure individuals of this species and their habitat. Thus, we anticipate only small numbers of individuals of this species will experience mortality, effects to growth and reproduction, and small reductions in the forage base over the duration of the Action. However, we do not anticipate the loss of small numbers of individuals, or the low levels of expected sublethal take and reductions in the forage base would result in species-level effects.

Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of the friendly ground dove in the wild.

Conclusion Friendly ground dove: **Not likely to jeopardize**

***ADDITIONAL REFERENCES*:**

U.S. Fish and Wildlife Service (USFWS). 81 FR 65465 65508, Endangered Status for Five Species from American Samoa; Final Rule, September 22, 2016.

U.S. Fish and Wildlife Service (USFWS). 2019. Recovery outline for American Samoa species. Honolulu, Hawaii. 21 pp.

U.S. Fish and Wildlife Service (USFWS). 2021. Friendly ground dove (*Gallicolumba stairi*). 5-Year Review. Honolulu, Hawaii. 27 pp.

Integration and Synthesis Summary: Pacific Islands Mammals

Scientific Name	Common Name	Entity ID
Emballonura semicaudata rotensis	Pacific sheath-tailed bat	8166
Emballonura semicaudata semicaudata	Pacific sheath-tailed bat	4564
Lasiurus cinereus semotus	Hawaiian Hoary Bat	15
Pteropus mariannus mariannus	Mariana fruit Bat (=Mariana flying fox)	8962

VULNERABILITY: Pacific sheath-tailed bats

(Summary of status, environmental baseline and cumulative effects)

The Pacific sheath-tailed bats are a small bat (forearm length about 45 millimeters (1.8 inches), weight 5.5 grams (0.19 ounces) and is a member of the Emballonuridae, an Old-World bat family that has an extensive distribution primarily in the tropics (Nowak 1994). The Pacific sheath-tailed bat was once common and widespread in Polynesia and Micronesia and is the only insectivorous bat recorded from a large part of this area (Hutson et al. 2001). The species as a whole (*Emballonura semicaudata*) occurred on several of the Caroline Islands (Palau, Chuuk, and Pohnpei), Samoa (Independent and American), the Mariana Islands (Guam and the CNMI), Tonga, Fiji, and Vanuatu (Flannery 1995; Koopman 1997; Helgen and Flannery 2002). While populations appear to be healthy in some locations, mainly in the Caroline Islands, they have declined drastically in other areas, including Independent and American Samoa, the Mariana Islands, and Fiji (Bruner and Pratt 1979; Grant et al. 1994; Wiles et al. 1997; Wiles and Worthington 2002) (USFWS 2013).

Species: Pacific sheath-tailed bat, *Emballonura semicaudata rotensis*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: Single population. 359 Individuals (USFWS 2020)

Species Trends: Declining population

Habitat: Forest and cave (USFWS 2020)

Pesticides noted ☒

Environmental Baseline/Cumulative Effects Summary *Emballonura semicaudata rotensis*:

The Pacific sheath-tailed bat appears to be extirpated from all but one island in the Mariana Archipelago (Hutson et al. 2001; Wiles and Worthington 2002; as cited in USFWS 2013). The single remaining population of this subspecies occurs on Aguiguan, CNMI. Aguiguan is currently uninhabited and is the smallest of the southern islands of the CNMI, only 3 miles (mi)

(5 kilometers (km)) long, .9 mi (1.5 km) wide, and 1,730 acres (7 km) in area 2 (Engbring et al. 1986, as cited in USFWS 2013).

Fecal pellets collected from two caves on Aguiguan show a diverse array of prey items, but mostly consisting of small-sized prey, with hymenopterans (ants, wasps, and bees), lepidopterans (moths), and coleopterans (beetles) being the three major food items in the diet of bats from both roosts (OShea and Valdez 2009, p. 4; as cited in USFWS 2013). Analysis of presence-absence of foraging bats from echolocation stations deployed across Aguiguan indicate that peak activity and occurrence is related to canopy cover, vegetation structure, and distance to known roosts, and native limestone forest is preferred foraging habitat (OShea and Valdez 2009, p. 4; as cited in USFWS 2013).

Analysis of presence-absence of foraging bats from echolocation stations deployed across Aguiguan indicate that peak activity and occurrence is related to canopy cover, vegetation structure, and distance to known roosts, and native limestone forest is preferred foraging habitat (OShea and Valdez 2009, p. 4; as cited in USFWS 2013).

The population on Aguiguan appears to prefer relatively large caves (Guam Division of Aquatic and Wildlife Resources (GDAWR) 1995; as cited in USFWS 2013). Large roosting colonies appear to be common for the Palau subspecies, but smaller aggregations may be more typical of at least the Mariana Island subspecies and perhaps other Emballonura (Nowak 1994; Flannery 1995; Wiles et al. 1997; Wiles and Worthington 2002; as cited in USFWS 2013). The Pacific sheath-tailed bat is nocturnal and typically emerges around dusk to forage on insects (Hutson et al. 2001; as cited in USFWS 2013). In 1995, roosting bats on Aguiguan were detected in 5 of 77 caves surveyed (Wiles 2007, pers. comm. ; as cited in USFWS 2013), with colony sizes ranging from 2 to 64 individuals. Observations at that time indicated that the bats preferred large caves, as nearly all of the caves used for roosting were characterized as large by the researchers (Wiles and Worthington 2002; as cited in USFWS 2013). Recent work supports that this bat prefers larger caves (OShea and Valdez 2009, p. 4; as cited in USFWS 2013). A survey of habitat use by Pacific sheath-tailed bats on Aguiguan in 2003 revealed that bats foraged almost entirely in forests (native and non-native) near their roosting caves and clearly did not utilize the non-forested habitats on the island (Esselstyn et al. 2004; as cited in USFWS 2013). Bruner and Pratt (1979; as cited in USFWS 2013) also observed sheath-tailed bats foraging in native forests on Pohnpei.

The Pacific sheath-tailed bat population on Aguiguan has not been adequately monitored to date due to the relative inaccessibility of the island. It is an uninhabited island, only accessible by helicopter or boat, and boat access is treacherous because there are no safe landings. Surveys in 1995 indicated a population of roughly 150 to 250 bats (Wiles and Worthington 2002; as cited in USFWS 2013), while 2003 surveys indicated a population of about 400 to 500 bats, but it was unclear if this difference reflected a population increase (Wiles 2007, pers. comm; as cited in USFWS 2013.). When the Mariana subspecies was listed in 2015 as Endangered, there were estimated 359 to 466 individuals from several roosting colonies (Wiles and Worthington 2002, p. 15; Wiles 2007, pers. comm.; O’Shea and Valdez 2009, pp. 2–3; Wiles et al. 2011, p. 299; Oyler-McCance et al. 2013, p. 1,030; as cited in USFWS 2020).

A limited survey for the presence of these bats on Tinian was also conducted. The assessment report summarizes previously unpublished results on numbers of Pacific sheath-tailed bats roosting in caves on Aguiguan in 1995 and 2003 and compares past results with findings from new surveys conducted in 2008 (OShea and Valdez 2009, p. 3; as cited in USFWS 2013). The results of this assessment indicate a small population of Pacific sheath-tailed bat persists on Aguiguan, with a range of 359-466 individuals counted at 5 of 41 caves (OShea and Valdez 2009, p. 3; as cited in USFWS 2013). Comparison with past counts suggests that the population has increased over the past 13 years (OShea and Valdez 2009, p. 3; as cited in USFWS 2013).

The forested habitats needed for foraging by the Pacific sheath-tailed bat on Aguiguan were reduced in the past for agricultural purposes and are currently being degraded by the activities of feral goats (*Capra hircus*) on the island (Engbring et al. 1986; Wiles and Worthington 2002; Esselstyn et al. 2004; as cited in USFWS 2013). The native forests on the plateaus of the island of Aguiguan were cleared in the 1930s for agriculture by the Japanese and the abandoned fields are overgrown with weeds (Engbring et al. 1986). A large number of feral goats still currently inhabit the island; in fact, the local name for the island is Goat Island. Continued grazing by feral goats poses a serious threat to the foraging habitat of the Pacific sheath-tailed bat (Wiles and Worthington 2002; Esselstyn et al. 2004; as cited in USFWS 2013). The CNMI Division of Fish and Wildlife (DFW), considers habitat loss due to feral goat grazing to be the biggest threat to the bat on Aguiguan (Williams 2005, pers. comm.; as cited in USFWS 2013)

It is not believed that intentional take is a threat to the Pacific sheath-tailed bat, but they may be threatened by human recreational use of caves (Wiles and Worthington 2002; as cited in USFWS 2013). Roost disturbance is a well-known problem for many cave-dwelling species (Palmeirim et al. 2005; as cited in USFWS 2013). Disturbance at caves may cause bats to leave for alternate roost sites, in turn, increasing their risk of predation and decreasing their roost time, the latter which could increase stress.

This subspecies has been extirpated from at least four (Guam, Rota, Tinian, Saipan), and possibly six (including Anatahan and Maug), islands of the Mariana archipelago, and the remaining isolated population occurs on only one small island.

Current threats to this subspecies include habitat loss and degradation, predation by introduced species, vulnerability due to small population size and significantly reduced distribution, and possible disturbance to roosting caves (Grant et al. 1994; Hutson et al. 2001; Wiles and Worthington 2002; Esselstyn et al. 2004; as cited in USFWS 2013).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2013. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form. Pacific Region. 12 pp.

U.S. Fish and Wildlife Service (USFWS). 2020. Pacific Sheath-Tailed Bat (*Emballonura semicaudata rotensis*). 5-Year Review. Honolulu, Hawaii. 13 pp.

Species: Pacific sheath-tailed bat, *Emballonura semicaudata semicaudata*

Status: Endangered

Distribution: Unknown

Number of Populations: Extirpated in American Samoa and declining throughout the remainder of its range outside U.S. boundaries.

Species Trends: Extirpated in American Samoa and declining throughout the remainder of its range outside U.S. boundaries.

Pesticides noted ☐

Environmental Baseline/Cumulative Effects Summary *Emballonura semicaudata semicaudata*:

This small bat, forearm length about 45 millimeters (1.8 inches), weight 5.5 grams (0.19 ounces), is a member of the Emballonuridae, an Old-World bat family that has an extensive distribution primarily in the tropics (Nowak 1994, as cited in USFWS 2019). The Pacific sheath-tailed bat was once common and widespread in Polynesia and Micronesia and is the only insectivorous bat recorded from a large part of this area (Hutson et al. 2001, as cited in USFWS 2019).

The endangered Pacific sheath-tailed bat is extirpated in American Samoa and declining throughout the remainder of their range outside U.S. boundaries. This species was last detected in American Sāmoa within the cave at Anapeapea Cove on the north shore of Tutuila in 1998 (Hutson et al. 2001, p. 138; as cited in USFWS 2021). Recent surveys in American Sāmoa have failed to detect the Pacific sheath-tailed bat (DMWR 2006, p. 54; Fraser et al. 2009, p. 9; Uyehara and Wiles 2009, p. 5; Tulafono 2011, in litt., entire; DMWR 2013, in litt., entire; Miles 2015, in litt., entire; as cited in USFWS 2021). Systematic surveys are needed to assess the current distribution of these species and their habitat requirements, so recovery areas can be expanded beyond current and historical distributions. Modeling based on species requirements and known distributions will assist in selecting additional areas needed for recovery. Models incorporating climate change projections need to be developed to map potential future distributions. The National Park of American Samoa (NPSA) was established to preserve and protect the tropical forest and archaeological and cultural resources, to maintain Pacific sheath-tailed bat habitat, to preserve the ecological balance of the Samoan tropical forest, and, consistent with the preservation of these resources, to provide for the enjoyment of the unique resources of the Samoan tropical forest by visitors from around the world (Public Law 100-571, Public Law 100-336). Under a 50-year lease agreement between local villages, the American Samoa Government, and the Federal Government, approximately 8,000 acres (ac) (3,240 hectares (ha)) of forested habitat on the islands of Tutuila, Tau, and Ofu are protected and managed, including suitable habitat for the five species (NPSA Lease Agreement 1993, as cited in USFWS 2019).

Threat to the species include deforestation (agriculture and urban development), goats, flooding, climate change, and predation by rats (USFWS 2019).

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2019. Recovery Outline for American Samoa Species. Honolulu, Hawaii. 21 pp.

U.S. Fish and Wildlife Service (USFWS). 2021. Pacific Sheath-tailed Bat (*Emballonura semicaudata semicaudata*). 5-Year Review. Honolulu, Hawaii. 13 pp.

Species: Hawaiian Hoary Bat

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: Multiple populations

Species Trends: Declining population(s) – one or more populations declining

Habitat: Forest (lowland and montane) (USFWS 2019)

Pesticides noted ☒

Environmental Baseline/Cumulative Effects Summary Hawaiian Hoary Bat:

The ʻōpeʻapeʻa or Hawaiian hoary bat is an endangered endemic mammal found in the Hawaiian archipelago. Listed as a subspecies of the hoary bat (*Lasiurus cinereus*), the ʻōpeʻapeʻa is distributed across all of the major islands of the Hawaiian archipelago, including Kauaʻi, Oʻahu, Lānaʻi, Maui, Molokaʻi, and Hawaiʻi. Most recently (USFWS 2021), ʻōpeʻapeʻa have been observed visiting the island of Kahoʻolawe (KIRC 2017, as cited in USFWS 2021). ʻŌpeʻapeʻa roost alone or with dependent young in native and nonnative trees, typically more than 4.6 meters (15 feet) tall (Amlin and Siddiqi 2015, as cited in USFWS 2021). The pupping season extends from June to September; the Service and Hawaiʻi Division of Forestry and Wildlife (DOFAW) currently recommend avoiding tree-trimming from June 1 to September 15 while pups are unable to fly (Amlin and Siddiqi 2015, as cited in USFWS 2021). ʻŌpeʻapeʻa primarily feed on nocturnal moths and beetles (Jacobs 1999, as cited in USFWS 2021), which they hunt in flight across a wide array of habitat types and plant communities from sea level to at least 3,600 meters (11,800 feet) above sea level (Todd 2012, Gorresen et al. 2013, Bonaccorso et al. 2015, Gorresen et al. 2015, Bonaccorso et al. 2016, Todd et al. 2016, Johnston et al. 2019; as cited in USFWS 2021). No historical or current population estimates exist for this subspecies, although recent studies and ongoing research have shown the bats to be distributed across all of the Hawaiian archipelago. The ʻōpeʻapeʻa was listed as endangered in 1970 (35 FR 16046), based on apparent habitat loss and limited knowledge of its distribution and life history requirements. At the time of listing, no population estimate was given. It has also been observed in coastal areas, above wetlands and streams, rainforest, and dry forest habitats. Lowland sites are generally most important during the pupping season, while bats appear to use upland sites more frequently during the winter and spring (Bonaccorso, pers. comm. 2011; as cited in USFWS 2011). On

Hawaii, most observations of these bats have been made between sea level and 2,286 meters (7,500 feet) elevation, although bats have been seen as high as 4,023 meters (13,200 feet) (Baldwin 1950; Theresa Cabrera Menard, U. of Hawaii, personal communications (pers. comm.) 1997; Fujiok and Gon 1988; Kepler and Scott 1990; Tomich 1974; as cited in USFWS 1998).

Threats to this subspecies include habitat destruction (elimination of roosting sites), and possibly direct and indirect effects of pesticides, introduced insects, and disease (USFWS 1998). New threats include wind turbines, timber harvest, coqui frogs, and climate change (USFWS 2021).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 1998. Recovery Plan for the Hawaiian Hoary Bat (*Lasiurus cinereus semotus*). Portland, Oregon. 59 pp.

U.S. Fish and Wildlife Service (USFWS). 2011. Ōpe`ape`a or Hawaiian Hoary Bat (*Lasiurus cinereus semotus)* 5-year review Summary and Evaluation; Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii. 13 pp.

U.S. Fish and Wildlife Service (USFWS). 2021. Ōpe`ape`a or Hawaiian Hoary Bat (*Lasiurus cinereus semotus)* 5-year review. Honolulu, Hawaii. 45 pp.

Species: Mariana fruit Bat (=Mariana flying fox)

Status: Threatened

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: Multiple populations (few)

Species Trends: Declining population(s) – one or more populations declining

Habitat:

Pesticides noted ☐

Environmental Baseline/Cumulative Effects Summary Mariana fruit Bat (=Mariana flying fox):

The Mariana fruit bat ranges over nearly the entire length of the Mariana Islands in western Micronesia and is presumed to have once been abundant throughout the archipelago. During the past century, fruit bat populations on the main southern islands of Guam, Rota, Tinian, and Saipan have seriously declined due to overhunting, forest loss, and, on Guam, predation by introduced brown tree snakes, *Boiga irregularis* (Bechstein) (Wheeler 1980, Wiles 1987, Wiles et al. 1989, 1995, Stinson et al. 1992, Krueger and O'Daniel 1999; as cited in USFWS 2009). In the northern volcanic portion of the island chain, fruit bat populations have been considered more secure because of their isolation from humans.

Surveys for Mariana fruit bats suggest populations are stable or declining throughout most of their range (USFWS 2009). A notable exception to the declining trend is the island of Rota, where the population has been increasing since 2008. The population increase on Rota is due to a sharp decrease in illegal hunting at roost sites of fruit bat maternity colonies. The decrease in illegal hunting can be attributed to an increase in enforcement of wildlife regulations that began in 2009 (CNMI 2010; as cited in USFWS 2014). While Rota, which has the largest population, is surveyed annually, most islands have not been re-surveyed recently to get more up to date population estimates across the range (USFWS 2021). For Rota, the island has averaged 2,500-3,000 bats across 2012-2019 with peaks after major typhoons (DFW 2019, as cited in USFWS 2021), with the most recent estimate being 3,000 bats in 4 colonies (DFW 2020, as cited in USFWS 2021). Other recent estimates have found the small population on Guam increasing from ~15 in 2014 to ~82 in 2019 (DAWR 2020, as cited in USFWS 2021), the population on Alamagan increasing from 86 in 2010 to ~385 in 2017 in 3 colonies (DFW 2017, as cited in USFWS 2021), and around 249 bats on Guguan (Liske-Clarke et al. 2016, as cited in USFWS 2021).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2009. Draft Revised Recovery Plan for the Mariana Fruit Bat or Fanihi (*Pteropus mariannus mariannus*). Portland, Oregon. xiv + 83 pp.

U.S. Fish and Wildlife Service (USFWS). 2014. *Pteropus mariannus mariannus* (Mariana fruit bat) 5-Year Review. Honolulu, Hawaii, August 2014. 11 pp.

U.S. Fish and Wildlife Service (USFWS). 2021. Mariana fruit bat, Fanihi (*Pteropus mariannus mariannus*). 5-Year Review. Honolulu, Hawaii, August 2014. 9 pp.

Overall Vulnerability *Emballonura semicaudata rotensis*: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability *E. semicaudata semicaudata*: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability Hawaiian hoary bat: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability Mariana fruit bat: ☒ **High** ☐ **Medium** ☐ **Low**

RISK

(Risk is based on species exposure and response from labelled uses across the range)

Risk to individuals if exposed:

Effects to Pacific Island bats from use sites:

Pacific Island bats are not expected to experience mortality or sublethal effects from foraging on dietary items exposed to malathion on use sites or via spray drift.

Effects to Pacific Island bats from mosquito control:

Pacific Island bats are not expected to experience mortality or sublethal effects from foraging on dietary items exposed to malathion for mosquito control, if applied.

Risk to the species from labelled uses across the range:

DIRECT (all uses except mosquito adulticide)	
Use areas – mortality and sublethal effects	No effects expected
Spray drift areas – mortality	No effects expected
Direct spray or contact with contaminated media	No effects expected
Volatilization	Could contribute to exposure of Hawaiian hoary bats
INDIRECT (all uses except mosquito adulticide)	
Use areas - Prey item mortality	Hawaiian hoary bat: Mortality to invertebrates on use sites and via spray drift. Mariana fruit bat: Decline in plant growth on use sites with higher allowable application rates.
MOSQUITO ADULTICIDE	
Direct (mortality and sublethal)	No effects expected
Indirect	Hawaiian hoary bat: Mortality to terrestrial invertebrates, if use occurs. Mariana fruit bat: No effects expected to plants.

Risk modifiers:

Hawaiian hoary bats roost in a variety of tree species, both native and non-native, during the day and forage in a wide range of habitat types during the night (Service 1998, pp. 12-13). A few studies have documented Hawaiian hoary bats in a wide range of locations and habitat types on the island of Hawaii. Bat activity has been noted at open sites, forest edges, lava flows, volcanic pit craters, residential and agricultural clearings, and roads. Hawaiian hoary bats are insectivorous, and analysis of fecal pellets has shown that the insects consumed most often (by volume) are Pepidoptera followed by Coleoptera, making up to 67% and 32% (respectively; Bonaccorso, pers. comm. 2011). Foraging generally occurs three to 492 feet above the ground or open water, three to 50 feet above the ground in closed forest habitats, and up to 100 feet and more above tree canopy.

Mariana fruit bat habitat use is influenced by several characteristics of the species. The species is typically highly colonial, and can form large, dense roosts in multiple adjacent trees. Fruits, nectar, pollen, and some leaves comprise the majority of the bats' diet; rapid digestion and metabolism of such foods makes these animals reliant on forest habitat containing diverse food resources that are available throughout the year. Mariana fruit bats are strong fliers and highly mobile; although the pattern and frequency of interisland movements is unknown, fruit bats have been observed flying over the ocean between islands. Connectivity of the archipelago's islands for Mariana fruit bat depends on the presence of enough suitable forest for roosting and foraging to sustain resident and in-transit bats. Mariana fruit bats forage and roost primarily in native forest and forage occasionally in agricultural forests composed primarily of nonnative plants (Wiles 1987b; Worthington and Taisacan 1996).

Although we would expect species within high-level elevation areas to be exposed to malathion via volatilization, we conclude, based on the best information available, that species in high elevations would not be exposed to concentration levels that would affect them (see *General Effects* for further information on volatilization).

Allowable uses driving effects: Effects to terrestrial invertebrate forage base for the Hawaiian hoary bat on use sites and from spray drift. Because invertebrates exhibit a range of sensitivities to malathion, exposure is expected to reduce the abundance in these areas, but not completely eliminate the prey base in these portions of the range. This reduction is anticipated to be greater on use sites, where estimated environmental concentrations are higher than would be anticipated from spray drift. These reductions are likely temporary (based on application frequency) with community recovery over a short period of time.

Overall Risk *Emballonura semicaudata rotensis*: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk *E. semicaudata semicaudata*: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk Hawaiian Hoary Bat: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk Mariana Fruit Bat: ☐ **High** ☐ **Medium** ☒ **Low**

USAGE

(Anticipated usage within the range based on past usage data)

Information regarding past usage of malathion in Hawaii is not available, however prior survey data has indicated that 4.8% of agricultural crops were treated with insecticides, with malathion being only a subset of this use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the Approach to Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in Hawaii; future use cannot be ruled out but is not expected to increase significantly.

Overall Usage *Emballonura semicaudata rotensis*: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Usage *E. semicaudata semicaudata*: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Usage Hawaiian Hoary Bat: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Usage Mariana Fruit Bat: ☐ **High** ☒ **Medium** ☐ **Low**

CONSERVATION MEASURES

Residential use label changes: New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely), reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing initial any residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

Reduced application number and rate: New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop, previous allowable number of applications ranged from 3 to 13 applications per year). We anticipate this measure will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

CONCLUSION

After reviewing the current status of these species, the environmental baseline for the Action area, and the effects of the proposed registration of malathion, as proposed, is not likely to jeopardize the continued existence of the two sheath-tailed bats, *Emballonura semicaudata rotensis and Emballonura semicaudata semicaudata*, the Hawaiian hoary bat, and the Mariana fruit bat. As discussed below, even though the vulnerabilities are high for these species, we anticipate the risk is low likelihood of exposure is medium, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure to malathion. We do not anticipate the Action will result in species-level effects.

Emballonura semicaudata semicauta

Emballoura semicaudata semicaudata is currently extirpated from American Samoa, the only portion of its range within the United States. There are no expected effects for this species, as we do not anticipate exposure will occur. Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of *Emballonura semicaudata semicaudata* in the wild.

Emballonura semicaudata rotensis

Emballonura semicaudata rotensis has high vulnerability based on its estimated status, distribution, and trends. The risk to this species posed by the labeled uses across the range is low, and the estimated usage is expected to be low. *Emballonura semicaudata rotensis* is insectivorous and reductions in prey due to pesticide use could occur, but this species occurs on the uninhabited island of Aguiguan and malathion applications are not expected to occur.

All subspecies of the Pacific sheath-tailed bat are nocturnal and appear to be cave-dependent, roosting during the day in a wide range of cave types, including overhanging cliffs, crevices, lava tubes, and limestone caves (Grant 1993, p. 51; Grant et al. 1994, pp. 134-135; Hutson et al. 2001, p. 139; Palmeririm et al. 2005, p. 28, as cited in USFWS 2020). The Mariana subspecies forages almost entirely in forests (native and nonnative) near their roosting caves (Esselstyn et al. 2004, p. 307 as cited in USFWS 2020) and consumes insects, including ants, bees, wasps (Hymenoptera), moths (Lepidoptera), and beetles (Coleoptera), as their primary pray (O'Shea and Valdez 2009, pp. 63-65; Valdez et al. 2011, pp. 301-307 as cited in USFWS 2020). Currently, this subspecies is known only from the island of Aguiguan (Engbring et al. 1986, p. 8 as cited in USFWS 2020), which, while currently uninhabited, it was once inhabited by the Chamorro people (Russel 1998, pp. 90-91 as cited in USFWS 2020). However, malathion applications are not expected to occur. Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of the *Emballonura semicaudata rotensis* in the wild.

The Hawaii hoary bat and Mariana fruit bat

The Hawaiian hoary bat and Mariana fruit bat have high vulnerability based on their estimated status, distribution, and trends, but the risk to these species posed by the labeled uses across the range is low; also, there is a medium amount of estimated usage within the range of this species. While usage is not expected on all use sites and at the maximum rates allowed by the labels where used each year, we anticipate that some use will occur based on information from a prior survey that estimated 4.8% of agricultural crops were treated with insecticides. However, no mortality or sublethal effects are anticipated for these species.

Because the Hawaiian hoary bat is insectivorous, we expect modest reductions in insect prey would occur where malathion is applied. The species is a strong flier and highly mobile, and if there are areas where its prey are temporarily lost, it has the ability to move to unaffected areas to forage. Because the Mariana fruit bat forages and roosts primarily in native forest and forage occasionally in agricultural forests, we anticipate low levels of exposure to malathion. Since fruits, nectar, pollen, and some leaves comprise the majority of the Mariana fruit bats diet, loss of insects in localized areas are not expected to significantly affect the species unless the insect loss significantly affects pollinators responsible for pollinating fruit trees, although we do not anticipate the moderate amount of usage is likely to result losses of pollination. The Mariana fruit bat is also a strong flier and highly mobile. If there are areas where fruits, nectar, pollen, and some leaves that compose its food base are temporarily lost, the species has the ability to move to unaffected areas to forage, with minimal impacts to fitness.

In addition, we anticipate the conservation measures above, including residential use labels changes and reductions to the allowable number of applications and application rates will further reduce the risk of exposure to these species and their prey. Since these bat species forage on insects or fruit, residential use restrictions (spot treatment application decreases malathion use and makes spray drift offsite unlikely) and agricultural restrictions (that include reducing the number of applications and application rates for certain crops) are expected to decrease the amount of malathion used and further decrease the likelihood of exposure to these species, their prey, and their habitats. Together, these measures are anticipated to substantially reduce the likelihood of exposure to these species and their habitat. Due to the low risk and moderate usage, and the implementation of the conservation measures, we expect exposure of individuals of these species and their forage base will occur only at very low levels over the duration of the Action and would likely not result in mortality, sublethal effects, or measurable impacts to their food resources.

Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of the Hawaiian hoary bat and Mariana fruit bat in the wild.

Conclusion *Emballonura semicaudata rotensis*: **Not likely to jeopardize**

Conclusion *E. semicaudata semicaudata*: **Not likely to jeopardize**

Conclusion Hawaiian hoary bat: **Not likely to jeopardize**

Conclusion Mariana fruit bat: **Not likely to jeopardize**

***REFERENCES*:**

U.S. Fish and Wildlife Service (USFWS). 2011. Ōpe`ape`a or Hawaiian Hoary Bat (*Lasiurus cinereus semotus)* 5-year review Summary and Evaluation; Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii. 13 pp.

U.S. Fish and Wildlife Service (USFWS). 1998. Recovery Plan for the Hawaiian Hoary Bat (*Lasiurus cinereus semotus*). Portland, Oregon. 59 pp.

U.S. Fish and Wildlife Service (USFWS). 2020. Pacific Sheath-Tailed Bat (*Emballonura semicaudata rotensis*). 5-Year Review. Honolulu, Hawaii. 13 pp.

Integration and Synthesis Summary: Pacific Islands Reptiles

Scientific Name:	Common Name:	Entity ID:
Emoia slevini	Slevin's skink	10732

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: Multiple populations (few)

Species Trends: Declining population(s) – one or more populations declining

Pesticides noted ☐

Environmental Baseline/Cumulative Effects Summary Slevin's skink:

The Slevin's skink (*Emoia slevini*) is a small lizard in the reptile family Scincidae, the largest lizard family in number of worldwide species. Slevin's skink was first described in 1972 by Walter C. Brown and Marjorie V.C. Falanruw, which is the most recent and accepted taxonomy (Brown and Falanruw 1972, p. 107; as cited in USFWS 2015). It is the only lizard endemic to the Mariana Islands and is on the Government of Guam's Endangered Species List (Fritts and Rodda 1993, p. 3; Rodda et al. 1997, p. 568; Rodda 2002, p. 2; CNMI Division of Fish and Wildlife (DFW) 2005, p. 174; GDAWR 2006, p. 107; Guam Department of Agriculture 2014, in litt.; as cited in USFWS 2015). Slevin's skink previously occurred on the southern Mariana Islands (Guam, Cocos Island, Rota, Tinian, and Aguiguan), where it is now extirpated, except from Cocos Island off Guam, where it was recently rediscovered (Fritts and Rodda 1993, p. 2; Steadman 1999; Lardner 2013, in litt.; as cited in USFWS 2015). Local skink experts hypothesize that the individuals on Cocos Island may be a distinct species or subspecies from Slevin's skinks in the northern islands and are currently conducting a genetic analysis to determine the taxonomic status (Reed 2015, in litt.; as cited in USFWS 2015).

Emoia slevini now occurs on only 4 or 5 of the 9 islands from which it has previously been recorded (Reed et al. 2010, as cited in USFWS 2020). On both Asuncion and Alamagan, a dramatic decline has occurred from numbers recorded in the 1980s and 1990s. Presently, we lack an explanation for the decline on these islands other than possibly cumulative impacts to forest understory from feral ungulates over time (Alcala and Brown 1967, entire; Brown 1991, entire; Vogt in litt. 2007; as cited in USFWS 2020). Despite the hopeful redetection of Slevin's on Cocos in 2010, the distribution of the species on that island remains limited, and both density and abundance appear to be low. Based upon the fact that Slevin's skink remained undetected on Cocos for nearly 20 years preceding eradication of rats from the island, it is necessary to emphasize that Slevin's skink possibly remains extant, but at undetectably low levels, on other islands with records of historical populations – or even on some islands with no records (e.g., Saipan). *Emoia sleveni* viability mostly rests on a single population on Sarigan with substantial numbers (Vogt in litt. 2007; DFW, 2006; as cited in USFWS 2021).Once widespread, the remaining known populations of Slevin's skink are made up of a few individuals on Cocos Island, and occurrences of undetermined numbers of individuals on Alamagan and Sarigan. Populations of Slevin's skink are decreasing from initial numbers observed on Cocos Island, Alamagan, Pagan, and Asuncion; the species has been lost from 90% of its former range (USFWS 2014).

The endangered Slevin's skink is vulnerable to threats due to its limited distribution, loss of forest habitat due to agriculture and development. New threats include volcanic eruption, invasive species, climate change, and typhoons (USFWS 2020).

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2015. Endangered and Threatened Wildlife and Plants; Endangered Status for 16 Species and Threatened Status for 7 Species in Micronesia. 80 FR 59423 59497. Final Rule. October 1, 2015.

U.S. Fish and Wildlife Service (USFWS). 2020. Slevin's skink, gualiik halumtanu (*Emoia slevini*). 5-year review. Honolulu, Hawaii. 16 pp.

Overall Vulnerability Slevin's skink: ☒ High ☐ Medium ☐ Low

RISK

(Risk is based on species exposure and response from labelled uses across the range)

Risk to individuals if exposed: Slevin's skink is not expected to enter malathion use sites, therefore mortality or sublethal effects are not expected. No effects are expected from exposure via spray drift.

DIRECT (all uses except mosquito adulticide)	
Use areas – mortality and sublethal effects	No effects expected
Spray drift areas – mortality	No effects expected
INDIRECT (all uses except mosquito adulticide)	
Use areas - Prey item mortality	No effects expected

Spray drift areas - Prey item mortality	Effects to terrestrial invertebrates, though spray drift within the forested habitat is expected to be low, even if adjacent to use sites.
MOSQUITO ADULTICIDE	
Direct (mortality and sublethal)	No effects expected
Indirect	Effects to terrestrial invertebrates if exposed

Risk modifiers: Slevin's skink is a fast-moving, alert, insectivorous lizard, typically found on the ground or at ground level. The species occurs in the forest ecosystem, with most individuals observed on the forest floor using leaf litter as cover (Brown and Falanruw 1972; GDAWR 2006, p. 107). Slevin's skinks are oviparous (lay eggs that mature and hatch externally).

Slevin's skink are expected to have low exposure to malathion. Direct exposure is not expected as malathion is not registered for use within the forested habitat, and the forest is expected to be protective in stopping penetration of spray drift into the habitat. Any spray drift that did enter the skink's habitat from adjacent uses is not expected to be at concentrations that would directly cause adverse effects to the skink but could reduce insect prey. Because invertebrates taken as food items exhibit a range of sensitivities to malathion, exposure is expected to reduce the abundance in these areas, but not completely eliminate the prey base in these portions of the range. These reductions are likely temporary (based on application frequency) with community recovery over a short period of time.

Overall Risk Slevin's skink: ☐ High ☐ Medium ☒ Low

USAGE

(Anticipated usage within the range based on past usage data)

Information regarding past usage of malathion is not available for the Mariana Islands. Based on survey data collected in Hawaii, we estimate that 4.8% of agricultural crops were treated with insecticides, with malathion use being a subset of this, assuming its use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the Approach to Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in the Mariana Islands; future use cannot be ruled out but is not expected to increase significantly.

Overall Usage Slevin's skink: ☐ High ☒ Medium ☐ Low

CONSERVATION MEASURES

Residential use label changes: New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely), reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application.

Reduced application number and rate: New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop, previous allowable number of applications ranged from 3 to 13 applications per year). We anticipate this measure will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

CONCLUSION

After reviewing the current status of the species, the environmental baseline for the Action area, and the effects of the proposed registration of malathion, as proposed, is not likely to jeopardize the continued existence of the Slevin's skink. As discussed below, even though the vulnerability is high, the risk to the species is low and usage is medium, and we anticipate the implementation of the general conservation measures described above is expected to reduce the likelihood of exposure to malathion. We do not anticipate the Action will result in species-level effects.

Although the Slevin's skink has high vulnerability, and there is medium potential of overall usage of malathion, this species has a low risk of exposure as it occurs in forested habitat where we do not expect malathion will be applied. No mortality or sublethal effects to individuals are anticipated from spray drift. Loss of prey resources as a result of spray drift could occur within the forested habitat, but such an effect is expected to occur only at low levels, even if adjacent to use sites. In addition, we anticipate the conservation measures above, including residential use label changes and reductions to the allowable number of applications and application rates, would further reduce the risk of exposure to this species and its prey. Since, the Slevin's skink typically occurs in forest habitats but has also been observed in clearings and near abandoned buildings (USFWS 2020), the residential use restrictions reduce exposure to species that overlap with developed and open space developed areas and changes to the label ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely). The reduction in number of applications and application rates for certain agricultural crops further decreases the amount of malathion used and the likelihood of exposure to the species and its habitat. Thus, we expect exposure of individuals of this species and its prey to occur only at very low levels over the duration of the Action and would likely not result in mortality, sublethal effects, or measurable impacts to its prey base.

Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of the Slevin's skink in the wild.

Conclusion Slevin's skink: **Not likely to jeopardize**

***ADDITIONAL REFERENCES*:**

U.S. Fish and Wildlife Service (USFWS). 2015. Endangered and Threatened Wildlife and Plants; Endangered Status for 16 Species and Threatened Status for 7 Species in Micronesia. 80 FR 59423 59497. Final Rule. October 1, 2015.

U.S. Fish and Wildlife Service (USFWS). 2020. Slevin's Skink, Gualiik halumtanu (*Emoia slevini*). 5-Year Review. Honolulu, Hawaii. 16 pp.

Integration and Synthesis Summary: Pacific Islands Invertebrates

Pacific Island invertebrates were separated into the following groups based on similarity in the anticipated effects of malathion within the group:

1. Damselflies
2. Two anchialine pool shrimp species
3. Two butterflies
4. The Blackburn's sphinx moth
5. Twenty-one upland insects (14 pomace/picture wing flies and seven yellow-faced bees)
6. One aquatic snail
7. Forty-seven upland snail species, including *Achatinella, Samoana, Erinna, Partula, Eua,* and *Sisi* species.
8. One arachnid
9. Kauai cave amphipod

We expect applications of malathion will cause mortality in invertebrates exposed to this pesticide at the levels occurring on the ground and on vegetation within application sites and in nearby habitats exposed to spray drift. Exposure would occur with the pesticide being directly deposited onto the terrestrial invertebrates and when they consume contaminated food and water. Terrestrial insects in the fog zones in Hawai'i obtain water by lapping water droplets deposited by fog which could be a pathway of exposure. Offsite deposition could also occur due to volatilization and downwind dry and wet deposition on invertebrate bodies, on their habitat, in their water sources, and on their food sources. On the Hawaiian Islands with high elevation areas (>1,000 m), deposition would occur in the montane fog belt due to both volatilization and condensation. Although we would expect species within high-level elevation areas to be exposed to malathion via volatilization, we conclude, based on the best information available, that species in high elevations would not be exposed to concentration levels that would affect them (see *General Effects* for further information on volatilization).

DAMSELIFLIES

This section describes our analysis for seven damselfly species. The analysis for five of the species will be presented together as a group below, although each species was considered individually and has a separate conclusion. The remaining two species, the Pacific and orangeblack Hawaiian damselflies, will be presented individually after the group below.

Damselfly Group

Scientific Name:	Common Name:	Entity ID:
Megalagrion leptodemas	Crimson Hawaiian damselfly	4326
Megalagrion nesiotes	Flying earwig Hawaiian damselfly	2144
Megalagrion nigrohamatum nigrolineatum	Blackline Hawaiian damselfly	1361
Megalagrion oceanicum	Oceanic Hawaiian damselfly	6231
Ischnura luta	Rota blue damselfly	9282

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Hawaiian damselflies are vulnerable due to stressors associated with small, isolated populations, habitat loss, and ongoing threats to water quality and quantity, predation and habitat modification by non-native species.

Historically, Hawaiian damselflies were generally widespread on the Hawaiian Islands, often occurring from sea-level to higher elevations. Due to habitat loss from development and agricultural, water diversions and withdrawals, the introduction of non-native species (especially non-native fish), many of the Hawaiian damselflies are severely restricted in range and are typically only found in suitable native habitat. The exception being the orangeblack Hawaiian damselfly which still maintains a much broader distribution. The Rota blue damselfly is currently found in the Talakhaya watershed area which is afforded some protection from human impact by its remote and relatively inaccessible location. More species-specific information is found below.

Species: Crimson Hawaiian damselfly

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Multiple population (few)

Species Trends: Declining population(s) – one or more populations

Pesticides noted ☒

Currently, only three occurrences of the crimson Hawaiian damselfly are known, all from the Koʻolau Mountains in the lowland wet and wet cliff ecosystems at Moanalua, north Hālawa, and Maʻakua (TNC, 2007; Polhemus, 2008a, in litt.; HBMP, 2008; Preston, 2011, in litt.; as cited in

USFWS 2019). The threats posed by conversion of wetlands and other aquatic habitat for agriculture and urban development are ongoing and are expected to continue into the future. These modified areas lack the aquatic habitat features that the crimson Hawaiian damselfly requires for essential life history needs, such as marshes, side pools along streams, and slow sections of perennial streams, and no longer support populations of this species (USFWS 2012, p. 57674; as cited in USFWS 2019).

One peer reviewer of the 2012 endangered listing for this species (USFWS 2012, as cited in USFWS 2019) expressed concern regarding the potential threat to the three proposed Hawaiian damselflies from the use of biopesticides (pesticides derived from natural materials such as animals, plants, bacteria, and minerals) to combat, for example, mosquitoes. However, there was insufficient data to evaluate the effects that biopesticides, in particular, *Bacillus thuringiensis israelensis* (Bti), may have on Hawaiian damselflies, and therefore, Bti was not considered a current threat to the three Hawaiian damselflies addressed in the listing package.

Species: Flying earwig Hawaiian damselfly

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Single population

Species Trends: Unknown population trends.

Pesticides noted ☐

Adult flying earwig Hawaiian damselfly inhabit the wet forest understory and do not frequent stream corridors (Polhemus and Asquith 1996, as cited in USFWS 2018). The only confirmed adult population found in the last 15 years (confirmed in 2005) occurs in east Maui. Adults were observed along a steep, riparian rock slope densely covered with *Dicranopteris linearis* (uluhe) and the adjacent stream on windward Haleakalā (USFWS 2011, as cited in USFWS 2018). It is hypothesized that individuals observed in this area are actually part of a larger population that may be located in the extensive belt of uluhe habitat located upslope, where the habitat is predominantly native shrubs and matted fern understory (Foote 2007, Hawaii Biodiversity and Mapping Program (HBMP) 2006; as cited in USFWS 2018). Degradation, modification, and destruction of native riparian stream corridors and adjacent uluhe stream bank habitats in east Maui and its historical range elsewhere on Maui and Hawaiʻi threaten the existence of the flying earwig Hawaiian damselfly. The factors that contribute to these detriments are stream diversion and channelization, agricultural and urban development, improper water well placement, introduced feral pigs (*Sus scrofa*), invasive plants, hurricanes, landslides, and drought (USFWS 2011, as cited in USFWS 2018). The ongoing and likely increasing effects of global climate change (such as increasing temperature and changing rainfall patterns) are also likely to directly or indirectly impact the habitat of the pinapinao in general.

Species: Blackline Hawaiian damselfly

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Multiple population (few)

Species Trends: Unknown population trends

Pesticides noted ☒

The blackline Hawaiian damselfly occurs in the slow sections or pools along midreach and headwater sections of perennial upland streams and in seep-fed pools along overflow channels bordering such streams. This species appears to be restricted to wet forest understory at elevations up to 3,000 - 4,000 feet and does not frequent stream corridors. Currently, this species is found in the lowland wet ecosystem on the windward and leeward sides of the Koʻolau Mountains, in the headwaters and upper reaches of 17 streams. The threats posed by conversion of wetlands and other aquatic habitat for agriculture and urban development are ongoing and are expected to continue into the future. These modified areas lack the aquatic habitat features that the blackline Hawaiian damselfly requires for essential life history needs, such as marshes, side pools along streams, and slow sections of perennial streams, and no longer support populations of this species (USFWS 2012, p. 57674; as cited in USFWS 2019).

One peer reviewer of the 2012 endangered listing for this species (USFWS 2012, as cited in USFWS 2019) expressed concern regarding the potential threat to the three proposed Hawaiian damselflies from the use of biopesticides (pesticides derived from natural materials such as animals, plants, bacteria, and minerals) to combat, for example, mosquitoes. However, there was insufficient data to evaluate the effects that biopesticides, in particular, *Bacillus thuringiensis israelensis* (Bti), may have on Hawaiian damselflies, and therefore, Bti was not considered a current threat to the three Hawaiian damselflies addressed in the listing package.

Species: Oceanic Hawaiian damselfly

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Multiple population (few)

Species Trends: Unknown population trends

Pesticides noted ☒

Oceanic Hawaiian damselfly now currently occupies 12 sites above 300 feet (100 m) in elevation on the windward side of the Koʻolau Mountains. Habitat consists of perennial streams, swift-flowing sections and riffles of streams in lowland mesic, lowland wet, and wet cliff ecosystems on Oʻahu. The threats posed by conversion of wetlands and other aquatic habitat for agriculture and urban development are ongoing and are expected to continue into the future. These modified areas lack the aquatic habitat features that the oceanic Hawaiian damselfly requires for essential life history needs, such as marshes, side pools along streams, and slow sections of perennial streams, and no longer support populations of this species (USFWS 2012, p. 57674; as cited in USFWS 2019).

One peer reviewer of the 2012 endangered listing for this species (USFWS 2012, as cited in USFWS 2019) expressed concern regarding the potential threat to the three proposed Hawaiian damselflies from the use of biopesticides (pesticides derived from natural materials such as animals, plants, bacteria, and minerals) to combat, for example, mosquitoes. However, there was insufficient data to evaluate the effects that biopesticides, in particular, *Bacillus thuringiensis israelensis* (Bti), may have on Hawaiian damselflies, and therefore, Bti was not considered a current threat to the three Hawaiian damselflies addressed in the listing package.

