Interim Core Map Documentation for the Delta Smelt

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Draft interim core map developed by the Center for Biological Diversity (CBD)[1]
Documentation/analysis supplemented by the U.S. Environmental Protection Agency's (EPA) Office of Pesticide Programs

Species Summary

The delta smelt (Hypomesus transpacificus; Entity ID 305) is an endangered estuarine fish. There is designated critical habitat for this species, which is similar to the species range but includes land areas where the species does not live. This species is endemic to the upper San Francisco Bay-Delta estuary and distribution is restricted broadly to this area. Additional information is provided in **Appendix 1**. This species is currently included in the Herbicide Strategy.

Description of Core Map

The core map for the delta smelt is based on the range. The available range layer is refined and represents areas important for this species' conservation. Based on information from the 2023 species assessment and listing priority assignment form, the species number of populations are not fully discussed in the U.S. Fish and Wildlife Service (FWS) documentation. Critical habitat has been designated for this species, which is similar to the species range but is broader and contains land areas where the species does not live. **Figure 1** depicts the interim core map for the delta smelt. The core map represents approximately **89,811** acres.

Landcover categories within the core map area are included in **Table 1.** Landcover is predominantly open water, which is consistent with the habitat of this species.

The core map developed for the delta smelt is considered interim. This core map will be used to develop pesticide use limitation areas (PULAs) that include the delta smelt. This core map incorporates information developed by FWS and made available to the public; however, the core map has not been formally reviewed by FWS. This interim core map may be revised in the future to incorporate expert feedback from FWS. This interim core map has a "none" best professional classification because it consists of the species' range without additions or subtractions. There is confidence in the core map because the species' range is highly refined, represents areas important for this species' conservation, and contains all four known populations of this species. This core map does not replace or revise any range or designated critical habitat developed by FWS for this species.

[1] CBD sent EPA a draft core map for this species before EPA released its mapping process document and example documentation. EPA supplemented the documentation and supporting analysis for consistency with EPA's most recent documentation examples made available after CBD developed this core map.