Species: Rota blue damselfly

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Single population

Species Trends: Unknown population trends

Pesticides noted ☐

The Rota blue damselfly (*Ischnura luta*) is a small damselfly endemic to the island of Rota and found within the stream ecosystem. The damselfly is a stream-obligate insect that inhabits one confirmed stream system on the island of Rota (USFWS 2020). This stream occurs within a forested portion of an area known as Talakhaya that contains the entirety of available stream habitat on Rota. There have been no studies of the ecology or life history of the species to date (Polhemus et al. 2000, as cited in USFWS 2020). In the past, adults have been observed in association only with the single perennial stream on Rota; therefore, it is believed that the larval stage of the Rota blue damselfly is aquatic. The Rota blue damselfly's population sites, both within the Talakhaya watershed area is afforded some protection from human impact by its remote and relatively inaccessible location. However, the first documented location (stream locations downstream from the Talakhaya Water Cave), are threatened by a reduction or removal of stream flow due to increased interception for municipal usage, and from lower water quantities resulting from the effects of future climate change, which could eliminate one of the only two known populations of the species. The other known population occurs at a stream in the same watershed area, but east of Talakhaya Water Cave.

Overall Vulnerability Crimson Hawaiian damselfly: ☒ High ☐ Medium ☐ Low

Overall Vulnerability Flying earwig Hawaiian damselfly: ☒ High ☐ Medium ☐ Low

Overall Vulnerability Blackline Hawaiian damselfly: ☒ High ☐ Medium ☐ Low

Overall Vulnerability Oceanic Hawaiian damselfly: ☒ High ☐ Medium ☐ Low

Overall Vulnerability Rota blue damselfly: ☒ High ☐ Medium ☐ Low

RISK

(Risk is based on species exposure and response from labelled uses across the range)

Risk to individuals if exposed: Pacific island damselflies exposed to malathion on use sites are expected to die. Damselflies exposed from spray drift or runoff could die depending on proximity to use sites.

Risk to the species from labelled uses across the range:

The table below summarizes the risk to the species from labelled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

DIRECT (all uses except mosquito control)	
Use areas – mortality	Mortality if suitable habitat occurs within malathion use site
Spray drift and runoff areas – mortality	Mortality depending on proximity to use sites
Volatilization	Not an appreciable source of exposure
INDIRECT (all uses except mosquito control)	
Use areas - Prey item mortality	Prey mortality if suitable habitat occurs within malathion use site
Spray drift and runoff areas - Prey item mortality	Prey mortality depending on proximity to use sites
Plants affected (decline in growth)	N/A
MOSQUITO CONTROL	
Direct (mortality)	Possible mortality if exposed
Indirect	Prey mortality if exposed

Risk modifiers:

Malathion could enter damselfly habitat due to runoff and ground water recharge that originates in adjacent and upslope pesticide application sites, and drift.

Aquatic invertebrates spend all or a portion of their life cycle immersed in water. Damselfly benthic larvae and eggs can occur within perennial and intermittent streams at and below the elevation where malathion is applied. Damselfly adults would be exposed to the pesticide in application and drift sites when it is sprayed on them, they absorb it after contact, after consuming sprayed food and water.

Agriculture and urban development continue to pose a threat to its habitat through encroachment and modification of water resources (USFWS 2018).

Current range maps of these species were visually compared to the 2015 Hawaii Statewide Agricultural Land Use Baseline (University of Hawaii 2015) to determine potential overlap with agricultural use sites. The crimson, blackline and oceanic Hawaiian damselflies current ranges do not overlap with any agricultural use sites. Based on current aerial photography, it does not appear that any agricultural sites have expanded into these species' ranges since the 2015 Agricultural Land Use Baseline was created and these three species do not appear to overlap with any significant developed or open-space developed areas. Current range for the flying earwig Hawaiian damselfly overlaps with agricultural sites and developed and open-space developed areas; however, these current range maps are mapped at the island level and do not necessarily reflect the true current range of the species when compared against current known localities.

There is no agricultural use layer for Rota, Common Wealth of the Northern Mariana Islands (CNMI). Based on aerial photography, the Rota blue damselfly does overlap with potential agricultural use sites and potentially limited developed or open-space developed areas, however, the current range map is much larger in area compared to where the species is known to occur.

Blackline Hawaiian damselfly: Habitat loss due to agriculture is a threat, but once converted, is not likely habitat.

Overall Risk Crimson Hawaiian damselfly: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk Flying earwig Hawaiian damselfly: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Risk Blackline Hawaiian damselfly: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk Oceanic Hawaiian damselfly: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk Rota blue damselfly: ☐ **High** ☒ **Medium** ☐ **Low**

USAGE

(Anticipated usage within the range based on past usage data)

Past malathion usage data in Hawai'i and the Mariana Islands is unavailable, however, prior survey data has indicated that 4.8% of agricultural crops in Hawai'i were treated with insecticides, with malathion only being a subset of this, assuming its use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed areas could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the Approach to Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in Hawai'i or the Mariana Islands, although future as low to moderate lows remains possible.

Overall Usage Crimson Hawaiian damselfly: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Usage Flying earwig Hawaiian damselfly: ☐ High ☒ Medium ☐ Low

Overall Usage Blackline Hawaiian damselfly: ☐ High ☒ Medium ☐ Low

Overall Usage Oceanic Hawaiian damselfly: ☐ High ☒ Medium ☐ Low

Overall Usage Rota blue damselfly: ☐ High ☒ Medium ☐ Low

CONSERVATION MEASURES

Rain restriction: Label language includes restricting malathion application to periods where rain is not forecasted for at least 48 hours for agriculture and 24 hours for residential use or when the soil is not saturated. Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing the likelihood of exposure by substantially reducing the amount of malathion that would reach the habitat in which these species reside.

Aquatic habitat buffers: Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects. We anticipate that, in many cases, these buffers will substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

Residential use label changes: New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely), reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from “repeat as necessary” to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

Reduced application number and rate: New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop, previous allowable number of applications ranged from 3 to 13 applications per year). We anticipate this measure will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

CONCLUSION

After reviewing the current status of the species, the environmental baseline for the Action area, and the effects of the proposed registration of malathion, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the crimson Hawaiian damselfly, flying earwig Hawaiian damselfly, blackline Hawaiian damselfly, oceanic Hawaiian damselfly and the Rota blue damselfly. As discussed below, even though the vulnerability is high, the risk is medium to low, usage is medium, and we anticipate the implementation of the general conservation measures described above will reduce the likelihood of exposure. We do not anticipate the Action will result in species-level effects. Our rationale for each of these species is provided in the following paragraphs.

Flying earwig Hawaiian Damselfly and Rota blue Damselfly

The flying earwig Hawaiian and Rota blue damselflies have high vulnerability based on their status, distributions, and trends. The risk to these species posed by the labeled uses across the range is also high. Based on the current range maps for the flying earwig Hawaiian and Rota blue damselflies, it does not appear that agricultural use sites occur within these species' ranges nor are developed and open-space developed areas a component of the ranges.

The flying earwig Hawaiian damselfly inhabits the wet forest understory and does not frequent stream corridors (Polhemus and Asquith 1996, as cited in USFWS 2018). The only confirmed adult population in the last 15 years (confirmed in 2005) was found along a steep, riparian rock slope densely covered with *Dicranopteris linearis* (uluhe) and the adjacent stream on windward Haleakalā (USFWS 2011, as cited in USFWS 2018). It is hypothesized that individuals observed in this area are actually part of a larger population that may be located in the extensive belt of uluhe habitat located upslope, where the habitat is predominantly native shrubs and matted fern understory (Foote 2007, Hawaii Biodiversity and Mapping Program (HBMP) 2006; as cited in USFWS 2018).

The Rota blue damselfly is a stream-obligate insect that inhabits one confirmed stream system on the island of Rota (USFWS 2020). The only known population of the Rota blue damselfly is restricted to two streams in the upper Talakhaya watershed. The Rota blue damselfly's population site (Talakhaya watershed area) is afforded some protection from human impact by its remote and relatively inaccessible location (USFWS 2015). Other than water withdrawal, this area is afforded some protection from human impact due to its remote and relatively inaccessible location.

Due to the habitat needs of both the flying earwig Hawaiian and Rota blue damselflies and their restricted ranges, we do not believe that they coexist with existing agricultural or developed areas, and therefore, their risk from malathion exposure is low. At present, information indicates that malathion is not used as a mosquito control agent in Hawai'i or the Mariana Islands. As a result, we do not anticipate species-level effects to these two species due to limited potential overlap and the low likelihood of being exposed to volatilization and mosquito adulticide applications.

In addition, we anticipate the conservation measures above, including rain restrictions and aquatic habitat buffers, residential use label changes, and reduced numbers and application rates would further reduce the risk of exposure to these species and their prey. Since damselflies are aquatic invertebrates and rely on water bodies for breeding and foraging, we anticipate the rain restriction will reduce the likelihood of exposure to these two species (directly or in runoff) following a precipitation event. Similarly, we expect that the aquatic habitat buffers will reduce spray drift and decrease the likelihood of exposure to these two species. The new residential restrictions render spray drift offsite to be unlikely and reduces exposure to these species that overlap with developed and open space developed areas. Also, we anticipate that the reduction in number of applications and application rates for certain agricultural crops will further help to reduce the amount of malathion used and decrease the likelihood of exposure to these species and their habitat. Together, these measures are anticipated to substantially reduce the likelihood of exposure to these species and their habitat. We expect exposure of individuals of these species and their forage base will occur only at very low levels over the duration of the Action and would likely not result in mortality, sublethal effects, or measurable impacts to their prey base.

Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of the flying earwig Hawaiian and the Rota blue damselflies in the wild.

Crimson, Blackline, and Oceanic Hawaiian Damselflies

The crimson, blackline, and oceanic Hawaiian damselflies have high vulnerability based on their status, distributions, and trends, and the risk to these species posed by the labeled uses across the range is also high. The amount of estimated usage within the range of these species as a whole is medium. Past malathion usage data in Hawai'i is unavailable, however, prior survey data has indicated that 4.8% of agricultural crops in Hawai'i were treated with insecticides, assuming malathion is only a subset of this use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed areas would undergo some level of treatment with malathion. Based on the current range maps for the crimson, blackline and oceanic Hawaiian damselflies, it does not appear that agricultural use sites occur within these species ranges nor are developed and open-space developed areas a component of their ranges. Additionally, present information indicates that malathion is not used as a mosquito control agent in Hawai'i. As a result, we do not anticipate species-level effects to these three species due to limited potential overlap and the low likelihood of being exposed to volatilization and mosquito adulticide applications.

In addition, we anticipate the conservation measures above, including rain restrictions and aquatic habitat buffers, residential use label changes, and reduced numbers and application rates will further reduce the risk of exposure to these species and their prey. Since damselflies are aquatic invertebrates and rely on water bodies for breeding and foraging, we anticipate the rain restriction will reduce the likelihood of exposure to these three species (directly or in runoff) following a precipitation event. Similarly, we expect that the aquatic habitat buffers will reduce spray drift and decrease the likelihood of exposure to these three species. The new residential restrictions render spray drift offsite to be unlikely and reduce exposure to these species that overlap with developed and open space developed areas. Also, we anticipate that the reduction in number of applications and application rates for certain agricultural crops will further help reduce the amount of malathion used and decrease the likelihood of exposure to these species and their habitat. Together, these measures are anticipated to substantially reduce the likelihood of exposure to these species and their habitat. We expect exposure of individuals of these species and their forage base will occur only at very low levels over the duration of the Action and would likely not result in mortality, sublethal effects, or measurable impacts to their prey base.

Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of the crimson, blackline, and oceanic Hawaiian damselflies in the wild.

Conclusion Crimson Hawaiian damselfly: **Not likely to jeopardize**

Conclusion Flying Hawaiian earwig damselfly: **Not likely to jeopardize**

Conclusion Blackline Hawaiian damselfly: **Not likely to jeopardize**

Conclusion Oceanic Hawaiian damselfly: **Not likely to jeopardize**

Conclusion Rota blue damselfly: **Not likely to jeopardize**

ADDITIONAL REFERENCES

University of Hawaii at Hilo. 2015. Spatial Data Analysis and Visualization (SDAV) Laboratory data in conjunction with the Hawaii State Department of Agriculture. Hilo, HI.

U.S. Fish and Wildlife Service (USFWS). 2012. Endangered and Threatened Wildlife and Plants; Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species. Final Rule. September 18, 2012. 77 FR 57647 57862

U.S. Fish and Wildlife Service (USFWS). 2015. Endangered and Threatened Wildlife and Plants; Endangered Status for 16 Species and Threatened Status for 7 Species in Micronesia. Final Rule. October 1, 2015. 80 FR 59423-59497.

U.S. Fish and Wildlife Service (USFWS). 2016. Endangered and Threatened Wildlife and Plants; Endangered Status for 49 Species from the Hawaiian Islands. Final Rule. September 30, 2016. 81 FR 67786-67860.

U.S. Fish and Wildlife Service (USFWS). 2018. Flying Hawaiian Earwig Damselfly (*Megalagrion nesiotes*). 5-year Review. Honolulu, Hawaii. 17 pp.

U.S. Fish and Wildlife Service (USFWS). 2019. Crimson Hawaiian Damselfly (*Megalagrion leptodemas*). 5-year Review. Honolulu, Hawaii. 19 pp.

U.S. Fish and Wildlife Service (USFWS). 2019. Blackline Hawaiian Damselfly (*Megalagrion nigrohamatum nigrolineatum*). 5-year Review. Honolulu, Hawaii. 18 pp.

U.S. Fish and Wildlife Service (USFWS). 2019. Oceanic Hawaiian Damselfly (*Megalagrion oceanicum*). 5-year Review. Honolulu, Hawaii. 17 pp.

U.S Fish and Wildlife Service (USFWS). 2020. 5-Year Review. Summary and Evaluation. Rota Blue Damselfly (*Ischnura luta*). Honolulu, Hawaiʻi. 8 pp.

Damselflies

Scientific Name:	Common Name:	Entity ID:
Megalagrion pacificum	Pacific Hawaiian damselfly	1953

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Hawaiian damselflies are vulnerable due to stressors associated with small, isolated populations, habitat loss, and ongoing threats to water quality and quantity, predation and habitat modification by non-native species.

Historically, Hawaiian damselflies were generally widespread on the Hawaiian Islands, often occurring from sea-level to higher elevations. Due to habitat loss from development and agricultural, water diversions and withdrawals, the introduction of non-native species (especially non-native fish), many of the Hawaiian damselflies are severely restricted in range and are typically only found in suitable native habitat. The exception being the orangeblack Hawaiian damselfly which still maintains a much broader distribution.

Species: Pacific Hawaiian damselfly

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Multiple population (few) (USFWS 2018)

Species Trends: Unknown

Pesticides noted ☐

Environmental Baseline/Cumulative Effects Summary Pacific Hawaiian damselfly:

Pacific Hawaiian damselflies historically were known from lower elevations [below 2,000 feet (600 meters)] and to breed in lentic systems including marshes, seepage fed pools, large ponds, and quiet pools in gulches, usually in areas with dense surrounding vegetation (USFWS 2018). Observations confirmed that the Pacific Hawaiian damselfly is no longer found in lentic habitats in Hawaiʻi due to predation by nonnative fish and are restricted almost exclusively to seepage fed pools along overflow channels in the terminal reaches of perennial streams, usually in areas surrounded by thick vegetation (Moore and Gagné 1982, Englund et al 2007, USFWS 2010; as cited in USFWS 2018). Adults do not stray far from the vicinity of the breeding pools and are rarely seen along main stream channels. Pacific damselflies do not disperse over long distances compared to other Hawaiian damselflies (Jordan et al 2007, USFWS 2011; as cited in USFWS 2018). Adult and immature (naiad) stages of this damselfly are predaceous. The naiad stage is aquatic and feeds on small aquatic invertebrates (Polhemus and Asquith 1996, as cited in USFWS 2018). Current threats to the *Megalagrion pacificum* include predation by nonnative fish, backswimmers, bullfrogs, and ant species; and lack of population representation, resiliency, and redundancy due to its extreme reduction in range and dispersed populations (USFWS 2018). The factors that contribute to these detriments are stream diversion and channelization, agricultural and urban development, improper water well placement, dewatering of aquifers, invasive plants, hurricanes, landslides, and drought (USFWS 2011, as cited in USFWS 2018). Currently, Pacific Hawaiian damselflies are found on Maui and Molokaʻi with one population found on Hawaiʻi Island (USFWS 2010, 2011; as cited in USFWS 2018). Recent state Commission of Water Resource Management decisions to restore stream flows and reduce or eliminate flow diversions in East Maui watershed may provide future suitable habitat if nonnative predatory fish are excluded (DLNR 2018, as cited in USFWS 2018).

Overall Vulnerability Pacific Hawaiian damselfly: ☒ High ☐ Medium ☐ Low

RISK

(Risk is based on species exposure and response from labelled uses across the range)

Risk to individuals if exposed: Pacific Hawaiian damselflies exposed to malathion on use sites are expected to die. Damselflies exposed from spray drift or runoff could die depending on proximity to use sites.

Risk to the species from labelled uses across the range:

The table below summarizes the risk to the species from labelled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

DIRECT (all uses except mosquito control)	
Use areas – mortality	Mortality if suitable habitat occurs within malathion use site
Spray drift and runoff areas – mortality	Mortality depending on proximity to use sites

Volatilization	Not an appreciable source of exposure
INDIRECT (all uses except mosquito control)	
Use areas - Prey item mortality	Prey mortality if suitable habitat occurs within malathion use site
Spray drift and runoff areas - Prey item mortality	Prey mortality depending on proximity to use sites
Plants affected (decline in growth)	N/A
MOSQUITO CONTROL	
Direct (mortality)	Possible mortality if exposed
Indirect	Prey mortality if exposed

Risk modifiers:

Malathion could enter damselfly habitat due to runoff and ground water recharge that originates in adjacent and upslope pesticide application sites, and drift.

Aquatic invertebrates spend all or a portion of their life cycle immersed in water. Damselfly benthic larvae and eggs can occur within perennial and intermittent streams at and below the elevation where malathion is applied. Damselfly adults would be exposed to the pesticide in application and drift sites when it is sprayed on them, they absorb it after contact, after consuming sprayed food and water.

Adults do not stray far from the vicinity of the breeding pools and are rarely seen along main stream channels. Pacific damselflies do not disperse over long distances compared to other Hawaiian damselfies (Jordan et al 2007, USFWS 2011). Currently, Pacific Hawaiian damselflies are found on Maui and Moloka‘i with one population found on Hawai‘i island (USFWS 2010, 2011). Agriculture and urban development continue to pose a threat to its habitat through encroachment and modification of water resources (USFWS 2018).

Current range maps for the Pacific Hawaiian damselfly species were visually compared to the 2015 Hawaii Statewide Agricultural Land Use Baseline (University of Hawaii 2015) to determine potential overlap with agricultural use sites. Current ranges for this species overlap with agricultural sites and developed and open space developed areas; however, these current range maps are mapped at the island level and do not necessarily reflect the true current range of the species when compared against current known localities.

Overall Risk Pacific Hawaiian damselfly: ☒ **High** ☐ **Medium** ☐ **Low**

USAGE

(Anticipated usage within the range based on past usage data)

Past malathion usage data in Hawai’i and the Mariana Islands is unavailable, however, prior survey data has indicated that 4.8% of agricultural crops in Hawai’i were treated with insecticides, with malathion only being a subset of this, assuming its use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed areas could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the Approach to Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in Hawai'i or the Mariana Islands, although future as low to moderate lows remains possible.

Overall Usage Pacific Hawaiian damselfly: ☐ **High** ☒ **Medium** ☐ **Low**

CONSERVATION MEASURES

General Conservation Measures

Rain restriction: Label language includes restricting malathion application to periods where rain is not forecasted for at least 48 hours for agriculture and 24 hours for residential use or when the soil is not saturated. Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing the likelihood of exposure by substantially reducing the amount of malathion that would reach the habitat in which these species reside.

Aquatic habitat buffers: Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects. We anticipate that, in many cases, these buffers will significantly reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

Residential use label changes: New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely), reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10

days between any repeated applications are expected to reduce environmental concentrations by allowing initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

Reduced application number and rate: New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop, previous allowable number of applications ranged from 3 to 13 applications per year). We anticipate this measure will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

Species-specific Measures
The following species-specific measures are now part of the Action and will be included in *BulletinsLive Two*

Within the range of the species below 4,000 feet, applicators must follow one of these measures, where feasible:

- Apply malathion only when wind is blowing away from lentic habitats that may include marshes, seepage fed pools, large ponds, and quiet gulches OR
- Use a 100-foot ground buffer or a 150-foot aerial from the edges of marshes, seepage fed pools, large ponds, and quiet gulches. Buffer size may be reduced by 50 feet if a full swatch displacement upwind is used during aerial application.

If it is not feasible to implement one of the above measures, applicators must reach out to the local USFWS Ecological Services field offices to determine appropriate measures to ensure the proposed application is likely to have no more than minor effects on the species. The applicator must retain documentation of the technical assistance and the agreed upon species-specific measures that were implemented.

In addition, applicators must schedule irrigations and malathion applications to maximize the interval of time between malathion application and the first subsequent irrigation, allowing at least 24 hours between malathion application and irrigation.

CONCLUSION

After reviewing the current status of the species, the environmental baseline for the Action area, and the effects of the proposed registration of malathion, it is the Service’s biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the Pacific Hawaiian damselfly. As discussed below, even though the vulnerability and risk are high and for this species, we anticipate the likelihood of exposure of malathion is medium. Moreover, the implementation of the general and species-specific conservation measures described above are expected to further reduce the likelihood of exposure to malathion. While we anticipate that very small numbers of individuals of these species will be affected over the duration of the proposed Action, we do not expect species-level effects to occur.

The Pacific Hawaiian damselfly has high vulnerability based on its status, distribution, and trends. The risk to this species posed by the labeled uses across the range is also high. The amount of estimated usage within the range of this species is medium. Past malathion usage data in Hawai'i is unavailable, however, prior survey data has indicated that 4.8% of agricultural crops in Hawai'i were treated with insecticides, assuming malathion is only a subset of this use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed areas will undergo some level of treatment with malathion.

We expect the Pacific Hawaiian damselfly will be directly exposed to the pesticide and pesticide drift where malathion enters damselfly habitat due to runoff and ground water recharge that originates in adjacent and upslope pesticide application sites, and by drift. However, we anticipate a reduction in the level of exposure from these use types since this species prefers seepage fed pools along overflow channels in the terminal reaches of perennial streams, that will likely serve as a buffer to spray drift or runoff from these activities. Although malathion volatilizes readily and is transported downwind and deposited as dry deposition, in precipitation and, at higher elevations, in fog deposition, we do not expect volatilization to be an appreciable source of exposure. Although we would expect species within high-level elevation areas to be exposed to malathion via volatilization, we conclude, based on the best information available, that species in high elevations would not be exposed to concentration levels that would affect them (see *General Effects* for further information on volatilization). In addition, we anticipate the general conservation measures above would further reduce the risk of exposure from these use types to the species and its habitat.

We anticipate that the rain restrictions and aquatic habitat buffers, residential use restrictions and the reduction in number of application and application rates, wind restrictions, ground/aerial buffers, and time restrictions for scheduling irrigations and applications are expected to reduce the amount of malathion used and limit the likelihood of spray drift and runoff exposure to this species and seepage fed pools along overflow channels in the terminal reaches of perennial streams habitat. As with most invertebrates with an aquatic life cycle, we anticipate that the rain restriction reduces the likelihood of exposure to the species (directly or in runoff) following a precipitation event. Also, we expect the pesticide will most likely have sufficient time to degrade before runoff into aquatic habitats can occur, which will further decrease the likelihood of exposure by reducing the amount of malathion to wetland habitats in which this species resides. Similarly, we anticipate the aquatic habitat buffers reduce spray drift and decrease the likelihood of exposure to aquatic organisms by also limiting the pesticide from reaching coastal and wetland ecosystems. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely), reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. We also anticipate the new label restrictions reducing the number of applications and application rate for pasture will reduce the amount of malathion used and decrease potential exposure to the species. Furthermore, the species-specific conservation measure prohibits application of malathion within the range of this species plus 200 feet beyond the range to account for potential spray drift from applicators adjacent to the range. Moreover, the species-specific conservation measure requires that malathion be applied when wind is blowing away from lentic habitats or using a 100-foot ground buffer or a 150-foot aerial buffer within the range of the species below 4,000 feet. In addition, irrigations and malathion applications must be scheduled to maximize the interval of time between malathion application and the first subsequent irrigation, allowing at least 24 hours between malathion application and irrigation. Furthermore, if the species-specific measures are not feasible to implement, applicators are required to reach out to local USFWS Ecological Services field office to determine appropriate measures to ensure the proposed application is likely to have no more than minor effects on the species. The applicator must retain documentation of the technical assistance and the agreed upon species-specific measures that were implemented.

Together, these measures are anticipated to substantially reduce mortality of individuals of this species from application of malathion within and immediately surrounding the range of this species. Thus, while we anticipate that small numbers of individuals will be adversely affected through mortality of a small number of individuals and small reductions in the forage base) over the duration of the Action, we do not anticipate species-level effects to occur. Therefore, we do not anticipate the proposed Action would appreciably reduce survival and recovery of the Pacific Hawaiian damselfly in the wild.

Conclusion Pacific Hawaiian damselfly: **Not likely to jeopardize**

Damselflies

Scientific Name:	Common Name:	Entity ID:
Megalagrion xanthomelas	Orangeblack Hawaiian damselfly	6867

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Hawaiian damselflies are vulnerable due to stressors associated with small, isolated populations, habitat loss, and ongoing threats to water quality and quantity, predation and habitat modification by non-native species.

Historically, Hawaiian damselflies were generally widespread on the Hawaiian Islands, often occurring from sea-level to higher elevations. Due to habitat loss from development and agricultural, water diversions and withdrawals, the introduction of non-native species (especially non-native fish), many of the Hawaiian damselflies are severely restricted in range and are typically only found in suitable native habitat. The exception being the orangeblack Hawaiian damselfly which still maintains a much broader distribution.

Species: Orangeblack Hawaiian damselfly

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Multiple population (numerous)

Species Trends: Declining population(s) – one or more populations declining

Pesticides noted ☐

Environmental Baseline/Cumulative Effects Summary Orangeblack Hawaiian damselfly:

Megalagrion xanthomelas is now only found on the islands of Hawaiʻi, Maui, Molokaʻi and Oʻahu where thirty-four known naturally occurring population units are found (USFWS unpublished data; as cited in USFWS 2021). The orangeblack Hawaiian damselfly is a lowland species that occupies a wide range of habitats (e.g., anchialine pools, coastal, and wetland ecosystems) and has broad ecological tolerances (Polhemus and Asquith 1996, p. 91, as cited in USFWS 2021). However, *Megalagrion xanthomelas* is most commonly found sheltering in the vegetation along the borders of low elevation streams and coastal wetlands, particularly those fed by basal springs (Polhemus and Asquith 1996, p. 91, as cited in USFWS 2021). They can also be found breeding along terminal and lower mid-reaches of perennial streams. If fish and other aquatic predators are not present, *M. xanthomelas* can also breed in reservoirs and ornamental ponds, as documented at the old Lodge at Kōʻele (now Four Seasons Hotel Lānaʻi at Kōʻele) on Lānaʻi (Polhemus and Asquith 1996, p. 91, as cited in USFWS 2021). This species can also exploit temporary habitats, such as ephemeral side pools bordering flashy streams on the island of Hawaiʻi and pipeline seepages on Lānaʻi (Polhemus and Asquith 1996, p. 91, as cited in

USFWS 2021). *Megalagrion xanthomelas* is typically observed at lower elevations (between 0–200 feet (ft) [61 meters (m)]) but has been spotted up to 2,000 ft (610 m) (Polhemus and Asquith 1996, p. 92, as cited in USFWS 2021). Results from salinity readings at Palaʻau, Molokaʻi demonstrate that individuals at this location could tolerate concentrations of at least 2 parts per thousand (ppt) and may be able to tolerate salinity as high as 8 ppt (Polhemus and Asquith 1996, p. 92, as cited in USFWS 2021). The orangeblack Hawaiian damselfly appear to be generalists at all stages (Haines 2020c, in litt). As in most species of Hawaiian damselflies, the immature larval stages (naiads) are aquatic, breathing through three flattened abdominal gills, and are predacious (Williams 1936, p. 303, as cited in USFWS 2021). *Megalagrion xanthomelas* naiads are passive predators with exceptional vision, stalking live prey that swim or crawl within reach (Evenhuis et al. 1995, p. 18, as cited in USFWS 2021). Early-stage naiads consume small zooplankton such as cladocerans, copepods, and ostracods while late stage naiads consume larger zooplankton and a variety of aquatic invertebrates (Haines 2020c, in litt, as cited in USFWS 2021). Typical adult damselflies form a basket with their spiny legs to capture prey while flying or will perch and pounce on prey (Polhemus and Asquith 1996, p. 7, as cited in USFWS 2021). *Megalagrion xanthomelas* has been observed eating fruit flies, mosquitos, crane flies, small moths, leafhoppers, plant bugs, and sometimes other species of damselflies (Haines 2020c, in litt, as cited in USFWS 2021). The orangeblack Hawaiian damselfly has also been observed feeding on conspecifics, however, this does not appear to be a common occurrence (Haines 2020c, in litt, as cited in USFWS 2021). *Megalagrion xanthomelas* is now considered extirpated from Kauaʻi (Polhemus and Asquith 1996, p. 91) and Lānaʻi (Polhemus and Haines 2020, entire) (all as cited in USFWS 2021). The status of the population on Niʻihau is unknown. Populations on Molokaʻi and Hawaiʻi are considered locally abundant. The three populations on Maui are still extant but not abundant. Until recently, the last report of the orangeblack Hawaiian damselfly on Oʻahu was in 1935 (Williams 1936, p. 310), and it was believed extirpated on this island (Polhemus 1993, pp. 344, 346) (all as cited in USFWS 2021). In 1994, a very small population was discovered existing in pools of an intermittent stream at the TAMC (Englund 2001, p. 256; as cited in USFWS 2021). Feral ungulates and invasive plants continue to threaten the existence of *Megalagrion xanthomelas* by destroying vegetative habitat that is essential for hunting, breeding, and rearing. However, the lack of *M. xanthomelas* in many aquatic habitats around the Hawaiian Islands is strongly correlated with the presence of predatory nonnative fish, which are the biggest current threat. Based on severe restriction of its range due to habitat modification/destruction, water management practices, drought and other stochastic events, feral ungulates, nonnative plants, predators, and the limited number of populations, the resiliency of *M. xanthomelas* is very low.

Overall Vulnerability Orangeblack Hawaiian damselfly: ☒ High ☐ Medium ☐ Low

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RISK

(Risk is based on species exposure and response from labelled uses across the range)

Risk to individuals if exposed: Pacific island damselflies exposed to malathion on use sites are expected to die. Damselflies exposed from spray drift or runoff could die depending on proximity to use sites.

Risk to the species from labelled uses across the range:

The table below summarizes the risk to the species from labelled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

DIRECT (all uses except mosquito control)	
Use areas – mortality	Mortality if suitable habitat occurs within malathion use site
Spray drift and runoff areas – mortality	Mortality depending on proximity to use sites
Volatilization	Not an appreciable source of exposure
INDIRECT (all uses except mosquito control)	
Use areas - Prey item mortality	Prey mortality if suitable habitat occurs within malathion use site
Spray drift and runoff areas - Prey item mortality	Prey mortality depending on proximity to use sites
Plants affected (decline in growth)	N/A
MOSQUITO CONTROL	
Direct (mortality)	Possible mortality if exposed
Indirect	Prey mortality if exposed

Risk modifiers:

Malathion could enter damselfly habitat due to runoff and ground water recharge that originates in adjacent and upslope pesticide application sites, and drift.

Aquatic invertebrates spend all or a portion of their life cycle immersed in water. Damselfly benthic larvae and eggs can occur within perennial and intermittent streams at and below the elevation where malathion is applied. Damselfly adults would be exposed to the pesticide in application and drift sites when it is sprayed on them, they absorb it after contact, after consuming sprayed food and water.

Current range maps for the orangeblack Hawaiian damselfly were visually compared to the 2015 Hawaii Statewide Agricultural Land Use Baseline (University of Hawaii 2015) to determine potential overlap with agricultural use sites. Current ranges for this species overlap with agricultural sites and developed and open space developed areas; however, these current range maps are mapped at the island level and do not necessarily reflect the true current range of the species when compared against current known localities.

Overall Risk Orangeblack Hawaiian damselfly: ☒ **High** ☐ **Medium** ☐ **Low**

USAGE

(Anticipated usage within the range based on past usage data)

Past malathion usage data in Hawai'i and the Mariana Islands is unavailable, however, prior survey data has indicated that 4.8% of agricultural crops in Hawai'i were treated with insecticides, with malathion only being a subset of this, assuming its use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed areas could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the Approach to the Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in Hawai'i or the Mariana Islands, although future as low to moderate lows remains possible.

Overall Usage Orangeblack Hawaiian damselfly: ☐ High ☒ Medium ☐ Low

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CONSERVATION MEASURES

General Conservation Measures

Rain restriction: Label language includes restricting malathion application to periods where rain is not forecasted for at least 48 hours for agriculture and 24 hours for residential use or when the soil is not saturated. Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing the likelihood of exposure by substantially reducing the amount of malathion that would reach the habitat in which these species reside.

Aquatic habitat buffers: Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. In many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects. We anticipate that, in many cases, these buffers will significantly reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects

Residential use label changes: New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely), reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

Reduced application number and rate: New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop, previous allowable number of applications ranged from 3 to 13 applications per year). We anticipate this measure will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

Species-specific Measures

The following species-specific measure is now part of the Action and will be included in *BulletinsLive Two:*

Malathion application is prohibited within the range of this species, plus 200 feet beyond the range to account for potential spray drift from applicators adjacent to the range.

CONCLUSION

After reviewing the current status of the species, the environmental baseline for the Action area, and the effects of the proposed registration of malathion, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the orangeblack Hawaiian damselfly. As discussed below, even though the vulnerability and risk are high for this species, we anticipate the likelihood of exposure of malathion is low, given the implementation of the general and species-specific conservation measures described above. While we anticipate that very small numbers of individuals of this species will be affected over the duration of the proposed Action, we do not expect species-level effects to occur.

The orangeblack Hawaiian damselfly has high vulnerability based on its status, distribution, and trends. The risk to this species posed by the labeled uses across the range is also high. The amount of estimated usage within the range of this species as a whole is medium. Past malathion usage data in Hawai'i is unavailable, however, prior survey data has indicated that 4.8% of agricultural crops in Hawai'i were treated with insecticides, assuming malathion is only a subset of this use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed areas could undergo some level of treatment with malathion.

The orangeblack Hawaiian damselfly could be directly exposed to the pesticide and pesticide drift where malathion enters damselfly habitat due to runoff and ground water recharge that originates in adjacent and upslope pesticide application sites, and by drift. However, we anticipate a reduction in the level of exposure from these use types since this species prefers sheltering in the vegetation along the borders of low elevation streams and coastal wetlands, that will likely serve as a buffer to spray drift or runoff from these activities. Although malathion could volatilize and deposit as dry deposition, in precipitation at higher elevations (in fog), we do not expect volatilization to be an appreciable source of exposure. Although we would expect the species to be exposed to malathion via volatilization, we conclude, based on the best information available, that the species would not be exposed to concentration levels that would affect it from this route. In addition, we anticipate the general conservation measures above would further reduce the risk of exposure from these use types to the species and its habitat.

We anticipate that the rain restrictions and aquatic habitat buffers, residential use restrictions and the reduction in number of application and application rates are expected to reduce the amount of malathion used and limit the likelihood of spray drift and runoff exposure to this species and its vegetation along the borders of low elevation streams and coastal wetlands habitat. As with most invertebrates with an aquatic life cycle, we anticipate that the rain restriction reduces the likelihood of exposure to the species (directly or in runoff) following a precipitation event. Also, we expect the pesticide will most likely have sufficient time to degrade before runoff into aquatic habitats can occur, which will further decrease the likelihood of exposure by reducing the amount of malathion to wetland habitats in which this species resides. Similarly, we anticipate the aquatic habitat buffers will reduce spray drift and decrease the likelihood of exposure to aquatic organisms by also limiting the pesticide from reaching coastal and wetland ecosystems. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely), reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. We also anticipate the new label restrictions reducing the number of applications and application rate for pasture will reduce the amount of malathion used and decrease potential exposure to the species. Furthermore, the species-specific conservation measure prohibits application of malathion within the range of this species plus 200 feet beyond the range to account for potential spray drift from applicators adjacent to the range.

Together, these measures are anticipated to substantially reduce mortality of individuals of this species from application of malathion within and immediately surrounding the range of this species. Thus, while we anticipate that small numbers of individuals will be adversely affected through mortality and a small reduction in forage base over the duration of the Action, we do not anticipate species-level effects to occur. Therefore, we do not anticipate the proposed Action would appreciably reduce survival and recovery of the orangeblack Hawaiian damselfly in the wild.

Conclusion Orangeblack Hawaiian damselfly: Not likely to jeopardize

ADDITIONAL REFERENCES

University of Hawaii at Hilo. 2015. Spatial Data Analysis and Visualization (SDAV) Laboratory data in conjunction with the Hawaii State Department of Agriculture. Hilo, HI.

U.S. Fish and Wildlife Service (USFWS). 2012. Endangered and Threatened Wildlife and Plants; Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species. Final Rule. September 18, 2012. 77 FR 57647 57862

U.S. Fish and Wildlife Service (USFWS). 2015. Endangered and Threatened Wildlife and Plants; Endangered Status for 16 Species and Threatened Status for 7 Species in Micronesia. Final Rule. October 1, 2015. 80 FR 59423-59497.

U.S. Fish and Wildlife Service (USFWS). 2016. Endangered and Threatened Wildlife and Plants; Endangered Status for 49 Species from the Hawaiian Islands. Final Rule. September 30, 2016. 81 FR 67786-67860.

U.S. Fish and Wildlife Service (USFWS). 2018. Pacific Hawaiian damselfly (*Megalagrion pacificum*). 5-Year Review Summary and Evaluation. Honolulu, HI. 19 pp.

U.S Fish and Wildlife Service (USFWS). 2021. 5-Year Review. Summary and Evaluation. Orangeblack Hawaiian damselfly (*Megalagrion xanthomelas*). Honolulu, Hawai‘i. 35 pp.

Integration and Synthesis Summary: Pacific Islands Invertebrates

ANCHIALINE POOL SHRIMPS

Scientific Name:	Common Name:	Entity ID:
Procaris hawaiana	Anchialine pool shrimp	2929
Vetericaris chaeorum	Anchialine pool shrimp	5449

Procaris hawaiana and *Vetericaris chaceorum* are species of shrimp in the family Procarididae found in anchialine pools on the islands of Maui (both species) and Hawai'i (*V. chaceorum* only).

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Anchialine pool shrimp are vulnerable due to stressors associated with small, isolated populations, habitat loss, and ongoing threats to water quality and quantity, predation and habitat modification by non-native species. The persistence of *P. hawaiana*, *V. chaceorum* and other anchialine pool shrimp species is hampered by the small number of extant populations and the small geographic range of the known populations (USFWS 2016).

Species: *Procaris hawaiana*

Status: Endangered

Distribution: Species/Populations neither constrained nor widespread

Number of Populations: Multiple populations

Species Trends: Unknown population trends

Pesticides noted ☒

Environmental Baseline/Cumulative Effects Summary:

Of the 700 known anchialine pools in the State of Hawaiʻi, *Procaris hawaiana* has only been documented in two pools at ʻĀhihi-Kinaʻu NARs (Natural Area Reserves) (formerly referred to as Cape Kinau) on Maui island (Holthuis 1973, entire; Maciolek 1983, entire; USFWS 1998, 2003, entire; as cited in USFWS 2020) and in 26 pools on the island of Hawaiʻi (one at Lua O Palahemo, 24 at Manukā, and one at Kaloko-Honokōhau National Historical Park on the island of Hawaiʻi) (Maciolek and Brock 1974, entire; Chan 1995, entire; Brock 2004, p. 28; Sakihara 2009, entire; as cited in USFWS 2020). State NARs, which are constantly monitored, were created to preserve and protect samples of Hawaiʻi's ecosystems and geological formations. Designation as a State NAR prohibits the removal of any native organism and the disturbance of pools (HAR 13-209-4; as cited in USFWS 2020).

ʻĀhihi-Kinaʻu is a NAR that was established in 1973 for the protection of Native Hawaiian ecosystems and geological features in as unmodified a manner as possible (NARS 2012, p. 1; as cited in USFWS 2020). Since that establishment, the anchialine pools within the reserve have been completely fenced off from public access. There have also been a number of other conservation actions taken to ensure the longevity of the entire reserve including the anchialine pools.

Lua O Palahemo is not part of a NAR. Instead, it is on land controlled by the Hawaiʻi State Department of Hawaiian Home Lands at the southern tip of the island. Lua O Palahemo is within 710 acres designated as a National Historic Landmark and is a popular recreation place for locals and visitors (Department of Hawaiian Home Lands 2016).

Part of the Manukā watershed was designated as a NAR in 1983 and consequently much of Manukā's anchialine habitats have seen very little change over the past few decades (Chan 1995 pp. 15-16; Brock 2004, pp. 28-33; Sakihara 2012, pp. 83-84; as cited in USFWS 2020). The Manukā NAR is currently the largest of 19 reserves established by the State of Hawaiʻi, covering 25,550 acres from sea level to 5,524 feet elevation (Sakihara 2012, pp. 83-84; as cited in USFWS 2020). The anchialine habitats within Manukā are considered exceptionally unique from other Hawaiian anchialine communities for several reasons: 1) the lack of development within the watershed considerably reduced anthropogenic effects on groundwater intrusion, 2) the remoteness and difficulty of access limits the amount of people in the area, 3) the barren landscape presents little to no encroaching vegetation, and 4) the high salinity levels of the pools within this area provide preferable conditions to rare shrimp species such as *Procaris hawaiana* (Brock 2004, p. 6, 31-32; as cited in USFWS 2020). There are currently 24 anchialine pools within the Manukā watershed that are known to host *P. hawaiana*. While 19 of those pools fall within the NAR boundary, the other five pools are located on unencumbered State land that is adjacent to the NAR, which means that they are not subject to the same protections from potentially harmful activity as the pools that are within the NAR (Conry 2012, in litt.; as cited in USFWS 2020).

Established on November 10, 1978, Kaloko-Honokōhau is a National Historical Park (PL 95-625; as cited in USFWS 2020) which encompasses 650 acres of land and 500 acres of ocean. The anchialine pools within Kaloko-Honokōhau have been consistently monitored by park staff since 1994.

Like other anchialine pool shrimp species, *P. hawaiana* inhabits an extensive network of water-filled interstitial spaces (cracks and crevices) leading to and from the actual pool, a trait which has precluded researchers from ascertaining accurate population size estimates without draining the entire pool (Holthuis 1973, p. 36; Maciolek 1983, pp. 613-616; Iwai et al. 2009, entire; as cited in USFWS 2020). Thus, population estimates are typically derived from shrimp observations in the epigeal portion of the habitat. However, since only a few individuals at each site have been observed at a single time, population size is believed to be small. Small populations are extremely vulnerable to reduced reproductive success caused by inbreeding depression and loss of genetic variation over time due to random genetic drift, which results in a decreased evolutionary potential and ability to cope with environmental change (Lande 1988, p. 1455; as cited in USFWS 2020). Small populations like these are also demographically vulnerable to extinction caused by random fluctuations in population size and sex ratio (Lande

1988, p. 1455; as cited in USFWS 2020). In addition, there is likely little to no connectivity between sites. Based on the low number of individuals observed at each site and the distance between populations, there is likely limited connectivity between population and therefore little gene flow. However, no genetic work on this species has been completed. Therefore, comprehensive surveys and genetic studies are needed to more accurately determine total population size and structure.

The primary threats to *Procaris hawaiana* are: (1) habitat degradation and destruction due to urban development and other associated anthropogenic activities and (2) predation, competition, and habitat degradation by non-native fish, plants, and invertebrates, and (3) lack of population representation, resiliency, and redundancy due to its apparent low population count (USFWS 2020).

EB/CE Sources:

Department of Hawaiian Home Lands. 2016. South Point Resources Management Plan, Final. October 2016. 168 pp.

U.S. Fish and Wildlife Service (USFWS). 2020. *Procaris hawaiana* (anchialine pool shrimp). 5-year Review. Honolulu, Hawaii. 29 pp.

Species: *Vetericaris chaceorum*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: Multiple populations (few)

Species Trends: Unknown population trends

Pesticides noted ☒

Environmental Baseline/Cumulative Effects Summary:

Of the 700 known anchialine pools in the State of Hawaiʻi, *Vetericaris chaceorum* has only been documented in four pools at Manukā (Sakihara 2012, pp. 83−95; Sakihara 2013a, in litt.; as cited in USFWS 2020), and the single pool at Lua O Palahemo (Kensley and Williams 1986; Brock 2004, p. 7; Lau 2012, in litt; Wada 2012, in litt.; as cited in USFWS 2020). The Service has concluded that the lack of detection of this species in the several hundred anchialine pools surveyed on the island of Hawaii since the 1970s suggests this species has a very limited range (Holthius 1973, pp. 1–128 cited in Sakihara 2012).

A site visit by U.S. Fish and Wildlife Service (Service) employees to Lua o Palahemo was conducted in 2005 and 2012 and no individuals of *Vetericaris chaceorum* were observed (USFWS 2005, in litt; Wada 2012, in litt.; as cited in USFWS 2012). There are no records from any population surveys for this species at Lua O Palahemo since 1991. However, because of the difficulties in sampling a large anchialine pool, the rarity of the species, and infrequency of surveys we cannot conclude that *V. chaceorum* has been extirpated from this system and therefore we still include it as an extant population.

Lua O Palahemo is not part of a Natural Area Reserve (NAR). Instead, it is on land controlled by the Hawaiʻi State Department of Hawaiian Home Lands at the southern tip of the island (USFWS 2020). Lua O Palahemo is within 710 acres designated as a National Historic Landmark and is a popular recreation place for locals and visitors (Department of Hawaiian Home Lands 2016).

Manukā Watershed - Eighty-one pools in Manukā NAR and on adjacent state land were surveyed by Sakihara between 2009 and 2010, and *V. chaceorum* was only observed in four pristine pools. These pools occur in area that isn't highly desirable for fishing or camping, however vehicles do pass through to get to camp sites further down the coast (Sakihara 2012, pp. 83−95; Sakihara 2013a, in litt.; as cited in USFWS 2020). A total of five individuals were observed in three pools within the NAR and two individuals were observed in one pool just outside the NAR boundary (Sakihara 2012, in litt; Sakihara 2013b, in litt.; as cited in USFWS 2020). However, the total number of individuals within this population is undeterminable due to the cryptic nature of this species (Sakihara 2012, in litt.; as cited in USFWS 2020).

There are only four anchialine pools within the Manukā watershed that are known to host *V. chaceorum*. While three of those pools fall within the NAR boundary, the other pool is located on unencumbered State land that is adjacent to the NAR, which means that it is not subject to the same protections from potentially harmful activity as the pools that are within the NAR (Sakihara 2013a, in litt.; as cited in USFWS 2020).

Like other anchialine pool shrimp species, *V. chaceorum* inhabits an extensive network of water-filled interstitial spaces (cracks and crevices) leading to and from the actual pool, a trait which has precluded researchers from ascertaining accurate population size estimates without draining the entire pool (Holthuis 1973, p. 36; Maciolek 1983, pp. 613-616; Iwai et al. 2009, entire; as cited in USFWS 2020). Thus, population estimates are typically derived from shrimp observations in the epigeal portion of the habitat. However, since only a few individuals at each site have been observed at a single time, population size is believed to be small. Small populations are extremely vulnerable to reduced reproductive success caused by inbreeding depression and loss of genetic variation over time due to random genetic drift, which results in a decreased evolutionary potential and ability to cope with environmental change (Lande 1988, p. 1455; as cited in USFWS 2020). Small populations like these are also demographically vulnerable to extinction caused by random fluctuations in population size and sex ratio (Lande 1988, p. 1455). Although no genetic work has been completed for this species, genetic exchange between populations is likely non-existent since there is no direct connection between the Manukā watershed and Lua O Palahemo (Fransen et al. 2013, p. 630; as cited in USFWS 2020). Therefore, comprehensive surveys and genetic studies are needed to more accurately determine total population size and structure.

Overall, the primary threats to *V. chaceorum* are: (1) habitat degradation and destruction due to urban development and other associated anthropogenic activities and (2) predation, competition, and habitat degradation by non-native fish, plants, and invertebrates, and (3) lack of population representation, resiliency, and redundancy due to its apparent low population count (USFWS 2020).

EB/CE Sources:

Department of Hawaiian Home Lands. 2016. South Point Resources Management Plan, Final. October 2016. 168 pp.

U.S. Fish and Wildlife Service (USFWS). 2020. *Vetericaris chaceorum* (anchialine pool shrimp) 5-year Review. Honolulu, Hawaii. 29 pp.

Overall Vulnerability *Procaris hawaiana*: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability *Vetericaris chaceorum*: ☒ **High** ☐ **Medium** ☐ **Low**

RISK

(Risk is based on species exposure and response from labelled uses across the range)

Risk to individuals if exposed: Mortality is expected for anchialine pool shrimp exposed to malathion on use sites or from spray drift.

Risk to the species from labelled uses across the range:

The table below summarizes the risk to the species from labelled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

DIRECT (all uses except mosquito control)	
Use areas – mortality	No effects expected
Spray drift and runoff areas – mortality	Possible mortality depending on proximity to use sites
Volatilization	Not an appreciable source of exposure
INDIRECT (all uses except mosquito control)	
Use areas - Prey item mortality	N/A
Spray drift areas - Prey item mortality	N/A
Plants affected (decline in growth)	No effects expected
MOSQUITO CONTROL	
Direct (mortality)	Possible mortality if exposed
Indirect	No effects expected

Risk modifiers: Of the approximately 700 anchialine pools on the island of Hawai'i, only 26 are known to contain *P. hawaiana* and 5 to contain *V. chaceorum* which occur in a submerged lava tube on the southern point of Hawai'i Island and in a series of anchialine pool complexes on the southwestern edge of the island. Anchialine pools are land-locked bodies of water that occur coastally and form in enclosed limestone or volcanic rock coastal areas with a subterranean connection to the ocean but are not openly connected to the ocean (Macioleck 1983, pp. 607-612). They are mixohaline (or brackish), with salinities typically ranging from 2 ppt to concentrations just below that of sea water (32 ppt), although there are pools recorded as having salinities as high as 41 ppt (Maciolek 1983, pp. 607-612; Brock et al. 1987, p. 200). Anchialine pools are subject to tidal fluctuations. *P. hawaiana* also occurs on Maui, in two pools at Ahihi-Kinau Natural Area Reserve.

Anchialine pool shrimp spend all of their life cycle immersed in water. Malathion could enter anchialine pool shrimp habitat if there were direct application of mosquito adulticide, runoff and ground water recharge that originates in adjacent and upslope pesticide application sites, drift, and via volatilization and downwind deposition. Anchialine pools are at and below the elevations where applications and deposition of the pesticide would occur.

Overall Risk *Procaris hawaiana*: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Risk *Vetericaris chaceorum*: ☐ **High** ☒ **Medium** ☐ **Low**

USAGE

(Anticipated usage within the range based on past usage data)

Information regarding past usage of malathion in Hawaii is not available, however prior survey data has indicated that 4.8% of agricultural crops were treated with insecticides, with malathion only being a subset of this, assuming its use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the Approach to Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in Hawaii. Future use cannot be ruled out but is not expected at high levels.

Overall Usage *Procaris hawaiana*: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Usage *Vetericaris chaceorum*: ☐ **High** ☒ **Medium** ☐ **Low**

CONSERVATION MEASURES

Rain restriction: Label language includes restricting malathion application to periods where rain is not forecasted for at least 48 hours for agriculture and 24 hours for residential use or when the soil is not saturated. Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing the likelihood of exposure by substantially reducing the amount of malathion that would reach the habitats in which these species reside.

Aquatic habitat buffers: Application buffers are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. We anticipate that, in many cases, these buffers significantly reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

Reduced application number and rate: New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop, previous allowable number of applications ranged from 3 to 13 applications per year). We anticipate this measure will help reduce the amount of malathion used and decrease potential exposure to the species.

CONCLUSION

After reviewing the current status of the species, the environmental baseline for the Action area, and the effects of the proposed registration of malathion, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of *Procaris hawaiana* and *Vetericaris chaceorum* anchialine pool shrimp. As discussed below, even though the vulnerability is high and the risk and usage is medium for these two species, we anticipate the likelihood of exposure will be low as the implementation of the general conservation measures described above are expected to reduce the likelihood of exposure. While we anticipate that very small numbers of individuals will be affected over the duration of the proposed Action, we do not expect species-level effects to occur.

The *P. hawaiana* and *V. chaceorum* anchialine pool shrimp have high vulnerability based on their status, distributions, and trends. *P. hawaiana* faces threats from development upslope of anchialine pool habitats and the infiltration of wastewater or application of fertilizer and pesticides that may enter the ground water system of the anchialine pools and consequently affect the pool's water quality (USFWS 2016b). *V. chaceorum* is only known from five sites on the island of Hawai'i in anchialine pools that are at and below the elevations where applications and deposition of the pesticide would occur. In addition, pesticides are listed as a concern for these species.

The risk to these species posed by the labeled uses across the range is medium, with a medium amount of estimated usage within the range of these species. While usage is not expected on all use sites at the maximum rates allowed by the label, we anticipate that usage would occur in a few areas related to certain use types, as described below.

On the Island of Hawaii, currently known populations of *P. hawaiana* and *V. chaceorum* do not occur within or adjacent to agricultural crop areas. Mapped pasture is found within approximately a mile from the *P. hawaiana* site at Kaloko-Honokōhau, a National Historic Park and within a mile at the *P. hawaiana* and *V. chaceorum* site at Lua O Palahemo. Mapped pasture is also adjacent to the *P. hawaiana* site at the ʻĀhihi-Kinaʻu Natural Area Reserve (NAR) Maui. While pasture is mapped adjacent to some of these sites, it appears based on visual analysis of GIS data layers, that forage crops (namely alfalfa) are not the sole use of these areas within proximity of occupied anchialine pool shrimp sites. Grazing appears to occur on existing vegetation cover, but we anticipate malathion use would likely be minimal. The only known population of anchialine pool shrimp that is directly adjacent to developed areas is the *P. hawaiana* population at Kaloko-Honokōhau. At present, available information indicates that malathion is not used as a mosquito control agent in Hawaii.

The areas in which these species are found offer varying degrees of protection from exposure of malathion applications. For example, of the 28 populations of *P. hawaiana*, 22 are found in protected areas (one in Kaloko-Honokōhau, two in ʻĀhihi-Kinaʻu NAR, and 19 in Manukā NAR). It is not anticipated that malathion applications will occur in these areas, therefore direct spray or spray drift is not anticipated. Five of the remaining sites occur within the Manukā watershed, outside of the NAR, in adjacent unencumbered State land. While these lands are not afforded the same protection as NAR lands, they are still void of agricultural crops sites, pasture and developed areas, and therefore, we do not anticipate malathion use in these areas. One other area of concern is the single site at Kaloko-Honokōhau. While the site is in a National Historic Park, the park abuts dense, developed areas. While direct spray and drift of malathion to the pools themselves is unlikely, ground water that feeds the pools may be contaminated by malathion runoff and drift where applications occur. We anticipate that ground water contaminated by malathion would cause mortality to one or more individuals of a given anchialine pool population.

Similarly, of the five populations of *V. chaceorum*, three are found in protected areas (all three in Manukā NAR). One additional site occurs within the Manukā watershed, outside of the NAR, in adjacent unencumbered State land. While these lands are not afforded the same protection as NAR lands, they are still void of agricultural crops sites, pasture and developed areas and therefore, and we do not anticipate malathion use in these areas.

For both species, the remaining site at which they are found is at Lua O Palahemo. This site is within a 710-acre designated National Historic Landmark and is a popular recreation place for locals and visitors. This area is also devoid of agricultural crop land and developed areas, and as such, direct spray or spray drift of malathion is not anticipated at this site. There are potential malathion use sites (agricultural crops/pasture/developed) in the upper watershed, therefore, groundwater that feeds the pool at Lua O Palahemo could be contaminated by malathion runoff and drift. As noted above for Kaloko-Honokōhau, ground water that is contaminated by malathion has the potential to cause mortality to one or more individuals of a given anchialine pool population.

Thus, we anticipate there are a limited number of sites for these species where exposure would be expected to occur. To summarize from above, of the 28 sites where *P. hawaiana* is known to occur, we believe that individuals in only two of these sites would be exposed to malathion through groundwater sources over the duration of the Action. Similarly, of the five sites where *V. chaceorum* is known to occur, we anticipate individuals in only one of these sites currently occupied would be exposed to malathion through groundwater sources. Groundwater may be contaminated by direct spray, spray drift and runoff on any of the malathion application sites that occur upslope of the drainages that *P. hawaiana* and *V. chaceorum* occur in (i.e., Lua O Palahemo and Kaloko-Honokōhau), although direct spray and spray drift are not anticipated to reach individuals of these species through other surface pathways. Groundwater contaminated with malathion poses a risk to one or more individuals within individual pools, in the absence of effective conservation measures.

In addition, we anticipate the conservation measures above, including rain restrictions and aquatic habitat buffers, residential use label changes, and reduced numbers and application rates would further reduce the risk of exposure to these species. Since *P. hawaiana* and *V. chaceorum* are aquatic invertebrates and spend their entire lives in anchialine pools for foraging and breeding, the rain restriction is anticipated to reduce the likelihood of exposure to these crustaceans (directly or in runoff) and the aquatic habitat buffers are expected to reduce the likelihood of spray drift and exposure to aquatic organisms. The reduction in the number of applications and application rates for certain agricultural crops will further help reduce the amount of malathion used and the likelihood of exposure to these species and their habitat.

Based on the limited amount of malathion that would reach individuals of the species, which we expect will be further reduced based on the implementation of these conservation measures, we anticipate only very small numbers of individuals will be lost over the duration of the Action. We do not believe the loss of a small number of individuals in a few pools relative to the overall number of populations would lead to species-level effects.

Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of *P. hawaiana* and *V. chaceorum* in the wild.

Conclusion *Procaris hawaiana*: **Not likely to jeopardize**

Conclusion *Vetericaris chaceorum*: **Not likely to jeopardize**

ADDITIONAL REFERENCES

Brock, R.E., J.E. Norris, D.A. Ziemann, and M.T. Lee. 1987. Characteristics of water quality in anchialine ponds of the Kona, Hawaii, coast. Pac. Sci. 41: 200-208.

Maciolek, J.A. 1983. Distribution and biology of Indo-Pacific insular hypogeal shrimps. Bull. Mar. Sci. 33:606-618.

U.S. Fish and Wildlife Service (USFWS). 2016a. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/ecp0/. Accessed October 2016.

U.S. Fish and Wildlife Service (USFWS). 2016b. Endangered Status for 49 Species from the Hawaiian Islands. Final Rule. Honolulu, HI.

Integration and Synthesis Summary: Pacific Islands Invertebrates

BUTTERFLIES

Scientific Name:	Common Name:	Entity ID:
Hypolimnas octocula marianensis	Mariana eight-spot butterfly	4308
Vagrans egistina	Mariana wandering butterfly	5168

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Species: Mariana eight-spot butterfly

Status: Endangered

Distribution:

Number of Populations: Single population

Species Trends: Declining

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary Mariana eight-spot butterfly:

The Mariana eight-spot butterfly (*Hypolimnas octocula marianensis*) is a butterfly in the Nymphalidae family, is known solely from the islands of Guam and Saipan, in the forest ecosystem (USFWS 2015). The species historical range included Guam and the Northern Mariana Islands. The larvae of this butterfly feed on two native plants, *Procris pedunculata* and *Elatostema calcareum* (tapun ayuyu) (Schreiner and Nafus, 1996, p. 1, as cited in USFWS 2015). Both of these forest herbs (family Urticaceae) are found only on karst substrate within the forest ecosystem, draped over boulders and small cliffs (Schreiner and Nafus 1996, p. 1; Rubinoff 2013, in litt., as cited in USFWS 2015). When adult butterflies were observed, they were always in proximity to the host plants (Rubinoff 2011, in litt.; Rubinoff 2013, p. 1, as cited in USFWS 2015). The two host plants have been recorded on the islands of Guam, Rota, Saipan, and Tinian (Schreiner and Nafus 1996, p. 2; Schreiner and Nafus 1997, p. 26; Harrington et al. 2012, in litt.; Rubinoff and Haines 2012, in litt.; Rubinoff, in litt. 2013, as cited in USFWS 2015). However, despite recent surveys (2011–2013) on Rota, Tinian, and Saipan, the Mariana eight-spot butterfly is currently known only from the island of Guam (Schreiner and Nafus 1996,

p. 2; Schreiner and Nafus 1997, p. 26; Rubinoff and Haines 2012, in litt.; Rubinoff 2013, in litt., as cited in USFWS 2015).

Mariana eight-spot butterfly has been detected at nine sites on Guam in the karst limestone forest ecosystem (Schreiner and Nafus 1996, p. 2; Schreiner and Nafus 1997, p. 26, as cited in USFWS 2015), and may be extirpated from Saipan (Schreiner and Nafus 1997, p. 26; Rubinoff and Haines 2012; Rubinoff 2013, as cited in USFWS 2015). Currently, there are six known populations (USFWS 2021).

The Mariana eight-spot butterfly is vulnerable to the impacts of continued habitat loss and destruction from agriculture, urban development, nonnative animals and plants, and typhoons. We anticipate the effects of climate change will further exacerbate many of these threats in the future. Herbivory of its host plants by nonnative animals, combined with direct predation by ants and parasitic wasps, contribute to the decline of the Mariana eight-spot butterfly (USFWS 2015).

EB/CE Source(s):

U.S. Fish and Wildlife Service (USFWS). 2015. Endangered and Threatened Wildlife and Plants; Endangered Status for 16 Species and Threatened Status for 7 Species in Micronesia. 80 FR 59423 59497. Final Rule. October 1, 2015.

U.S Fish and Wildlife Service (USFWS). 2021. Mariana eight-spot butterfly (*Hypolimnas octocula marianensis*). 5-Year Review. Honolulu, Hawai‘i. 24 pp.

Species: Mariana wandering butterfly

Status: Endangered

Distribution: Population size/location unknown

Number of Populations: Population size/location(s) unknown

Species Trends: Unknown population trends

Pesticides noted ☒

Environmental Baseline/Cumulative Effects (EB/CE) Summary Mariana wandering butterfly:

The Mariana wandering butterfly (*Vagrans egistina*) is endemic to the islands of Guam and Rota in the Mariana archipelago, in the forest ecosystem (USFWS 2015). Mariana wandering butterflies are known to be good fliers, and in earlier times, probably existed as a series of meta-populations (Harrison et al. 1988, p. 360; as cited in USFWS 2015), with considerable movement and interbreeding between local and stable populations and continued colonization and extinction in disparate localities. The larvae of this butterfly feed on the plant species *Maytenus thompsonii* (luluhut) in the Celastraceae family, which is endemic to the Mariana Islands (Swezey 1942, p. 35; Schreiner and Nafus 1996, p. 1; as cited in USFWS 2015). The host plant

M. thompsonii is known to occur within the forest ecosystem on Guam, Rota, Saipan, and Tinian (Vogt and Williams 2004, p. 121; as cited in USFWS 2015). Historically, the Mariana wandering butterfly was originally collected and described from the island of Guam where it was considered to be rare, but widespread (Swezey 1942, p. 35; as cited in USFWS 2015). The species has not been observed in Guam since 1979, where it was last collected in Agana. Currently, it is considered likely extirpated from Guam (Schreiner and Nafus 1996, pp. 1–2; Rubinoff 2013, in litt.; as cited in USFWS 2015). The Mariana wandering butterfly was first collected on Rota in the 1980s (Schreiner and Nafus 1996, p. 10; as cited in USFWS 2015). During several 1995 surveys on Rota, it was recorded at only one location among six different sites surveyed (Schreiner and Nafus 1996, pp. 1–2; as cited in USFWS 2015). From June through October 2008, extensive surveys for the Mariana wandering butterfly were conducted on the island of Tinian under the direction of the Service. While several *Maytenus thompsonii* host plant population sites were identified in limestone forest habitat, no life stages of the Mariana wandering butterfly were observed (Hawley in litt., 2008, pp. 1–9; as cited in USFWS 2015). Despite extensive surveys on Guam in 2013 for the Mariana wandering butterfly and several other candidate species, no evidence (i.e., egg, larva, or adult) of the Mariana wandering butterfly was found (Lindstrom and Benedict 2014, pp. 21– 41; as cited in USFWS 2015). Hundreds of hours of surveys on Guam were conducted annually from 2011 to 2015, but no Mariana wandering butterfly were recorded in areas of suitable limestone forest habitat often containing abundant host plants (Rubinoff and Holland 2018, p. 220; as cited in USFWS 2020). Similarly, rare butterfly surveys by other biologists in Guam over the years failed to detect the Mariana wandering butterfly (Rubinoff and Haines in litt. 2012; Rubinoff in litt. 2013; Moore 2013; Demeulenaere et al. 2018; as cited in USFWS 2020). In 2012, entomologists conducted approximately 40 hours of surveys across four days and examined the habitat in and near the last locality where the butterfly was observed, Chenchon Bird Sanctuary in southeast Rota. While the Mariana wandering butterfly was not found, hundreds of square meters of very dense and healthy stands of the Maytenus thompsonii host plant were observed (Rubinoff and Holland 2018, p. 223; as cited in USFWS 2020). Based on the population trend and lack of detections in recent surveys, the Mariana wandering butterfly is likely extirpated on Guam, but may still exist on Rota in small numbers (USFWS 2020).

It is possible this species occurs on the northern islands where host plants are found (Rubinoff 2014, in litt.; as cited in USFWS 2015), although there is no record of its presence. Several years of seasonal surveys are needed to determine the status of this species, but if it persists, it is likely in very low numbers as it has not been observed in many years. The native limestone forest in Guam and Rota that supports the wandering butterfly's presumed host plant continues to decline due to development and modification, ungulate pressure, typhoons, nonnative plants, and fire. The primary direct stressors to the butterfly likely include high egg mortality and predation from native and nonnative insects including ants and parasitic wasps (USFWS 2020). Pesticides were once applied in great quantities in Guam, Saipan, and Tinian (Wiles and Worthington 2002, p. 17; as cited in USFWS 2020) and may have contributed to the early decline and loss of the Marian wandering butterfly.

EB/CE Sources:

U.S. Fish and Wildlife Service USFWS. 2015. Endangered and Threatened Wildlife and Plants; Endangered Status for 16 Species and Threatened Status for 7 Species in Micronesia. Federal Register 80(190): 59424-59497. October 1, 2015.

U.S Fish and Wildlife Service (USFWS). 2020. Wandering Butterfly (*Vagrans egistina*) 5-Year Review. Honolulu, Hawai'i. 11 pp.

Overall Vulnerability Mariana eight-spot butterfly: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability Mariana wandering butterfly: ☒ **High** ☐ **Medium** ☐ **Low**

RISK

(Risk is based on species exposure and response from labelled uses across the range)

Risk to individuals if exposed: Mariana butterflies exposed to malathion on use sites or from spray drift are expected to die.

Risk to the species from labelled uses across the range:

The table below summarizes the risk to the species from labelled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

DIRECT (all uses except mosquito control)	
Use areas – mortality	Mortality if exposed
Spray drift areas – mortality	Mortality depending on proximity to use sites
Volatilization	Not an appreciable source of exposure
INDIRECT (all uses except mosquito control)	
Use areas - Prey item mortality	N/A
Spray drift areas - Prey item mortality	N/A
Plants affected (decline in growth)	Effects on use sites with higher allowable application rates
MOSQUITO CONTROL	
Direct (mortality)	Mortality if exposed
Indirect	No effects expected

Risk modifiers:

Mariana eight-spot butterfly larvae are known to feed on two native forest herbs, *Procris pedunculata* (the original recorded host plant) and *Elatostema calcareum* (also discovered to be a host during surveys in 1995) (Schreiner and Nafus, 1996, p. 1). Adult females lay their eggs on the larval host plants. Adults nectar feed on flowers including Hibiscus ornamental plants (Samson 1986 in Lindstrom and Benedict p. B8). On Guam, the butterfly and its life stages (e.g., eggs, larvae) are known to occur at Orote Point, Hilaan, Tweed's Cave area, Pagat Cave area, Mangilao golf course, Fadian cove, NWF, and the Finegayan area (NAVFAC Pacific 2010; USFWS 2012a; Globeteck and HDR 2012; Lindstrom and Benedict 2014, p. 9).

Mariana eight-spot butterflies are likely to be exposed to malathion in pasture, open space developed, other crops, vegetables and ground fruit, orchards and vineyards, and from mosquito control. Mariana eight-spot butterflies could be exposed to malathion if they come in contact with the pesticide in application and drift sites and it is deposited onto their bodies, absorbed from contacting it on host plants, when they nectar on treated plants, and when they ingest the pesticide by drinking water containing the pesticide. The butterfly larvae could ingest the pesticide when it is deposited on leaves of host plants. In addition, this pesticide volatilizes readily and transported downwind and deposited as dry deposition and in precipitation. Although we would expect species within high-level elevation areas to be exposed to malathion via volatilization, we conclude, based on the best information available, that species in high elevations would not be exposed to concentration levels that would affect them (see *General Effects* for further information on volatilization).

The Mariana wandering butterfly is known to occur within the I-Chenchon Park Bird Sanctuary on the southern coast of Rota in limestone karst forest habitat where its larva feeds on *Maytenus thompsonii*. I-Chenchon Park Bird Sanctuary is one of three areas on the island of Rota owned and under the jurisdiction and protection of the CNMI Division of Fish and Wildlife (DFW) (DFW 2013). Within this area and most areas surveyed on Rota, the host plant, *Maytenus thompsonii*, was found to be abundant (Schreiner and Nafus 1996, p. 1), so it is likely the butterflies range widely over the island, especially given that it is a strong flier. This species is declining due to numerous non-native insect predators and parasitoids. Non-native ants prey on egg and immature stages of butterflies.

Overall Risk Mariana eight-spot butterfly: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Risk Mariana wandering butterfly: ☐ **High** ☒ **Medium** ☐ **Low**

USAGE

(Anticipated usage within the range based on past usage data)

Information regarding past usage of malathion is not available for either Guam or the Mariana Islands. Based on survey data collected in Hawaii, we estimate that 4.8% of agricultural crops were treated with insecticides. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the Approach to Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in Guam or the Mariana Islands; future use cannot be ruled out but is not expected to increase significantly.

Overall Usage Mariana eight-spot butterfly: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Usage Mariana wandering butterfly: ☐ **High** ☒ **Medium** ☐ **Low**

CONSERVATION MEASURES

Residential use label changes: New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely), reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application.

Reduced application number and rate: New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop, previous allowable number of applications ranged from 3 to 13 applications per year). We anticipate this measure will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

CONCLUSION

After reviewing the current status of these species, the environmental baseline for the Action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the Mariana eight-spot butterfly and the Mariana wandering butterfly. As discussed below, even though the vulnerability is high, the risk and uage are medium, and we anticipate the implementation of the general conservation measures described above is expected to reduce the likelihood of exposure. We do not anticipate the Action will result in species-level effects.

The Mariana eight-spot butterfly and the Mariana wandering butterfly have high vulnerability based on their estimated status, distribution, and trends. The risk to these species posed by the labeled uses across the range is medium, and there is a medium amount of estimated usage within the range of these species. While usage is not expected on all use sites and at the maximum rates allowed by the labels where used each year, we anticipate that some use would occur based on information from a prior survey that estimated 4.8% of agricultural crops were treated with insecticides. The Mariana eight-spot butterfly and the Mariana wandering butterfly inhabit limestone karst forest habitat and at least one golf course. Mariana eight-spot butterflies are likely to be exposed to malathion in pasture, open space developed, other crops, vegetables and ground fruit, orchards, and vineyards, and from mosquito control, but the use is very low. Based on this information, we do not expect the Mariana eight-spot butterfly or the Mariana wandering butterfly to be exposed on malathion use sites. Furthermore, since these two species rely on specific host plants for foraging and breeding within karst forest ecosystems, we anticipate the conservation measures above, including residential use labels changes (such as application by spot treatment which renders spray drift off site unlikely) and reduction to the allowable number of applications and application rates (decreases the amount of malathion used) would further reduce the risk of exposure to these species and their habitats. Together, these measures are anticipated to further reduce the likelihood of exposure to these species and their habitat. We expect exposure of individuals of these species and their forage base will occur only at very low levels over the duration of the Action and would likely not result in mortality, sublethal effects, or measurable impacts to their food resources.

Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of these two butterflies in the wild.

Conclusion Mariana eight-spot butterfly: Not likely to jeopardize

Conclusion Mariana wandering butterfly: Not likely to jeopardize

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***ADDITIONAL REFERENCES*:**

Rubinoff, D. and B. Holland. 2018. The conservation status of two endangered Mariana butterflies, *Hypolimnas octocula marianensis* and *Vagrans egistina* (Nymphalidae). Journal of the Lepidopterists' Society. Volume 72, Number 3, pp. 1-9.

Integration and Synthesis Summary: Pacific Islands Invertebrates

MOTHS

Scientific Name:	Common Name:	Entity ID:
Manduca blackburni	Blackburn’s sphinx moth	446

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

The Blackburn’s sphinx moth (BSM) has been recorded from the islands of Kauai, Kahoolawe, Oahu, Lanai, Molokai, Maui, and Hawai’i but is now found only on Hawai’i, Maui, and Kahoolawe (USFWS 2019). The species has been observed from sea level to 5,000 feet (1,525 m) elevation (USFWS 2005, p. 10; Duvall, pers. comm., 2011). Most historical records were from coastal or lowland dry forest habitats in areas receiving less than 50 in (127 cm) annual rainfall. Blackburn’s sphinx moth (BSM) population numbers are believed to be small based upon past sampling results, however, no reasonably accurate estimate of population exists due to the adult moths’ wide-ranging behavior and the species’ overall rarity (A. Medeiros, USGS-BRD, pers. comm., 2014; Van Gelder and Conant 1998, pp. 7-16).

Status: Endangered

Distribution: Species/Populations neither constrained nor widespread

Number of Populations: Multiple populations (few)

Species Trends: Unknown population trends

Pesticides noted ☒

Environmental Baseline/Cumulative Effects (EB/CE) Summary:

The Blackburn’s sphinx moth (BSM) is endemic to the Hawaiian Islands and is currently found on the islands of Hawaii, Maui, and Kahoolawe (USFWS 2005, 2009). As of 2019, the species appears to be absent from Kaua‘i, O‘ahu, Lāna‘i and Moloka‘i (USFWS 2019). The Blackburn’s sphinx moth is believed to have declined over the past 100 years, probably as a result of habitat loss and mortality from non-native predators and parasitoids. Loss and degradation of habitat for the species continues due to overgrazing by introduced ungulates. Alien arthropods continue to impact the species through predation, competition, and parasitism. In addition, the accidental or intentional release of alien predators and competitors continues to threaten the species. Long-term changes in climatic conditions due to global warming are also expected to impact the distribution and abundance of available habitat for the species. However, the extent of these impacts on the Blackburn’s sphinx moth’s populations remains unknown. Although some habitats are under public ownership and zoned for conservation purposes, no known Blackburn’s sphinx moth-occupied habitat areas or populations are entirely protected from the threats of invasive, non-native weeds, wildfire, and/or predaceous or parasitic non-native insect species.

Impacts to the moth's habitat from urban and agricultural development, invasion by non-native plant species, habitat fragmentation and degradation, increased wildfire frequency, ungulates, and direct impacts to the moth from non-native parasitoids and insect predators have significantly reduced the species' range (A. Medeiros, U.S. Geological Survey-Biological Resource Division, pers. comm., 2001; E. Van Gelder and S. Conant, in litt., 1998; as cited in USFWS 2009). The primary threats to the moth now include predation by ants and parasitic wasps that prey on the eggs and caterpillars, and the continued decline of its native larval host plants partly as a result of feral ungulates.

Rubinoff and San Jose (2010; as cited in USFWS 2019) examined larval host plant preferences for this species and confirmed findings of previous studies that Blackburn's sphinx moth larvae could develop on a range of native and non-native plants in the Solanaceae (nightshade) family. In addition to using known larval hosts like the native and endangered ʻaiea (*Nothocestrum* spp.) and the invasive tree tobacco (*Nicotiana glauca*), the species also have the ability to develop fully on the native ʻolohua (glossy nightshade; *Solanum americanum*) and pōpoloʻaikeakua (*Solanum sandwicense*) in a laboratory setting. These potential larval host plants could provide additional restoration options for land managers that would benefit this species (Rubinoff and San Jose 2010; as cited in USFWS 2019). The 2005 Recovery plan noted that many alien weeds are known to be an important indirect threat to *Nothocestrum* sp. and that invasive weed control (e.g., removal by hand, local herbicide application, and biological control) should be a priority management activity for the Blackburn's sphinx moth management units (USFWS 2005). To avoid impacts to the Blackburn's sphinx moth, the recovery plan recommended that herbicide application be supervised by experienced managers.

Our current knowledge of the overall distribution of BSM is based largely on incidental sightings (USFWS 2019). On Maui, observations of BSM have been made from the Kanaio area on leeward Haleakalā, ʻUlupalakua, Wailea/Mākena, Makawao, Launiupoko on west Maui, along Kuihelani Highway in the central valley, and along the north coast from Waiheʻe to Kanahā (USFWS 2005, USFWS unpublished data; as cited in USFWS 2019). While incidental observations have occurred on both ʻaiea and tree tobacco in a variety of habitat types and elevations, the restricted distribution of ʻaiea leads us to believe that the majority of the current BSM range is now based on tree tobacco occurrence (USFWS 2019). As tree tobacco grows in disturbed areas (i.e., along roadsides or recently cleared/graded ground/fallow fields), BSM has incidentally been found along highway rights-of-way, parking lots, and other highly degraded areas, as well as in more intact native dry forests and shrublands where remnant ʻaiea persists. Tree tobacco has also appeared to have significantly expanded in the fallow sugar cane fields throughout the low-elevation "saddle" area of Maui since sugar production on Maui ended in 2016. Roadside surveys conducted by DOFAW documented the distribution of tree tobacco along major highways in 2017. They found tree tobacco widely distributed in dry and mesic areas from Nuʻu to Launiupoko in the south of the island, from Waiheʻe to Hoʻokipa in the north, and up to elevations of around 3,000 feet (ft) (940 meters [m]) in Kula (DOFAW 2017, as cited in USFWS 2019). This area would represent approximately 55,000 to 60,000 hectares (ha)

(135,000 to 150,000 acres [ac]) of potential habitat, though tree tobacco density varies widely within the entire area. BSM has been recently documented from surveys on Kahoʻolawe, which were conducted in 2018 and 2019. Similar to previous documentation, BSM was found to be not uncommon on tree tobacco (C. King pers. comm. 2018, as cited in USFWS 2019). On the island of Hawaiʻi, BSM are known from the Puʻu Anahulu and Puʻu Waʻawaʻa areas, as well as along Saddle Road, all locations where comprehensive surveys have been conducted. BSM presence is not currently known from Lānaʻi, though there were reports of moths present in 2011 (USFWS unpublished data, as cited in USFWS 2019). None have been reported since that time, though no comprehensive surveys have been conducted. No recent sightings have been made on Molokaʻi (last observed in 1940s), Oʻahu (1931), or Kauaʻi (1940). It is worth noting that tree tobacco has not been documented from Kauaʻi, though it is found on all other islands.

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2005. Recovery Plan for the Blackburn's Sphinx Moth (*Manduca blackburni*). Portland, Oregon. 125 pp.

U.S. Fish and Wildlife Service (USFWS). 2009. Blackburn's Sphinx Moth (*Manduca blackburni*) 5-Year Review Summary and Evaluation. Honolulu, Hawaii. 15 pp.

U.S. Fish and Wildlife Service (USFWS). 2019. Blackburn's Sphinx Moth (*Manduca blackburni*) 5-Year Review Summary and Evaluation. Honolulu, Hawaii. 20 pp.

Overall Vulnerability: ☒ **High** ☐ **Medium** ☐ **Low**

RISK

(Risk is based on species exposure and response from labelled uses across the range)

Risk to individuals if exposed: Blackburn's sphinx moth exposed to malathion on use sites or from spray drift are expected to die.

Risk to the species from labelled uses across the range:

The table below summarizes the risk to the species from labelled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

DIRECT (all uses except mosquito control)	
Use areas – mortality	Mortality if exposed
Spray drift areas – mortality	Mortality depending on proximity to use sites
Volatilization	May be a source of exposure
INDIRECT (all uses except mosquito control)	
Use areas - Prey item mortality	No effects expected
Spray drift areas - Prey item mortality	No effects expected
Plants affected (decline in growth)	On use sites with higher allowable application rates

MOSQUITO CONTROL	
Direct (mortality)	Mortality if exposed
Indirect	No effects expected

Risk modifiers: The Blackburn's sphinx moth adult is large, nocturnal, strong-flighted, and wide-ranging. Adults fly over large areas at night feeding on nectar of native plants and non-native plants including agricultural and horticultural plants. Rubinoff and San Jose (2010) examined larval host plant preferences for this species and confirmed findings of previous studies that Blackburn's sphinx moth larvae could develop on a range of native and non-native plants in the Solanaceae (nightshade) family. Blackburn's sphinx moth eggs are laid on the leaves of plants in the Solonacee Family including native aiea (*Nothocestrum* spp.), non-native tree tobacco (*Nicotiana glauca*), which readily invades and occupies disturbed areas such as agricultural fields and roadway margins, commercial tobacco (*Nicotiana tabacu)*, eggplant (*Solanum melongena*), and tomato (*Lycopersicon esculentum*), and possibly Jimson weed (*Datura stramonium*; Riotte 1986, p. 89).

Blackburn's sphinx moth adults and larvae may be exposed to malathion pesticide in application sites and from spray drift. Eggs, larvae, and adults can absorb the pesticide when it is deposited onto them and when they come into contact with vegetation where it has been deposited due to application, drift, downwind deposition, and, in Hawai'i, fog belt deposition. Although we would expect species within high-level elevation areas to be exposed to malathion via volatilization, we conclude, based on the best information available, that species in high elevations would not be exposed to concentration levels that would affect them (see *General Effects* for further information on volatilization). Blackburn's sphinx moth larvae may ingest the pesticide deposited on the leaves of tree tobacco and other Solonaceous host plants. Although difficult to predict and believed to be low, Blackburn's sphinx moth adults may also be exposed by ingesting the pesticide in nectar of flowers located within the drift areas adjacent to application sites and by drinking water droplets on leaves and stems of plants in the application and drift sites.

Overall Risk: ☒ **High** ☐ **Medium** ☐ **Low**

USAGE

(Anticipated usage within the range based on past usage data)

Information regarding past usage of malathion in Hawaii is not available, however prior survey data has indicated that 4.8% of agricultural crops were treated with insecticides, with malathion only being a subset of this, assuming its use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the Approach to Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in Hawaii; future use cannot be ruled out but is not expected to increase significantly.

Overall Usage: ☐ High ☒ Medium ☐ Low

CONSERVATION MEASURES

General Conservation Measures

Residential use label changes: New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

Reduced application number and rate: New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop, previous allowable number of applications ranged from 3 to 13 applications per year). We anticipate this measure will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

Species-specific Conservation Measures - The following species-specific measures are now part of the Action and will be included in *BulletinsLive Two:*

Within the range of the species, applicators must follow one of these measures, where feasible:

1. Apply malathion only when the wind is blowing away from dry and mesic forest and shrubland habitats OR
2. Use a 50-foot ground buffer from dry and mesic forest and shrubland habitats, and an aerial buffer from dry and mesic forest and shrubland habitats: (1) 50 feet for <0.5 lbs. ai/A; (2) 75 feet for 0.5 - <1 lb. ai/A; (3) 150 feet for 1-2.5 lbs. ai/A; (4) 200 feet for >2.5 lbs. ai/A. Buffer sizes may be reduced by 25 feet for application rates (1) and (2) if a full swath displacement upwind is used during aerial application. Buffer sizes may be reduced by 50 feet for application rates (3) and (4) if a full swath displacement upwind is used during aerial application. Swath displacement is a typical practice in the aerial

application of pesticides where applicators adjust the position of spray to account for pesticide that may drift into adjacent areas. For example, applicators may skip an outer row of trees or avoid spraying to the edge of the field. In our conservation measure for Blackburn's sphinx moth, we allow applicators to reduce the required buffer size by 50 feet if using a full swath displacement, which we anticipate will generally be roughly equivalent to this distance. The full swath displacement effectively acts as a buffer and the resultant distance from species habitat is expected to be the same size whether swath displacement is used or not.

If the measures above are not feasible to implement, applicators must contact the local USFWS Ecological Services Field Office to determine appropriate measures to ensure the proposed application is likely to have no more than minor effects on the Blackburn's Sphinx Moth. The applicator must retain documentation of the technical assistance and the agreed upon species-specific measures that were implemented and document the measures recommended and implemented.

In addition, applicators must schedule irrigations and malathion applications to maximize the interval of time between malathion application and the first subsequent irrigation, allowing at least 24 hrs. between malathion application and irrigation.

CONCLUSION

After reviewing the current status of the species, the environmental baseline for the Action area, and the effects of the proposed registration of malathion, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the Blackburn's sphinx moth. As discussed below, even though the vulnerability and risk are high and the usage is medium for the species, and we anticipate that the likelihood of exposure to malathion will be low with the implementation of the general and species-specific conservation measures described above. While we anticipate that very small numbers of individuals of this species will be affected over the duration of the proposed Action, we do not expect species-level effects to occur.

The Blackburn's sphinx moth has a high vulnerability based on its status, distribution, and trends. The risk to the species posed by the labeled uses across the range is also high, and there is a medium amount of estimated usage within the range of the species based on prior survey data. While usage is not expected on all use sites at the maximum rates allowed by the labels where used each year, we anticipate that usage could occur on up to 4.8% of agricultural crops, as stated above, and up to 5% of developed and open space developed use sites. Current information indicates that malathion is not used as a mosquito control agent in Hawaii.

Based on recent sightings and known behavior patterns, the Blackburn's sphinx moth is most likely to be directly exposed to malathion on agricultural and residential use sites. More specifically, malathion is registered for use on tomatoes, eggplant, and tobacco (crops belonging in the vegetables and ground fruit, and 'other crops' UDL categories), some of the plants the moth has been documented to use as larval host plants. It has also been found on non-native tree tobacco in highly disturbed sites, which is often associated with residential areas and open space developed areas where malathion use could occur. However, we anticipate a reduction in the level of potential exposure on developed, open space developed, and agricultural use sites due to changes on residential and agricultural label that reduce the amount of malathion use in these areas. Although malathion could be deposited through volatilization in precipitation from fog deposition at higher elevations, we do not expect volatilization to be an appreciable source of exposure (see *General Effects*).

We anticipate that the residential use restrictions and the reduction in number of application and application rates, wind restrictions, ground/aerial buffers, and time restrictions for scheduling irrigations and applications are expected to reduce the amount of malathion used and limit the likelihood of spray drift and runoff exposure to this species and its habitats. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely), reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. We also anticipate the new label restrictions reducing the number of applications and application rate for pasture will reduce the amount of malathion used and decrease potential exposure to the species. Importantly, the species-specific conservation measure requires that malathion be applied when wind is blowing away from dry and mesic forest and shrubland habitats or using a 50-foot ground buffer from dry and mesic forest and shrubland habitats and an aerial buffer ranging between 50 and 200 feet depending upon the lbs. ai/A. In addition, irrigations and malathion applications must be scheduled to maximize the interval of time between malathion application and the first subsequent irrigation, allowing at least 24 hours between malathion application and irrigation. Moreover, under this species-specific measure, if a measure is not feasible to implement, applicators are required to reach out to local USFWS Ecological Services field office to determine appropriate measures to ensure the proposed application is likely to have no more than minor effects on the Blackburn's sphinx moth. Together, these measures are anticipated to substantially reduce mortality of individuals of this species from application of malathion within and immediately surrounding the range of this species.

Thus, we anticipate small numbers of individuals of this species will experience mortality over the duration of the Action, we do not anticipate the loss of small numbers of individuals would result in species-level effects. Therefore, we do not anticipate the proposed Action would appreciably reduce survival and recovery of the Blackburn's sphinx moth in the wild.

Conclusion Blackburn's sphinx moth: Not likely to jeopardize

ADDITIONAL REFERENCES

Riotte, J. C. E. 1986. Re-evaluation of *Manduca blackburni* (Lepidoptera: Sphingidae). Proceedings of the Hawaiian Entomological Society 27:79-90.

Rubinoff, D. and M. San Jose. 2010. Life history and host range of Hawai‘i’s endangered Blackburn’s sphinx moth (*Manduca blackburni* Butler). Proceedings of the Hawaiian Entomological Society 42:53-59.

U.S. Fish and Wildlife Service (USFWS). 2005. Recovery plan for Blackburn’s sphinx moth (*Manduca blackburni*). Portland, Oregon. 125 pp.

Van Gelder, E. and S. Conant. 1998. Biology and conservation of *Manduca blackburni*. Report to U.S. Fish and Wildlife Service, Honolulu, Hawaii. 52 pp.

Integration and Synthesis Summary: Pacific Islands Invertebrates

PICTURE-WING FLIES

This section describes our analysis for Pacific island picture-wing flies. The analysis for most of the species will be presented together as a group below, as they generally do not overlap use sites, although each species was considered individually and has a separate conclusion. The remaining two picture-wing fly species, *Drosophila heteroneura* and *Drosophila mulli*, are expected to overlap with use sites, and will be presented individually after the group below.

Hawaiian piture-wing flies

Scientific Name:	Common Name:	Entity ID:
Drosophila aglaia	Hawaiian picture-wing fly	1248
Drosophila differens	Hawaiian picture-wing fly	1259
Drosophila digressa	Hawaiian picture-wing fly	4000
Drosophila hemipeza	Hawaiian picture-wing fly	1257
Drosopila montgomeryi	Hawaiian picture-wing fly	1250
Drosophila musaphilla	Hawaiian picture-wing fly	1252
Drosophila neoclavisitae	Hawaiian picture-wing fly	1253
Drosophila obatai	Hawaiian picture-wing fly	1254
Drosophila ochrobasis	Hawaiian picture-wing fly	1258
Drosophila sharpi	Hawaiian picture-wing fly	7261
Drosophila substenoptera	Hawaiian picture-wing fly	1255
Drosophila tarphytrichia	Hawaiian picture-wing fly	1256

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Flies in the Drosophilidae family are distributed throughout the higher, main Hawaiian Islands (*i.e*., Hawaii, Maui, Oahu, Kauai, Molokai, and Lanai), and each species is typically found on a single island. The distribution of the Hawaiian picture-wing flies (HPWF) varies by island, from the native dry *Diospyros* spp. (lama) and *Metrosideros polymorpha* (ohia) forests to mesic and wet native *Acacia koa* (koa) and ohia communities. HPWF use a variety of native host plant species found within these communities include.

Species: *Drosophila aglaia*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated

Number of Populations: Population size/location(s) unknown

Species Trends: Unknown population trends

Pesticides noted ☐

EB/CE Summary:

Hawaii picture-wing fly, *Drosophila aglaia*, is an endangered endemic species found only on the island of Oahu (USFWS 2012). *Drosophila aglaia* is restricted to the natural distribution of its host plant, *Urera glabra* (family Urticaceae), which is a small shrub-like endemic tree. The larvae of *D. aglaia* develop in the decomposing bark and stem of *Urera glabra*. This plant does not form large stands but is infrequently scattered throughout slopes and valley bottoms in mesic and wet forest habitat in the Waianae Mountains of Oahu. The Primary Constitutive Elements (PCE) for *D. aglaia* are: (1) dry to mesic, lowland, ohia, koa, and *Diospyros* sp., forest between the elevations of 568–910 meters; and (2) the larval stage host plant *Urera glabra*, which exhibits one or more life stages (from seedlings to senescent individuals).

A total of 20 individuals have been observed during bait-based surveys conducted since April 1969 in the historical range of *Drosophila aglaia* (Kaneshiro, 2005, in litt.; Magnacca, 2012a, in litt.; OANRP 2007; as cited in USFWS 2012). The historical sites include: three lowland mesic forest sites in Makaleha Valley, Palikea, and Peacock Flat (Kapuahikahi); one site in the diverse mesic forest at Puʻu Kaua; one lowland, dry to mesic forest site at Puʻu Pane (Kaneshiro, 2005, in litt.; as cited in USFWS 2012); and Kaʻala, where *Drosophila aglaia* was first collected by Hardy in 1946.

The last observation of this species occurred in May 1997 during a survey of Palikea. The species has not been observed at the other historical sites since 1970 or 1971. However, Makaleha Valley and Peacock Flats (Kapuahikahi Gulch) have not been surveyed since the 1970s and the Puʻu Pane has been surveyed only once in 1991 (Kaneshiro, 2005, in litt.; as cited in USFWS 2012). *Drosophila aglaia* flies have not been observed in subsequent surveys conducted at Palikea, Puʻu Kalena, Kaluaa Gulch, and Puʻu Hāpapa, or along Kaʻala trail, between 2006 and 2011 (Magnacca, 2012a, in litt.; as cited in USFWS 2012). Other listed *Drosophila* species have been observed during these surveys. The rarity in detection of *D. aglaia* and the wide variability in detection of *Drosophila* species in general, complicate estimation of population abundance, structure, and demographic. There has been no reported monitoring or survey efforts since 2011 (Magnacca, 2012a, in litt.; as cited in USFWS 2012). Previously identified, ongoing threats, continue to place *Drosophila aglaia* in danger of extinction. New surveys are needed to demonstrate the species is still extant.

Approximately three hundred *Urera glabra* were planted at four locations by OANRP for the active habitat management *for Drosophila montgomeryi* (ANRP 2018, as cited in USFWS 2012). One of these locations is Palikea where *D. aglaia* was last observed in 1997.

Threats to *Drosophila aglaia* include feral ungulates which feed on *Urera* sp., reducing regeneration and impacting host plant age distribution (USFWS 2012). Climate change may pose a threat to the larval host plant of this species (USFWS 2019). Lands with suitable habitats and those designated as Critical Habitat units need management and control for feral ungulates, such as pigs and goats. Invasive plants, particularly *Psidium cattleianum* and *Clidemia hirta*, further degrade the suitable habitat through competition, displacement, and increased wildfire risk. Picture-wing flies face predation threats by non-native ants, yellow jackets, tipulids, other insects, and lizards. Currently, existing regulations offer inadequate protection to these species from the introduction of nonnative insects and the loss of their host plants.

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2012. Picture-wing Fly (*Drosophila aglaia*) 5-Year Review. Honolulu, Hawaii. 16 pp.

U.S. Fish and Wildlife Service (USFWS). 2019. Picture-wing Fly (*Drosophila aglaia*) 5-Year Review. Honolulu, Hawaii. 6 pp.

Species: *Drosophila differens*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated

Number of Populations: Population size/location(s) unknown

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Drosophila differens*:

This picture-wing fly is endemic to Hawaii and is currently known from only two locations - the number of individuals at these locations is unknown (USFWS 2012). Due to its endemic nature and restricted range, it is very vulnerable to stochastic events (natural and anthropomorphic).

Hawaii picture-wing fly, *Drosophila differens*, is an endangered endemic species found only on the island of Molokai. *Drosophila differens* is restricted to the natural distribution of its host plants, *Clermontia* spp. (family Campanulaceae). Montgomery (1975, as cited in USFWS 2012) found that *Drosophila differens* larvae feed within the decomposing bark and stems of *Clermontia* sp. hosts in wet rainforest habitat. The Primary Constitutive Elements (PCE) for *Drosophila differens* are: (1) Wet, montane, ohia forest between the elevations of 1,111–1,370 meters (3,645–4,495 feet); and (2) the larval stage host plants *Clermontia arborescens* subspecies *waihiae*, *Clermontia granidiflora* subspecies *munroi*, *Clermontia kakeana*, *Clermontia oblongifolia* subspecies *brevipes*, and *Clermontia pallida*, which exhibit one or more age classes, from seedlings to senescent phases. On January 12 5, 2009, the Final Rule establishing Critical Habitat (CH) for *Drosophila differens*, went into effect. CH, designated *Drosophila differens*—Unit 1—Puu Kolekole consists of 400 hectares of montane, wet, *Metrosideros polymorpha* (ohia) forest within the eastern Molokai mountain range on the island of Molokai. According to the most recent survey data this unit was occupied by *Drosophila differens* at the time of listing. Threats to *Drosophila differens* include feral ungulates, such as goats, pigs, and axis deer; yellowjackets, tipulids, and other nonnative insects; rats; invasive plants, and wildfire (USFWS 2012). Effects due to climate change may pose a threat to the larval hosts of this species (USFWS 2018). Lands with suitable habitats, such as Kamakou Preserve and that designated as Critical Habitat need management and control for these threats. Currently, existing regulations offer inadequate protection to these species from the introduction of nonnative insects and the loss of their host plants.

A draft recovery plan for this species is being developed. New observations of *Drosophila differens* have not been reported since the species was listed as endangered under the Endangered Species Act. Most threats are not being managed.

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2012. Picture-wing Fly (*Drosophila differens*) 5-Year Review. Honolulu, Hawaii. 16 pp.

U.S. Fish and Wildlife Service (USFWS). 2018. Picture-wing Fly (*Drosophila differens*) 5-Year Review. Honolulu, Hawaii. 6 pp.

Species: *Drosophila digressa*

Status: Endangered

Distribution: Species/Populations neither constrained nor widespread

Number of Populations: Multiple populations (few)

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Drosophila digressa*:

This picture-wing fly is endemic to Hawaii and is currently known from only two locations - the number of individuals at these locations is unknown (USFWS 2013). Due to its endemic nature and restricted range, it is very vulnerable to stochastic events (natural and anthropomorphic).

Drosophila digressa (picture-wing fly) is found only on the island of Hawaii (Hardy and Kaneshiro 1968, pp. 180–1882; Carson 1986, p. 3–9; as cited in USFWS 2013). Breeding generally occurs year-round, but egg laying and larval development increase following the rainy season as the availability of decaying matter, which picture-wing flies feed on, increases in response to heavy rains. In contrast to most continental Drosophilidae, many endemic Hawaiian species are highly host-plant-specific (Magnacca et al. 2008, p. 1; as cited in USFWS 2013). *Drosophila digressa* relies on the decaying stems of *Charpentiera* spp. and Pisonia spp. for oviposition (to deposit or lay eggs) and larval substrate (Magnacca et al. 2008, pp. 11, 13; Magnacca 2013, in litt.; as cited in USFWS 2013). The larvae complete development in the decaying tissue before dropping to the soil to pupate (Montgomery 1975, pp. 65–103; Spieth 1986, p. 105; as cited in USFWS 2013). The adult flies are generalist microbivores (microbe eating) and feed upon a variety of decomposing plant material. *Drosophila digressa* occurs in elevations ranging from approximately 2,000 to 4,500 ft (610 to 1,370 m), in the lowland mesic, montane mesic, and montane wet ecosystems (Magnacca 2011a, pers. comm.; as cited in

USFWS 2013). Historically, *Drosophila digressa* was known from six sites: Moanuiahea pit crater on Hualalai, Papa in South Kona, Manuka FR, Kipuka 9 along Saddle Road, Bird Park in HVNP, and Olaa FR (Montgomery 1975, p. 98; Magnacca 2006, pers. comm.; HBMP 2010d; Magnacca 2011b, in litt.; Kaneshiro 2013, in litt.; as cited in USFWS 2013). The current population size, demographics, or distribution of *Drosophila digressa* is unknown; however, the species is believed to be extant in low numbers in the ‘Ōla‘a Forest within the ‘Ōla‘a Small Tract, and possibly extant at the Olopua Kīpuka fenced exclosure at Manukā Natural Area Reserve in small pockets that provide adequate host substrate and humidity (Magnacca 2012, entire; Magnacca 2019 in litt., entire; as cited in USFWS 2020). It is also possible that small populations of the picture-wing fly exist in areas on 9 private land owned by Kamehameha Schools that may have existing populations of *Charpentiera* sp. but no surveys have been conducted in those areas (Magnacca 2019 in litt., entire; as cited in USFWS 2020). The species is not currently in captivity (USFWS 2020).

The picture-wing fly faces threats throughout its range from the present and ongoing destruction and modification of its habitat from nonnative feral ungulates, nonnative plants, fire and drought. It also faces serious threats from predation by nonnative wasps and ants. The Service is concerned about the effects of projected climate change, particularly rising temperatures, but recognizes there is limited information on the exact nature of impacts that this species may experience. Existing regulatory mechanisms are inadequate to reduce current and ongoing threats. There are also serious and ongoing threats to the picture-wing fly due to factors associated with small numbers of populations and individuals and from competition for host plants with nonnative flies and declining numbers of host plants. These threats are exacerbated by the species’ inherent vulnerability to extinction from stochastic events at any time because of its endemism, small numbers of individuals and populations, and restricted habitats. Based on the Service’s analysis, population trends are not expected to improve, nor will the negative impacts of current threats acting on the species be effectively ameliorated in the future. Therefore, the picture-wing fly, *Drosophila digressa*, was listed as an endangered species in 2013.

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2013. Endangered and Threatened Wildlife and Plants; Determination of Endangered Species Status for 15 Species on Hawaii Island; October 29, 2013. Final Rule. Federal Register 78(209): 64638-64690.

U.S. Fish and Wildlife Service (USFWS). 2020. *Drosophila digressa* (picture-wing fly). 5-Year Review. Honolulu, Hawaii. 27 pp.

Species: *Drosophila hemipeza*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated

Number of Populations: Population size/location(s) unknown

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Drosophila hemipeza*:

This fly is endemic to Oahu, Hawaii (USFWS 2012). A total of 51 individuals have been observed during bait-based surveys conducted between 1965 and 2010. (K. Kaneshiro, in litt. 2005; K. Magnacca in litt. 2012a; as cited in USFWS 2012). Due to the rarity of detection and lack of reliable detection techniques, population numbers and trends are unknown, however only two individuals were found in three surveys conducted in 2009-2010 (USFWS 2012). Due to its endemic nature and restricted range this fly is assumed to be very vulnerable to stochastic events (both natural and anthropomorphic). In addition, one of the host plants this fly relies on for feeding is a federally endangered species (*Urera kaalae*). The Pacific Islands Fish and Wildlife Office reports that this species may occur within areas of managed forestry and rangeland where organophosphate pesticides are used. In addition, the species may occur within 10 kilometers of other pesticide application sites, where spray drift and dust containing pesticide residue may affect the species.

Hawaii picture-wing fly, *Drosophila hemipeza* is an endangered endemic species found only on the island of Oahu. *Drosophila hemipeza* larvae feed within the decomposing portions of several different mesic forest plants (USFWS 2012). Larvae hosts include three species of Lobelia, including one that is federally endangered, seven species of *Cyanea*, four of which are federally endangered, and one species of *Urera*, which is also federally endangered. These hosts grow on steep slopes and in gulches of mesic forest (Science Panel 2005, as cited in USFWS 2012). *Drosophila hemipeza* is historically known from seven mesic native forest localities from 1,500 to 2,900 feet (460 to 885 meters) above sea level. This does not include the Pupukea site of discovery, which is now considered an extirpated population. Biologists have observed a general decline of the Hawaiian *Drosophila* along with other components of the native ecosystem. Since formal surveys began for the species, 51 individuals have been recorded during a total of 60 different survey dates between 1965 and 2010. Palikea is the site of most recent record for *Drosophila hemipeza* presence, but additional surveys are needed at under-surveyed historical sites of *Drosophila hemipeza* in the Koolau and Waianae Mountains. Threats to *Drosophila hemipeza* include feral ungulates, such as goats and pigs; nonnative insects such as yellowjacket wasps, ants, and tipulids; rats; invasive plants, and wildfire (USFWS 2012). Lands with suitable habitats and those designated as Critical Habitat need management and control for these threats. Currently, existing regulations offer inadequate protection to these species from the introduction of nonnative insects and the loss of their host plants. Climate change will significantly impact the life cycle characteristics of *Drosophila hemipeza* and the range of its host plants (USFWS 2012, 2017). Observations of only two individuals of *Drosophila differens* have been reported since the species was listed as endangered under the Endangered Species Act. Most threats are not being managed.

EB/CE Source

U.S. Fish and Wildlife Service (USFWS). 2012. Picture-wing fly (*Drosophila hemipeza*). 5-Year Review. Honolulu, Hawaii. 16 pp.

U.S. Fish and Wildlife Service (USFWS). 2019. Picture-wing fly (*Drosophila hemipeza*). 5-Year Review. Honolulu, Hawaii. 6 pp.

Species: *Drosophila montgomeryi*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated

Number of Populations: Population size/location(s) unknown

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Drosophila montgomeryi*:

This fly is endemic to the island of Oahu, Hawaii and is currently present in three locations in the Waianae Mountains (USFWS 2012). Very few flies have been recorded since first surveyed in 1970. Given its endemic nature and small range size, this species is especially vulnerable to stochastic events (both natural and anthropomorphic). In addition, one of the host plants this fly relies on for feeding is a federally endangered species (*Urera kaalae*). The Pacific Islands Fish and Wildlife Office reports that this species may occur within areas of managed forestry and rangeland where organophosphate pesticides are used. In addition, the species may occur within 10 kilometers of other pesticide application sites, where spray drift and dust containing pesticide residue may affect the species.

Hawaii picture-wing fly, *Drosophila montgomeryi*, is an endangered endemic species found only on the island of Oahu (USFWS 2012). *Drosophila montgomeryi* is restricted to the natural distribution of its host plant, *Urera kaalae* (family Urticacaea, federally endangered plant). *Drosophila montgomeryi* larvae feed within the decaying bark of *Urera kaalae*, and possibly *Urera glabra* hosts that are found in dry to mesic, lowland forests. On January 5, 2009, the Final Rule establishing Critical Habitat (CH) for *Drosophila montgomeryi* went into effect. Three CH units totaling 332 hectares (822 acres) have been designated for *D. montgomeryi* on the island of Oahu. According to the most recent survey data these CH units were occupied by *Drosophila montgomeryi* at the time of listing. The CH Units are on the Honouliuli Preserve. The Honouliuli Preserve is managed by The Nature Conservancy of Hawaii (TNCH) and the Oahu Plant Extinction Prevention Program. The management measures include reducing the risk of wildfire and ungulate damage. The Oahu Army Natural Resources Program, U.S. Army Garrison, Hawaii has developed a stabilization plan for *Drosophila montgomeryi* on lands within Schofield Barracks. This plan includes a wildfire management plan to minimize risk of fire during Army training, managing ungulates through fencing, conducting weed control, monitoring for alien predatory insects, and expanding habitat restoration. Current threats to *Drosophila montgomeryi* include feral ungulates, such as goats and pigs; nonnative insects such as yellowjacket wasps, ants, and tipulids; rats; invasive plants, and wildfire. Lands with suitable habitats and those designated as Critical Habitat need management and control for these threats. Currently, existing regulations offer inadequate protection to these species from the introduction of nonnative insects and the loss of their host plants. Climate change may significantly impact the life cycle characteristics of *Drosophila montgomeryi* and the range of its host plants (USFWS 2012, 2017). Since *Drosophila montgomeryi* was listed as endangered under the Endangered Species Act, observations of 61 individuals at two locations were reported. Many significant threats to *Drosophila montgomeryi* are not being managed and its larval stage host plant is an endangered species. In 2004, only 41 individuals of the host plant *Urera kaalae* were known to remain in the wild.

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2012. Picture-wing fly (*Drosophila montgomeryi*). 5-Year Review. Honolulu, Hawaii. 17 pp.

U.S. Fish and Wildlife Service (USFWS). 2019. Picture-wing fly (*Drosophila montgomeryi*). 5-Year Review. Honolulu, Hawaii. 6 pp.

Species: *Drosophila musaphilla*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated

Number of Populations: Population size/location(s) unknown

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Drosophila musaphilia*:

This picture-wing fly is endangered and endemic to the island of Kauai. Since *Drosophila musaphilia* was first identified in 1952, the species has only been observed 17 times from 1966-2011 during 57 different survey dates (C. Campora, in litt. 2012; K. Kaneshiro, in litt. 2005; K. Magnacca, in litt. 2012; as cited in USFWS 2012). Historically, *Drosophila musaphilia* was known from only four sites, one at 579 meters above sea level, and three sites between 790-1,130 meters above sea level. The rarity in detection of *Drosophila musaphilia* and the wide variability in detection of *Drosophila* species in general, complicate estimation of population abundance, structure, and demographics. In the absence of *Acacia koa* slime fluxes, is not likely found (Science Panel 2005; as cited in USFWS 2012). The periodicity of the slime fluxes complicates monitoring the distribution pattern of the picture-wing fly. One *Drosophila musaphilia*, was observed during surveys conducted by the U.S. Navy on state lands and lands under U.S. Navy stewardship in the Kokee region of Kauai, in March 2010 (C. Campora, in litt. 2012; as cited in

USFWS 2012). The Pacific Missile Range Facility Integrated Natural Resources Management Plan includes measures to benefit *Drosophila musaphilia* on the lands managed by the U.S. Navy that are adjacent to the designated critical habitat.

The Primary Constituent Elements (PCE) for *Drosophila musaphilia* are: (1) mesic, montane, *Metrosideros polymorpha* (ohia) and *Acacia koa* (koa) forest between the elevations of 790–1,130 meters; and (2) the larval stage host plant *Acacia koa*, which exhibits one or more life stages, from seedlings to senescent plants (USFWS 2008, as cited in USFWS 2012). Critical habitat designated *Drosophila musaphilia*-Unit 1-Kokee consists of 321 hectares of montane, mesic, *Acacia koa* and *Metrosideros polymorpha* forest, and is located in the Kokee region of northwestern Kauai. Ranging in elevation from 1,010–1,140 meters (3,310–3,740 feet), this unit is owned by the State of Hawaii and occurs on lands managed as part of a State park, forest reserve, and natural area reserve. According to the most recent survey data (K. Kaneshiro, in litt. 2005; as cited in USFWS 2012), this unit was occupied by *Drosophila musaphilia* at the time of listing. This unit includes the known elevation range, moisture regime, and native forest components used by foraging adults that have been identified as the PCEs for this species. This unit also includes populations of *Acacia koa*, the larval stage host plant associated with this species. With no Final Recovery Plan for *Drosophila musaphilia*, recovery criteria and goals have not been identified for this species (USFWS 2017).

The general life cycle of Hawaiian *Drosophila* is typical of most flies: after mating, females lay eggs from which larvae (immature stage) hatch; as larvae grow, they molt (shed their skin) through three successive stages (instars); when fully grown, the larvae change into pupae (a transitional form) in which they metamorphose and emerge as adults. Montgomery (1975, as cited in USFWS 2012) determined that the host plant for *Drosophila musaphilia* is koa, *Acacia koa*. The females lay their eggs upon, and the larvae develop in, the moldy slime flux (seep) that occasionally appears on certain trees with injured plant tissue and seeping sap.

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2017. *Drosophila musaphilia* 5-Year Review. Honolulu, Hawaii. 5 pp.

U.S. Fish and Wildlife Service (USFWS). 2012. *Drosophila musaphilia* 5-Year Review. Honolulu, Hawaii. 16 pp.

Species: *Drosophila neoclavisetae*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated

Number of Populations: Population size/location(s) unknown

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Drosophila neoclavisetae*:

This fly is endemic to the island of Maui, Hawaii and has only been recorded twice (in 1969 and 1975, total less than 10 individuals) despite surveys covering 90-95% of the fly's potential range, no flies have been located (USFWS 2012). Given its endemic nature and small range size, this species is especially vulnerable to stochastic events (both natural and anthropomorphic). Habitat modification and degradation by feral pigs and rats is considered a significant and ongoing threat to this species. The Pacific Islands Fish and Wildlife Office reports that this species may occur within areas of managed forestry and rangeland where organophosphate pesticides are used. In addition, the species may occur within 10 kilometers of other pesticide application sites, where spray drift and dust containing pesticide residue may affect the species.

Hawaii picture-wing fly, *Drosophila neoclavisetae*, is an endangered endemic species found only on the island of Maui. *Drosophila neoclavisetae* has only been observed twice in one area of West Maui and has not been recorded since 1975. The larval stage host of *Drosophila neoclavisetae* has not been confirmed, although it is likely one or both of the two *Cyanea* sp. (*Cyanea kunthiana* and *Cyanea macrostegia* subspecies *macrostegia*) (family Campanulaceae) are present within its range. The habitat of this picture-wing fly and *Cyanea* spp., which are the unconfirmed larval stage host plants, are threatened by nonnative plants, possible tipulid competition, and predation by yellowjacket wasps (USFWS 2012). *Drosophila neoclavisetae* is limited to the highlands of West Maui, where degradation and modification of its habitat, particularly from the effects of feral pigs, have occurred. Rats are also a factor threatening *Drosophila neoclavisetae* habitat and are abundant in the areas where *Drosophila neoclavisetae* has been observed. Yellowjacket wasps are believed to be a significant threat to this species, and in combination with habitat loss, threaten its continued existence. These threats combined with the lack of positive survey results for *Drosophila neoclavisetae* despite extensive, focused efforts to relocate this species suggest *Drosophila neoclavisetae* may be in danger of extinction. Climate change will significantly impact the life cycle characteristics of *Drosophila neoclavisetae* and the range of its host plants. New threats include Coqui frogs, *Eleutherdactylus coqui*, which were introduced to the State of Hawaiʻi in the late 1980s (Woolbright et al. 2006, as cited in USFWS 2019) and are present on Maui.

A Final Rule establishing critical habitat for *Drosophila neoclavisetae*, went into effect January 5, 2009 (USFWS 2008, as cited in USFWS 2012). *Drosophila neoclavisetae*-Unit 1-Puu Kukui consists of 237 hectares (584 acres) of montane, wet, *Metrosideros polymorpha* (ohia) forest within the west Maui mountains on the island of Maui. Ranging in elevation between 1,040–1,400 meters (3,405–4,590 feet), this unit is both privately and State-owned. This unit occurs within the boundary of the Puu Kukui Watershed Preserve, lands jointly managed by The Nature Conservancy of Hawaii, the State of Hawaii, and Maui Land and Pineapple Company. According to the most recent survey data (K. Kaneshiro, in litt. 2005; as cited in USFWS 2012), this unit was occupied by *Drosophila neoclavisetae* at the time of listing. This unit includes the known elevation range, moisture regime, and native forest components used by foraging adults that have been identified as the PCEs for this species. This unit also includes populations of *Cyanea* *kunthiana* and *Cyanea macrostegia* subspecies *macrostegia*, the larval stage host plant associated with this species.

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2012. Picture-wing fly (*Drosophila neoclavisetae*). 5-Year Review. Honolulu, Hawaii. 13 pp.

U.S. Fish and Wildlife Service (USFWS). 2018. Picture-wing fly (*Drosophila neoclavisetae*). 5-Year Review. Honolulu, Hawaii. 6 pp.

Species: *Drosophila obatai*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated

Number of Populations: Population size/location(s) unknown

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Drosophila obatai*:

This fly is endemic to the island of Oahu, Hawaii and has only been recorded twice; 9 individuals in 1971 and one individual in 2011 (USFWS 2012). Given its endemic nature and small range size, this species is especially vulnerable to stochastic events (both natural and anthropomorphic). The species is particularly threatened by the rarity of its one known host plant, *Pleomele forbesii*, which is a candidate for Federal listing as endangered (USFWS 2011, as cited in USFWS 2012). The Pacific Islands Fish and Wildlife Office reports that this species may occur within areas of managed forestry and rangeland where organophosphate pesticides are used. In addition, the species may occur within 10 kilometers of other pesticide application sites, where spray drift and dust containing pesticide residue may affect the species.

Picture-wing fly, *Drosophila obatai*, is an endangered endemic species found only on the island of Oahu. *Drosophila obatai* is historically known from two dry to mesic native forest localities from 460-760 meters (1,500 to 2,500 feet) in elevation where the larval host plant, *Pleomele forbesii*, is present. *Pleomele forbesii* is also a candidate for listing and critical habitat designation. On January 5, 2009, the Final Rule establishing critical habitat for *Drosophila obatai*, went into effect. Two critical habitat units, one in the Waianae Mountains and one in the Koolau Mountains have been designated for *Drosophila obatai* on the island of Oahu. According to the most recent survey data, these two units were occupied by *Drosophila obatai* at the time of listing. These units include the known elevation range, moisture regime, and native forest components used by foraging adults that have been identified as the PCEs for this species. These units also include populations of *Pleomele forbesii*, the larval stage host plant associated with this species. Nine *Drosophila obatai* individuals were recorded during two surveys in 1971, and the species had not been observed again until 2011, when a female was observed at an elevation of 460 meters (1500 feet) in Mt. Kaala Reserve, in the Waianae Mountains. The rarity of this picture-wing fly and its host plant complicate determining population demographics, abundance, and current range. Threats to *Drosophila obatai* and its larval host plant, *Pleomele forbesii*, include feral ungulates, such as goats and pigs; ants, tipulids, two-spotted leafhopper, and other nonnative insects; rats; invasive plants; and wildfire (USFWS 2012). Lack of regeneration or low levels of regeneration of the host plant, *Pleomele forbesii* in the wild has also been documented. Climate change may pose a threat to the larval host plant of this species (USFWS 2019). Lands with suitable habitats and those that are designated as critical habitat need management and control for these threats. Currently, existing regulations offer inadequate protection to these species from the introduction of nonnative insects and the loss of their host plants. Climate change may significantly impact the life cycle characteristics of *Drosophila obatai* and the range of its host plants. Only a single observation of *Drosophila obatai* has been reported since the species was listed as endangered under the Endangered Species Act. Most threats are not being managed.

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2012. Picture-wing fly (*Drosophila obatai*) 5-Year Review. Honolulu, Hawaii. 16 pp.

U.S. Fish and Wildlife Service (USFWS). 2019. Picture-wing fly (*Drosophila obatai*) 5-Year Review. Honolulu, Hawaii. 5 pp.

Species: *Drosophila ochrobasis*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated

Number of Populations: Population size/location(s) unknown

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Drosophila ochrobasis*:

This fly is endemic to the island of Hawaii and is currently known to occur in ten localities on four of Hawaii Island's volcanoes. This species was recorded almost every year from 1967-1975, sometimes in relatively large numbers. Between 1976 and 2006, there was only one recorded observance of the species. It was again observed in 2006, 2009 and 2010, but in small numbers - five individuals in 2009 and 2010 (USFWS 2012). Given its endemic nature and small range size, this species is especially vulnerable to stochastic events (both natural and anthropomorphic). As with other Hawaiian picture wing flies, the major threat to *Drosophila ochrobasis* is habitat alteration and host plant herbivory/destruction by feral goats and pigs. The

Pacific Islands Fish and Wildlife Office reports that this species may occur within areas of managed forestry and rangeland where organophosphate pesticides are used. In addition, the species may occur within 10 kilometers of other pesticide application sites, where spray drift and dust containing pesticide residue may affect the species.

Hawaii picture-wing fly, *Drosophila ochrobasis*, is an endangered endemic species found only on the island of Hawaii. *Drosophila ochrobasis* is restricted to the natural distribution of its host plants in the *Clermontia* species family, Campanulaceae. On January 5, 2009, the Final Rule establishing critical habitat for *Drosophila ochrobasis*, went into effect. Five critical habitat management units totaling 178 hectares (437 acres) have been designated for *Drosophila ochrobasis* on the island of Hawaii. Historically, *Drosophila ochrobasis* was widely distributed between 1,035 to 1,690 meters (3,400 and 5,550 feet) on the island of Hawaii. Prior to 2006, the species had been recorded from ten localities on four of the island's five volcanoes (Hualalai, Mauna Kea, Mauna Loa, and the Kohala mountains). *Drosophila ochrobasis* was recorded almost every year from 1967 to 1975, ranging in number from 1 to 135 individuals per survey. *Drosophila ochrobasis* is now less commonly observed from its historical localities. Until 2006, the last observation of *Drosophila ochrobasis* was a single individual recorded at the 1855 lava flow in 1986. Several surveys between 1995 and 1997 failed to locate the species at many of its historical sites. However, during field surveys in 2006, one individual was recorded near Kawaiihae Uka on the southwestern flank of the Kohala Mountains, a previously unknown population site. There is still much to learn about the current range of this species. In 2009 and 2010, five *Drosophila ochrobasis* flies were observed on the Puu O Umi Preserve in the Kilohana exclosure (K. Magnacca, in litt. 2012a; as cited in USFWS 2012) in the Kohala Mountains. The current population size or distribution of *Drosophila ochrobasis* throughout its historic or suitable range is largely unknown (USFWS 2020). The species is believed to be extant in the Kohala Mountains within the Kilohana enclosure (Magnacca 2012b in litt., entire; Magnacca 2019 in litt., entire; as cited in USFWS 2020). It is possible the species survives in undocumented, isolated populations at other locations that have mesic and wet montane habitats with suitable host plants. Most of the historically occupied areas have not been surveyed in the last 20 years following the surveys in the late 1980s and 1990s that did not detect the species.

Threats to *Drosophila ochrobasis* include current and future degradation and modification to their limited remaining habitat from feral ungulates, nonnative plants, rats, and fire, resource competition and predation by nonnative insects, and inadequate regulatory mechanisms that protect the species from the introduction of nonnative insects and the loss of picture-wing fly host plants (USFWS 2012). Climate change may significantly impact the life cycle characteristics of *Drosophila ochrobasis* and the range of its host plants (USFWS 2012). Most of the mesic and wet montane habitats of *Drosophila ochrobasis* have experienced prolonged periods of abnormally dry to extreme drought conditions for the past 20 to 30 years (NIDIS 2020, as cited in USFWS 2020). This has resulted in overall habitat degradation and appears to alter decay processes of the picture-wing fly host plants. Drought also alters the entire plant community on which the fly depends. The plant disease, rapid ʻōhiʻa death (ROD) is an ongoing threat to ʻōhiʻa, an important canopy tree in the mesic and wet montane habitats of *Drosophila ochrobasis* (USFWS 2020).

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2012. Picture-wing fly (*Drosophila ochrobasis*). 5-Year Review. Honolulu, Hawaii. 17 pp.

U.S. Fish and Wildlife Service (USFWS). 2020. Picture-wing fly (*Drosophila ochrobasis*). 5-Year Review. Honolulu, Hawaii. 11 pp.

Species: *Drosophila sharpi*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated

Number of Populations: Population size/location(s) unknown

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Drosophila sharpi*:

Drosophila sharpi is endemic to Kauai, occurring in montane mesic and montane wet forest ecosystems, at elevations generally between 914 and 1,200 meters, although it has been found as low as 750 meters (USFWS 2017). *Drosophila sharpi* is a picture-wing fly that was last observed in the early 1990's. Host plant preferences of *Drosophila sharpi* are not specifically know but believed to be similar to its closely-related sibling species, *Drosophila primaeva*, which utilizes *Cheirodendron sp.* (olapa) and *Polyscias sp.* (ohe ohe) trees (both in the family Araliaceae) (Montgomery 1975, as cited in USFWS 2017), which may include the endangered *Polyscias flynii* (ohe ohe) found in the same habitat (USFWS 2010, as cited in USFWS 2017). These host plants currently occupy the montane mesic and montane wet forest ecosystems (USFWS 2010, as cited in USFWS 2017).

The species was first collected by Perkins in 1895 at Koholuamano (Grimshaw 1901, as cited in USFWS 2017), which is probably a misspelling of Kaholuamano, an area southwest of the Alakai Swamp (USFWS 1996, as cited in USFWS 2017). *Drosophila sharpi* was historically known from two populations on Kauai: one population east of the Alakai Plateau at Mount Kahili, where 19 males and 13 females were observed (Hardy and Kaneshiro 1969; Kaneshiro and Kaneshiro 1995; HBMP 2010, as cited in USFWS 2017), and one population on the western end of the Alakai Swamp in the Na Pali Kona FR at Pihea (K. Kaneshiro, pers. comm. 2007, as cited in USFWS 2017). The species was also collected at two other locations, Mohihi Stream located within the Alakai Wilderness Preserve in 1963, and at the Kokee Stream within Kokee State Park in 1991 (Kaneshiro and Kaneshiro 1995). Observations of *Drosophila sharpi* at the Pihea site have been somewhat sporadic, as the species has been observed there only three times, once each in 1986, 1987, and most recently in 1991, despite numerous surveys (HBMP 2010; K. Kaneshiro, pers. comm. 2007, as cited in USFWS 2017).

The general life cycle of *Drosophila sharpi* is typical of that of most Hawaiian *Drosophila*: after mating, females lay eggs from which larvae (immature stage) hatch; as larvae grow, they molt (shed their skin) through three successive instars (stages); when fully grown, the larvae change into pupae (a transitional form) in which they metamorphose and emerge as adults (USFWS 2006, as cited in USFWS 2017).

Breeding generally occurs year-round, but egg laying and larval development increase following the rainy season as the availability of decaying matter, upon which the flies feed, increases in response to the heavy rains (K. Kaneshiro, pers. comm. 2005; as cited in USFWS 2017). In general, Hawaiian *Drosophila* lay between 50 and 200 eggs in a single clutch. Eggs develop into adults in about a month, and adults generally become sexually mature one month later. Adults generally live for one to two months (USFWS 2006; as cited in USFWS 2017). The hatching larvae complete development within the decomposing bark before dropping to the soil to pupate (Montgomery 1975; Spieth 1980; Kaneshiro and Kaneshiro 1995; as cited in USFWS 2017). Like most Hawaiian picture-wing flies, the adult *Drosophila sharpi* are generalist microbivores (microbe eaters) and feed upon a variety of decomposing plant material. Threats include ungulates degradation of habitat, ecosystem altering invasive plants degradation of habitat, hurricanes, climate change, wasp and ant predation, fire, stochastic events, and loss of mutualists (USFWS 2017).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2017. *Drosophila sharpi* 5-Year Review. Summary and Evaluation. Honolulu, Hawaii. 18 pp

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Species: *Drosophila substenoptera*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated

Number of Populations: Population size/location(s) unknown

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Drosophila substenoptera:*

This picture-wing fly is an endangered endemic species found only on the island of Oʻahu. *Drosophila substenoptera* is found in mesic forest in the Waianae Mountains (USFWS 2012). The general life cycle of Hawaiian *Drosophila* is typical of most flies: after mating, females lay eggs from which larvae (immature stage) hatch; as larvae grow, they molt (shed their skin) through three successive stages (instars); when fully grown, the larvae change into pupae (a transitional form) in which they metamorphose and emerge as adults. Montgomery (1975, as cited in USFWS 2012) reported that the larvae of *Drosophila substenoptera* feed only within the decomposing bark of *Cheirodendron platyphyllum* subspecies *platyphyllum*, *Cheirodendron trigynum* subspecies *trigynum*, *Tetraplasandra kavaiensis*, and *Tetraplasandra oahuensis* trees, all of which are in the family Araliaceae. These host plants are particularly susceptible to ungulate damage when combined with competition from invasive plants (Magnacca et al. 2008, as cited in USFWS 2012). Management of this taxon will require maintaining these host trees in sufficient numbers and density to allow the perpetual presence of decaying host tree parts. *Drosophila substenoptera* is historically known from seven localities in the wet native forest of the Koolau and Waianae Mountains on Oahu at elevations from 395 to 1,220 meters above sea level. *Drosophila substenoptera* was most recorded at Palikea in 1977 and on the summit of Mt. Kaala, where historically it was most consistently observed from 1968-1998. *Drosophila* researchers have devoted intensive efforts to relocating this species at other sites because the species is considered important for genetic studies of the *Drosophila planitibia* phylogeny group. Surveys conducted from 1998 to 2005 failed to relocate this species at other sites (Science Panel 2005, as cited in USFWS 2012).

On lands managed by the Army there are three known population units (PUs) for *Drosophila substenoptera*: Palikea, Ka‘ala-Kalena, and Ōpae‘ula. At other PUs *Drosophila substenoptera* is highly sporadic, typically occurring as single individuals observed only once during a day (ANRP 2018, as cited in USFWS 2012). Between 2013 and mid-2018 a maximum of 19 individuals were observed during bait surveys in one day at Palikea (Magnacca, 2018, in litt., as cited in USFWS 2012). Monthly monitoring in the northern portion of Palikea Mitigation Unit has been ongoing since May 2013 with a total of 57 survey days (ANRP 2018, as cited in USFWS 2012). Between 2013 and mid-2018 a maximum of 1 individual was observed during bait surveys in one day at lower Ōpae‘ula. One individual was observed in 2013 and in 2015 (Magnacca, 2018, in litt., as cited in USFWS 2012). Collection effort has been limited due to the difficulty in accessing areas of intact habitat for this species (ANRP 2018, as cited in USFWS 2012). Between 2011 and mid-2018 a maximum of 1 individual was observed during bait surveys in one day at Ka‘ala. At less visited PUs between 2013 and 2015 a maximum of 1 individual was observed in East Makaleha.in 2013; and between 2007 and mid-2018 a maximum of 10 individuals were observed at Schofield Barracks (Magnacca, 2018, in litt., as cited in USFWS 2012).

Current threats to *Drosophila substenoptera* include feral ungulates such as goats and pigs; nonnative insects such as yellowjacket wasps, ants, and tipulids; rats; invasive plants; and wildfire (USFWS 2012). Climate change may pose a threat to the larval host plants of this species (USFWS 2019). Fortini *et al.* (2013, as cited in USFWS 2019) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini *et al.* (2013, as cited in USFWS 2019) was conducted for *Cheirodendron platyphyllum, Cheirodendron trigynum, Polyscias (=Tetraplasandra) kavaiensis,* and *Polyscias (=Tetraplasandra) oahuensis* (family Araliaceae) and concluded these larval host species are vulnerable to the impacts of climate change.

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2012. *Drosophila substenoptera* 5-Year Review. Honolulu, Hawaii. 17 pp.

U.S. Fish and Wildlife Service (USFWS). 2019. *Drosophila substenoptera* 5-Year Review. Honolulu, Hawaii. 7 pp.

Species: *Drosophila tarphytrichia*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated

Number of Populations: Population size/location(s) unknown

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Drosophila tarphytrichia*:

This picture-wing fly is an endangered endemic species found only on the island of Oʻahu. Oʻahu (USFWS 2012). The general life cycle of Hawaiian *Drosophila* is typical of most flies: after mating, females lay eggs from which larvae (immature stage) hatch; as larvae grow, they molt (shed their skin) through three successive stages (instars); when fully grown, the larvae change into pupae (a transitional form) in which they metamorphose and emerge as adults (USFWS 2012). The larvae of *Drosophila tarphytrichia* feed only within the decomposing portions of the stems and branches of Charpentiera obovata trees (family Amaranthaceae) in mesic forest habitat (Montgomery 1975, as cited in USFWS 2012). Historically, *Drosophila tarphytrichia* was known from both the Koʻolau and the Waiʻanae Mountains between 580 and 885 meters above sea level (USFWS 2012, 2019). The species is now considered to be extirpated from the Koʻolau Range where it was originally discovered near Mānoa Falls on Oʻahu (USFWS 2019). *Drosophila tarphytrichia's* four mesic forest habitat sites in the Waiʻanae Mountains include Puʻu Kaua, Mauna Kapu, Kaluaʻa Gulch, and Palikea. Only Kaluaʻa Gulch and Palikea were occupied during the last surveys conducted in 1972 and 1997, respectively (Kaneshiro, 2005, in litt.). At the four Waiʻanae habitat sites, a total of 31 *Drosophila tarphytrichia* individuals were recorded on 36 different survey dates between 1965 and 1997 (Kaneshiro, 2005, in litt.; as cited in USFWS 2019). *Drosophila tarphytrichia* was not observed during eight surveys conducted in the Waiʻanae Mountains on the Honouliuli Preserve from 2009-2011 (Magnacca, 2012a, in litt.; as cited in USFWS 2019). Primary Constituent Elements (PCE) for *Drosophila tarphytrichia* are: (1) dry to mesic, lowland, ohia and koa forest between the elevations of 524–910 meters; and (2) the larval stage host plant *Charpentiera obovata*, which exhibits one or more life stages (from seedlings to senescent individuals) (USFWS 2008; as cited in USFWS 2019).

A Final Rule establishing three critical habitat units for *Drosophila tarphytrichia* went into effect January 5, 2009 (USFWS 2008; as cited in USFWS 2019). *Drosophila tarphytrichia*-Unit 1-Kaluaa Gulch consists of 213 hectares of diverse, mesic forest within the southern Waianae Mountains of Oahu. Ranging in elevation from 525–850 meters, this unit is privately owned and is part of a larger area called the Honouliuli Preserve, administered and managed by The Nature Conservancy of Hawaii. *Drosophila tarphytrichia*-Unit 2-Palikea consists of 84 hectares of lowland, mesic, *Metrosideros polymorpha* (ohia) and *Acacia koa* (koa) forest within the southern Waianae Mountains of Oahu. Ranging in elevation from 585–910 meters, this unit is privately and State-owned, and is part of a larger area called the Honouliuli Preserve, administered and managed by The Nature Conservancy of Hawaii.

Drosophila tarphytrichia-Unit 3-Puu Kaua consists of 35 hectares (87 acres) of lowland, diverse mesic, *Metrosideros polymorpha* (ohia) and *Acacia koa* (koa) forest within the southern Waianae Mountains of Oahu. Ranging in elevation from 570–870 meters (1,865–2,855 feet), this unit is privately owned and is part of a larger area called the Honouliuli Preserve, administered and managed by The Nature Conservancy of Hawaii (USFWS 2012).

Current threats to *Drosophila tarphytrichia* include feral ungulates such as goats and pigs; ants, tipulids, and other nonnative insects; rats; invasive plants; wildfire, and climate change (USFWS 2012, 2019).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2012. *Drosophila tarphytrichia*. 5-Year Review. Honolulu, Hawaii. 15 pp.

U.S. Fish and Wildlife Service (USFWS). 2019. *Drosophila tarphytrichia*. 5-Year Review. Honolulu, Hawaii. 5 pp.

Environmental Baseline/Cumulative Effects (EB/CE) Summary includes multiple species:

Drosophila aglaia is historically known from five mesic native forest localities in the Waianae Mountains of Oahu between 427 and 853 meters (1,400 and 2,800 feet) above sea level. *Drosophila hemipeza* is restricted to the island of Oahu where it is historically known from seven mesic native forest localities between 488 and 853 meters (1,600 and 2,800 feet) above sea level and has been documented from seven sites. *Drosophila montgomeryi* is historically known from three mesic native forest localities in the Waianae Mountains on western Oahu between 610 and 853 meters (2,000 and 2,800 feet) above sea level. *Drosophila obatai* is historically known from two dry to mesic native forest localities between 457 to 670 meters (1,500 to 2,200 feet) in elevation on the island of Oahu. *Drosophila substenoptera* is historically known from seven localities in the wet native forest of the Koolau and Waianae Mountains on Oahu at elevations between 396 to 1,189 meters (1,300 to 3,900 feet) above sea level. Historically, *Drosophila tarphytrichia* was known from both the Koolau and the Waianae Mountains between 610 and 853 meters (2,000 and 2,800 feet) above sea level. *Drosophila heteroneura* has been recorded from 24 localities on 4 of the island's 5 volcanoes (Hualalai, Mauna Kea, Mauna Loa, and

Kilauea) in 5 different mesic to wet montane environments. *Drosophila mulli* is restricted to the island of Hawaii and is historically known from two locations between 985 and 1,220 meters (3,200 and 4,000 feet) above sea level. *Drosophila ochrobasis* was widely distributed between 1,189 to 1,615 meters (3,900 and 5,300 feet) in mesic to wet forest areas on the island of Hawaii and has been recorded from 10 localities on 4 of the island's 5 volcanoes (Hualalai, Mauna Kea, Mauna Loa, and the Kohala mountains). *Drosophila differens* is historically known from three sites on private land between 1,158 to 1,372 meters (3,800 to 4,500 feet) elevation on the island of Molokai, within montane wet ohia forest. *Drosophila musaphilia* is historically known from only four mesic native forest sites on Kauai, one at 579 meters (1,900 feet) above sea level, and four sites between 792 and 1,067 meters (2,600 and 3,500 feet) above sea level. *Drosophila neoclavisetae* is known historically from two populations on federal lands located in wet native forest on Maui. *Drosophila digressa* is known from only two locations on the island of Hawai'i in lowland mesic, montane mesic, and montane wet forests. It is not known at this time if *Drosophila sharpi* may have one population on Kauai.

Given the small, isolated populations for each of these species, these species will be further threatened by factors associated with small populations.

Overall Vulnerability *Drosophila aglaia*: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability *Drosophila differens*: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability *Drosophila digressa*: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability *Drosophila hemipeza*: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability *Drosophila montgomeryi*: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability *Drosophila musaphilia*: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability *Drosophila neoclavisetae*: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability *Drosophila obatai*: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability *Drosophila ochrobasis*: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability *Drosophila sharpi*: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability *Drosophila substenoptera*: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability *Drosophila tarphytrichia*: ☒ **High** ☐ **Medium** ☐ **Low**

RISK

(Risk is based on species exposure and response from labelled uses across the range)

Risk to individuals if exposed: Mortality is expected for pomace flies exposed to malathion on use sites or from spray drift.

Risk to the species from labelled uses across the range:

The table below summarizes the risk to the species from labelled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

DIRECT (all uses except mosquito control)	
Use areas – mortality	Mortality if exposed on alfalfa
Spray drift areas – mortality	Mortality depending on proximity to use sites
Volatilization	May be a source of exposure
INDIRECT (all uses except mosquito control)	
Use areas - Prey item mortality	No effects expected
Spray drift areas - Prey item mortality	No effects expected
Plants affected (decline in growth)	No effects expected
MOSQUITO CONTROL	
Direct (mortality)	Mortality if exposed
Indirect	No effects expected

Risk modifiers: Adult pomace flies feed on detritus; larvae feed on vegetative material.

The general life cycle of Hawaiian *Drosophila* is typical of that of most flies: after mating, females lay eggs from which larvae (immature stage) hatch; as larvae grow, they molt (shed their skin) through three successive stages (instars); when fully grown, the larvae change into pupae (a transitional form) in which they metamorphose and emerge as adults. Breeding generally occurs year-round, but egg laying and larval development increase following the rainy season as the availability of decaying matter, upon which the flies feed, increases in response to the heavy rains

Pomace flies will be directly exposed to the pesticide and pesticide drift where the pesticide is applied to pasture or used for mosquito control within areas occupied by the pomace fly. Pomace fly adults will also be exposed when they come in contact with the pesticide in application and drift sites when it is deposited onto their bodies, when they absorb it from contacting it the environment, when they eat material containing the pesticide, and when they ingest the pesticide by drinking water containing the pesticide. Although we would expect species within high-level elevation areas to be exposed to malathion via volatilization, we conclude, based on the best information available, that species in high elevations would not be exposed to concentration levels that would affect them (see *General Effects* for further information on volatilization).

Range maps of these species were visually compared to the 2015 Hawaii Statewide Agricultural Land Use Baseline (University of Hawaii 2015) to determine potential overlap with agricultural use sites. *Drosophila Aglaia, D. differens, D. Digressa, D. hemipeza, D. montgomeryi, D. musaphilia, D. neoclavisetae, D. obatai, D. sharpi, D. substenoptera, and D. tarphytrichia* did not overlap with any use sites and were not adjacent to any use sites (i.e., where spray drift could be a concern). *D. ochrobaris* had a very small overlap with pasture and a moderate amount of pasture adjacent to its range. It did not appear that pasture or other crop use sites have expanded into these species' ranges since the 2015 Agricultural Land Use Baseline was created.

Overall Risk: ☐ High ☒ Medium ☐ Low

USAGE

(Anticipated usage within the range based on past usage data)

Information regarding past usage of malathion in Hawaii is not available, however prior survey data has indicated that 4.8% of agricultural crops were treated with insecticides, with malathion being a subset of this. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the Approach to Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in Hawaii; future use cannot be ruled out but is not expected to increase significantly.

Overall Usage: ☐ High ☒ Medium ☐ Low

CONSERVATION MEASURES

Residential use label changes: New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely), reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

Reduced application number and rate: New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop, previous allowable number of applications ranged from 3 to 13 applications per year). We anticipate this measure will help reduce the amount of malathion used and decrease potential exposure to the species.

CONCLUSION

After reviewing the current status of the species, the environmental baseline for the Action area, and the effects of the proposed registration of malathion, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of *D. Aglaia, D. differens, D. digressa, D. hemipeza, D. montgomeryi, D. musaphilia, D. neoclavisetae, D. obatai, D. ochrobasis, D. sharpi, D. substenoptera, and D. tarphytrichia.* As discussed below, even though the vulnerability is high, the risk and usage of malathion is medium, and the implementation of the general conservation measures described above is expected to reduce the likelihood of exposure. We do not anticipate the Action will result in species-level effects.

D. Aglaia, D. differens, D. digressa, D. hemipeza, D. montgomeryi, D. musaphilia, D. neoclavisetae, D. obatai, D. ochrobasis, D. sharpi, D. substenoptera, and D. tarphytrichia have high vulnerability based on their status, distribution, and trends. The risk to these species posed by the labeled uses across the range is low and usage is expected to be low, if at all. Based on these species current ranges and the 2015 Agricultural Land Use Baseline geospatial layer, it does not appear that agricultural use sites or developed and open-space developed use sites overlap with these ranges, except for *D. ochrobaris*, which has a very low overlap with pasture, with a moderate amount of adjacent pasture. *D. ochrobaris* is found in mesic to wet forest areas, and is not expected to utilize the drier, more open pasture areas outside of its range. Spray drift from pasture areas into the species range is expected to be significantly lessened due to the denseness of the species' forested habitat. If mosquito adulticide applications using malathion did occur, there is potential for exposure to these species. However, at present, information indicates that malathion is not used as a mosquito control agent in Hawaii. Malathion could enter pomace fly habitat through volatilization and deposition since these species occur between 1,300 to 5,300 feet elevation in forested habitat. Although we would expect species within high-level elevation areas to be exposed to malathion via volatilization, we conclude, based on the best information available, that species in high elevations would not be exposed to concentration levels that would affect them (see *General Effects* for further information on volatilization).

In addition, we anticipate the conservation measures above, including residential use label changes and reduced numbers and application rates would further reduce the risk of exposure to these species. These species use dry, mesic, or wet forests for foraging and breeding. Restrictions to residential use reduces exposure to species that overlap with develop and open space developed and spot treatment application makes spray drift off site unlikely. Reductions to number of applications and application rates to certain agricultural crops further reduces the amount of malathion used and limits the likelihood of exposure to these species and their habitats. Together, these measures are anticipated to substantially reduce the likelihood of exposure to these species and their habitat. We expect exposure of individuals of these species will occur only at very low levels over the duration of the Action and would likely not result in mortality or sublethal effects.

Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of *D. Aglaia, D. differens, D. digressa, D. hemipeza, D. montgomeryi, D. musaphilia, D. neoclavisetae, D. obatai, D. ochrobasis, D. sharpi, D. substenoptera, and D. tarphytrichia* in the wild.

Conclusion *Drosophila aglaia*: **Not likely to jeopardize**

Conclusion *Drosophila differens*: **Not likely to jeopardize**

Conclusion *Drosophila digressa*: **Not likely to jeopardize**

Conclusion *Drosophila hemipeza*: **Not likely to jeopardize**

Conclusion *Drosophila montgomeryi*: **Not likely to jeopardize**

Conclusion *Drosophila musaphilia*: **Not likely to jeopardize**

Conclusion *Drosophila neoclavisetae*: **Not likely to jeopardize**

Conclusion *Drosophila obatai*: **Not likely to jeopardize**

Conclusion *Drosophila ochrobasis*: **Not likely to jeopardize**

Conclusion *Drosophila sharpi*: **Not likely to jeopardize**

Conclusion *Drosophila substenoptera*: **Not likely to jeopardize**

Conclusion *Drosophila tarphytrichia*: **Not likely to jeopardize**

ADDITIONAL REFERENCES

University of Hawaii. 2015. Spatial Data Analysis and Visualization (SDAV) Laboratory data in conjunction with the Hawaii State Department of Agriculture. Hilo, Hawaii.

U.S. Fish and Wildlife Service (USFWS). 2006. Recovery Outline for 12 Hawaiian Picture-wing Flies. Honolulu, HI. 32 pp.

U.S. Fish and Wildlife Service (USFWS). 2019. Recovery Outline for Hawai'i Island. Honolulu, HI. 25 pp.

U.S. Fish and Wildlife Service (USFWS). 2019. Draft Kauai Islandwide Recovery Plan. Portland, OR. 43 pp.

U.S. Fish and Wildlife Service (USFWS). 2020. Picture-wing fly (*Drosophila heteronuera*) 5-Year Review. Honolulu, Hawaii. 11 pp.

U.S. Fish and Wildlife Service (USFWS). 2021. Picture-wing fly (*Drosophila mulli*) 5-Year Review. Honolulu, Hawaii. 21 pp.

Picture-wing flies

The following two Hawaiian picture-wing flies (*Drosophila heteroneura* and *Drosophila mulli*) are expected to overlap with use sites and are discussed separately in the following species accounts.

Scientific Name:	Common Name:	Entity ID:
Drosophila heteroneura	Hawaiian picture-wing fly	1249

Species: *Drosophila heteroneura*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated

Number of Populations: One or more populations

Species Trends: Declining population(s) – one or more populations declining

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Drosophila heteroneura*:

This fly is endemic to the island of Hawaii and has experienced a dramatic population decline over the last 30-40 years. Historically, *Drosophila heteroneura* has been recorded from 24 localities on four of the island's five volcanoes (Hualalai, Mauna Kea, Mauna Loa, and Kilauea) in five different mesic to wet montane environments (USFWS 2012). The species was thought to be extinct in the late 1980s, but an extremely small population was rediscovered in 1993 on private land at Hualalai Volcano (Kaneshiro and Kaneshiro 1995 as cited in 2006). This species was not observed again until 1998 when eight individuals were observed (Kaneshiro 2005 in litt., entire as cited in USFWS 2020). In 1999, a *Drosophila heteroneura* population was recorded at the National Wildlife Refuge South Kona Hakalau Forest unit. At this South Kona site, over 134 individuals were observed from 1999-2001 (Foote 2005 in litt., entire as cited in USFWS 2020). The most recent observations of the species were on the South Kona Forest Reserve at Kukuiop'e and Ka'ohe area in 2011 (Magnacca 2012 in litt, entire as cited in USFWS 2020). Currently, the species appears to be limited to the South Kona area (Magnacca 2019 in litt., entire as cited in USFWS 2020). The current population size or distribution of *Drosophila heteroneura* throughout its historic range is unknown (USFWS 2020). It is possible the species survives in undocumented, isolated populations at other locations that have mesic to wet, montane habitats with suitable host plants (*Clermontia* spp., *Cheirondendron* sp., or *Delissea* sp.). Most of the historic areas have not been surveyed in the last 20 years (USFWS 2020) Because of its endemic nature and small range size, this species is considered very vulnerable to stochastic events (both natural and anthropomorphic).

On January 5, 2009, the Final Rule establishing Critical Habitat for *Drosophila heteroneura*, went into effect. Five Critical Habitat management units totaling 4,582 acres (855 ha) have been designated for *Drosophila heteroneura* on the island of Hawaii. The Critical Habitat units designated for *Drosophila heteroneura* occur on Federal, State, and privately managed lands. Conservation and management strategies for these State-owned forest reserves, USFWS-owned national wildlife refuge, and National Park Service-owned national park units include reducing the risk of wildfire, ungulate control through fencing and hunting, and protection of *Drosophila heteroneura* larval host plants (USFWS 2012).

The primary factors that pose serious and ongoing threats to the species, its plant hosts, and its habitat range include the following: habitat degradation and destruction, nonnative ungulates and plants, drought, fire, predation, parasitization, competition for breeding resources, inadequate regulatory mechanisms to address nonnative species, natural disasters, limited numbers of populations and individuals, potential environmental changes, and the interaction of these threats (USFWS 2020). Climate change will significantly impact the life cycle characteristics of *Drosophila heteroneura* and the range of its host plants.

Though adult *Drosophila heteroneura* are generalist microbivores feeding off decaying plant material, the species depends on decaying stems of *Cheirodendron* sp., *Clermontia* spp., and *Delissea* sp. as a host for oviposition and larval development (USFWS 2020). The loss or decrease in host plant resources and the degradation of habitat that meets the humidity needs of the fly and supports the decay cycle of the plant host threaten the existence of *Drosophila heteroneura*. The fly's host plant species are also threatened by herbivory and trampling by non-native vertebrates (goats, pigs, etc.).

Large populations of *Clermontia* sp. a host of *Drosophila heteroneura*, have reestablished on the northeastern slopes of Mauna Loa near Pu'u Maka'ala and Kulani in the wet montane 'ohi'a forest since ungulate fencing was installed (Magnacca 2019 in litt., entire as cited in USFWS 2020). The host plants occur as understory vegetation beneath the canopy of 'ohi'a and koa trees. Historically, *Drosophila heteroneura* is known from the northeastern slopes of Mauna Loa, through no recent surveys for the picture-wing fly have been conducted in this area. The presence of large populations of host plants provides an important resource for reestablishment of *Drosophila heteroneura* (USFWS 2020).

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2006. Recovery Outline for 12 Hawaiian Picture-wing Flies. Honolulu, Hawaii. 32 pp.

U.S. Fish and Wildlife Service (USFWS). 2012. Picture-wing fly (*Drosophila heteronuera*) 5-Year Review. Honolulu, Hawaii. 17 pp.

U.S. Fish and Wildlife Service (USFWS). 2020. Picture-wing fly (*Drosophila heteronuera*) 5-Year Review. Honolulu, Hawaii. 11 pp.

Overall Vulnerability *Drosophila heteroneura*: ☒ **High** ☐ **Medium** ☐ **Low**

RISK

(Risk is based on species exposure and response from labelled uses across the range)

Risk to individuals if exposed: Mortality is expected for pomace flies exposed to malathion on use sites or from spray drift.

Risk to the species from labelled uses across the range:

The table below summarizes the risk to the species from labelled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

DIRECT (all uses except mosquito control)	
Use areas – mortality	Mortality if exposed on alfalfa
Spray drift areas – mortality	Mortality depending on proximity to use sites
Volatilization	May be a source of exposure
INDIRECT (all uses except mosquito control)	
Use areas - Prey item mortality	No effects expected
Spray drift areas - Prey item mortality	No effects expected
Plants affected (decline in growth)	No effects expected
MOSQUITO CONTROL	
Direct (mortality)	Mortality if exposed
Indirect	No effects expected

Risk modifiers: Adult pomace flies feed on detritus; larvae feed on vegetative material.

The general life cycle of Hawaiian *Drosophila* is typical of that of most flies: after mating, females lay eggs from which larvae (immature stage) hatch; as larvae grow, they molt (shed their skin) through three successive stages (instars); when fully grown, the larvae change into pupae (a transitional form) in which they metamorphose and emerge as adults. Breeding generally occurs year-round, but egg laying and larval development increase following the rainy season as the availability of decaying matter, upon which the flies feed, increases in response to the heavy rains

Pomace flies will be directly exposed to the pesticide and pesticide drift where the pesticide is applied to pasture or used for mosquito control within areas occupied by the pomace fly. Pomace fly adults will also be exposed when they come in contact with the pesticide in application and drift sites when it is deposited onto their bodies, when they absorb it from contacting it the environment, when they eat material containing the pesticide, and when they ingest the pesticide by drinking water containing the pesticide. Although we would expect species within high-level elevation areas to be exposed to malathion via volatilization, we conclude, based on the best information available, that species in high elevations would not be exposed to concentration levels that would affect them (see *General Effects* for further information on volatilization).

Range maps for *Drosophila heteroneura* were visually compared to the 2015 Hawaii Statewide Agricultural Land Use Baseline (University of Hawaii 2015) to determine potential overlap with agricultural use sites. *Drosophila heteroneura* had approximately 25% overlap with pasture, and its species range was found adjacent to pasture. *Drosophila heteroneura* had minimal (less than 1%) overlap with diversified crops, and it did not appear that pasture or other crop use sites have further expanded into this species' range since the 2015 Agricultural Land Use Baseline was created.

Overall Risk: ☐ High ☒ Medium ☐ Low

USAGE

(Anticipated usage within the range based on past usage data)

Information regarding past usage of malathion in Hawaii is not available, however prior survey data has indicated that 4.8% of agricultural crops were treated with insecticides, with malathion being a subset of this. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the Approach to Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in Hawaii; future use cannot be ruled out but is not expected to increase significantly.

Overall Usage: ☐ High ☒ Medium ☐ Low

CONSERVATION MEASURES

General Conservation Measures

Residential use label changes: New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely), reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

Reduced application number and rate: New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop, previous allowable number of applications ranged from 3 to 13 applications per year). We anticipate this measure will help reduce the amount of malathion used and decrease potential exposure to the species.

Species-specific Conservation Measures
The following species-specific measure is now part of the Action and will be included in *BulletinsLive Two*

Malathion application is prohibited within the range of this species, plus 200 feet beyond the range to account for potential spray drift from applicators adjacent to the range.

CONCLUSION

After reviewing the current status of the species, the environmental baseline for the Action area, and the effects of the proposed registration of malathion, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of *Drosophila heteroneura.* As discussed below, even though the vulnerability is high,the risk and usage are medium for this species from malathion, and the implementation of the general and species-specific conservation measure will further reduce the likelihood of exposure. While we anticipate that very small numbers of individuals of these species will be affected over the duration of the proposed Action, we do not expect species-level effects to occur.

Drosophila heteroneura has high vulnerability based on its status, distribution, and trends. The risk to this species posed by the labeled uses across the range is medium and usage is expected to be medium. Information regarding past usage of malathion in Hawaii is not available, however prior survey data has indicated that 4.8% of agricultural crops were treated with insecticides, with malathion being a subset of this. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could also undergo some level of treatment with malathion. While usage is not expected on all use sites at the maximum rates allowed by the label, we anticipate that usage would occur, particularly from use occurring on pasture, which is found within the range of this species. Substantial exposure from other agricultural and residential uses is not anticipated because *Drosophila heteroneura* occupies mesic to wet montane habitats. This habitat will likely serve as a buffer to spray drift or runoff from these activities. Furthermore, we anticipate the additional conservation measures above, including residential use label changes and reduced numbers of applications and application rates would further reduce the likelihood of exposure of the species, and the plant species it depends on.

Exposure from malathion use on pasture will be addressed through the general and species-specific conservation measures listed above. We anticipate the new label restrictions reducing the number of applications and application rate for pasture will reduce the amount of malathion used and decrease potential exposure to the species. Furthermore, the species-specific conservation measure prohibits application of malathion within the range of this species plus 200 feet beyond the range to account for potential spray drift from applicators adjacent to the range. Together, these measures are anticipated to substantially reduce mortality of individuals of this species from application of malathion within and immediately surrounding the range of this species. Thus, we anticipate that small numbers of individuals of this specieswill experience mortality over the duration of the Action. However, we do not anticipate the loss of small numbers of individuals would result in species-level effects. Therefore, we do not anticipate the proposed Action would appreciably reduce survival and recovery of *Drosophila heteroneura,* in the wild.

Conclusion *Drosophila heteroneura*: **Not likely to jeopardize**

Picture-wing flies

Scientific Name:	Common Name:	Entity ID:
Drosophila mulli	Hawaiian picture-wing fly	1251

Species: *Drosophila mulli*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated

Number of Populations: Population size/location(s) unknown

Species Trends: Unknown population trends

Pesticides noted ☒

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Drosophila mulli*:

Drosophila mulli (Mull's picture wing fly) in the family Drosophilidae is endemic to montane wet ohia forests northeast of Kilauea volcano (Perreira and Kaneshiro 1990 pp. 79–81; as cited in USFWS 2021). The species has been documented at only two locations (Kaneshiro 2005 in litt., entire; Montgomery 2005 in litt., entire; Science Panel pp. 20–21; Magnacca 2006 in litt., entire; as cited in USFWS 2021). Last observed in 2014, one population occurs within the Upper Waiakea; the other population, observed in 2000 and 2001, occurs about 9.3 mi (15 km) south within the adjacent Olaa habitat (Kaneshiro in litt., 2005; Science Panel 2005, p. 21; Foote 2005 in litt., entire; Magnacca 2006 in litt., entire; Magnacca 2014, entire; as cited in USFWS 2021). The number of *Drosophila mulli* individuals in each population is unknown. Discovered in 1985, this picture-wing fly uses the fan palm, *Pritchardia beccariana* (loulu) as a breeding host (Perreira and Kaneshiro 1990 pp. 79–81; as cited in USFWS 2021). Adult flies are typically seen on the underside of the fronds and are believed to be generalist microbivores (i.e., microbe eating). In general, picture-wing flies use decaying bark, stems, leaves, or fermenting bark or sap fluxes as a larval substrate (Montgomery 1975, entire; as cited in USFWS 2021).

The species' primary threats include habitat and host plant degradation and destruction, nonnative ungulates and plants, predation and parasitization by nonnative species, drought, fire, inadequate regulatory mechanisms to address nonnative species, natural disasters, limited numbers of individuals and populations, climate change, and the interaction of these threats. Most threats to the picture-wing fly and its host plant are not being managed. Although this does not preclude the species' existence at unsurveyed populations of loulu in montane wet forests, *Drosophila mulli* and its host remain at risk throughout their range from unmanaged threats (USFWS 2021). The western yellowjacket (Vespula pensylvanica) is an aggressive, generalist predator that also threatens *Drosophila mulli* (Gambino et al. 1987, p. 170; Kaneshiro and Kaneshiro 1995, pp. 40-45; as cited in USFWS 2021).

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2021. Picture-wing fly (*Drosophila mulli*) 5-Year Review. Honolulu, Hawaii. 21 pp.

Overall Vulnerability *Drosophila mulli*: ☒ **High** ☐ **Medium** ☐ **Low**

RISK

(Risk is based on species exposure and response from labelled uses across the range)

Risk to individuals if exposed: Mortality is expected for pomace flies exposed to malathion on use sites or from spray drift.

Risk to the species from labelled uses across the range:

The table below summarizes the risk to the species from labelled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

DIRECT (all uses except mosquito control)	
Use areas – mortality	Mortality if exposed on alfalfa
Spray drift areas – mortality	Mortality depending on proximity to use sites
Volatilization	May be a source of exposure
INDIRECT (all uses except mosquito control)	
Use areas - Prey item mortality	No effects expected
Spray drift areas - Prey item mortality	No effects expected
Plants affected (decline in growth)	No effects expected
MOSQUITO CONTROL	
Direct (mortality)	Mortality if exposed
Indirect	No effects expected

Risk modifiers: Adult pomace flies feed on detritus; larvae feed on vegetative material.

The general life cycle of Hawaiian *Drosophila* is typical of that of most flies: after mating, females lay eggs from which larvae (immature stage) hatch; as larvae grow they molt (shed their skin) through three successive stages (instars); when fully grown, the larvae change into pupae (a transitional form) in which they metamorphose and emerge as adults. Breeding generally occurs year-round, but egg laying and larval development increase following the rainy season as the availability of decaying matter, upon which the flies feed, increases in response to the heavy rains

Pomace flies will be directly exposed to the pesticide and pesticide drift where the pesticide is applied to pasture or used for mosquito control within areas occupied by the pomace fly. Pomace fly adults will also be exposed when they come in contact with the pesticide in application and drift sites when it is deposited onto their bodies, when they absorb it from contacting it the environment, when they eat material containing the pesticide, and when they ingest the pesticide by drinking water containing the pesticide.

Range maps for *Drosophila mulli* were visually compared to the 2015 Hawaii Statewide Agricultural Land Use Baseline (University of Hawaii 2015) to determine potential overlap with agricultural use sites. *Drosophila mulli* had approximately 10% overlap with pasture, and its species' range was found adjacent to pasture. *Drosophila mulli* had minimal (less than 1%) overlap with diversified crops, and it did not appear that pasture or other crop use sites has expanded further into this species' range since the 2015 Agricultural Land Use Baseline was created.

Overall Risk: ☐ **High** ☒ **Medium** ☐ **Low**

USAGE

(Anticipated usage within the range based on past usage data)

Information regarding past usage of malathion in Hawaii is not available, however prior survey data has indicated that 4.8% of agricultural crops were treated with insecticides, with malathion being a subset of this. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the Approach to Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in Hawaii; future use cannot be ruled out but is not expected to increase significantly.

Overall Usage: ☐ **High** ☒ **Medium** ☐ **Low**

CONSERVATION MEASURES

General Conservation Measures

Residential use label changes: New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely), reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application. In addition, exposure to aquatic organisms is reduced due to buffers from waterways, which specify on the label a distance from water bodies where pesticides are not to be applied, and restrictions to application during periods where rain is not forecasted within 24 hours or when the soil is not saturated.

Reduced application number and rate: New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop, previous allowable number of applications ranged from 3 to 13 applications per year). We anticipate this measure will help reduce the amount of malathion used and decrease potential exposure to the species.

Species-specific Conservation Measure :
The following species-specific measure is now part of the Action and will be included in *BulletinsLive Two*:

Malathion application is prohibited within the range of the species, plus 200 feet beyond the range to account for potential spray drift from applicators adjacent to the range.

CONCLUSION

After reviewing the current status of the species, the environmental baseline for the Action area, and the effects of the proposed registration of malathion, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of *Drosophila mulli.* As discussed below, even though the vulnerability is high for this species, therisk usage are medium. Additionally, both general and species-specific conservation measure will be implemented for this species. While we anticipate that very small numbers of individuals of this species will be affected over the duration of the proposed Action, we do not expect species-level effects to occur.

Drosophila mulli has high vulnerability based on its status, distribution, and trends. The risk to this species posed by the labeled uses across the range is medium and usage is expected to be medium. Information regarding past usage of malathion in Hawaii is not available, however prior survey data has indicated that 4.8% of agricultural crops were treated with insecticides, with malathion being a subset of this. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed will also undergo some level of treatment with malathion.

While usage is not expected on all use sites at the maximum rates allowed by the label, we anticipate usage would occur, particularly from use occurring on pasture, which is found within the range of this species. Substantial exposure from other agricultural and residential uses is not anticipated, because *Drosophila mulli* occupies montane wet ohia forests northeast of Kilauea volcano. This habitat will likely serve as a buffer to spray drift or runoff from these activities. Furthermore, we anticipate the additional conservation measures above, including residential use label changes and reduced numbers of applications and application rates would further reduce the likelihood of exposure from these use types.

Exposure from malathion use on pasture will be addressed through the general and species-specific conservation measures listed above. We anticipate the new restrictions reducing the number of applications and application rate for pasture will reduce the amount of malathion used and decrease potential exposure to the species. Furthermore, the species-specific conservation measure prohibits application of malathion within the range of this species plus 200 feet beyond the range to account for potential spray drift from applicators adjacent to the range. Together, these measures are anticipated to substantially reduce mortality of individuals of this species from application of malathion within and immediately surrounding the range of this species. Thus, we anticipate only small numbers of individuals of this species will experience mortality over the duration of the Action. However, we do not anticipate the loss of a small number of individuals would result in species-level effects. Therefore, we do not anticipate the proposed Action would appreciably reduce survival and recovery of *Drosophila mulli,* in the wild.

Conclusion *Drosophila mulli*: **Not likely to jeopardize**

Integration and Synthesis Summary: Pacific Islands Invertebrates

HAWAIIAN YELLOW-FACED BEES

This section describes our analysis for Hawaiian yellow-faced bees. The analysis for most of the species will be presented together as a group below, as they generally do not overlap use sites, although each species was considered individually and has a separate conclusion. The remaining two Hawaiian yellow-faced bee species, *Hylaeus facilus* and *Hylaeus mana*, are expected to overlap with use sites and will be presented individually after the group below.

Hawaiian Yellow-faced bees

Scientific Name:	Common Name:	Entity ID:
Hylaeus anthracinus	Anthricinan yellow-faced bee	5580
Hylaeus assimulans	Assimulans yellow-faced bee	4413
Hylaeus hilaris	Hilaris yellow-faced bee	7955
Hylaeus kuakea	Hawaiian yellow-faced bee	10009
Hylaeus longiceps	Hawaiian yellow-faced bee	5333

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Habitat destruction and modification, and land use conversion leads to fragmentation of yellow-faced bee foraging and nesting areas. Coastal and lowland habitats have been severely altered and degraded, partly because of past and present land management practices, including agriculture, grazing, and urban development; the deliberate and accidental introductions of nonnative animals and plants; and recreational activities (USFWS 2010).

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Hylaeus anthracinus*:

Species: *Hyalaeus anthracinus*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Population size/location(s) unknown

Species Trends: Declining population(s) – one or more populations declining.

Pesticides noted ☐

Hylaeus anthracinus was historically known from numerous coastal and lowland dry forest habitats up to 2,000 ft (610 m) in elevation on the islands of Hawaii, Maui, Lanai, Molokai, and Oahu, and in some areas was ‘‘locally abundant’’ (USFWS 2016). Between 1997 and 1998, surveys for Hawaiian *Hylaeus* were conducted at 43 sites that were either historical collecting localities or potential suitable habitat. *Hylaeus anthracinus* was observed at 13 of the 43 survey sites but was not found at any of the 9 historically occupied sites (Daly and Magnacca 2003, p. 217; as cited in USFWS 2016). Several of the historical collection sites have been urbanized or are dominated by nonnative vegetation (Liebherr and Polhemus 1997, pp. 346–347; Daly and Magnacca 2003, p. 55; Magnacca 2007, pp. 186–188; as cited in USFWS 2016). There has been a dramatic decline in abundance or presence of *H. anthracinus* since surveys conducted in 1999 through 2002, noted on surveys conducted between 2011 and 2013 (Magnacca 2015, in litt. ; as cited in USFWS 2016). Currently, *Hylaeus anthracinus* is known from 15 small patches of coastal and lowland dry forest habitat (Magnacca 2005a, in litt., p. 2); 5 locations on the island of Hawaii in the coastal ecosystem; 2 locations on Maui in the coastal and lowland dry ecosystems; 1 location on Kahoolawe in the lowland dry ecosystem; 3 locations on Molokai in the coastal ecosystem, and 4 locations on Oahu in the coastal ecosystem (Daly and Magnacca 2003, p. 217; Magnacca 2005a, in litt., p. 2; Magnacca and King 2013, pp. 13–14; Graham 2015, in litt.; as cited in USFWS 2016). These 15 locations supported small populations of *Hylaeus anthracinus*, but the number of individual bees is unknown. In 2004, a single individual was collected in montane dry forest on the island of Hawaii (possibly a vagrant); however, the presence of additional individuals has not been confirmed at this site (Magnacca 2005a, in litt., p. 2; as cited in USFWS 2016). Although this species was previously unknown from the island of Kahoolawe, it was observed at one location on the island in 2002 (Daly and Magnacca 2003, p. 55; as cited in USFWS 2016). Additionally, during surveys between 1997 and 2008, *Hylaeus anthracinus* was absent from 17 other sites with potentially suitable habitat from which other species of Hylaeus were collected (Daly and Magnacca 2003, pp. 4, 55; as cited in USFWS 2016) on Hawaii Island, Maui, Lanai, Molokai, and Oahu. Anthracinan yellow-faced bees currently occur in five coastal locations on Oʻahu, three coastal locations on Molokaʻi, one coastal and one dry forest location on Maui, a coastal location on Kahoʻolawe, and five coastal and possibly one montane dry forest population on Hawaiʻi (USFWS 2021). The species has not been documented on Lānaʻi for over 100 years. In general, the populations are small and patchily dispersed. The species was not observed in many areas that contained suitable pollen and nectar sources, suggesting the availability of nesting substrates and threats, such as ants or competition for resources, constrain the location of the populations (USFWS 2021). Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *H. anthracinus* described above. In addition, disease has been suggested as a threat, as pathogens carried by nonnative bees, wasps, and ants could be transmitted to *Hylaeus anthracinus* through shared food sources (Graham 2015, in litt.; as cited in USFWS 2016); however, we have no reports of this type of disease transmission at this time. The remaining populations of *Hylaeus anthracinus* and its habitat are at risk. The known individuals are restricted to 15 locations on Hawaii, Maui, Kahoolawe, Molokai, and Oahu and continue to be negatively affected by habitat destruction and modification by urbanization and land-use conversion, and by habitat destruction and removal of food and nesting sites by nonnative ungulates and nonnative plants. Habitat destruction by fire is a threat. Randomly occurring events such as hurricanes and drought modify habitat and remove food and nesting sources for *Hylaeus anthracinus*. Predation by nonnative ants and wasps is a threat. Existing regulatory mechanisms and agency policies do not address the primary threats to the yellow-faced bees and its habitat from nonnative ungulates. Competition with nonnative bees for food and nesting sites is a threat. The small number of remaining populations limits this species' ability to adapt to environmental changes. The effects of climate change are likely to further exacerbate these threats. Because of these threats, we find that *Hylaeus anthracinus* is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2016. Endangered and Threatened Wildlife and Plants; Endangered Status for 49 Species from the Hawaiian Islands. Federal Register 81(190):67786-67860. September 30, 2016.

U.S. Fish and Wildlife Service (USFWS). 2021. Anthracinan yellow-faced bee (*Hylaeus anthracinus*). Honolulu, Hawai'i. 30 pp.

Species: *Hyalaeus assimulans*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Population size location(s) unknown

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Hyalaeus assimulans*:

Hylaeus anthracinus was historically known from numerous coastal and lowland dry forest habitats up to 2,000 ft (610 m) in elevation on the islands of Hawaii, Maui, Lanai, Molokai, and Oahu, and in some areas was ''locally abundant'' (USFWS 2016). Between 1997 and 1998, surveys for Hawaiian *Hylaeus* were conducted at 43 sites that were either historical collecting localities or potential suitable habitat. *Hylaeus anthracinus* was observed at 13 of the 43 survey sites but was not found at any of the 9 historically occupied sites (Daly and Magnacca 2003, p. 217; as cited in USFWS 2016). Several of the historical collection sites have been urbanized or are dominated by nonnative vegetation (Liebherr and Polhemus 1997, pp. 346–347; Daly and Magnacca 2003, p. 55; Magnacca 2007, pp. 186–188; as cited in USFWS 2016). There has been a dramatic decline in abundance or presence of H. anthracinus since surveys conducted in 1999 through 2002, noted on surveys conducted between 2011 and 2013 (Magnacca 2015, in litt.; as cited in USFWS 2016). Currently, *Hylaeus anthracinus* is known from 15 small patches of coastal and lowland dry forest habitat (Magnacca 2005a, in litt., p. 2; as cited in USFWS 2016); 5 locations on the island of Hawaii in the coastal ecosystem; 2 locations on Maui in the coastal and lowland dry ecosystems; 1 location on Kahoolawe in the lowland dry ecosystem; 3 locations on Molokai in the coastal ecosystem, and 4 locations on Oahu in the coastal ecosystem (Daly and Magnacca 2003, p. 217; Magnacca 2005a, in litt., p. 2; Magnacca and King 2013, pp. 13–14;

Graham 2015, in litt.; as cited in USFWS 2016). These 15 locations supported small populations of *H. anthracinus*, but the number of individual bees is unknown. In 2004, a single individual was collected in montane dry forest on the island of Hawaii (possibly a vagrant); however, the presence of additional individuals has not been confirmed at this site (Magnacca 2005a, in litt., p. 2; as cited in USFWS 2016). Although this species was previously unknown from the island of Kahoolawe, it was observed at one location on the island in 2002 (Daly and Magnacca 2003, p. 55; as cited in USFWS 2016). Additionally, during surveys between 1997 and 2008, *Hylaeus anthracinus* was absent from 17 other sites with potentially suitable habitat from which other species of *Hylaeus* were collected (Daly and Magnacca 2003, pp. 4, 55; as cited in USFWS 2016) on Hawaii Island, Maui, Lanai, Molokai, and Oahu. Most recently, assimulans yellow-faced bee has been photo-documented at several locations in west and east Maui (Kenolio 2020 in litt., entire; as cited in USFWS 2021). The sightings include the following four general locations: on the southwest coast of east Maui near Makena, Maui; in 2013, on an ūlei flower near the north coast of west Maui in the Kahakuloa area; in 2011 in the Honolua area; and in 2018 in the Papanalahoa Point area, near Wailuku. The bees were seen visiting flowers of ʻōhelo kai, naupaka kahakai, ʻūlei, and ʻōhai (Kenolio 2020 in litt., entire; as cited in USFWS 2021). Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *Hylaeus anthracinus* described above. In addition, disease has been suggested as a threat, as pathogens carried by nonnative bees, wasps, and ants could be transmitted to *Hylaeus anthracinus* through shared food sources (Graham 2015, in litt.); however, we have no reports of this type of disease transmission at this time. The remaining populations of *Hylaeus anthracinus* and its habitat are at risk. The known individuals are restricted to 15 locations on Hawaii, Maui, Kahoolawe, Molokai, and Oahu and continue to be negatively affected by habitat destruction and modification by urbanization and land-use conversion, and by habitat destruction and removal of food and nesting sites by nonnative ungulates and nonnative plants. Habitat destruction by fire is a threat. Randomly occurring events such as hurricanes and drought modify habitat and remove food and nesting sources for *Hylaeus anthracinus*. Predation by nonnative ants and wasps is a threat. Existing regulatory mechanisms and agency policies do not address the primary threats to the yellow-faced bees and its habitat from nonnative ungulates. Competition with nonnative bees for food and nesting sites is a threat. The small number of remaining populations limits this species' ability to adapt to environmental changes. The effects of climate change are likely to further exacerbate these threats. Because of these threats, we find that *H. anthracinus* is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2016. Endangered and Threatened Wildlife and Plants; Endangered Status for 49 Species from the Hawaiian Islands. Federal Register 81(190):67786-67860. September 30, 2016.

U.S. Fish and Wildlife Service (USFWS). 2021. *Hylaeus assimulans* (Assimulans yellow-faced bee). Honolulu, Hawaiʻi. 30 pp.

Species: *Hyalaeus hilaris*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Population size location(s) unknown

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Hylaeus hilaris*:

Historically, *Hylaeus hilaris* was known from coastal habitat on Maui, Lanai, and Molokai; and lowland dry habitat on Maui (USFWS 2016). It is believed to have occurred along much of the coast of these islands because its primary hosts, *Hylaeus anthracinus, Hylaeus assimulans*, and *Hylaeus longiceps* likely occurred throughout this habitat. First collected on Maui in 1879, *Hylaeus hilaris* has only been collected twice in the last 100 years. *Hylaeus hilaris* was absent from three of its historical population sites revisited by researchers between 1998 and 2006 (Magnacca 2007, p. 181; as cited in USFWS 2016). It was also not observed in 2003 at 10 additional sites with potentially suitable habitat (Daly and Magnacca 2003, pp. 103, 106; as cited in USFWS 2016). Currently, the only known population of *Hylaeus hilaris* is located on Molokai, in the coastal ecosystem (Daly and Magnacca 2003, pp. 103, 106; Magnacca 2005d, in litt., p. 2; Magnacca 2007, p. 181; as cited in USFWS 2016). Because *Hylaeus hilaris* is an obligate parasite on *Hylaeus anthracinus*, *Hylaeus assimulans*, and *Hylaeus longiceps*, its occurrences are determined by the remaining populations of these three species. The small number of populations and individuals of *Hylaeus hilaris* makes this species more vulnerable to extinction because of the higher risks from genetic bottlenecks, random demographic fluctuations, and localized catastrophes such as hurricanes and drought (Daly and Magnacca 2003, p. 3; Magnacca 2007, p. 173; as cited in USFWS 2016). Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *Hylaeus hilaris* described above. The remaining populations *of Hylaeus hilaris* and its habitat are at risk. There is one known occurrence on Molokai. *Hylaeus hilaris* and its host species continue to be negatively affected by habitat destruction and modification by urbanization and land-use conversion, and by habitat destruction and removal of food and nesting sites (for host species) by nonnative ungulates and nonnative plants. Habitat destruction by fire is a threat. Randomly occurring events such as hurricanes and drought modify habitat and remove food and nesting sources for *Hylaeus hilaris* and its host species. Predation by nonnative ants and wasps is a threat. Existing regulatory mechanisms and agency policies do not address the primary threats to the yellow-faced bees and its habitat from nonnative ungulates. Competition with nonnative bees for food and nesting sites is a threat. The small number of remaining populations limits this species' ability to adapt to environmental changes, especially because it is an obligate parasite of other rare *Hylaeus* bees. Because of these threats, we find that *Hylaeus hilaris* is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2016. Endangered and Threatened Wildlife and Plants; Endangered Status for 49 Species from the Hawaiian Islands. Federal Register 81(190):67786-67860. September 30, 2016.

U.S. Fish and Wildlife Service (USFWS). 2021. Hilaris yellow-faced bee (*Hylaeus hilaris*). Honolulu, Hawaiʻi. 30 pp.

Species: *Hyalaeus kuakea*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Population size location(s) unknown

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Hylaeus kuakea*:

Because the first collection of *Hylaeus kuakea* was not made until 1997, its historical range is unknown (Magnacca 2005e, in litt., p. 2; Magnacca 2007, p. 184; as cited in USFWS 2016). Phylogenetically, *Hylaeus kuakea* belongs in a species-group primarily including species inhabiting mesic forests (Magnacca and Danforth 2006, p. 405; as cited in USFWS 2016). Only four individuals (all males) have been collected from two different sites in the Waianae Mountains of Oahu in the lowland mesic ecosystem (Magnacca 2007, p. 184; as cited in USFWS 2016). The species has never been collected in any other habitat type or area, including some sites that have been more thoroughly surveyed (Magnacca 2011, in litt. ; as cited in USFWS 2016). Not all potentially suitable habitat has been surveyed due to the remote and rugged locations, small size, rareness, and distant spacing among large areas of nonnative forest (Smith 1985, pp. 227– 233; Juvik and Juvik 1998, p. 124; Wagner et al. 1999, pp. 66–67, 75; as cited in USFWS 2016). Habitat destruction and modification by feral pigs leads to fragmentation of, and eventual loss of, foraging and nesting areas of *Hylaeus kuakea*. Habitat destruction and modification by nonnative plants adversely impacts native plant species by modifying the availability of light, altering soil-water regimes, modifying nutrient cycling, altering the fire characteristics, and ultimately converting native dominated plant communities to nonnative plant communities, and results in removal of food sources and nesting sites for *Hylaeus kuakea*. Nonnative plant species that modify and destroy habitat of *Hylaeus kuakea* are noted in the descriptions for *Hylaeus assimulans* and *Hylaeus facilis*, above. Fire is a threat to *Hylaeus kuakea* because it destroys native plant communities and opens habitat for increased invasion by nonnative plants. Because of the greater frequency, intensity, and duration of fires that have resulted from the human alteration of landscapes and the introduction of nonnative plants, especially grasses, fires are now more destructive, including in lowland mesic areas (Brown and Smith 2000, p. 172; as cited in USFWS 2016), and a single grass-fueled fire often kills most native trees and shrubs in the area (D'Antonio and Vitousek 1992, p. 74; as cited in USFWS 2016) and could destroy food and nesting resources for *Hylaeus kuakea*. The numbers of wildfires and the acreages involved are increasing in the main Hawaiian Islands; however, their occurrences and locations are unpredictable, and could affect habitat for yellow-faced bees at any time (Gima 1998, in litt.; County of Maui 2009, ch. 3, p. 3; Hamilton 2009, in litt.; Honolulu Advertiser 2010, in litt.; Pacific Disaster Center 2011, in litt.; as cited in USFWS 2016). Random, naturally occurring events such as hurricanes and drought can modify and destroy habitat of *Hylaeus kuakea* by creating disturbed areas conducive to invasion by nonnative plants, eliminating food and nesting resources (Kitayama and Mueller-Dombois 1995, p. 671; Businger 1998, pp. 1–2; as cited in USFWS 2016). Predation by nonnative ants (the big-headed ant, the long-legged ant, *Solenopsis papuana*, and *S. geminata*) on *Hylaeus* egg, larvae, and pupal stages is a threat to *Hylaeus kuakea*; additionally, ants compete with *Hylaeus kuakea* for their nectar food source (Howarth 1985, p. 155; Hopper et al. 1996, p. 9; Holway et al. 2002, pp. 188, 209; Daly and Magnacca 2003, p. 9; Lach 2008, p. 155; as cited in USFWS 2016). Predation by nonnative western yellow jacket wasps is a threat to *Hylaeus kuakea* because the wasp is an aggressive, generalist predator, and occurs in great numbers in many habitat types, from sea level to over 8,000 ft (2,450 m), including areas where *Hylaeus kuakea* and other yellow-faced bees occur (Gambino et al. 1987, p. 169; as cited in USFWS 2016). Existing regulatory mechanisms and agency policies do not address the primary threats to the yellow-faced bees and its habitat from nonnative ungulates. Competition with nonnative bees (honeybees, carpenter bees, sweat bees, and alien *Hylaeus* bees) for nectar and pollen is a threat to *Hylaeus kuakea* (Magnacca 2007, p. 188; Graham 2015, in litt.; Magnacca 2015, in litt.; as cited in USFWS 2016). The small number of populations and individuals of *Hylaeus kuakea* makes this species

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2016. Endangered and Threatened Wildlife and Plants; Endangered Status for 49 Species from the Hawaiian Islands. Federal Register 81(190):67786-67860. September 30, 2016.

U.S. Fish and Wildlife Service (USFWS). 2021. Yellow-Faced Bee (*Hylaeus kuakea*). 5-Year Review. Honolulu, Hawai‘i. 16 pp.

Species: *Hyalaeus longiceps*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Population size location(s) unknown

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Hylaeus longiceps*:

Hylaeus longiceps is historically known from coastal and lowland dry shrubland habitat up to 2,000 ft (610 m) in numerous locations on the islands of Maui, Lanai, Molokai, and Oahu. Longiceps yellow-faced bees, are believed to be ground-nesting, though nests have not been described (USFWS 2021). Ground-nesting yellow-faced bees usually construct their nests opportunistically within existing burrows or small natural cavities under bark or rocks. Longiceps yellow-faced bee appears to nest at sandy or ashy sites (Ka‘ena Point, O‘ahu; Waiehu dune, Maui; Kahue area, Lāna‘i; and Mo‘omomi Preserve, Moloka‘i). Longiceps yellow-faced bees and anthracinan yellow-faced bees (*Hylaeus anthracinus*) are often found together; however, longiceps yellow-faced bees have not been found at strictly rocky sites (e.g., Manawainui, Maui or Kalaupapa, Moloka‘i) where anthracinan yellow-faced bees, which also nest in twigs, are found (Magnacca 2010 in litt., entire; as cited in USFWS 2021). Perkins (1899, p. 98; as cited in USFWS 2015) noted *H. longiceps* was locally abundant, and probably occurred throughout much of the leeward and lowland areas on these islands. *Hylaeus longiceps* is now restricted to small populations in patches of coastal and lowland dry habitat on the Maui, Lanai, Molokai, and Oahu (Magnacca 2005f, in litt., p. 2; Magnacca and King 2013, pp. 13, 16; as cited in USFWS 2015). Twenty-five sites that were either historical collecting localities or contained potentially suitable habitat for this species were surveyed between 1997 and 2008 (Magnacca and King 2013, p. 16; as cited in USFWS 2015). *Hylaeus longiceps* was observed at only seven of the surveyed sites: Three sites on Lanai (in the coastal and lowland dry ecosystems), two sites on Oahu (in the coastal ecosystem), and one site on each of the islands of Maui (in the coastal ecosystem) and Molokai (in the coastal ecosystem) (Daly and Magnacca 2003, p. 135; Magnacca and King 2013, pp. 11–12; as cited in USFWS 2015). The current population size or demographics of *hylaeus longiceps* yellow-faced bees is unknown; however, the species is believed to be extant in low numbers in seven populations located on four islands in Hawai‘i. Though the species is present on four islands, there are a limited number of populations on each island and all are vulnerable to catastrophic events (USFWS 2021). The small number of populations and individuals of *Hylaeus longiceps* makes this species more vulnerable to extinction because of the higher risks from genetic bottlenecks, random demographic fluctuations, and localized catastrophes such as hurricanes and drought (Daly and Magnacca 2003, p. 3; Magnacca 2007, p. 173; as cited in USFWS 2015). The remaining population of *Hylaeus longiceps* and its habitat are at risk. The known individuals are restricted to seven locations, three on Lanai, two on Oahu, and one each on Maui and Molokai, and continue to be negatively affected by habitat destruction and modification by urbanization and land use conversion, by habitat destruction and removal of food and nesting sites by nonnative ungulates and nonnative plants, and by recreational use vehicles on Lanai. Habitat destruction by fire is a threat. Randomly occurring events such as hurricanes and drought may modify habitat and remove food and nesting sources for *Hylaeus longiceps*. Predation by nonnative ants and wasps is a threat. Existing regulatory mechanisms and agency policies do not address the primary threats to the yellow-faced bees and its habitat from nonnative ungulates. Competition with nonnative bees for food and nesting sites is a threat. The small number of remaining populations limits this species' ability to adapt to environmental changes. Because of these threats, we find that *Hylaeus longiceps* is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range.

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2016. Endangered and Threatened Wildlife and Plants; Endangered Status for 49 Species from the Hawaiian Islands. Federal Register 81(190):67786-67860. September 30, 2016.

U.S. Fish and Wildlife Service (USFWS). 2021. Longiceps or long head yellow-faced bee (*Hylaeus longiceps*). 5-Year Review. Honolulu, Hawaiʻi. 32 pp.

Overall Vulnerability *Hylaeus anthracinus*: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability *Hylaeus assimulans*: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability *Hylaeus hilaris*: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability *Hylaeus kuakea*: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability *Hylaeus longiceps*: ☒ **High** ☐ **Medium** ☐ **Low**

RISK

(Risk is based on species exposure and response from labelled uses across the range)

Risk to individuals if exposed: Yellow-faced bees exposed to malathion on use sites or from spray drift are expected to die.

Risk to the species from labelled uses across the range:

The table below summarizes the risk to the species from labelled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

DIRECT (all uses except mosquito control)	
Use areas – mortality	Mortality if exposed
Spray drift areas – mortality	Mortality depending on proximity to use sites
Volatilization	Not an appreciable source of exposure
INDIRECT (all uses except mosquito control)	
Use areas - Prey item mortality	No effects expected

Spray drift areas - Prey item mortality	No effects expected
Plants affected (decline in growth)	Effects on use sites with higher allowable application rates
MOSQUITO CONTROL	
Direct (mortality)	Mortality if exposed
No effects expected	No effects expected
Indirect	No effects expected

Risk modifiers: The yellow-faced bees occur in habitats below 2,000 feet elevation (610 meters) on the Islands of Hawai'i, Maui, Lanai, Kahoolawe, Molokai, and Oahu. Hawaiian yellow-faced bee species almost exclusively visit native plants to collect nectar and pollen, pollinating those plants in the process (Daly and Magnacca 2003, p. 11, Sakai et al. 1995, pp. 2,524-2,528; Cox and Elmqvist 2000, p. 1,238; Sahli et al. 2008, p. 1). *Hylaeus* bees are very rarely found visiting non-native plants for nectar and pollen (Magnacca 2007a, pp. 186, 188) and are almost completely absent from habitats dominated by non-native plant species (Daly and Magnacca 2003, p. 11). The female yellow-faced bee lays eggs in brood cells she constructs in the nest and lines with a self-secreted, cellophane-like material. Prior to sealing the nest, the female provides her young with a mass of semiliquid nectar and pollen left alongside her eggs. Upon hatching, the grub-like larvae eat the provisions left for them, grow and molt through three instar stages, pupate, and eventually emerge as adults (Michener 2000, p. 24, USFWS, 2014).

Hylaeus anthracinus is currently known from 16 small patches of coastal and lowland dry forest habitat (Magnacca 2005a, p. 2): five locations on the island of Hawai'i; one location on Kahoolawe; two locations on Maui; three locations on Molokai; and five locations on Oahu (Daly and Magnacca 2003, p. 217; Magnacca 2005a, p. 2; Magnacca 2007b, p. 44; Magnacca and King 2013, pp. 13-14). These 16 locations supported small populations of *Hyalaeus anthracinus*, but the number of individual bees is unknown. Currently, *Hylaeus assimulans* is known from five small patches of coastal and lowland dry forest habitat: one location on Kahoolawe; two locations on Lanai; and two locations on Maui (Daly and Magnacca 2003, p. 58; Magnacca 2005, p. 2). *Hylaeus facilis* is currently only known from two locations, one each on the islands of Molokai and Oahu (Daly and Magnacca 2003, pp. 81-82; Magnacca 2005c, p. 2). Currently, the only known population of *Hylaeus hilaris* is located on TNCs Moomomi Preserve on Molokai (Daly and Magnacca 2003, pp. 103, 106; Magnacca 2005d, p. 2). Because *Hylaeus hilaris* is an obligate parasite on *Hylaeus anthracinus*, *Hylaeus assimulans*, *and Hylaeus longiceps*, its occurrences are determined by the remaining populations of these three species.

Hylaeus kuakea was first described by Daly and Magnacca (2003, pp. 1, 125-1,127) from specimens collected in 1997 in the Waianae Mountains on Oahu. (USFWS, 2014). *Hylaeus longiceps* was recently observed at three sites on Lanai and one site each on the islands of Maui, Molokai, and Oahu (Daly and Magnacca 2003, p. 135, USFWS, 2014).

Yellow-faced bees will be directly exposed to the pesticide and pesticide drift where the pesticide is applied to pasture, open space developed, other crops, vegetables and ground fruit, orchards and vineyards, or used for mosquito control within areas where yellow-faced bee's nest and forage. In addition, the pesticide volatilizes readily, and it is transported downwind and deposited as dry deposition, in precipitation and, at higher elevations, in fog deposition. Although we would expect species within high-level elevation areas to be exposed to malathion via volatilization, we conclude, based on the best information available, that species in high elevations would not be exposed to concentration levels that would affect them (see *General Effects* for further information on volatilization). Yellow-faced bee adults would be exposed when they come in contact with the pesticide in application and drift sites when it is deposited onto their bodies, when they absorb it from contacting it on host plants, when they eat pollen and nectar containing the pesticide, and when they ingest the pesticide by drinking water containing the pesticide. Yellow-faced bee larvae would be exposed by ingesting the pesticide in any nectar and pollen in the nest cavity contaminated with the pesticide. A membrane surrounds the nest cavity, which is usually protected within a dead branch or in cavities under rocks. This membrane may protect the egg and larvae from deposition of the pesticide due to direct application to the nest site, spray drift, and volatilization and dry and wet deposition; if not, the egg and larvae would be exposed to absorbing the pesticide deposited on the nest cavity membrane.

Current range maps of *Hylaeus anthracinus, H. assimilans, H. hilaris, H. kuakea,* and *H. longiceps* were visually compared to the 2015 Hawaii Statewide Agricultural Land Use Baseline (University of Hawaii 2015) to determine potential overlap with agricultural use sites. In addition, current range maps were compared with aerial photography to determine if developed and open-space developed areas occur within or adjacent to these species' ranges.

- *Hylaeus anthracinus* had 21 total populations of which 11 populations had no overlap with agricultural use sites or developed areas, nor were adjacent to any of these sites. Two populations overlapped with pasture, one with parkland, and six were adjacent to pasture and diversified crops. We anticipate that two out of the 21 populations could be exposed to malathion if pasture was treated and six populations where pasture and diversified crops were identified as being adjacent to, but outside of the species range, where applications could be close enough where spray drift could enter into the species habitat.
- *Hylaeus assimulans* had eight populations with no overlap with agricultural use sites or developed areas, nor were adjacent to any of these sites. One population overlapped with developed and two were adjacent to developed areas. We anticipate that one population out of 11 could be exposed to malathion if developed areas were treated and two populations where developed areas were identified as being adjacent to, but outside of the species range, where applications could be close enough where spray drift could enter into the species habitat.
- *Hylaeus hilaris*, consisting of one population, had no overlap with agricultural use sites or developed areas, nor was adjacent to any of these sites. The species only known population is located on The Nature Conservancy's Moomomi Preserve on Molokai, in the coastal ecosystem (Daly and Magnacca 2003, pp.103, 106; Magnacca 2005d, p. 2; Magnacca 2007b, p. 181, USFWS 2015).
- *Hylaeus kuakea*, consisting of one population, had no overlap with agricultural use sites or developed areas, nor was adjacent to any of these sites.
- *Hylaeus longiceps* had nine populations out of 11 that had no overlap with agricultural use

sites or developed areas, nor were adjacent to any of these sites. One population was adjacent to diversified crops and one was adjacent to developed sites.

Overall Risk *Hylaeus anthracinus*: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Risk *Hylaeus assimulans*: ☐ **High** ☒ **Medium** ☐ **Low**

Overall Risk *Hylaeus hilaris*: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk *Hylaeus kuakea*: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk *Hylaeus longiceps*: ☐ **High** ☒ **Medium** ☐ **Low**

USAGE

(Anticipated usage within the range based on past usage data)

Information regarding past usage of malathion in Hawaii is not available, however prior survey data has indicated that 4.8% of agricultural crops were treated with insecticides, with malathion only being a subset of this, assuming its use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the Approach to Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in Hawaii; future use cannot be ruled out but is not expected to increase significantly.

Overall Usage: ☐ **High** ☒ **Medium** ☐ **Low**

CONSERVATION MEASURES

Residential use label changes: New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely), reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10

days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application.

Reduced application number and rate: New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop, previous allowable number of applications ranged from 3 to 13 applications per year). We anticipate this measure will help reduce the amount of malathion used and decrease potential exposure to these species.

Species-specific Measures: In addition to the general label changes that would apply to all uses specified on the label, which would be protective of a wide range of species, the registrants have also agreed to additional conservation measures, such as use limitation areas.

CONCLUSION

After reviewing the current status of the species, the environmental baselines for the Action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of these species. As discussed below, the vulnerability is high and risk are medium or low for these species, while usage is medium. Additionally, implementation of the conservation measures described above is expected to further reduce the likelihood of exposure. We do not anticipate the Action will result in species-level effects.

The risk to these yellow-faced bees posed by the labeled uses across the range is medium or low, with a medium amount of estimated usage within the range of the species based on CONUS data. Information regarding past usage of malathion in Hawaii is not available, however prior survey data has indicated that 4.8% of agricultural crops were treated with insecticides, with malathion only being a subset of this, assuming its use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. While individuals, especially those that are found co-occurring with use sites would be killed by direct contact with malathion applications or from spray drift, the area of application that overlaps with the range is relatively small. Application sites adjacent to these populations, where spray drift could occur, are likely distant enough where spray drift would not penetrate into the species habitat at any significant distance due to the characteristics (density) of the species habitat. Based on the low overlap of use sites with these species' ranges and the minimal impact anticipated from spray drift from sites adjacent to the species' range, we do not anticipate species-level effects. Moreover, we anticipate that the residential use restrictions and the reduction in number of application and application rates are expected to reduce the amount of malathion used and limit the likelihood of spray drift and runoff exposure to these species and their habitats. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely), reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. We also anticipate that the reduced application number and rate will decrease the amount of malathion used in pasture and on certain crops and further reduce potential exposure to these species. Thus, while we anticipate that small numbers of individuals may be lost over the duration of the Action, we do not anticipate species-level effects to occur. Therefore, we anticipate that the proposed Action would not appreciably reduce survival and recovery of *H. anthracinus, H. assimulans, H. hilaris, H. Kuakea, and H. longiceps* in the wild.

Conclusion *Hylaeus anthracinus*: **Not likely to jeopardize**

Conclusion *Hylaeus assimulans*: **Not likely to jeopardize**

Conclusion *Hylaeus hilaris*: **Not likely to jeopardize**

Conclusion *Hylaeus kuakea*: **Not likely to jeopardize**

Conclusion *Hylaeus longiceps*: **Not likely to jeopardize**

ADDITIONAL REFERENCES

University of Hawaii. 2015. Spatial Data Analysis and Visualization (SDAV) Laboratory in conjunction with the Hawaii State Department of Agriculture. Hilo, HI.

Hawaiian yellow-faced bees

Scientific Name:	Common Name:	Entity ID:
Hylaeus facilis	Easy yellow-faced bee	6747

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Habitat destruction and modification, and land use conversion leads to fragmentation of yellow-faced bee foraging and nesting areas. Coastal and lowland habitats have been severely altered and degraded, partly because of past and present land management practices, including agriculture, grazing, and urban development; the deliberate and accidental introductions of nonnative animals and plants; and recreational activities (USFWS 2010).

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Hylaeus facilis*

Species: *Hyalaeus facilis*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Population size location(s) unknown

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Hylaeus facilis*:

Historically, *Hylaeus facilis* was known from Maui, Lanai, Molokai, and Oahu, in dry shrubland to wet forest from sea level to 3,000 ft (1,000 m) (Gagne and Cuddihy 1999, p. 93; Daly and Magnacca 2003, pp. 81, 83; as cited in USFWS 2016). Perkins (1899, p. 77; as cited in USFWS 2016) remarked *H. facilis* was among the most common and widespread *Hylaeus* species on Oahu, Maui, Lanai, and Molokai. Although the species was collected in a wide range of habitat types, it likely prefers dry to mesic forest and shrubland (Magnacca 2005c, in litt., p. 2; as cited in USFWS 2016), which are increasingly rare and patchily distributed habitats (Smith 1985, pp. 227–233; Juvik and Juvik 1998, p. 124; Gagne and Cuddihy 1999, pp. 66–67, 75; Magnacca 2005c, in litt., p. 2; as cited in USFWS 2016). Researchers believe the wet forest site on Oahu where *Hylaeus facilis* was observed likely had a more open understory (more mesic conditions) and represented an outlier or residual population (Perkins 1899, p.76; Liebherr and Polhemus 1997; p. 347; as cited in USFWS 2016). *Hylaeus facilis* has almost entirely disappeared from most of its historical range (Maui, coastal and lowland mesic; Lanai, lowland dry and lowland mesic; and Oahu, coastal and lowland dry) (Daly and Magnacca 2003, p. 7; Magnacca 2007, p. 183; as cited in USFWS 2016). Between 1998 and 2006, 39 sites on Maui, Lanai, Molokai, and Oahu were surveyed, including 13 historical sites. *Hylaeus facilis* was absent from all 13 locations (Magnacca 2007, p. 183; as cited in USFWS 2016) and was not observed at 26 additional sites with potentially suitable habitat (Daly and Magnacca 2003, pp. 7, 81–82; Magnacca 2007, p. 183; as cited in USFWS 2016). In spite of extensive surveys in the historical areas and in other sites with potentially suitable habitat on the islands of Oʻahu and Maui, the last documentation of easy yellow-faced bee is limited to one location on each island, Oʻahu in 1975, Maui in 1993, and Molokaʻi in 2005 (USFWS 2021). Already believed to be extirpated on Lānaʻi and possibly on Maui, yellow-faced bees may also be extirpated from Oʻahu, or at best, extremely limited in abundance (USFWS 2021). The primary factors that pose serious and ongoing threats to the species, its plant hosts, and its habitat range include the following: habitat degradation and destruction, nonnative ungulates and plants, drought, fire, predation, inadequate regulatory mechanisms to address nonnative species, natural disasters, limited numbers of populations and individuals, competition, potential environmental changes, and the interaction of these threats (USFWS 2021). Randomly occurring events such as hurricanes and drought modify habitat and remove food and nesting sources for *Hylaeus facilis*. Predation by nonnative ants and wasps is a threat. Existing regulatory mechanisms and agency policies do not address the primary threats to the yellow-faced bees and its habitat from nonnative ungulates. Competition with nonnative bees for food and nesting sites is a threat. The small number of remaining populations limits this species' ability to adapt to environmental changes. The effects of climate change are likely to further exacerbate these threats.

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2016. Endangered and Threatened Wildlife and Plants; Endangered Status for 49 Species from the Hawaiian Islands. Federal Register 81(190):67786-67860. September 30, 2016.

U.S Fish and Wildlife Service (USFWS). 2021. 5-Year Review. Summary and Evaluation. Easy or facilis yellow-faced bee (*Hylaeus facilis*). Region 12, Portland Regional Office/Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu, Hawaiʻi.

Overall Vulnerability *Hylaeus facilis*: ☒ **High** ☐ **Medium** ☐ **Low**

RISK

(Risk is based on species exposure and response from labelled uses across the range)

Risk to individuals if exposed: Yellow-faced bees exposed to malathion on use sites or from spray drift are expected to die.

Risk to the species from labelled uses across the range:

The table below summarizes the risk to the species from labelled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

DIRECT (all uses except mosquito control)	
Use areas – mortality	Mortality if exposed
Spray drift areas – mortality	Mortality depending on proximity to use sites
Volatilization	Not an appreciable source of exposure
INDIRECT (all uses except mosquito control)	
Use areas - Prey item mortality	No effects expected
Spray drift areas - Prey item mortality	No effects expected
Plants affected (decline in growth)	Effects on use sites with higher allowable application rates
MOSQUITO CONTROL	
Direct (mortality)	Mortality if exposed
No effects expected	No effects expected
Indirect	No effects expected

Risk modifiers: Hawaiian yellow-faced bee species almost exclusively visit native plants to collect nectar and pollen, pollinating those plants in the process (Daly and Magnacca 2003, p. 11, Sakai et al. 1995, pp. 2,524-2,528; Cox and Elmquist 2000, p. 1,238; Sahli et al. 2008, p. 1). *Hylaeus* bees are very rarely found visiting non-native plants for nectar and pollen (Magnacca 2007a, pp. 186, 188) and are almost completely absent from habitats dominated by non-native plant species (Daly and Magnacca 2003, p. 11). The female yellow-faced bee lays eggs in brood cells she constructs in the nest and lines with a self-secreted, cellophane-like material. Prior to sealing the nest, the female provides her young with a mass of semiliquid nectar and pollen left alongside her eggs. Upon hatching, the grub-like larvae eat the provisions left for them, grow and molt through three instar stages, pupate, and eventually emerge as adults (Michener 2000, p. 24, USFWS, 2014).

Hylaeus facilis is currently only known from two locations, one each on the islands of Molokai and Oahu (Daly and Magnacca 2003, pp. 81-82; Magnacca 2005c, p. 2).

Yellow-faced bees will be directly exposed to the pesticide and pesticide drift where the pesticide is applied to pasture, open space developed, other crops, vegetables and ground fruit, orchards and vineyards, or used for mosquito control within areas where yellow-faced bee's nest and forage. In addition, the pesticide volatilizes readily, and it is transported downwind and deposited as dry deposition, in precipitation and, at higher elevations, in fog deposition. Although we would expect species within high-level elevation areas to be exposed to malathion via volatilization, we conclude, based on the best information available, that species in high elevations would not be exposed to concentration levels that would affect them (see *General Effects* for further information on volatilization). Yellow-faced bee adults would be exposed when they come in contact with the pesticide in application and drift sites when it is deposited onto their bodies, when they absorb it from contacting it on host plants, when they eat pollen and nectar containing the pesticide, and when they ingest the pesticide by drinking water containing the pesticide. Yellow-faced bee larvae would be exposed by ingesting the pesticide in any nectar and pollen in the nest cavity contaminated with the pesticide. A membrane surrounds the nest cavity, which is usually protected within a dead branch or in cavities under rocks. This membrane may protect the egg and larvae from deposition of the pesticide due to direct application to the nest site, spray drift, and volatilization and dry and wet deposition; if not, the egg and larvae would be exposed to absorbing the pesticide deposited on the nest cavity membrane.

Current range maps for *Hylaeus facilis* were visually compared to the 2015 Hawaii Statewide Agricultural Land Use Baseline (University of Hawaii 2015) to determine potential overlap with agricultural use sites. In addition, current range maps were compared with aerial photography to determine if developed and open space developed areas occur within or adjacent to these species' ranges. *Hylaeus facilis* had two populations that had no overlap with agricultural use sites or developed areas, nor were adjacent to any of these sites. One population overlapped with open space developed and two populations overlapped with developed and were adjacent to pasture and pineapple use sites.

Overall Risk *Hylaeus facilis*: ☐ **High** ☒ **Medium** ☐ **Low**

USAGE

(Anticipated usage within the range based on past usage data)

Information regarding past usage of malathion in Hawaii is not available, however prior survey data has indicated that 4.8% of agricultural crops were treated with insecticides, with malathion only being a subset of this, assuming its use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the Approach to Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in Hawaii; future use cannot be ruled out but is not expected to increase significantly.

Overall Usage: ☐ **High** ☒ **Medium** ☐ **Low**

CONSERVATION MEASURES

General Conservation Measures

Residential use label changes: New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely), reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application.

Reduced application number and rate: New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop, previous allowable number of applications ranged from 3 to 13 applications per year). We anticipate this measure will help reduce the amount of malathion used and decrease potential exposure to these species.

Species-specific Conservation Measures

The following species-specific measure is now part of the Action and will be included in *BulletinsLive Two*:

Malathion application is prohibited within the range of the species, plus 200 feet beyond the range to account for potential spray drift from applicators adjacent to the range.

Avoidance and use limitation areas such as the species' range, critical habitat, or key habitat types and areas, are effective ways to reduce exposure to malathion by preventing use directly in these important areas, thus reducing the likelihood the species will come into contact with malathion.

CONCLUSION

After reviewing the current status of the species, the environmental baseline for the Action area, and the effects of the proposed registration of malathion, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of *Hylaeus facilis.* As discussed below, even though the vulnerability is high for this species and the risk and usage are medium, we anticipate the likelihood of exposure to malathion is low, given the implementation of the general and species-specific conservation measures described above. While we anticipate that very small numbers of individuals of this species will be affected over the duration of the proposed Action, we do not expect species-level effects to occur.

Hylaeus facilis has high vulnerability based on their status, distribution, and trends. The risk to these species posed by the labeled uses across the range is high, with a medium amount of estimated usage within the range of the species based on CONUS data. Information regarding past usage of malathion in Hawaii is not available, however prior survey data has indicated that 4.8% of agricultural crops were treated with insecticides, with malathion only being a subset of this, assuming its use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion.

Hylaeus facilis could be directly exposed to the pesticide and pesticide drift where the pesticide is applied to pasture, open space developed, other crops, vegetables and ground fruit and orchards and vineyards, within areas where *Hylaeus facilis* nests and forages. However, we anticipate a reduction in the level of exposure from these use types since this species prefers dry to mesic forest and shrubland, that will likely serve as a buffer to spray drift or runoff from these activities. Although malathion volatilizes readily and is transported downwind and deposited as dry deposition, in precipitation and, at higher elevations, in fog deposition, we do not expect volatilization to be an appreciable source of exposure. In addition, we anticipate the general conservation measures above, including changes to residential use labels and reductions to the allowable number of applications and application rates would further reduce the risk of exposure from these use types to the species and its habitat.

We anticipate that the residential use restrictions and the reduction in number of application and application rates are expected to reduce the amount of malathion used and limit the likelihood of spray drift and runoff exposure to this species and its dry to mesic forest and shrubland habitat. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely), reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. We also anticipate the new label restrictions reducing the number of applications and application rate for pasture will reduce the amount of malathion used and decrease potential exposure to the species. Furthermore, the species-specific conservation measure prohibits application of malathion within the range of this species plus 200 feet beyond the range to account for potential spray drift from applicators adjacent to the range. Together, these measures are anticipated to substantially reduce the likelihood of exposure to this species and its habitat. Thus, we anticipate that small numbers of individuals of this species will experience mortality over the duration of the Action. However, we do not anticipate species-level effects to occur. Therefore, we do not anticipate the proposed Action would appreciably reduce survival and recovery of *Hylaeus facilis,* in the wild.

Conclusion *Hylaeus facilis*: **Not likely to jeopardize**

ADDITIONAL REFERENCES

University of Hawaii. 2015. Spatial Data Analysis and Visualization (SDAV) Laboratory in conjunction with the Hawaii State Department of Agriculture. Hilo, HI.

Hawaiian yellow-faced bees

Scientific Name:	Common Name:	Entity ID:
Hylaeus mana	Hawaiian yellow-faced bee	10008

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Habitat destruction and modification, and land use conversion leads to fragmentation of yellow-faced bee foraging and nesting areas. Coastal and lowland habitats have been severely altered and degraded, partly because of past and present land management practices, including agriculture, grazing, and urban development; the deliberate and accidental introductions of nonnative animals and plants; and recreational activities (USFWS 2010).

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Hylaeus mana*

Species: *Hyalaeus mana*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Population size location(s) unknown

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Hylaeus mana*:

Hylaeus mana is known only from lowland mesic forest dominated by native *Acacia koa* in the Koolau Mountains of Oahu, at 1,400 ft (430 m) (USFWS 2016). Few other *Hylaeus* species have been found in this type of forest on Oahu (Daly and Magnacca 2003, p. 138; as cited in USFWS 2016). This type of native forest is increasingly rare and patchily distributed because of competition and encroachment into habitat by nonnative plants (Smith 1985, pp. 227–233; Juvik and Juvik 1998, p. 124; Wagner et al. 1999, pp. 66– 67, 75; as cited in USFWS 2016). Decline of this forest type could lead to decline in populations and numbers of *Hylaeus mana*. Three additional population sites were discovered on Oahu in 2012, including a new observation of the species at the original site (Magnacca and King 2013, pp. 17– 18; as cited in USFWS 2016). The three new sites are within a narrow range of lowland mesic forest at 1,400 ft (430 m), bordered by nonnative plant habitat at lower elevations and wetter native forest habitat above (Magnacca and King 2013, pp. 17–18; as cited in USFWS 2016). *Hylaeus mana* was most often observed on *Santalum freycinetianum var. freycinetianum*, which suggests that *Hylaeus mana* may be closely associated with this plant species (Magnacca and King 2013, p. 18; as cited in USFWS 2016). Additional surveys may reveal more populations; however, the extreme rarity of this species, its absence from many survey sites, the fact that it was not discovered until very recently, and the limited range of its possible host plant, all suggest that few populations remain (Magnacca

2005g, in litt., p. 2; Magnacca and King 2013, pp. 17–18; as cited in USFWS 2016). The small number of populations and individuals of *Hylaeus mana* makes this species more vulnerable to extinction because of the higher risks from genetic bottlenecks, random demographic fluctuations, and localized catastrophes such as hurricanes and drought (Daly and Magnacca 2003, p. 3; Magnacca 2007, p. 173; as cited in USFWS 2016). Although we cannot predict the timing, extent, or magnitude of specific impacts, we do expect the effects of climate change to exacerbate the threats to *Hylaeus mana* described above. The remaining populations of *Hylaeus mana* and its habitat are at risk. The known individuals are restricted to three locations of native koa forest on Oahu and continue to be negatively affected by habitat destruction and removal of food and nesting sites by nonnative ungulates and nonnative plants. Habitat destruction by fire is a threat. Randomly occurring events such as hurricanes and drought may modify habitat and remove food and nesting sources for *Hylaeus mana*. Predation by nonnative ants and wasps is a threat. Existing regulatory mechanisms and agency policies do not address the primary threats to the yellow-faced bees and their habitat from nonnative ungulates. Competition with nonnative bees for food and nesting sites is a threat. The small number of remaining populations limits this species' ability to adapt to environmental changes. The effects of climate change are likely to further exacerbate these threats.

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2016. Endangered and Threatened Wildlife and Plants; Endangered Status for 49 Species from the Hawaiian Islands. Federal Register 81(190):67786-67860. September 30, 2016.

Overall Vulnerability *Hylaeus mana*: ☒ **High** ☐ **Medium** ☐ **Low**

RISK

(Risk is based on species exposure and response from labelled uses across the range)

Risk to individuals if exposed: Yellow-faced bees exposed to malathion on use sites or from spray drift are expected to die.

Risk to the species from labelled uses across the range:

The table below summarizes the risk to the species from labelled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

DIRECT (all uses except mosquito control)	
Use areas – mortality	Mortality if exposed
Spray drift areas – mortality	Mortality depending on proximity to use sites
Volatilization	Not an appreciable source of exposure
INDIRECT (all uses except mosquito control)	
Use areas - Prey item mortality	No effects expected

Spray drift areas - Prey item mortality	No effects expected
Plants affected (decline in growth)	Effects on use sites with higher allowable application rates
MOSQUITO CONTROL	
Direct (mortality)	Mortality if exposed
No effects expected	No effects expected
Indirect	No effects expected

Risk modifiers: Hawaiian yellow-faced bee species almost exclusively visit native plants to collect nectar and pollen, pollinating those plants in the process (Daly and Magnacca 2003, p. 11, Sakai et al. 1995, pp. 2,524-2,528; Cox and Elmquist 2000, p. 1,238; Sahli et al. 2008, p. 1). *Hylaeus* bees are very rarely found visiting non-native plants for nectar and pollen (Magnacca 2007a, pp. 186, 188) and are almost completely absent from habitats dominated by non-native plant species (Daly and Magnacca 2003, p. 11). The female yellow-faced bee lays eggs in brood cells she constructs in the nest and lines with a self-secreted, cellophane-like material. Prior to sealing the nest, the female provides her young with a mass of semiliquid nectar and pollen left alongside her eggs. Upon hatching, the grub-like larvae eat the provisions left for them, grow and molt through three instar stages, pupate, and eventually emerge as adults (Michener 2000, p. 24, USFWS, 2014).

Hylaeus mana was first discovered in lowland mesic forest located along the Manana Trail in the Koolau Mountains on Oahu, at an elevation of about 1,400 ft (430 m). Few Hylaeus bees have been found in this type of Acacia koa-dominated, lowland mesic forest on Oahu (Daly and Magnacca 2003, p. 138). In addition to the original population site at Manana Trail, three additional *Hylaeus mana* population sites were discovered on Oahu in 2012, including a new observation of the species at the Manana Trail site (Magnacca and King 2013, pp. 17-18).

Yellow-faced bees will be directly exposed to the pesticide and pesticide drift where the pesticide is applied to pasture, open space developed, other crops, vegetables and ground fruit, orchards and vineyards, or used for mosquito control within areas where yellow-faced bee's nest and forage. In addition, the pesticide volatilizes readily, and it is transported downwind and deposited as dry deposition, in precipitation and, at higher elevations, in fog deposition. Although we would expect species within high-level elevation areas to be exposed to malathion via volatilization, we conclude, based on the best information available, that species in high elevations would not be exposed to concentration levels that would affect them (see *General Effects* for further information on volatilization). Yellow-faced bee adults would be exposed when they come in contact with the pesticide in application and drift sites when it is deposited onto their bodies, when they absorb it from contacting it on host plants, when they eat pollen and nectar containing the pesticide, and when they ingest the pesticide by drinking water containing the pesticide. Yellow-faced bee larvae would be exposed by ingesting the pesticide in any nectar and pollen in the nest cavity contaminated with the pesticide. A membrane surrounds the nest cavity, which is usually protected within a dead branch or in cavities under rocks. This membrane may protect the egg and larvae from deposition of the pesticide due to direct application to the nest site, spray drift, and volatilization and dry and wet deposition; if not, the egg and larvae would be exposed to absorbing the pesticide deposited on the nest cavity membrane.

Current range maps for *Hylaeus mana* were visually compared to the 2015 Hawaii Statewide Agricultural Land Use Baseline (University of Hawaii 2015) to determine potential overlap with agricultural use sites. In addition, current range maps were compared with aerial photography to determine if developed and open space developed areas occur within or adjacent to this species' range. *Hylaeus mana*, a single population, overlapped with diversified crop and pasture and was adjacent to diversified crop, pasture, banana, and papaya. Although, this species' range appeared to be mapped by county, and therefore, actual species locations may not co-occur with use sites.

Overall Risk *Hylaeus mana*: ☐ **High** ☒ **Medium** ☐ **Low**

USAGE

(Anticipated usage within the range based on past usage data)

Information regarding past usage of malathion in Hawaii is not available, however prior survey data has indicated that 4.8% of agricultural crops were treated with insecticides, with malathion only being a subset of this, assuming its use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the Approach to Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in Hawaii; future use cannot be ruled out but is not expected to increase significantly.

Overall Usage: ☐ **High** ☒ **Medium** ☐ **Low**

CONSERVATION MEASURES

General Conservation Measures

Residential use label changes: New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely), reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10

days between any repeated applications are expected to reduce environmental concentrations by allowing initial any residues to degrade prior to the next application.

Reduced application number and rate: New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop, previous allowable number of applications ranged from 3 to 13 applications per year). We anticipate this measure will help reduce the amount of malathion used and decrease potential exposure to these species.

Species-specific Conservation Measures

The following species-specific measure is now part of the Action and will be included in *BulletinsLive Two*

Malathion application is prohibited within the range of this species, plus 200 feet beyond the range to account for potential spray drift from applicators adjacent to the range.

CONCLUSION

After reviewing the current status of the species, the environmental baseline for the Action area, and the effects of the proposed registration of malathion, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of *Hylaeus mana.* As discussed below, even though the vulnerability is high for this species, the risk and usage are medium. We anticipate implementation of the general and species-specific conservation measures described above are expected to reduce the likelihood of exposure. While we anticipate that very small numbers of individuals of this species will be affected over the duration of the proposed Action, we do not expect species-level effects to occur.

Hylaeus mana has high vulnerability based on its status, distribution, and trends. The risk to this species posed by the labeled uses across the range is high, with a medium amount of estimated usage within the range of the species based on CONUS data. Information regarding past usage of malathion in Hawaii is not available, however prior survey data has indicated that 4.8% of agricultural crops were treated with insecticides, with malathion only being a subset of this, assuming its use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion.

Hylaeus mana could be directly exposed to the pesticide and pesticide drift where the pesticide is applied to pasture, open space developed, other crops, vegetables and ground fruit, or orchards and vineyards within areas where *Hylaeus mana* nests and forages. However, we anticipate a reduction in the level of exposure from these use types since this species prefers lowland mesic forest dominated by native *Acacia koa*, that will likely serve as a buffer to spray drift or runoff from these activities. Although malathion volatilizes readily and is transported downwind and deposited as dry deposition, in precipitation and, at higher elevations, in fog deposition, we do not expect volatilization to be an appreciable source of exposure. In addition, we anticipate the general conservation measures above, including changes to residential use labels and reductions to the allowable number of applications and application rates would further reduce the risk to this species and its habitat.

We anticipate that the residential use restrictions and the reduction in number of application and application rates are expected to reduce the amount of malathion used and limit the likelihood of spray drift and runoff exposure to this species and its lowland mesic forest habitat. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely), reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. We also anticipate that the new label restrictions reducing the number of applications and application rate for pasture will reduce the amount of malathion used and decrease potential exposure to the species. Furthermore, the species-specific conservation measure prohibits application of malathion within the range of this species plus 200 feet beyond the range to account for potential spray drift from applicators adjacent to the range. Together, these measures are anticipated to substantially reduce mortality of individuals of this species from application of malathion within and immediately surrounding the range of this species.

Thus, while we anticipate only small numbers of individuals of this species will experience mortality over the duration of the Action, we do not anticipate species-level effects to occur. Therefore, we do not anticipate the proposed Action would appreciably reduce survival and recovery of *Hylaeus mana,* in the wild.

Conclusion *Hylaeus mana*: **Not likely to jeopardize**

ADDITIONAL REFERENCES

University of Hawaii. 2015. Spatial Data Analysis and Visualization (SDAV) Laboratory in conjunction with the Hawaii State Department of Agriculture. Hilo, HI.

Integration and Synthesis Summary: Pacific Islands Invertebrates

PACIFIC ISLAND SNAILS

This section describes our analysis for Pacific Island snails. The analysis for most of the species will be presented together as a group below, as they are tree snails, although each species was considered individually and has a separate conclusion. The *Erinna newcombi* is an aquatic snail and will be presented individually before the group below. The *Ostodes strigatus* is a ground-dwelling snail and will also be presented individually, but after the group below.

Aquatic snail

Scientific Name:	Common Name:	Entity ID:
Erinna newcombi	Newcomb's snail	418

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

The Newcomb's snail is a freshwater aquatic herbivore. The total known range, historic and present, is only nine streams on the island of Kauai (Cowie et al. 1995; Hubendick 1951, 1952; as cited in NatureServe 2020) with only two harboring large numbers of individuals. They feed on algae and vegetation growing on submerged rocks (USFWS 2004). Eggs are attached to submerged rocks or vegetation. There are no widely dispersing larval stages, and their entire life cycle is tied to a single stream system (USFWS 2004).

Status: Threatened

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: Multiple populations (few)

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary:

Newcomb's snail (*Erinna newcombi*) is one of four freshwater snail species native to Hawaii in the family Lymnaeidae (USFWS 2006). The distribution of Newcomb's snail is restricted to approximately ten very small sites located on seven streams in the interior of the island of Kauai. Little quantitative data is available regarding the distribution of subpopulations among these sites, current population sizes, or population variability over time. For example, at least five of these subpopulations have been visited only on a single occasion (e.g., on the event of their discovery) and these populations have never been resurveyed (e.g., Lumahai - 7 - and lower Hanalei). These two "known" snail populations lack documentation completely (no field notes, no photographs, no GPS location/position data). In the listing rule, the Lumahai River site was considered the largest population based on a single anecdotal report. Given the extremely rugged terrain of interior Kauai island, these locations would be quite difficult to relocate, and if snails were found it would not be possible to determine if the original population was relocated or if a new neighboring subpopulation was found.

Other locations that were considered known populations in the listing and critical habitat rules have been revisited one or more times, but these visits have not revealed snails (e.g., the South Fork of the Wailua River site and upper Hanalei River site). In recent years, snails have only been observed at large flowing springs, such as the Makaleha Spring site, and springs located in lower Kalalau Valley (described below). No snails have been observed at any mainstem stream (non-spring-associated) locations in recent years and numerous questions remain regarding the distribution of Newcomb's snails and their population dynamics. On August 25, 2005, Newcomb's snails were observed in a small spring/stream that forms a tributary to Kalalau Stream (Boynton and Wood 2007; as cited in USFWS 2009). Qualitative observation suggests that several thousand snails were present at this location. This probably represents a newly discovered subpopulation in addition to the population previously known from Kalalau which is referred to in the listing and critical habitat documents. On September 25, 2006, Newcomb's snails were observed in spring-fed waterfalls at the 800 to 1000-foot elevation of Hanakoa Stream in the vicinity of Hanakoa Falls (Boynton and Wood 2007; as cited in USFWS 2009). This location was considered a historical population based on Bishop museum specimens collected on July 16, 1907. A snail survey at that site in 1996 revealed no snails. A qualitative survey conducted on February 20, 2007, at Makaleha Stream indicated that several hundred snails were present at that location (USFWS 2009).

As described in the Recovery Plan, quantitative surveys of snails are challenging. Snails inhabit a jumbled and complex three-dimensional cobble and boulder substrate that is covered with shallow turbulent water. Visual observation is difficult because snails are submerged, are small, and are the same black color as the basaltic substrate. A high priority task continues to be to develop a method to adequately enumerate snails so that their population size and population variability over time can be estimated. A pilot program to begin a longer-term time-series of a snail population using both artificial substrate and quadrat- or line-transect methods should be developed and implemented.

According to the Recovery Plan, the island-wide distribution of Newcomb's snail prior to human caused alteration of surface and groundwater systems was probably limited by long-term water supply: these snails are only found in locations that appear to have hydrologic regimes supporting perennial water flow throughout even the most severe drought conditions. Introduced predators (found throughout their range) may be limiting factors that currently affect snail populations. These include the non-native predatory snail *Euglandina rosea*, two species of nonnative marsh fish. New threats include Altered hydrology (USFWS 2000, 2006; Polhemus and Asquith 1996; P. Levin, pers. comm. 2011a,b; as cited in USFWS 2017), landslides and flooding loss or degradation of habitat (Jones et al. 1984; Polhemus 1993; USFWS 2000, 2006; as cited in USFWS 2017), and stochastic events (e.g., hurricane mortality and reduced viability) (Polhemus 1993, as cited in USFWS 2017).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2006. Recovery plan for the Newcomb's snail (*Erinna newcombi*). U.S. Fish and Wildlife Service, Portland, OR. 52 pages.

U.S. Fish and Wildlife Service (USFWS). 2009. Newcomb's Snail (*Erinna newcombi*). 5-Year Review Summary and Evaluation. Honolulu, Hawaii. 11 pp.

U.S. Fish and Wildlife Service (USFWS). 2017. Newcomb's Snail (*Erinna newcombi*). 5-Year Review Summary and Evaluation. Honolulu, Hawaii. 6 pp.

Overall Vulnerability Newcomb's snail: ☒ High ☐ Medium ☐ Low

RISK

(Risk is based on species exposure and response from labelled uses across the range)

Risk to individuals if exposed: Mortality is not expected for Newcomb's snails exposed to malathion on use sites or from spray drift.

Risk to the species from labelled uses across the range:

The table below summarizes the risk to the species from labelled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

DIRECT (all uses except mosquito control)	
Use areas – mortality	No effects expected
Spray drift areas – mortality	No effects expected
Volatilization	Not an appreciable source of exposure
INDIRECT (all uses except mosquito control)	
Use areas - Prey item mortality	No effects expected
Spray drift areas - Prey item mortality	No effects expected
Plants affected (decline in growth)	No effects expected
MOSQUITO CONTROL	
Direct (mortality)	No effects expected
Indirect	No effects expected

Risk modifiers: The only labeled use of malathion that overlaps with the Newcomb's snail range includes mosquito control. Malathion may also volatilize from application sites within two miles downwind from Newcomb's snail populations such as lower elevation pasture, agriculture, and developed areas and deposit into Newcomb's snail habitat. However, that exposure is not expected to result in concentrations that would affect them (see *General Effects* for further information on volatilization).

Data in the primary literature for aquatic snails indicate this taxa group tends to be less sensitive to malathion and are generally at low risk of adverse effects from malathion exposure. Using other aquatic snails as a surrogate for the species, we expect the Newcomb's snail should also exhibit a high tolerance to malathion exposure and is unlikely to experience direct effects from malathion.

Overall Risk Newcomb's snail: ☐ High ☐ Medium ☒ Low

USAGE

(Anticipated usage within the range based on past usage data)

Information regarding past usage of malathion in Hawaii is not available, however prior survey data has indicated that 4.8% of agricultural crops were treated with insecticides, with malathion only being a subset of this, assuming its use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the Approach to Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in Hawaii; future use cannot be ruled out but is not expected to increase significantly.

Overall Usage Newcomb's snail: ☐ High ☐ Medium ☒ Low

CONSERVATION MEASURES

Rain restriction: Label language has been added restricting malathion application to periods where rain is not forecasted for at least 48 hours for agriculture and 24 hours for residential use or when the soil is not saturated. Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e. 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing the likelihood of exposure by and substantially reducing the amount of malathion that would reach the habitat in which this species resides.

Aquatic habitat buffers: Application buffers, which specify on the label a distance from water bodies where pesticides are not to be applied, are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g. flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. We anticipate that in many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

CONCLUSION

Information from primary literature for aquatic snails indicate this taxa group tends to be less sensitive to malathion and are generally at low risk of adverse effects from malathion exposure. After reviewing the current status of the species, the environmental baseline for the Action area, and the effects of the proposed registration of malathion, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the Newcomb's snail. As discussed below, even though the vulnerability is high, we anticipate the risk and usage is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure. We do not anticipate the Action will result in species-level effects.The Newcomb's snail has high vulnerability based on its status, distribution, and trends. The risk to the species posed by the labeled uses across the range is low, with a low amount of estimated usage within the range of this species. The only labeled use of malathion that overlaps with the Newcomb's snail range includes mosquito control. Malathion may also volatilize from application sites within two miles downwind from Newcomb's snail populations such as lower elevation pasture, agriculture, and developed areas and deposit into Newcomb's snail habitat. The magnitude of that exposure is uncertain, although, as stated above, aquatic snails tend to be less sensitive to malathion and are generally at low risk of adverse effects from malathion exposure. Therefore, the likelihood of effects cannot be predicted, however present information suggests that malathion is not being used for mosquito control. Furthermore, conservation measures, such as rain restrictions and aquatic habitat buffers, are expected to substantially reduce environmental concentrations of malathion in the species' range, decreasing the risk of exposure and adverse effects that may result from the Action. The Newcomb's snail occupies fresh water streams and waterfalls and like most aquatic species, the rain restrictions are anticipated to reduce the likelihood of exposure (directly or in runoff) following a precipitation event. Similarly, the aquatic habitat buffers reduce the likelihood of spray drift and exposure to aquatic organisms.

Thus, we do not anticipate individuals of this species would experience mortality, effects to growth or reproduction, or impacts to their food base. This level of anticipated risk would not result in species-level effects. Therefore, we anticipate that the proposed Action would not appreciably reduce survival and recovery of the Newcomb's snail in the wild.

Conclusion Newcomb's snail: **Not likely to jeopardize**

***REFERENCES*:**

U. S. Fish and Wildlife Service. 2009. Newcomb's Snail (*Erinna newcombi*) 5-Year Review Summary and Evaluation. Honolulu, Hawaii. 11 pp.

Pacific Island Snails

The following tree snail species will be presented together as a group below, although each species was considered individually and has a separate conclusion.

Tree Snails

Scientific Name:	Common Name:	Entity ID:
	Tree snail species	
Genus *Achatinella*	Hawaiian tree snails (41 snails)	397
Partulina semcarinata	Lanai tree snail	1989
Partulina variabilis	Lanai tree snail	3385
Newcombia cumingi	Newcomb's tree snail	3876
Partula langfordi	Langford's tree snail	7731
Partula gibba	Humped tree snail	2364
Partula radiolata	Guam tree snail	7907
Samoana fragilis	Fragile tree snail	1862
Eua zebrina	No common name (Tutuila tree snail)	7918

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

A total of 49 tree snails are found in the Pacific Islands including:

Hawaii Tree Snails

Oahu tree snails (41 species of *Achatinella*)

Lanai tree snail (*Partulina semicarinata*)

Lanai tree snail (*Partulina variabilis*)

Newcomb's tree snail (*Newcombia cumingi*)

Northern Mariana Islands Tree Snails

Langford's tree snail (*Partula langfordi*)

Humped tree snail (*Partula gibba*)

Guam tree snail (*Partula radiolata*)

Fragile tree snail (*Samoana fragilis*)

American Samoa Tree Snail

Tutuila tree snail (*Eua zebrina)*

Genus: ***Achatinella***		**Genus Status: Endangered**		
Scientific Name	**Distribution**	**Population Numbers**	**Species Trends**	**Pesticides mentioned**
A. abbreviata	Small, endemic, constrained, and/or isolated population(s)	Probably extinct, not seen after 1963 (USFWS 1993)	Unknown	No
A. apexfulva	Small, endemic, constrained, and/or isolated population(s)	Extant but uncommon; range very restricted (USFWS 1993)	Unknown	No
A. belluta	Small, endemic, constrained, and/or isolated population(s)	Probably extant; very few snails seen recently (USFWS 1993)	Unknown	No
A. buddi	Small, endemic, constrained, and/or isolated population(s)	Almost certainly extinct (USFWS 1993)	Unknown	No
A. bulimoides	Small, endemic, constrained, and/or isolated population(s)	Probably extant; very few snails seen recently (USFWS 1993)	Unknown	No
A. byronii	Small, endemic, constrained, and/or isolated population(s)	Probably extant; very few snails seen recently (USFWS 1993)	Unknown	No
A. caesia	Small, endemic, constrained, and/or isolated population(s)	Almost certainly extinct (USFWS 1993)	Unknown	No
A. casta	Small, endemic, constrained, and/or isolated population(s)	Almost certainly extinct (USFWS 1993)	Unknown	No
A. cestus	Small, endemic, constrained, and/or isolated population(s)	Possibly extant; not seen after 1973 (USFWS 1993)	Unknown	No
A. concavospira	Small, endemic, constrained, and/or isolated population(s)	Extant but uncommon; range very restricted (USFWS 1993)	Unknown	No

Genus: *Achatinella*		Genus Status: Endangered		
Scientific Name	**Distribution**	**Population Numbers**	**Species Trends**	**Pesticides mentioned**
A. curta	Small, endemic, constrained, and/or isolated population(s)	Extant but uncommon; range very restricted (USFWS 1993)	Unknown	No
A. decipiens	Small, endemic, constrained, and/or isolated population(s)	Extant but uncommon; range very restricted (USFWS 1993)	Unknown	No
A. decora	Small, endemic, constrained, and/or isolated population(s)	Almost certainly extinct (USFWS 1993)	Unknown	No
A. dimorpha	Small, endemic, constrained, and/or isolated population(s)	Possibly extant; not seen after 1973 (USFWS 1993)	Unknown	No
A. elegans	Small, endemic, constrained, and/or isolated population(s)	Probably extinct; not seen after 1963 (USFWS 1993)	Unknown	No
A. fulgens	Small, endemic, constrained, and/or isolated population(s)	Extant but uncommon; range very restricted (USFWS 1993)	Unknown	No
A. fuscobasis	Small, endemic, constrained, and/or isolated population(s)	Extant but uncommon; range very restricted (USFWS 1993)	Unknown	No
A. judii	Small, endemic, constrained, and/or isolated population(s)	Probably extinct; not seen after 1963 (USFWS 1993)	Unknown	No
A. iuncea	Small, endemic, constrained, and/or isolated population(s)	Almost certainly extinct (USFWS 1993)	Unknown	No
A. lehuiensis	Small, endemic, constrained, and/or isolated population(s)	Almost certainly extinct (USFWS 1993)	Unknown	No
A. lila	Small, endemic, constrained, and/or isolated population(s)	Extant but uncommon; range very restricted (USFWS 1993)	Unknown	No

Genus: ***Achatinella***		**Genus Status: Endangered**		
Scientific Name	**Distribution**	**Population Numbers**	**Species Trends**	**Pesticides mentioned**
A. livida	Small, endemic, constrained, and/or isolated population(s)	Probably extant; very few snails seen recently (USFWS 1993)	Unknown	No
A. lorata	Small, endemic, constrained, and/or isolated population(s)	Probably extant; very few snails seen recently (USFWS 1993)	Unknown	No
A. mustelina	Small, endemic, constrained, and/or isolated population(s)	Extant with occasional moderate local density (USFWS 1993)		No
A. pypyracea	Small, endemic, constrained, and/or isolated population(s)	Almost certainly extinct (USFWS 1993)	Unknown	No
A. phaeozona	Small, endemic, constrained, and/or isolated population(s)	Probably extant; very few snails seen recently (USFWS 1993)	Unknown	No
A. pulcherrima	Small, endemic, constrained, and/or isolated population(s)	Probably extant; very few snails seen recently (USFWS 1993)	Unknown	No
A. pupukanioe	Small, endemic, constrained, and/or isolated population(s)	Probably extant; very few snails seen recently (USFWS 1993)	Unknown	No
A. rosea	Small, endemic, constrained, and/or isolated population(s)	Probably extinct; not seen after 1963 (USFWS 1993)	Unknown	No
A. sowerbyana	Small, endemic, constrained, and/or isolated population(s)	Extant with occasional moderate local density (USFWS 1993)	Unknown	No

Genus: *Achatinella*		Genus Status: Endangered		
Scientific Name	**Distribution**	**Population Numbers**	**Species Trends**	**Pesticides mentioned**
A. spaldingi	Small, endemic, constrained, and/or isolated population(s)	Almost certainly extinct (USFWS 1993)	Unknown	No
A. stewartii	Small, endemic, constrained, and/or isolated population(s)	Probably extinct; not seen after 1963 (USFWS 1993)	Unknown	No
A. swiftii	Small, endemic, constrained, and/or isolated population(s)	Possibly extant; not seen after 1973 (USFWS 1993)	Unknown	No
A. taenoiolata	Small, endemic, constrained, and/or isolated population(s)	Possibly extant; not seen after 1973 (USFWS 1993)	Unknown	No
A. thanumi	Small, endemic, constrained, and/or isolated population(s)	Almost certainly extinct (USFWS 1993)	Unknown	No
A. turgida	Small, endemic, constrained, and/or isolated population(s)	Probably extant; very few snails seen recently (USFWS 1993)	Unknown	No
A. valida	Small, endemic, constrained, and/or isolated population(s)	Probably extinct; not seen after 1963 (USFWS 1993)	Unknown	No
A. viridana	Small, endemic, constrained, and/or isolated population(s)	Probably extant; very few snails seen recently	Unknown	No
A. vittata	Small, endemic, constrained, and/or isolated population(s)	Almost certainly extinct (USFWS 1993)	Unknown	No
A. vulpina	Small, endemic, constrained, and/or isolated population(s)	Possibly extant; not seen after 1973 (USFWS 1993)	Unknown	No

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Achatinella*:

All 41 species in the genus *Achatinella* are federally listed as endangered. Individual species of Achatinella were referred to with common names, which are not in use today. Collectively, members of the genus are commonly known as O'ahu tree snails, little agate shells, kahuli, pupu kuahiwi, and pupu kanioe. Species of the genus *Achatinella* are found only on the island of O'ahu in the Hawaiian Islands. Although *Achatinella* are restricted to the island of O'ahu, several introductions to the forests of Kauai have been attempted (Christensen, 1985). *A. Belluta* was introduced around 1892, has not been seen since 1911. *A. vulpine* was introduced around 1903-1907 and observed as late as 1973. The current status of these populations is unknown. Five of the species have not been seen in over 15 years, and 18 of the remaining 36 species are on the edge of extinction. Only *Achatinella mustelina* and perhaps *A. sowerbyana* are believed to exist in substantial numbers, however, their ranges are greatly reduced. Recent observations show their numbers to be substantially diminished and their numbers rapidly declining. Population levels and distributions are generally unknown due to the lack of recent comprehensive surveys. Members of the genus *Achatinella* are currently found in mountainous (above 400 m elevation) dry to wet forests and shrublands on the island of O'ahu, Hawai'i. Habitats for tree snails occur in both the Ko'olau and Wai'anae Mountains on O'ahu. Little is known about the specific habitat requirements of *Achatinella* species. They are arboreal, nocturnal, and feed by grazing fungus from the surface of native plant leaves. Individuals of *Achatinella* species are hermaphroditic but are assumed to be self-sterile. Adult snails almost invariably contain a single embryo in the uterus, and embryos are present at all times of year (Henshaw, in Pilsbry and Cooke, 1912-1914; Neal, 1928; Hadfield and Mountain, 1980). Young snails are born live at a relatively large size and coexist with the adults. Data on growth, population size, and age distribution are lacking for most species of *Achatinella*. The most extensively studied species is *A. mustelina* from the Wai'anae mountains. Hadfield and his colleagues have studied the demography and life history of this species since 1972 (Hadfield and Mountain, 1980; Hadfield, 1986; Hadfield et. Al., unpublished) and recorded *Achatinella mustelina* to be about 4.5 mm at birth. Lifespan is estimated to be 11 years of age. The number of young produced by an adult snail is estimated at 1 to 4 per year. During the day achatinelline snails seal themselves to leaves or trunks; at night they move about to graze. Movement of *A. mustelina* between trees is limited, and individually marked snails are often recovered month after month in the same bush or tree (Hadfield and Mountain, 1980; Hadfield 1986). Only after a strong wind storm are snails found scattered into neighboring trees (Hadfield et. al., unpublished). Although, they are occasionally seen on exotic plants, it is unknown whether the fungal biota of these plants provides long-term support for healthy breeding populations. The most serious threats to the survival of O'ahu tree snails are predation by the introduced carnivorous snail, *Euglandina rosea*, predation by rats and the loss of habitat due to the spread of non-native vegetation into the higher elevation forests. Low reproductive rates and limited dispersal abilities make them very sensitive to loss of habitat, shell collecting, and predation, all known to have contributed to the extinction of populations, varieties, and species (Hatfield, 1986). Lower elevation lands now used for pasture, agriculture, or housing once supported native forests occupied by achatinellid snails (Pilsbry and Cooke, 1912-191; Emerson, Ma., undated, post-1900). Forests not cleared for agriculture were invaded by feral cattle, horses, goats, and pigs (Baldwin, 1887). The grazing activities of these mammals reduced the forest understory, prevented recovery of native plants, and aided the invasion of exotic plants by spreading their seeds and clearing areas for the seeds to set. At the present time, goats and pigs remain a serious threat to the native forest as well as human activities such as hunting, hiking, military maneuvers, clearing for illegal marijuana patches, and construction of helicopter landing sites.

Populations of *Achatinella mustelina* exist within the boundaries of the State of Pahole and Ka'ala Natural Area Reserves. Most other known extant populations of *Achatinella spp*. Occur in forests regulated by the Hawai'i State Department of Land and Natural Resources, the United States Department of Defense, or private owners such as Campbell Estate. In 1990, The Nature Conservancy leased a 3,692-acre tract from Campbell Estate at Palikea in the Wai'anae Mountains. This reserve was established in part to protect populations of *A. mustelina*. Virtually all of the lands managed by the State are zoned conservation (USFWS 1993).

The Department of Land and Natural Resource's Division of Forestry and Wildlife, Snail Extinction Prevention Program (SEPP) staff with help from the Oahu Army Natural Resource Program, The Natural Area Reserve System, The U.S. Fish and Wildlife Service, and the University of Hawaii Hawaiian Tree Snail Conservation Lab in a collaborative effort, extracted the entire snail population of 24 snails of the species, *Achatinella concavosphira*, into the University of Hawaii Hawaiian Tree Snail Conservation Lab, until they could be safely returned to protected habitat. All 24 snails were returned to protected habitat deep within the Honouliuli Forest Reserve. These snails now reside inside a newly constructed exclosure which is approximately 1,200 meters from the snails' original home. This population will be intensely monitored by SEPP, with future genetic studies planned to assess potential introductions of individuals from other remaining populations of *Archatinella concavospira* (DLNR Blog 2018).

The Army natural resource program on Oahu (OANRP) manages eight populations of *Achatinella mustelina* within six Evolutionarily Significant Unit (ESU) (PICHTR 2018). The snail populations within each ESUs are divided into Population Reference Sites (PRSs). Each PRS is a discrete grouping of snails. There are many PRSs in each ESU given the fragmented status of the populations. The OANRP, manages some of these PRSs for threats such as predators, ungulates, and weeds. Predators include black rats (*Rattus rattus*), rosy wolf snails (*Euglandina rosea*), and Jackson's chameleons (*Trioceros jacksonii xantholophus*). Management for the species include translocation of snails to exclosures.

EB/CE Sources:

U. S. Fish and Wildlife Service. 1993. Recovery Plan O'ahu Tree Snails of the Genus *Achatinella*. Portland, Oregon. 137 pp.

Pacific International Center for High Technology Research, Army Natural Resource Program – Oahu. 2018. 2018 Status Report for the Makua and Oahu Implementation Plans. 242 pp.

Department of Land and Natural Resources. 2019. RIP George. The Last Known Land Snail of His Kind Dies News Release. January 4, 2019. Accessed on July 13, 2020 at: https://dlnr.hawaii.gov/blog/2019/01/04/nr19-001/

Department of Land and Natural Resources. 2018. “Operation Snail Bail” moves 2000 Rare Hawaiian Snails to Safety. August 24, 2018. Accessed on July 7, 2020, at https://dlnr.hawaii.gov/blog/2018/08/24/nr18-173/.

Species: *Partulina semicarinta*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Population size/location(s) unknown

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Partulina semicarinata* :

Partulina semicarinata (Lanai tree snail, pupu kani oe), a member of the family Achatinellidae and the endemic Hawaiian subfamily Achatinellinae, is known only from the island of Lanai (Pilsbry and Cooke 1912-1914, p. 86. Adults may attain an age exceeding 15 to 20 years, and reproductive output is low, with an adult snail giving birth to 4 to 6 live young per year (Hadfield and Miller 1989, pp. 10-12). The number of individuals of *Partulina semicarinata* and *Partulina variabilis* has declined by approximately 50 percent between 1993 and 2005 at known locations (Hadfield 2005, p. 305). Although there are no historical population estimates for these two tree snails, qualitative accounts of Hawaiian tree snails indicate they were widespread and abundant, possibly numbering in the tens of thousands between the 1800s and early 1900s (Hadfield 1986, p. 69). However, the best available survey information, conducted between 1993 and 2005, indicated *Partulina semicarinata* and *Partulina variabilis* total fewer than 120 individuals on Lanai (Hadfield 2005, pp. 3-5). From 2017-2019, surveys for *Partulina semicarinata* on Lānaʻihale identified three isolated populations. One of those populations was small at the time and was not re-discovered in subsequent surveys. This population is assumed to be extirpated, likely due to rat predation. Neither of the two remaining known populations have a complete population estimate; however, each of the two populations appear to be small (USFWS 2020). Construction of a predator-proof snail enclosure, completed by Pūlama Lānaʻi in 2019, protects one of the two known populations of *P. semicarinata* (USFWS 2020). The *Partulina semicarinata* remaining in the wild that are not within an enclosure may benefit from ongoing rat control efforts across Lānaʻihale but continue to be at high risk of predation from rats, *Euglandina* spp., Jackson’s chameleons (*Chamaeleo jacksonii*), habitat-related threats, and catastrophic and stochastic events (USFWS 2020). Based on the history of collection of endemic Hawaiian tree snails, the market for Hawaiian tree snail shells, and the vulnerability of the small populations of *Newcombia cumingi*, *Partulina semicarinata*, and *Partulina variabilis* to the negative impacts of any collection, we consider the potential overcollection of these three Hawaiian tree snails to pose a serious and ongoing threat, because it can occur at any time, although its occurrence is not predictable.

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2013. Determination of Endangered Status for 38 Species on Molokai, Lanai, and Maui. Final Rule. 78 FR 32013 32065, May 28, 2013.

U.S Fish and Wildlife Service (USFWS). 2020. 5-Year Review. Summary and Evaluation. Lanai tree snail (*Partulina semicarinata*). Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu, Hawai‘i.

Species: *Partulina variabilis*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Population size/location(s) unknown

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Partulina variabilis*:

Partulina variabilis (Lanai tree snail, pupu kani oe), a member of the family Achatinellidae and the endemic Hawaiian subfamily Achatinellinae, is known only from the island of Lanai (Pilsbry and Cooke 1912-1914, p. 86; as cited in USFWS 2013; as cited in USFWS 2013). The habitat of *Partulina variabilis* includes the wet montane forest of the Mount Lāna‘ihale summit, the surrounding wet cliffs, and the lowland wet forest that extends below Lāna‘ihale (USFWS 2020). The montane wet ecosystem, where populations of *Partulina variabilis* occur, is found at elevations ranging from 3,300 feet (ft) (1,000 meters [m]) up to the summit of Mount Lāna‘ihale at 3,660 ft (1,116 m), in areas where annual precipitation is greater than 75 in (190 centimeters [cm]). Adults may attain an age exceeding 15 to 20 years, and reproductive output is low, with an adult snail giving birth to 4 to 6 live young per year (Hadfield and Miller 1989, pp. 10-12; as cited in USFWS 2013). The number of individuals of *Partulina semicarinata* and *Partulina variabilis* has declined by approximately 50 percent between 1993 and 2005 at known locations (Hadfield 2005, p. 305; as cited in USFWS 2013). Although there are no historical population estimates for these two tree snails, qualitative accounts of Hawaiian tree snails indicate they were widespread and abundant, possibly numbering in the tens of thousands between the 1800s and early 1900s (Hadfield 1986, p. 69; as cited in USFWS 2013). However, the best available survey information, conducted between 1993 and 2005, indicates that currently *Partulina semicarinata* and *Partulina variabilis* total fewer than 120 individuals on Lanai (Hadfield 2005, pp. 3-5; as cited in USFWS 2013). From 2017-2019, surveys for *Partulina variabilis* on Lāna‘ihale identified 10 isolated populations in previously known wet forest habitats (Sischo 2019 in litt., entire; as cited in USFWS 2020). The number of known wild populations is declining (USFWS 2020). A population census has not been conducted for any of the 10 populations. Biologists have reported that hurricanes are a threat to the three tree snails in this final rule (*Newcombia* *cumingi*, *Partulina semicarinata*, and *Partulina variabilis*). High winds and intense rains from hurricanes can dislodge snails from the leaves and branches of their host plants and deposit them on the forest floor where they may be crushed by falling vegetation or exposed to predation by nonnative rats and snails (see Disease or Predation section below) (Hadfield 2011, pers. comm.; as cited in USFWS 2013). Although there is historical evidence of only one hurricane that approached from the east and impacted the islands of Maui and Hawaii (Businger 1998, p. 3; as cited in USFWS 2013), damage by future hurricanes could further decrease the remaining native plant-dominated habitat areas that support the Maui Nui ecosystems (Bellingham et al. 2005, p. 681; as cited in USFWS 2013). Drought is a threat to all three tree snails (*Newcombia cumingi*, *Partulina semicarinata*, and *Partulina variabilis*) by the loss or degradation of habitat due to death of individual native plants and host tree species, as well as an increase in forest and brush fires. These threats are serious and have the potential to occur at any time, although their occurrence is not predictable. Based on the history of collection of endemic Hawaiian tree snails, the market for Hawaiian tree snail shells, and the vulnerability of the small populations of *Newcombia cumingi*, *Partulina semicarinata*, and *Partulina variabilis* to the negative impacts of any collection, we consider the potential overcollection of these three Hawaiian tree snails to pose a serious and ongoing threat, because it can occur at any time, although its occurrence is not predictable. Rats (*Rattus* spp.) have been suggested as the invasive animal responsible for likely the greatest number of animal extinctions on islands throughout the world, including extinctions of various snail species (Towns et al. 2006, p. 88; as cited in USFWS 2013). On Maui, rat predation on the tree snail species *Newcombia cumingi*, addressed in this final rule, has led to a decrease in the number of individuals (Hadfield 2006 in litt., p. 3; 2007, p. 9; 2011, pers. comm.; as cited in USFWS 2013). As rats are found in nine of the described ecosystems on Lanai and Maui (the islands on which *Newcombia cumingi*, *Partulina semicarinata*, and *Partulina variabilis* occur), including the three ecosystems (lowland wet, montane wet, and wet cliff) in which the three tree snails in this rule are found, the results of the above studies, in addition to direct observations from field biologists, suggest that rats directly damage or destroy Hawaiian tree snails and are a serious and ongoing threat to the three tree snail species in this final rule. The only known wild populations of *Newcombia cumingi*, *Partulina semicarinata*, and *Partulina variabilis* face serious threats from predation by nonnative rats, Jackson's chameleons, and snails (Solem 1990, p. 35; Hadfield 1986, p. 325; Hadfield et al. 1993, p. 611; Hadfield 2007, p. 9; Hadfield 2009, p. 11; as cited in USFWS 2013).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2013. Determination of Endangered Status for 38 Species on Molokai, Lanai, and Maui. Final Rule. 78 FR 32013 32065, May 28, 2013.

U.S Fish and Wildlife Service (USFWS). 2020. 5-Year Review. *Partulina variabilis* (Lānaʻi tree snail). Honolulu, Hawaiʻi. 23 pp.

Species: *Newcombia cumingi*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Single population

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Newcombia cumingi*:

Newcombia cumingi, (Newcomb 1853), is a member of the family Achatinellidae and the endemic subfamily Achatinellinae (Newcomb 1853, p. 25; as cited in USFWS 2020). The genus *Newcombia* (Pfeiffer) is endemic to the islands of Maui and Moloka‘i (USFWS 2020). Newcomb's tree snail reaches an adult length of approximately 0.8 in (21 mm) and its native host plant is *Metrosideros polymorpha* (ohia) (Pilsbry and Cooke 1912-1914, p. 10; Thacker and Hadfield 1998, p. 4; as cited in USFWS 2009). In general, tree snails subsist entirely by grazing throughout the night on microbes that live on the leaf and trunk surfaces of plants (Pilsbry and Cooke 1912–1914a, p. 103; O'Rorke *et al*. 2016, p. 177; as cited in USFWS 2020). The exact life span and fecundity of Newcomb's tree snails is unknown, but they attain adult size within 4 to 5 years (Thacker and Hadfield 1998, p. 2; as cited in USFWS 2009). Newcomb's tree snail is believed to exhibit the low reproductive rate of other Hawaiian tree snails belonging to the same family (Thacker and Hadfield 1998, p. 2; as cited in USFWS 2009). Historically, this species was distributed from the West Maui mountains (near Lahaina and Wailuku) to the slopes of Haleakala (Makawao) on East Maui (Pilsbry and Cooke 1912-1914, p.10; as cited in USFWS 2009). In 1994, a small population of Newcomb's tree snail was found on a single ridge on the northeastern slope of the west Maui mountains, in the lowland wet ecosystem (Thacker and Hadfield 1998, p.3; TNC 2007; as cited in USFWS 2009). Eighty-six snails were documented in the same location in 1998; in 2006, only nine individuals were located; and, in 2012, only one individual was located (Thacker and Hadfield 1998, p. 2; Hadfield 2007, p. 8; Higashino 2013, in litt.; as cited in USFWS 2009). In 2019, a population of Newcomb’s tree snail was identified in the wet forest between 2,500 and 3,000 ft (760-920 m) elevation in the Launuipoko Valley area of West Maui (USFWS 2020). Also in 2019, a second population of Newcomb’s tree snail was discovered in Ukumehame Valley (USFWS 2020). In addition, biologists have reported that hurricanes are a threat to the three tree snails in this final rule (*Newcombia cumingi*, *Partulina semicarinata*, and *P. variabilis*). High winds and intense rains from hurricanes can dislodge snails from the leaves and branches of their host plants and deposit them on the forest floor where they may be crushed by falling vegetation or exposed to predation by nonnative rats and snails (see Disease or Predation section below) (Hadfield 2011, pers. comm.; as cited in USFWS 2009). Although there is historical evidence of only one hurricane that approached from the east and impacted the islands of Maui and Hawaii (Businger 1998, p. 3), damage by future hurricanes could further decrease the remaining native plant-dominated habitat areas that support the Maui Nui ecosystems (Bellingham et al. 2005, p. 681; as cited in USFWS 2009). Nonnative plants represent a serious and ongoing threat to 36 of the 40 species listed in this final rule (35 plant species and the tree snail *Newcombia cumingi*; see Table 4) through habitat destruction and modification because they: (1) Adversely impact microhabitat by modifying the availability of light; (2) alter soil-water regimes; (3) modify nutrient cycling processes; (4) alter fire characteristics of native plant habitat, leading to incursions of fire-tolerant nonnative plant species into native habitat; and (5) outcompete, and possibly directly inhibit the growth of, native plant species. Each of these threats can convert native-dominated plant communities to nonnative plant communities (Cuddihy and Stone 1990, p. 74; Vitousek 1992, pp. 33-35; as cited in USFWS 2009). This conversion has negative impacts on 35 of the 37 plant species addressed here, as well as the native plant species upon which *Newcombia cumingi* depends for essential life-history needs. Drought is a threat to six plant species (*Canavalia pubescens*, *Cyanea horrida*, *Festuca molokaiensis*, *Schiedea jacobii*, *Schiedea salicaria*, and *Stenogyne kauaulaensis*) and all three tree snails (*Newcombia cumingi*, *Partulina semicarinata*, and *Partulina variabilis*) by the loss or degradation of habitat due to death of individual native plants and host tree species, as well as an increase in forest and brush fires (USFWS 2009). These threats are serious and have the potential to occur at any time, although their occurrence is not predictable. Based on the history of collection of endemic Hawaiian tree snails, the market for Hawaiian tree snail shells, and the vulnerability of the small populations of *Newcombia cumingi*, *Partulina semicarinata*, and *Partulina variabilis* to the negative impacts of any collection, we consider the potential overcollection of these three Hawaiian tree snails to pose a serious and ongoing threat, because it can occur at any time.

EB/CE Sources:

U. S. Fish and Wildlife Service (USFWS). 2009. Newcomb's Snail (*Erinna newcombi*) 5-Year Review Summary and Evaluation. Honolulu, Hawaii. 11 pp.

U.S Fish and Wildlife Service (USFWS). 2020. 5-Year Review. *Newcombia cumingi* (Newcomb's tree snail). Honolulu, Hawai'i. 23 pp.

Species: *Partula langfordi*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Population size/location(s) unknown

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Partula langfordi*:

Langford's tree snail (*Partula langfordi*; akaleha, denden), in the Partulidae family, is endemic to the forest ecosystem (USFWS 2015). The species has only ever been recorded from the island of

Aguigan. The tree snail needs cool, shaded forest habitat with high humidity and reduced air movement that prevents excessive water loss (USFWS 2020). All partulids including the Langford's tree snail need live and decaying plant material, as their diet consists of fungus and/or microalgae. Little information is available about vegetation that this species is most associated with; however, it has been observed on *Aglaia* sp. and *Guamia mariannae* (Smith 1995, as cited in USFWS 2020). The species has been found or was suspected to be found because of co-occurrence with the humped tree snail in at least seven forested sites in the northwest section of Aguiguan (Smith 2013, as cited in USFWS 2015). In 2013, surveys at seven established survey sites only detected the presence of snails at two sites and these sites only contained deceased snails (i.e., empty shells) (Smith 2013, as cited in USFWS 2015). The shells found were very old, suggesting that the species could possibly be extinct. However, more extensive and thorough surveys are needed to determine this species status. The species was first detected in 1952 and has not been found since 1992 (USFWS 2020). However, when first collected, the Langford's tree snail was assumed to be a variant of the humped tree snail (*Partula gibba*), with which it was often found. The Langford's tree snail spatial distribution likely decreased long before its discovery in 1952 and the last observation in 1992.

Although much less studied than related partulid snails from the Mariana Islands, the biology of Langford's tree snail is believed to be the same (see Humped tree snail (*Partula gibba*), above for details). Berger et al. (2005, as cited in USFWS 2015) states that all partulid snails are selected as a species of special conservation need, and that as many as 31 snails were found on the underside of a single leaf of caladium demonstrating that it would be easy to miss a large number of snails if that one particular leaf were missed during a survey. The conservation strategy for the species outlines several conservation actions, including more numerous and intensive surveys, removal of goats from Aguiguan island, control of nonnative species, and reforestation with native plants (Berger et al. 2005, pp. 158–159, as cited in USFWS 2015). Given that so few surveys have been conducted on Aguiguan, and only previously surveyed sites were ever revisited, it is possible Langford's tree snail may yet be found.

Langford's tree snail is at risk from threats associated with small numbers of individuals and populations (e.g., population declines through loss of vigor and genetic representation), habitat loss and degradation by nonnative animals (goats and rats), and predation by nonnative animals (rats and flatworms). Due to the anticipated small number of individuals and populations, natural events such as typhoons also pose a threat, as a single catastrophic event could potentially result in the extinction of the species. Further, the collection of snail shells for trade may also contribute to the decline of the humped tree snail (USFWS 2012, in litt.; as cited in USFWS 2015). The cumulative data also suggest that climate change will impact Langford's tree snails, likely by means of alteration of habitat to less favorable conditions.

EB/CE Sources:

U. S. Fish and Wildlife Service (USFWS). 2020. Langford's Tree Snail (*Partula langfordi*) 5-Year Review Summary and Evaluation. Honolulu, Hawaii. 11 pp.

U.S. Fish and Wildlife Service (USFWS). 2015. Endangered Status for 16 Species and Threatened Status for 7 Species in Micronesia. Final Rule. 2015 80 FR 59423 59497.

Species: *Partula gibba*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Multiple populations (few)

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Partula gibba*:

The humped tree snail (*Partula gibba*; akaleha, denden), in the Partulidae family, is endemic to the forest ecosystem on the Mariana Islands of Guam, Rota, Saipan, Tinian, Aguiguan, Anatahan, Sarigan, Alamagan, and Pagan (USFWS 2015). It was once considered the most abundant tree snail on Guam (Crampton 1925, pp. 8, 25, 60). Currently, the humped tree snail is known from the islands of Guam, (Hopper and Smith 1992, p. 81; Smith et al. 2009, pp. 10, 12, 16), Rota (Smith 1995, p. 1; Bauman 1996, pp. 15, 18), Saipan (Hadfield 2010, pp. 20–21), Tinian (NavFac, Pacific 2014, pp. 5–7), Sarigan (Hadfield 2010, p. 21), Alamagan (Bourquin 2002, p. 30), and Pagan (Hadfield 2010, pp. 8–14) (all as cited in USFWS 2015), in the forest ecosystem. It may occur on Aguiguan but was not relocated on a survey by Smith in 2006 (Smith 2013, p. 14; as cited in USFWS 2015). It and is no longer extant on Anatahan due to volcanic activity in 2003 and 2005 (Kessler 2011, pp. 321, 323; as cited in USFWS 2015). Partulid snails may live up to 5 years and reproduce in less than 1 year, at which time they can produce up to 18 young each year. They are ovoviviparous (give birth to live young), more mobile during higher ambient humidity and precipitation and less mobile during dry periods, live on bushes or trees, and feed primarily on dead or decaying plant material (Cowie 1992, p. 167; Hopper 2014, in litt.; as cited in USFWS 2015). Generally, the humped tree snail needs cool, shaded forest habitat with high humidity and reduced air movement that prevents excessive water loss (USFWS 2020). The snails do not appear to require specific host plants but can be found on many different species of large-leaved plants (trees, shrubs, herbaceous plants, and even ferns) both native and introduced. They need live and decaying plant material, as their diet consists of fungi and microalgae. Partulidae are relatively slow-growing, long-lived and slow-reproducing land snails (Cowie 1992, as cited in USFWS 2020). Partulids are simultaneous hermaphrodites, meaning they have both male and female reproductive organs, which are functional at the same time. Like most land snails, partulids appear to be predominantly out-breeding hermaphrodites; in other words, breeding occurs between unrelated individuals (Tompa 1984, as cited in USFWS 2020). Mariana Islands partulid tree snails live on subcanopy vegetation and are not found in high canopy. Although tree snails in the Mariana Islands likely evolved to live upon native vegetation, there is no clear indication of obligate relationships with any particular type of tree or plant

(Fiedler 2014, in litt.; as cited in USFWS 2015). Further, Mariana partulid snail species are observed to use nonnative ‘‘home plants’’ to which they have apparently adapted (Fiedler 2014, in litt.; as cited in USFWS 2015). Although it has been suggested that native crabs may prey on Mariana partulid snails (Fiedler 2014, in litt. ; as cited in USFWS 2015), they are not regarded as a major threat to these tree snails compared to alien carnivorous flatworms (i.e., the manokwari flatworm) and snails (i.e., the rosy wolf snail *Euglandina rosea* and *Gonaxis spp*.; Cowie 1992, p. 175; as cited in USFWS 2015). Nonnative mites and ants have also raised some concerns about their impacts on Mariana partulid snails (Fiedler 2014, in litt.; as cited in USFWS 2015); however, these are only potential threats at this time. Populations of the humped tree snail are rapidly decreasing from initial numbers observed, and with continued habitat loss and predation by nonnative species, are at risk. In 1989, only one of 47 sites on Guam (including most of those surveyed by Crampton in 1920) were occupied by the humped tree snail (Hopper and Smith 1992, as cited in USFWS 2020). In 2015, at the time of listing, this was still the only site on Guam where the species was found and had no more than 150 individuals (USFWS 2020). The effects of future climate change are likely to have negative impacts on the habitat of the humped tree snail, and further exacerbate other threats to the species, such as threats from typhoons to small, isolated populations. The populations on Sarigan may be relatively more stable due to the removal of ungulates (see Conservation Efforts to Reduce Habitat Destruction, Modification, or Curtailment of Its Range section below), but predation by rats remains a threat on that island (Kessler 2011, p. 320; as cited in USFWS 2015), as does the potential introduction of other harmful nonnative species (Hopper 2014, in litt.). Collecting of snail shells for trade may also contribute to the decline of the humped tree snail (USFWS 2012, in litt.; as cited in USFWS 2015).

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2015. Endangered Status for 16 Species and Threatened Status for 7 Species in Micronesia. Final Rule. 2015. 80 FR 59423 59497.

Species: *Partula radiolata*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Multiple populations (few)

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Partula radiolata*:

The Guam tree snail (*Partula radiolata*; akaleha, denden) is an island endemic and in the Partulidae family. Generally, the Guam tree snail needs cool, shaded forest habitat with high humidity and reduced air movement that prevents excessive water loss. The snails do not appear to require specific host plants but can be found on many different species of large-leaved plants (trees, shrubs, herbaceous plants, and even ferns), both native and introduced. They need live and decaying plant material, as their diet consists of fungi and microalgae (USFWS 2020). Partulidae are relatively slow-growing, long-lived and slow-reproducing land snails (Cowie 1992, as cited in USFWS 2020). Partulids are simultaneous hermaphrodites, meaning they have both male and female reproductive organs, which are functional at the same time. Like most land snails, partulids appear to be predominantly out-breeding hermaphrodites, in other words breeding occurs between unrelated individuals (Tompa 1984, as cited in USFWS 2020). Historically, suit prior to World War II, and included strand vegetation, forested river borders, and lowland and highland forests (USFWS 2015). Some snail experts who frequently conduct fieldwork in the Mariana Islands have reported there are at least 26 populations of the Guam tree snail; however, they also note that habitat destruction and the manokwari flatworm still pose significant threats to this species, which is particularly vulnerable as a single-island endemic (Fiedler 2014, in litt.; as cited in USFWS 2015). The number of individuals per population is unknown, but likely ranges from a few individuals to some populations with over 1,000 individuals (USFWS 2020). The results from this genetic analysis by Lindstrom and Benedict (2014, p. 27; as cited in USFWS 2015) showed the Guam tree snail has a very low degree of genetic diversity between all the surveyed populations, which makes this species vulnerable to extinction pressures associated with low numbers of individuals and populations (e.g., disease). Additionally, despite being the most widespread partulid on Guam, Lindstrom and Benedict's data (2014, pp. 27, 31, 32; as cited in USFWS 2015) show that Guam tree snails are still disappearing compared to historical abundance (Lindstrom and Benedict 2014, p. 32; as cited in USFWS 2015). Overall, populations of the Guam tree snail continue to decline, from first observations of at least 37 populations as observed by Crampton, down to 26 colonies or fewer today. Continued loss of habitat due to development and removal of native plants by ungulates contribute to this loss, trade of shells by collectors may be a threat, and predation by the invasive manokwari flatworm is likely a significant source of mortality (see Summary of Biological Status and Threats Affecting the 23 Mariana Islands Species, USFWS 2015). We anticipate the effects of climate change will further exacerbate many of these threats in the future.

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2015. Endangered Status for 16 Species and Threatened Status for 7 Species in Micronesia. Final Rule. 2015 80 FR 59423 59497.

U.S Fish and Wildlife Service (USFWS). 2020. 5-Year Review. Summary and Evaluation. Guam tree snail (*Partula radiolata*). Honolulu, Hawai'i. 14 pp.

Species: *Samoana fragilis*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Multiple populations (few)

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Samoana fragilis*:

The fragile tree snail (*Samoana fragilis*; akaleha dogas, denden), in the Partulidae family, is known from the forest ecosystems of Guam and Rota. It is the only species representing the genus of *Samoana* in the Mariana Islands. Sometimes the Guam tree snail and fragile tree snail are difficult to distinguish from one another and DNA comparison is necessary to determine the identity (Fiedler 2014, in litt.; as cited in USFWS 2015). Generally, the fragile tree snail needs cool, shaded forest habitat with high humidity and reduced air movement that prevents excessive water loss. The snails do not appear to require specific host plants but can be found on many different species of large-leaved plants (trees, shrubs, herbaceous plants, and even ferns) both native and introduced. They need live and decaying plant material, as their diet consists of fungi and microalgae (USFWS 2020). Partulidae are relatively slow-growing, long-lived and slow-reproducing land snails (Cowie 1992, as cited in USFWS 2020). Partulids are simultaneous hermaphrodites, meaning they have both male and female reproductive organs, which are functional at the same time. Like most land snails, partulids appear to be predominantly out-breeding hermaphrodites, in other words breeding occurs between unrelated individuals (Tompa 1984, as cited in USFWS 2020). Currently, there are seven known locations of the fragile tree snail on Guam, four in the north and three in the south (Fiedler unpublished data and GPEPP unpublished data, as cited in USFWS 2020). All populations appear to be small (<100 individuals) and narrowly dispersed, with the exception of the population at the northern portion of the Haputo Ecological Reserve Area at Finegayan (Fiedler, unpublished data as cited in USFWS 2020). The original site from where this species was discovered and described on Rota was converted to agricultural fields, and no living snails were found there in 1995 (USFWS 2020). In 1996, a new colony was discovered on Rota in a different location (Bauman 1996, as cited in USFWS 2020). At this site along the mountain slope of the Talakhaya region, the fragile tree snail co-occurs with another endemic *Partula* spp. (Fiedler 2019, as cited in USFWS 2020). Available data indicate the number of known colonies has declined between 1925 and the present. In summary, populations of the fragile tree snail are decreasing from initial numbers observed on Guam and Rota, and are at risk, due to continued habitat loss and destruction from agriculture, urban development, nonnative animals and plants, and typhoons. We anticipate the effects of climate change will further exacerbate many of these threats in the future. Trade of shells by collectors, combined with direct predation by rats and flatworms, also contribute to the decline of the fragile tree snail. Low numbers of individuals likely contribute to population declines through loss of vigor and genetic representation.

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2015. Endangered Status for 16 Species and Threatened Status for 7 Species in Micronesia. Final Rule. 2015. 80 FR 59423 59497.

U.S Fish and Wildlife Service (USFWS). 2020. 5-Year Review. Summary and Evaluation. Fragile Tree Snail (*Samoana fragilis*). Honolulu, Hawai‘i. 14 pp.

Species: *Eua zebrina*

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated populations

Number of Populations: Multiple populations (few)

Species Trends: Unknown population trends

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary *Eua zebrina*:

Eua zebrina, a tropical tree snail in the family Partulidae, occurs solely on the islands of Tutuila and Ofu in American Samoa. Snails in the family Partulidae are predominantly nocturnal, arboreal herbivores that feed mainly on partially decayed and fresh plant material (Murray 1972 cited in Cowie 1992, p. 175; Murray et al. 1982, p. 324; Cowie 1992, pp. 167, 175; Miller 2014, pers. comm.; as cited in USFWS 2016, 2021). Partulids are slow growing and hermaphroditic (Cowie 1992, pp. 167, 174; as cited in USFWS 2016). The importance of native forest canopy and understory for Samoan land snails cannot be underestimated; all live snails were found on understory vegetation beneath intact forest canopy (Miller 1993, p. 16; as cited in USFWS 2016). Review of long-term changes in the American Samoa land snail fauna characterized 3 of 12 species as being stable in numbers, with the rest described as declining in numbers, including *Eua zebrina* (Solem 1975, as cited in Cowie 2001, pp. 214– 216; Christensen 1980, p. 1; Miller 1993, p. 13; Cowie 2001, p. 215; as cited in USFWS 2016). The uneven distribution of the 1,102 live snails on Tutuila suggests an overall decline in distribution and abundance (Cowie and Cook 1999, p. 30; as cited in USFWS 2016). On Tutuila, the survey sites with the highest numbers of *Eua zebrina* (except one site, Amalau) are concentrated in the central area of the National Park of American Samoa (Cowie and Cook 1999, p. 30; as cited in USFWS 2016). Because the island of Ofu in the Manua Islands does not yet have the predatory rosy wolf snail (see Factor C. Disease or Predation), the population of *Eua zebrina* on Ofu is of major conservation significance (Cowie 2001, p. 217; as cited in USFWS 2016). Based on the best available scientific and commercial information, we consider the threats of destruction, modification, and curtailment of the species habitat and range to be ongoing threats to *Eua zebrina*. The decline of the native land snails in American Samoa has resulted, in part, from the loss of native habitat to agriculture and development, disturbance by feral pigs, and the establishment of nonnative plant species; these threats are ongoing and are likely exacerbated by impacts to native forest structure from hurricanes. Predation by the nonnative species, including rosy wolf snail, *Gonaxis kibweziensis*, New Guinea flatworm and rats, is a current threat to *Eua zebrina* and will continue into the future. No existing Federal laws, treaties, or regulations specify protection of *Eua zebrina*’s habitat from the threat of deforestation or address the threat of predation by nonnative species such as rats, the rosy wolf snail, and the New Guinea flatworm. Some existing Territorial laws and regulations have the potential to afford *Eua zebrina* some protection, but their implementation does not achieve that result. The destruction of native vegetation and forest canopy, and modification of light and moisture conditions both during and in the months and possibly years following hurricanes, can negatively impact the populations of *Eua zebrina*. In summary, we consider *Eua zebrina* vulnerable to extinction because of threats associated with low numbers of individuals and low numbers of populations. This species has suffered a serious decline and is limited by its slow reproduction and growth (Cowie and Cook 1999, p. 31; as cited in USFWS 2016). Threats to *Eua zebrina* include habitat destruction and modification by hurricanes, agriculture and development, nonnative plant species and feral pigs; collection and overutilization; and predation by the rosy wolf snail, *Gonaxis kibweziensis*, and the New Guinea flatworm. The effects of these threats are compounded by the current low number of individuals and populations of *Eua zebrina*.

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2016. Endangered Status for Five Species from American Samoa. Final Rule. 2016. 81 FR 65465 65508.

U.S Fish and Wildlife Service (USFWS). 2021. 5-Year Review. Summary and Evaluation. *Eua zebrina*. Honolulu, Hawai‘i. 23 pp.

Overall Vulnerability *Achatinella* genus (41 snails): ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability *Partulina semicarinata*: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability *Partulina variabilis*: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability Newcomb's tree snail: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability Langford's tree snail: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability Humped tree snail: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability Guam tree snail: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability Fragile tree snail: ☒ **High** ☐ **Medium** ☐ **Low**

Overall Vulnerability *Eua zebrina*: ☒ **High** ☐ **Medium** ☐ **Low**

RISK

(Risk is based on species exposure and response from labelled uses across the range)

Risk to individuals if exposed: Mortality is not expected for tree snails exposed to malathion on use sites or from spray drift.

Risk to the species from labelled uses across the range:

The table below summarizes the risk to the species from labelled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

DIRECT (all uses except mosquito control)	
Use areas – mortality	No effects expected.
Spray drift areas – mortality	No effects expected.
Volatilization	Exposure via this route for Hawaiian tree snails
INDIRECT (all uses except mosquito control)	
Use areas - Prey item mortality	N/A
Spray drift areas - Prey item mortality	N/A
Plants affected (decline in growth)	No effects expected
MOSQUITO CONTROL	
Direct (mortality)	No effects expected.
Indirect	No effects expected

Risk modifiers: Tree snails prefer cool, shaded forest habitats (Crampton 1925, Cowie 1992, Smith 1995) with high humidity and reduced air movement that might otherwise promote excessive water loss. Hawaiian tree snails occur on the main Hawaiian Islands above 400 feet (122 meters) elevation. They feed on epiphytic lichens, fungi and algae that grow on the leaves and trunks of the host plant (Pilsbry and Cooke 1912-1914, p. 103). The Guam tree snail lives on bushes or trees in 22 locations in Guam. They feed primarily on senescent or decaying plant material. Tree snail young are born live at relatively large size. Natural dispersal from the host tree is suspected to occur through high winds and hurricanes/typhoons.

Hawaiian tree snails are currently restricted to forests above 400 meters (1,312 feet). Snails have may high susceptibility to pesticides due to their small size and permeable skin. Juvenile and adult tree snails would absorb pesticide deposited on their bodies. Their mode of movement could result in high exposure to treated surfaces as their foot would absorb pesticide applied to leaves of their host tree during application and as a result of drift and downwind deposition. In addition, the pesticide could be deposited on their lichen, algae, and fugal food material in the form of dry and wet deposition.

Hawaiian tree snail habitat is in the fog zone and are not expected to occur on malathion use sites but may be found within one mile (0.6 km) downwind of pasture, open space developed, developed, other crops, orchards and vineyards, vegetables and ground fruit, other grains, and corn use sites. Given the forested habitats where Hawaiian tree snails occur, we do not expected drift from these use sites to pose significant risk to these species. Hawaii tree snails could be exposed to insecticide that has volatilized and deposited at locations downwind from the application site and, in the Main Hawaiian Islands, in the fog deposition zone, though the exposure is not expected to result in concentrations that would affect them (see *General Effects* for further information on volatilization)

The humped tree snail, Guam tree snail, and fragile tree snail occur in areas within and adjacent to pesticide application sites including pasture, open space developed, other crops, vegetables and ground fruit, orchards and vineyards, and mosquito adulticide.

The Langford's tree snail occurs on the uninhabited island of Aguigan, and we do not anticipate applications of malathion will occur on this island for the duration of the proposed Action. Therefore, we do not anticipate individuals of the species would be exposed to malathion either through direct application or spray drift, or through their forage base. *Eua zebrina* snails are typically found scattered on understory vegetation in forest with intact canopy 10 to 20 meters above the ground and are therefore not expected to be exposed to malathion on use sites or from spray drift. This species is presumed to feed mainly on partially decayed and fresh plant material.

Data in the primary literature for aquatic snails indicate this taxa group tends to be less sensitive to malathion and are generally at low risk of adverse effects from malathion exposure. While terrestrial species may not be exposed to malathion via this same exposure route (i.e., in water), we consider aquatic snails to be a more suitable surrogate and assume terrestrial snails exhibit similar tolerance to malathion from contact exposure. With this high tolerance for malathion in mind, we expect these snail species should also exhibit a high tolerance to malathion exposure and are unlikely to experience direct effects from malathion.

Overall Risk *Achatinella* genus (41 snails): ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk *Partulina semicarinata*: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk *Partulina variabilis*: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk Newcomb's tree snail: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk Langford's tree snail: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk Humped tree snail: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk Guam tree snail: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk Fragile tree snail: ☐ **High** ☐ **Medium** ☒ **Low**

Overall Risk *Eua zebrina*: ☐ **High** ☐ **Medium** ☒ **Low**

***USAGE* Hawaii, Guam, and the Mariana Islands**

(Anticipated usage within the range based on past usage data)

Information regarding past usage of malathion is not available for Hawaii, Guam, or the Mariana Islands. Based on survey data collected in Hawaii, we estimate that 4.8% of agricultural crops were treated with insecticides. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the

Approach to Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in Hawaii, Guam or the Mariana Islands. Future use cannot be ruled out but is not expected to increase significantly.

***USAGE* American Samoa**

(Anticipated usage within the range based on past usage data)

Information regarding past usage of malathion in American Samoa is not available, however prior survey data has indicated that 0.9% of agricultural crops were treated with insecticides, with malathion only being a subset of this, assuming its use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the Approach to Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in American Samoa; future use cannot be ruled out but is not expected to increase significantly.

Overall Usage *Achatinella* genus (41 snails):	☐ **High**	☒ **Medium**	☐ **Low**
Overall Usage *Partulina semicarinata*:	☐ **High**	☒ **Medium**	☐ **Low**
Overall Usage *Partulina variabilis*:	☐ **High**	☒ **Medium**	☐ **Low**
Overall Usage Newcomb's tree snail:	☐ **High**	☒ **Medium**	☐ **Low**
Overall Usage Langford's tree snail:	☐ **High**	☐ **Medium**	☒ **Low**
Overall Usage Humped tree snail:	☐ **High**	☒ **Medium**	☐ **Low**
Overall Usage Guam tree snail:	☐ **High**	☒ **Medium**	☐ **Low**
Overall Usage Fragile tree snail:	☐ **High**	☒ **Medium**	☐ **Low**
Overall Usage *Eua zebrina*:	☐ **High**	☐ **Medium**	☒ **Low**

CONSERVATION MEASURES

Residential use label changes: New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely), reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application.

Reduced application number and rate: New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop, previous allowable number of applications ranged from 3 to 13 applications per year). We anticipate this measure will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

CONCLUSION

Hawaii and American Samoa Tree Snails:

After reviewing the current status of the species, the environmental baseline for the Action area, and the effects of the proposed registration of malathion, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the *Achatinella* genus, *Partulina semicarinata*, *Partulina variabilis*, *Newcombia cumingi*, and *Eua zebrina*. As discussed below, even though the vulnerability is high, the risk is low for these species and usage ranges from low to medium. We expect the implementation of the general conservation measures described above will further reduce the likelihood of exposure to malathion. We do not anticipate the Action will result in species-level effects.

The Hawaiian tree snails (genus *Achatinella*, *Partulina semicarinata*, *Partulina variabilis*, *Newcombia cumingi*) have high vulnerabilities based on their status, distributions, and trends. The risk to these tree snails posed by the labeled uses across the range is low, and there is a medium amount of estimated usage within the range of the species based on prior survey data. The Hawaiian tree snails are currently restricted to forests above 400 meters (1,312 feet) where the pesticide has the potential to be applied as a mosquito adulticide. No mortality and or sublethal effects are expected for these snails on use sites and through spray drift.

The *Eua zebrina* has high vulnerability based on its status, distribution, and trend and a low risk of exposure. There is a low amount of estimated usage within the range of the species based on prior survey data that indicated that only 0.9% of agricultural crops are treated with insecticides. Therefore, exposure to malathion is expected to be low. In addition, spray drift that did enter the species habitat from adjacent uses is not expected to be at concentrations that would directly cause adverse effects.

At present, information indicates that malathion is not used as a mosquito control agent in Hawaii and American Samoa; future use cannot be ruled out but is not expected to increase significantly. Therefore, we anticipate that the proposed Action would not appreciably reduce survival and recovery of the *Achatinella* (genus), *Partulina semicarinata*, *Partulina variabilis*, *Newcombia cumingi,* and *Eua zebrina*.

Conservation measures, such as changes to residential use labels and reductions in the allowable number of applications and application rates, are expected to substantially reduce environmental concentrations of malathion within these species' ranges, reducing the risk of exposure, because these snails use dry to wet forests and shrublands on islands for foraging and breeding. Furthermore, as terrestrial snails are expected to be quite tolerant to malathion exposure, we would expect that the medium to low expected usage in combination with the conservation measures, would reduce the risk of adverse effects that might result from the Action.

Northern Mariana Islands Tree Snails: Langford's Tree Snail

After reviewing the current status of the species, the environmental baseline for the Action area, and the effects of the proposed registration of malathion, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the existence of Langford's tree snail.

The Langford's tree snail only occurs on the island of Aguigan. The island is currently uninhabited, and there are no use sites that would warrant applications of malathion now or in the immediate future. Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of the Langford's tree snail in the wild.

Northern Mariana Islands Tree Snails: Humped, Guam, and Fragile Tree Snails

After reviewing the current status of the species, the environmental baseline for the Action area, and the effects of the proposed registration of malathion, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the humped tree snail, Guam tree snail, and fragile tree snail.

The humped tree snail, Guam tree snail, and fragile tree snail have high vulnerabilities based on their status, distribution, and trend and high risk of exposure posed by the labeled uses across the range. There is a medium amount of estimated usage within the range of these species based on prior survey data. The humped tree snail, Guam tree snail, and fragile tree snail occur in areas within and adjacent to pesticide application sites including pasture, open space developed, other crops, vegetables and ground fruit, orchards and vineyards, and mosquito adulticide.

While tree snails are vulnerable due to stressors associated with small, isolated populations, habitat loss, and predators, we expect that, similar to aquatic snail species, tree snails would exhibit a high tolerance for malathion exposure, reducing the risk of adverse effects. Furthermore, conservation measures, such as changes to residential use labels and reductions in the allowable number of applications and application rates, are expected to substantially reduce the environmental concentrations of malathion within the species' ranges, reducing the risk of exposure and effects within dry to wet forests and shrublands on islands where these species forage and breed. Given this general tolerance of malathion as well as these conservation measures, we do not anticipate individuals of this species would experience mortality, effects to growth or reproduction, or impacts to their food base.

Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of humped tree snail, Guam tree snail, and fragile tree snail in the wild.

Conclusion *Achatinella* genus (41 snails):	**Not likely to jeopardize**
Conclusion *Partulina semicarinata*:	**Not likely to jeopardize**
Conclusion *Partulina variabilis*:	**Not likely to jeopardize**
Conclusion Newcomb's tree snail:	**Not likely to jeopardize**
Conclusion Langford's tree snail:	**Not likely to jeopardize**
Conclusion Humped tree snail:	**Not likely to jeopardize**
Conclusion Guam tree snail:	**Not likely to jeopardize**
Conclusion Fragile tree snail:	**Not likely to jeopardize**
Conclusion *Eua zebrina*:	**Not likely to jeopardize**

ADDITIONAL REFERENCES

Cowie, R.H. 1992. Evolution and extinction of Partulidae, endemic Pacific island land snails. Philosophical Transactions of the Royal Society, London B 335:167–191.

Crampton, H.E. 1925. Studies on the variation, distribution, and evolution of the genus *Partula*: The species of the Mariana Islands, Guam and Saipan. Carnegie Inst. Washington Publ. 228A:1–116.

Pilsbry, H.A. and C.M. Cooke, Jr. 1912-1914. Achatinellidae. Manual of Conchology, 2nd Ser., Vol. 21.

Smith, B.D. 1995. Tree snails, tropical storms, and drought in the Mariana Islands. (Abstract only). Programs and abstracts, American Malacological Union, 61st Annual Meeting, Hilo, Hawaii.

Pacific Island Snails

The following snail is a ground-dwelling species and is discussed separately in the following species account.

Ground-dwelling snail

Scientific Name:	Common Name:	Entity ID:
Ostodes strigatus	Sisi snail	3224

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Survey work in 1992 (Miller, 1993; Miller et al., 1993a, b) found live snails at only a single locality; fewer than 50 live snails were seen. This was the last time sisi snails were observed. All live sisi snails found were in the leaf litter beneath remaining intact forest canopy. No snails were found in areas bordering agricultural plots or in forest areas that were severely damaged by three recent hurricanes (1987, 1990 and 1991).

Status: Endangered

Distribution: Small, endemic, constrained and/or isolated population(s)

Number of Populations: Unknown (USFWS 2019)

Species Trends: Declining population(s) – one or more populations declining. Last observed in 1992, and its status is currently unknown (USFWS 2019)

Pesticides noted ☐

Environmental Baseline/Cumulative Effects (EB/CE) Summary:

Little is known about the life history or ecology of the sisi snail, but it can be assumed that this snail feeds on decaying leaf litter and fungus, and probably deposits eggs into leaf litter where they develop and hatch. The snails are found to be highly scattered in the leaf litter on the forest floor under an intact canopy of 10-15 m above the ground. (USFWS 2016). *Ostodes strigatus* is found on the ground in rocky areas under relatively closed canopy with sparse understory plant coverage at elevations below 1,280 feet (ft) (390 meters [m]) (Girardi 1978, p. 224; Miller 1993, pp. 13, 15, 23, 24, 27; as cited in USFWS 2021). Moisture supply is the principal environmental influence on *Ostodes* spp. (Girardi 1978, p. 245; as cited in USFWS 2021). Based on extensive material in the Bishop Museum that was collected mostly in the first half of the twentieth century, particularly during an expedition in 1926, it appears that this snail was at one time widespread and abundant on Tutuila. In 1975, it was still widespread and not considered threatened (Solem, 1975). Survey work in 1992 (Miller, 1993; Miller et al., 1993a, b, as cited in USFWS 2016) found live snails at only a single locality; fewer than 50 live snails were seen. All live sisi snails found were in the leaf litter beneath remaining intact forest canopy. No snails were found in areas bordering agricultural plots or in forest areas that were severely damaged by three recent hurricanes (1987, 1990 and 1991). Live individuals of *Ostodes strigatus* have not been reported since 1992 (USFWS 2021), and no systematic surveys have been conducted for this species since the late 1990s (Cowie and Cook 1999, p. 24; Miles 2015, in litt., entire; as cited in USFWS 2021).

The sisi snail current range is Maloata Valley (37-122 m elevation) on the western end of the island of Tutuila, American Samoa (USFWS 2016).

Ostodes strigatus is likely to be affected by loss of forest habitat, overcollection for commercial purposes, predation by nonnative snails, flatworms, and rats, and the vulnerability of its small, isolated populations to chance demographic and environmental occurrences. Climate change effects as another source of risk to the species because increased ambient temperature and storm severity resulting from climate change are likely to exacerbate other direct threats to *Ostodes strigatus* in American Sāmoa, and in particular place additional stress on its habitat; these effects of climate change are projected to increase in the future (USFWS 2021).

EB/CE Sources:

U.S. Fish and Wildlife Service (USFWS). 2016. Endangered and threatened wildlife and plants; determination of endangered status for five species from American Samoa. Federal Register 81:65466-65508.

U.S Fish and Wildlife Service (USFWS). 2021. 5-Year Review. Summary and Evaluation. *Ostodes strigatus*. Honolulu, Hawai‘i. 20 pp.

Overall Vulnerability Sisi snail: ☒ High ☐ Medium ☐ Low

RISK

(Risk is based on species exposure and response from labelled uses across the range)

Risk to individuals if exposed: Mortality is not expected for sisi snails exposed to malathion on use sites or from spray drift.

Risk to the species from labelled uses across the range:

The table below summarizes the risk to the species from labelled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses. Expected mortality rates reported below are based on the most sensitive terrestrial arthropod and are likely overestimated and not representative of this taxa.

DIRECT (all uses except mosquito control)	
Use areas – mortality	No effects expected
Spray drift areas – mortality	No effects expected
Volatilization	Not an appreciable source of exposure
INDIRECT (all uses except mosquito control)	

Use areas - Prey item mortality	N/A
Spray drift areas - Prey item mortality	N/A
Plants affected (decline in growth)	No effects expected
MOSQUITO CONTROL	
Direct (mortality)	No effects expected
Indirect	No effects expected

Risk modifiers: The sisi snail is a land snail found mostly on the ground in rocky areas under relatively closed canopy with sparse understory plant coverage. Sisi snails occur at elevations below 1,280 feet (390 meters) where the pesticide may be applied on pasture, open space developed, other crops, vegetables and ground fruit, orchards and vineyards, and for mosquito control. Pesticide drift from these actions may also occur within tree snail habitat.

Although the biology of the genus *Ostodes* is not well studied, and therefore the exact diet is unknown, it is highly probably and reasonable to believe that the sisi snail feeds, at least in part, on decaying leaf litter and fungus (Girardi 1978, p. 245; Miller 2014, pers. comm.). Most land snails feed on decaying leaf litter and whatever fungus, algae, or other decaying debris lies within the leaf litter; even partially decayed animal matter.

While results indicate high mortality to snails from estimated environmental concentrations of malathion as calculated using the most sensitive terrestrial invertebrate (*A. mellifera*) as a surrogate, data in the primary literature for aquatic snails indicate this taxa group tends to be less sensitive to malathion and are generally at low risk of adverse effects from malathion exposure. While terrestrial species may not be exposed to malathion via this same exposure route (i.e., in water), we consider aquatic snails to be a more suitable surrogate and assume terrestrial snails exhibit similar tolerance to malathion from contact exposure. With this high tolerance for malathion in mind, the expected mortality reported above is likely an overestimation of what will happen over the duration of the Action. Therefore, we assume that the Sisi snail is unlikely to experience direct effects from terrestrial estimated environmental concentrations of malathion.

Overall Risk Sisi snail: ☐ High ☐ Medium ☒ Low

USAGE

(Anticipated usage within the range based on past usage data)

Information regarding past usage of malathion in American Samoa is not available, however prior survey data has indicated that 0.9% of agricultural crops were treated with insecticides. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the Approach to Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in American Samoa; future use cannot be ruled out but is not expected to increase significantly.

Overall Usage Sisi snail: ☐ High ☐ Medium ☒ Low

CONSERVATION MEASURES

Residential use label changes: New restrictions to the method and frequency of application for residential use of malathion are expected to substantially reduce exposure to species that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely), reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from "repeat as necessary" to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing any initial residues to degrade prior to the next application.

Reduced application number and rate: New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and groundfruit lower the maximum allowable number of applications to 2-4 per year (depending on the specific crop, previous allowable number of applications ranged from 3 to 13 applications per year). We anticipate this measure will help reduce the amount of malathion used and decrease potential exposure to the species, thus decreasing the risk of both indirect and direct effects to the species.

CONCLUSION

After reviewing the current status of the species, the environmental baseline for the Action area, and the effects of the proposed registration of malathion, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the sisi snail. As discussed below, even though the vulnerability is high, the risk and usage is low, and the implementation of the general conservation measures described above is expected to further reduce the likelihood of exposure to malathion. We do not anticipate the Action will result in species-level effects.

The sisi snail has high vulnerability based on its status, distribution, and trends. The risk to the species posed by the labeled uses across the range is low, with a low amount of estimated usage within the range of this species. Information regarding past usage of malathion in American Samoa is not available, however prior survey data has indicated that 0.9% of agricultural crops were treated with insecticides. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion.

Based on the current range for the sisi snail, it does not appear that agricultural use sites occur within these species ranges nor are developed and open space developed areas a component of the range. It is unlikely that this species could be exposed via volatilization or by mosquito adulticide application, because malathion for mosquito control does not currently occur in American Samoa. The sisi snail inhabits leaf litter beneath remaining intact forest canopy and has not been found in areas bordering agricultural plots. Due to the habitat needs of the sisi snail, we do not believe that it coexists with existing agricultural or developed areas, and its risk from malathion exposure is low. In addition, aquatic snails tend to be less sensitive to malathion and are generally at low risk of adverse effects from malathion exposure; therefore, we infer that the sisi snail is unlikely to experience direct effects from terrestrial estimated environmental concentrations of malathion. Furthermore, conservation measures, such as changes to residential use labels and reductions to the allowable number of applications and application rates, are expected to reduce the environmental concentrations of malathion in the species' range (including leaf litter on the forest floor under intact canopies) that might occur in the future, further decreasing risk of exposure to this species. We do not anticipate individuals of this species would experience mortality, effects to growth or reproduction, or impacts to their food base, andwe do not anticipate species-level effects to the sisi snail. Therefore, we do not anticipate that the proposed Action would appreciably reduce survival and recovery of the sisi snail in the wild.

Conclusion Sisi snail: **Not likely to jeopardize**

ADDITIONAL REFERENCES

U.S. Fish and Wildlife Service (USFWS). 2019. Recovery Outline for American Samoa Species. Honolulu, HI. 21 pp.

Integration and Synthesis Summary: Pacific Islands Invertebrates

HAWAIIAN CAVE SPECIES

This section describes our analysis for two cave species – the Kauai cave wolf spider and the Kauia cave amphipod. The analyses for these two species will be presented individually below.

Arachnids

Scientific Name:	Common Name:	Entity ID:
Adelocosa anops	Kauai cave wolf or pe'e pe'e maka 'ole spider	463

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Species: Kauai cave wolf spider

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: Single population

Species Trends: All populations stable, with none known to be increasing or decreasing

Pesticides noted ☒

Environmental Baseline/Cumulative Effects (EB/CE) Summary:

A. anops is an obligate cave-dwelling arthropod restricted to the Hawaiian island of Kauai. It has only been found in the Koloa Basin of the island of Kauai where lava tubes and other cave bearing rock are present. Surveys conducted since completion of the 2006 5-year review for this species reconfirm that the Kauai cave wolf spider is only known to be regularly observed in a single cave system (USFWS 2017). In this cave, referred to here as Koloa Cave 2, up to 41 individuals have been found in one survey (USFWS, unpublished data 2006 through 2016; as cited in USFWS 2017). Both sub-adult and adult spiders are regularly observed and females with egg sacs are occasionally seen. In an adjacent Koloa Cave 1, about 260 to 390 feet away, adult cave wolf spiders are occasionally present (USFWS, unpublished data 1996-2016; as cited in USFWS 2017). A small, but persistent population of Kauai cave wolf spiders is known to be present in a third cave, the Kiahuna Mauka Cave. One to four individuals were observed per visit during the monitoring period, 2006-2016 (USFWS 2017).

The Kauai cave wolf spider has low reproductive rates compared to non-cave dwelling counterparts (Howarth 1981; Foelix 1982; as cited in USFWS 2006). Food is limiting in most cave systems and this appears to be true in the Koloa caves as well. This species likely lives in inaccessible mesocaverns (voids and inaccessible passages) as well as large cave passages which means their populations are almost certainly greater than the numbers observed. However, few of the known caves in the Koloa District provide appropriate habitat for this arthropod which is typically only found in the Dark and Stagnant Air Zones (two of five cave zones typified by low air movement, elevated relative humidity, and reduced temperature fluctuations) of caves and require high humidity conditions (Bousfield and Howarth 1979; Hadley et al. 1981; Ahearn and Howarth 1982; as cited in USFWS 2006). The limited number of occupied caves greatly limits our knowledge of the life history requirements. Given the cryptic nature of caves and the uncertain distribution of inaccessible mesocaverns, our knowledge of the distribution and population status is greatly limited. Among threats listed the impacts of urbanization and pollution/toxins were especially noted. The recovery plan indicates that "moisture runoff and recharge that originates in urban areas may inadvertently deliver high concentrations of insecticides or other pesticides (e.g., herbicides, fungicides) into cave and mesocavern habitats, with potentially devastating effects on the Kauai cave arthropods and other cave animals."

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2006. Recovery Plan for the Kauai Cave Arthropods: the Kauai Cave Wolf Spider (*Adelocosa anops*) and the Kauai Cave Amphipod (*Spelaeorchestia koloana*). Portland, Oregon. 64 pp; 71 FR 41041.

U.S Fish and Wildlife Service (USFWS). 2017. 5-Year Review. Short Form Summary. Pe`e pe`e maka`ole or Kauai Cave Wolf Spider (*Adelocosa anops*). Honolulu, Hawai‘i. 7 pp.

Overall Vulnerability Kauai cave wolf spider: ☒ High ☐ Medium ☐ Low

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RISK

(Risk is based on species exposure and response from labelled uses across the range)

Risk to individuals if exposed: Kauai cave amphipods exposed to malathion are expected to die. Kauai cave wolf spiders may be killed, but there is less certainty that concentrations in its prey items would reach levels to cause mortality if consumed.

The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

Risk to the species from labelled uses across the range:

DIRECT (all uses except mosquito control)	
Use areas – mortality and sublethal effects	Mortality for the species
Spray drift areas – mortality	N/A
Volatilization	Not an appreciable source of exposure
INDIRECT (all uses except mosquito control)	

Use areas - Prey item mortality, host fish, forage base for non-predators, etc.	As the Kauai cave amphipod is the main food sources of the Kauai cave wolf spider, mortality predicted for this species would affect the spider's prey base
Spray drift areas - Prey item mortality, host fish, forage base for non-predators, etc.	N/A
Plants affected (decline in growth)	No effects anticipated
MOSQUITO CONTROL	
Direct (mortality)	Mortality if exposed
Indirect	Any mortality for the Kauai cave amphipod would affect the spider's prey base

Risk modifiers:

The Kauai cave wolf spider is known to occur in a single cave in the Koloa Basin on the island of Kauai where lava tubes and other cave bearing rock are present. The limited number of occupied caves greatly limits our knowledge of the life history requirements. Given the cryptic nature of caves and the uncertain distribution of inaccessible mesocaverns, our knowledge of the distribution and population status is greatly limited. The Kauai cave wolf spider has low reproductive rates compared to non-cave dwelling counterparts (Howarth 1981; Foelix 1982). Very little else is known about the reproductive strategy of the Kauai cave wolf spider. The Kauai cave wolf spider's primary prey is likely to be the Kauai cave amphipod (*Spelaeorchestia koloana*), which is also listed as endangered.

Nutrients in most lava tubes and cave ecosystems in Hawaii are derived from the surface either directly (organic material washed in or brought in by animals) or indirectly, by feeding on the lava tube invertebrates that feed on surface-derived nutrients. In some cases, the most important source of nutrients for a target troglobite may be the fungus, microbes, and/or smaller troglophiles and troglobites that grow on the leaves or feces rather than the original material itself. Tree roots can penetrate into caves and may also provide direct nutrient input to shallow caves. In deeper cave reaches, nutrients enter through water containing dissolved organic matter percolating vertically through karst fissures and solution features. For predatory troglobites, accidental species of invertebrates (those that wander in or are trapped in a cave) may be an important nutrient source in addition to other troglobites and troglophiles found in the cave. Troglobytes typically have very slow metabolisms, an adaptation to the sparse amounts of food found in their environment.

Based on the location of caves near developed and disturbed areas in the Koloa Basin, and the identification of pesticides as a threat to these species, we anticipate malathion usage could occur in this area and enter caves.

Overall Risk Kauai cave wolf spider: ☐ High ☒ Medium ☐ Low

USAGE

(Anticipated usage within the range based on past usage data)

Information regarding past usage of malathion in Hawaii is not available, however prior survey data has indicated that 4.8% of agricultural crops were treated with insecticides. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the Approach to Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in Hawaii; future use cannot be ruled out but is not expected to increase significantly.

Overall Usage Kauai cave wolf spider: ☐ High ☒ Medium ☐ Low

CONSERVATION MEASURES

General Conservation Measures

Rain restriction: Label language has been added restricting malathion application to periods where rain is not forecasted for at least 48 hours for agriculture and 24 hours for residential use or when the soil is not saturated. Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and reducing the amount of malathion that would reach the subsurface habitats in which these species reside.

Aquatic habitat buffers: Application buffers are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. We anticipate that in many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

Species-specific Measures
The following species-specific measures are now part of the Action and will be included in *BulletinsLive Two*

In addition to the general label changes that would apply to all uses specified on the label, which would be protective of a wide range of species, the registrants have also agreed to the additional conservation measure:

For the Kauai Cave Wolf Spider: Within the pesticide use limitation area (Koloa Basin area as shown in the map from the USFWS 2006 Recovery Plan): Applicator must not apply malathion by ground within 50 feet or aerially within 200 feet of cave openings and sinkholes. Avoidance and use limitation areas such are effective ways to reduce exposure to malathion by preventing use directly in these important areas, thus reducing the likelihood the species will come into contact with malathion.

Application buffers are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to species. While the exact amount of spray drift reduction will vary depending on traits of the ecosystem (e.g., flow rate, volume, etc.) as well as the application method, based on AgDRIFT modeling we can expect spray drift reductions ranging from 82 to 90%.

Restricting irrigation of fields to a minimum of 24 hours after malathion application ensures that there is some time for the pesticide to degrade before potential runoff events can transport malathion to adjacent water bodies or groundwater aquifers.

CONCLUSION

After reviewing the current status of the species, the environmental baseline for the Action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the Kauai cave wolf spider. As discussed below, even though the vulnerability is high, the risk and usage are medium for this species, and we anticipate the likelihood of exposure to malathion will be further reduced with the implementation of the general and species-specific conservation measures described above. While we anticipate that very small numbers of individuals of this species will be affected over the duration of the proposed Action, we do not expect species-level effects to occur.

The Kauai cave wolf spider has a high vulnerability based on its status, distribution, and trends. The risk to the species posed by labeled uses across the range is medium. The estimated usage within the range is medium. Past malathion usage data in Hawai'i is unavailable, however, prior survey data has indicated that 4.8% of agricultural crops in Hawai'i were treated with insecticides, assuming malathion is only a subset of this use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed areas would undergo some level of treatment with malathion.

The Kauai cave wolf spider would be directly exposed to the pesticide if usage occurs in the area around caves near developed and disturbed areas in the Koloa Basin and enters the caves. However, we anticipate a reduction in the level of exposure from these use types since this species is an obligate cave-dwelling arthropod and is found where lava tubes and cave bearing rocks are present, that will likely serve as a buffer to spray drift or runoff from these activities. Although malathion volatilizes readily and is transported downwind and deposited as dry deposition, in precipitation and, at higher elevations, in fog deposition, we do not expect volatilization to be an appreciable source of exposure. In addition, we anticipate the general conservation measures above would further reduce the risk of exposure from these use types to the species and its habitat.

We anticipate that the rain restrictions and aquatic habitat buffers, ground and aerial buffers, and irrigation restrictions are expected to reduce the amount of malathion used and limit the likelihood of spray drift and runoff exposure to this species and its lava tube and cave habitat. As with most invertebrates, we anticipate that the rain restriction reduces the likelihood of exposure to the species (directly or in runoff) following a precipitation event. Also, we expect the pesticide will most likely have sufficient time to degrade before runoff into aquatic habitats can occur, which will further decrease the likelihood of exposure by reducing the amount of malathion to wetland habitats in which this species resides. Similarly, we anticipate the aquatic habitat buffers will reduce spray drift and decrease the likelihood of exposure to aquatic organisms by also limiting the pesticide from reaching coastal and wetland ecosystems. In addition, we expect that restricting applications of malathion by ground within 50 feet or aerially within 200 feet of cave openings and sinkholes will effectively reduce exposure to malathion by preventing use directly in these important areas, thus reducing the likelihood the species will come into contact with malathion. Furthermore, restricting irrigation of fields to a minimum of 24 hours after malathion application ensures that there is some time for the pesticide to degrade before potential runoff events can transport malathion to adjacent water bodies or groundwater aquifers.

Together, these measures are anticipated to substantially reduce mortality of individuals of this species from application of malathion within and immediately surrounding the range of this species. Thus, we anticipate only small numbers of individuals of this species will experience mortality over the duration of the Action. However, we do not anticipate the loss of small numbers of individuals would result in species-level effects. Therefore, we do not anticipate the proposed Action would appreciably reduce survival and recovery of the Kauai cave wolf spider in the wild.

Conclusion Kauai cave wolf spider: Not likely to jeopardize

ADDITIONAL REFERENCES

U.S. Fish and Wildlife Service (USFWS). 2019. Draft Kauai Islandwide Recovery Plan. U.S. Fish and Wildlife Service, Portland, Oregon. 43 pp.

U.S. Fish and Wildlife Service (USFWS). 2006b. Kauai Cave Wolf Spider (*Adelocosa anops*) 5-Year Review Summary and Evaluation. U.S. Fish and Wildlife Service, Honolulu, Hawaii. 12 pp.

Hawaiian Cave Species

Crustaceans

Scientific Name:	Common Name:	Entity ID:
Spelaeorchestia koloana	Kauai Cave amphipod	485

VULNERABILITY

(Summary of status, environmental baseline and cumulative effects)

Species: Kauai cave amphipod

Status: Endangered

Distribution: Small, endemic, constrained, and/or isolated population(s)

Number of Populations: Multiple populations (few)

Species Trends: All populations stable, with none known to be increasing or decreasing

Pesticides noted ☒

Environmental Baseline/Cumulative Effects (EB/CE) Summary:

The Kauai cave amphipod (*Spelaeorchestia koloana*) is an obligate cave-dwelling arthropod restricted to the Hawaiian island of Kauai. It has only been found in the Koloa Basin of the island of Kauai where lava tubes and other cave bearing rock are present. Based on data from the survey period, 2006-2016, the Kauai cave amphipod is frequently observed in six caves regularly monitored (USFWS, unpublished data 2006 through 2016; as cited in USFWS 2017). The population size observed in each cave varies: typically, fewer than 20 individuals are in each of Cave 1927C, Cave 3179, Cave 3075C, and Quarry Cave; 9 to 182 individuals in Cave 1914; and 18 to 82 individuals in Kiahuna Mauka Cave. In another two caves where Kauai cave amphipods are infrequently observed (Cave 3075A and Cave 3075B), there are typically fewer than five individuals.

The existence of amphipods in geographically separate areas may make them less vulnerable to catastrophic events that might impact a single cave. Runoff and recharge that contain urban and household pesticides may inadvertently deliver high concentrations of insecticides or other pesticides (e.g., herbicides, fungicides) into cave and mesocavern habitats, with potentially devastating effects on the Kauai cave amphipod. Non-native predators are known to feed on mainland cave-dwelling species (USFWS 1994) and are assumed to compete with resident cave-dwelling animals for common food resources which are already in low supply. Howarth (1981; as cited in USFWS 2006) documented the replacement of an endemic cave-dwelling spider, *Erigone stygius*, by a non-native web-building cave dwelling spider, *Nesticus mogera*. There is good evidence to suggest that the Kauai cave amphipod is preyed upon by the nonnative brown violin spider (*Loxosceles rufescens*; A. Asquith, in litt. 1994a, b; D. Hopper, in litt. 1999; as cited in USFWS 2006). Web-building spiders, such as the brown violin, may pose a particularly serious threat since webs present a method of predation to which the Kauai cave amphipod is likely not adapted (Howarth 1981; as cited in USFWS 2006). Lastly, the introduced lesser brown scorpion (*Isometrus maculatus*) and centipedes (*Scolopendra* spp.) have both been observed in some of the caves inhabited by the endemic cave-dwelling species and the generalized diet of these predators would certainly include Kauai cave amphipods. All of the caves may be threatened by prolonged drought, brought about either by global climatic changes or by local alteration of the vegetation that may reduce rainfall or otherwise result in reduced soil moisture content. Prolonged drought may desiccate the cave interior, making it less accommodating to cave-dwelling animals (Howarth 1983; as cited in USFWS 2006). Urbanization typically results in large areas being covered by asphalt or other artificial surfaces that lack or have only limited permeability. Reduced local ground water recharge may greatly reduce humidity levels within caves, subterranean cracks, and mesocaverns, degrading or eliminating habitat for these species. Human visitation to and uses of caves are recognized as being a serious threat (Culver 1986; as cited in USFWS 2006). Cave ecosystems are affected by the following activities: used as sites for dumping and filling; contaminated by surface sources of toxic chemicals from spills, pesticides, and waste disposal which enter caves via streams and/or ground-water seepage; and mining and quarrying. In addition, Polynesians utilized caves as burial sites and many of the caves in the Koloa District show signs of this use (Hammatt and Tomonari Tuggle 1978; Hammatt et al. 1988; as cited in USFWS 2006), which often attract curiosity seekers (Howarth 1982, 1983; Culver 1986; as cited in USFWS 2006).

EB/CE Source:

U.S. Fish and Wildlife Service (USFWS). 2006. Recovery Plan for the Kauai Cave Arthropods: the Kauai Cave Wolf Spider (*Adelocosa anops*) and the Kauai Cave Amphipod (*Spelaeorchestia koloana*). Portland, Oregon. 64 pp; 71 FR 41041.

U.S Fish and Wildlife Service (USFWS). 2017. 5-Year Review. Short Form Summary. Kauai cave amphipod (*Spelaeorchestia koloana*). Honolulu, Hawaiʻi. 6 pp.

Overall Vulnerability Kauai cave amphipod: ☒ **High** ☐ **Medium** ☐ **Low**

RISK

(Risk is based on species exposure and response from labelled uses across the range)

Risk to individuals if exposed: Kauai cave amphipods exposed to malathion are expected to die. Kauai cave wolf spiders may be killed, but there is less certainty that concentrations in its prey items would reach levels to cause mortality if consumed.

The table below summarizes the risk to the species from labeled uses across the range based on range overlaps with use sites and anticipated effects associated with the particular uses.

Risk to the species from labelled uses across the range:

DIRECT (all uses except mosquito control)	
Use areas – mortality and sublethal effects	Mortality for the species
Spray drift areas – mortality	N/A
Volatilization	Not an appreciable source of exposure
INDIRECT (all uses except mosquito control)	
Use areas - Prey item mortality, host fish, forage base for non-predators, etc.	As the Kauai cave amphipod is the main food sources of the Kauai cave wolf spider, mortality predicted for this species would affect the spider's prey base
Spray drift areas - Prey item mortality, host fish, forage base for non-predators, etc.	N/A
Plants affected (decline in growth)	No effects anticipated
MOSQUITO CONTROL	
Direct (mortality)	Mortality if exposed
Indirect	Any mortality for the Kauai cave amphipod would affect the spider's prey base

Risk modifiers:

The Kauai cave amphipod inhabits the deep zone and stagnant air zone of lava tubes and intermediate-size voids (mesocaverns) in pahoehoe lava, as well as similar habitats in a limestone cave resting on top of the lava flow. Its lowland (0 to 100 feet above sea level) habitat is warm (between 25 and 30 C) and always in damp to wet areas with calm, stagnant, water-saturated air, which sometimes contains more than three percent by volume carbon dioxide.

The Kauai cave amphipod is a detritivore and herbivore and has been observed feeding on the roots of Pithecellobium dulce (*Manila tamarind*) and *Ficus* sp. (fig), rotting roots, sticks, branches, and other plant material washed into, or otherwise carried into caves, as well as the fecal material of other arthropods.

Nutrients in most lava tubes and cave ecosystems in Hawaii are derived from the surface either directly (organic material washed in or brought in by animals) or indirectly, by feeding on the lava tube invertebrates that feed on surface-derived nutrients. In some cases, the most important source of nutrients for a target troglobite may be the fungus, microbes, and/or smaller troglophiles and troglobites that grow on the leaves or feces rather than the original material itself. Tree roots can penetrate into caves and may also provide direct nutrient input to shallow caves. In deeper cave reaches, nutrients enter through water containing dissolved organic matter percolating vertically through karst fissures and solution features. For predatory troglobites, accidental species of invertebrates (those that wander in or are trapped in a cave) may be an important nutrient source in addition to other troglobites and troglophiles found in the cave. Troglobytes typically have very slow metabolisms, an adaptation to the sparse amounts of food found in their environment.

Based on the location of caves near developed and disturbed areas in the Koloa Basin, and the identification of pesticides as a threat to these species, we anticipate malathion usage could occur in this area and enter caves.

Overall Risk Kauai cave amphipod: ☒ **High** ☐ **Medium** ☐ **Low**

USAGE

(Anticipated usage within the range based on past usage data)

Information regarding past usage of malathion in Hawaii is not available, however prior survey data has indicated that 4.8% of agricultural crops were treated with insecticides. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed could undergo some level of treatment with malathion. Due to the high degree of uncertainty associated with this data, discussed in the Approach to Usage Analysis section in the Opinion, we consider this quantitative usage data broadly. Instead, we assess exposure from malathion usage qualitatively by considering the likelihood that species will occur in the areas where insecticide usage will take place, as described individually for each species or group of species.

At present, information indicates that malathion is not used as a mosquito control agent in Hawaii; future use cannot be ruled out but is not expected to increase significantly.

Overall Usage Kauai amphipod: ☐ **High** ☒ **Medium** ☐ **Low**

CONSERVATION MEASURES

General Conservation Measures

Rain restriction: Label language has been added restricting malathion application to periods where rain is not forecasted for at least 48 hours for agriculture and 24 hours for residential use or when the soil is not saturated. Given the relatively short half-life of malathion and rapid degradation via hydrolysis and other processes, persistence of malathion in storm run-off into most aquatic habitats is not anticipated to last longer than 48 hours under typical pH values, (i.e., 6.5-8.5) and water temperatures corresponding to growing season. Restricting malathion application to periods where rain is not forecasted or when the soil is not saturated will provide time for the pesticide to degrade before runoff into aquatic habitats can occur, decreasing exposure and reducing the amount of malathion that would reach the subsurface habitats in which these species reside.

Aquatic habitat buffers: Application buffers are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to aquatic species. While the exact amount of spray drift reduction depends on the physical traits of the aquatic ecosystem (e.g., flow rate, volume, etc.) as well as the application method, we can expect (based on AgDRIFT modeling) spray drift reductions ranging from 40 to 91%, with low flow and low volume aquatic habitats receiving the most reduction in spray drift deposition. We anticipate that in many cases, these buffers substantially reduce exposure to aquatic organisms and subsequent risk of direct and indirect effects.

Species-specific Measures
The following species-specific measures are now part of the Action and will be included in *BulletinsLive Two*

In addition to the general label changes that would apply to all uses specified on the label, which would be protective of a wide range of species, the registrants have also agreed to additional conservation measures, such as use limitation areas, additional application buffers, and irrigation timing restrictions.
For the Kauai Cave Amphipod: Within the pesticide use limitation area (Koloa Basin area as shown in the map from the FWS 2006 Recovery Plan): Applicator must not apply malathion by ground within 50 feet or aerially within 200 feet of cave openings and sinkholes.

Avoidance and use limitation areas such as the Koloa Basin area as shown in the map from the USFWS 2006 Recovery Plan, the species' range, critical habitat, or key habitat types and areas, are effective ways to reduce exposure to malathion by preventing use directly in these important areas, thus reducing the likelihood the species will come into contact with malathion.

Application buffers are designed to reduce spray drift from entering sensitive non-target areas, thereby providing protection to species. While the exact amount of spray drift reduction will vary depending on traits of the ecosystem (e.g., flow rate, volume, etc.) as well as the application method, based on AgDRIFT modeling we can expect spray drift reductions ranging from 82 to 90%.

Restricting irrigation of fields to a minimum of 24 hours after malathion application ensures that there is some time for the pesticide to degrade before potential runoff events can transport malathion to adjacent water bodies or groundwater aquifers.

CONCLUSION

After reviewing the current status of the species, the environmental baseline for the Action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the Kauai cave amphipod. As discussed below, even though the vulnerability and risk are high for this species, we anticipate the likelihood of exposure to malathion is medium. We expect that the implementation of the general and species-specific conservation measures will further reduce exposure. While we anticipate that very small numbers of individuals of this species will be affected over the duration of the proposed Action, we do not expect species-level effects to occur.

The Kauai cave amphipod has a high vulnerability based on its status, distribution, and trends. The risk to the species posed by labeled uses across the range is also high, but the estimated usage within the range is medium. Past malathion usage data in Hawai'i is unavailable, however, prior survey data has indicated that 4.8% of agricultural crops in Hawai'i were treated with insecticides, assuming malathion is only a subset of this use. Based on information collected for CONUS species, we estimate that 5% of developed and open space developed areas could undergo some level of treatment with malathion.

The Kauai cave amphipod would be directly exposed to the pesticide where usage occurs in the area around caves near developed and disturbed areas in the Koloa Basin and enters the caves. However, we anticipate a reduction in the level of exposure from these use types since this species is an obligate cave-dwelling arthropod and is found where lava tubes and cave bearing rocks are present, that will likely serve as a buffer to spray drift or runoff from these activities. Although malathion volatilizes readily and is transported downwind and deposited as dry deposition, in precipitation and, at higher elevations, in fog deposition, we do not expect volatilization to be an appreciable source of exposure. In addition, we anticipate the general conservation measures above, including rain restrictions and aquatic buffers, and species-specific measures including ground and aerial buffers, and irrigation restrictions would further reduce the risk of exposure from these use types to the species and its habitat.

We anticipate that the rain restrictions and aquatic habitat buffers, ground and aerial buffers, and irrigation restrictions are expected to reduce the amount of malathion used and limit the likelihood of spray drift and runoff exposure to this species and its lava tube and cave habitat. As with most invertebrates, we anticipate that the rain restriction reduces the likelihood of exposure to the species (directly or in runoff) following a precipitation event. Also, we expect the pesticide will most likely have sufficient time to degrade before runoff into aquatic habitats can occur, which will further decrease the likelihood of exposure by reducing the amount of malathion to wetland habitats in which this species resides. Similarly, we anticipate the aquatic habitat buffers will reduce spray drift and decrease the likelihood of exposure to aquatic organisms by also limiting the pesticide from reaching coastal and wetland ecosystems. In addition, not allowing applications of malathion by ground within 50 feet or aerially within 200 feet of cave openings and sinkholes are effective ways to reduce exposure to malathion by preventing use directly in these important areas, thus reducing the likelihood the species will come into contact with malathion. Furthermore, restricting irrigation of fields to a minimum of 24 hours after malathion application ensures that there is some time for the pesticide to degrade before potential runoff events can transport malathion to adjacent water bodies or groundwater aquifers.

Together, these measures are anticipated to substantially reduce mortality of individuals of this species from application of malathion within and immediately surrounding the range of this species. Thus, we anticipate only small numbers of individuals of this species will experience mortality and small reductions in the forage base for this species over the duration of the Action. However, we do not anticipate species-level effects.

Therefore, we do not anticipate the proposed Action would appreciably reduce survival and recovery of the Kauai cave amphipod in the wild.

Conclusion Kauai cave amphipod: **Not likely to jeopardize**

ADDITIONAL REFERENCES

U.S. Fish and Wildlife Service (USFWS). 2019. Draft Kauai Islandwide Recovery Plan. U.S. Fish and Wildlife Service, Portland, Oregon. 43 pp.

U.S. Fish and Wildlife Service (USFWS). 2006b. Kauai Cave Wolf Spider (*Adelocosa anops*) 5-Year Review Summary and Evaluation. U.S. Fish and Wildlife Service, Honolulu, Hawaii. 12 pp.