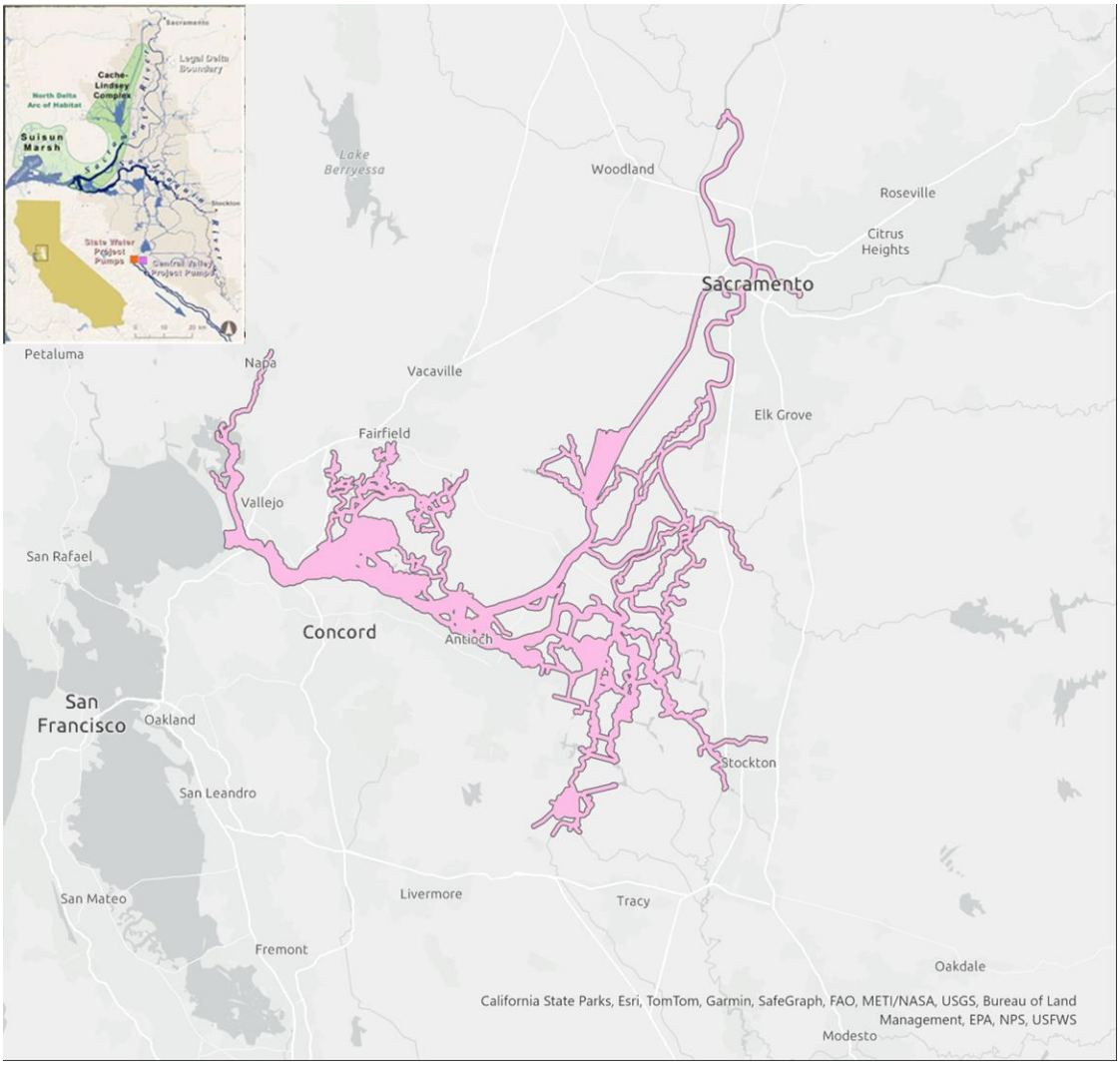

Figure 1. Interim core map for the delta smelt. Total acreage of the interim core map is approximately 89,811 acres.

Table 1. Percentage of Interim Core Map Represented by NLCD[2] Land Covers and Associated Example Pesticide Use Sites/Types.

Example pesticide use sites/types	NLCD Landcover (Value)	% of core map represented by landcover	% of core map represented by example pesticide use
Forestry	Deciduous Forest (41)	0	0
Forestry	Evergreen Forest (42)	0	0
Forestry	Mixed Forest (43)	0	0
Agriculture	Pasture/Hay (81)	1	1
Agriculture	Cultivated Crops (82)	<1	1
Mosquito adulticide, residential	Open space, developed (21)	<1	1
Mosquito adulticide, residential	Developed, Low intensity (22)	1	1
Mosquito adulticide, residential	Developed, Medium intensity (23)	<1	1
Mosquito adulticide, residential	Developed, High intensity (24)	<1	1
Invasive species control	Woody Wetlands (90)	1	98
Invasive species control	Emergent Herbaceous Wetlands (95)	5	98
Invasive species control	Open water (11)	92	98
Invasive species control	Grassland/herbaceous (71)	0	98
Invasive species control	Scrub/shrub (52)	0	98
Invasive species control	Barren land (rock/sand/clay; 31)	0	98
Total Acres	**Interim Core Map Acres**	**~89,811**	

Evaluation of Known Location Information

There are four datasets with known location information for this species:

- Descriptions of locations provided by FWS;
- Occurrence locations included in iNaturalist;
- Occurrence locations included in the Global Biodiversity Information Facility (GBIF); and
- Occurrence locations included in NatureServe.

EPA evaluated these four sets of data to inform or support the core map. FWS provided the most refined descriptions of the occurrence information and confirmed that all known locations of extant populations are located within the range. iNaturalist had three research grade observations, which are consistent with the species range. GBIF's occurrence data also are consisted with the species' range. NatureServe included 15 documented areas, all of which were consistent with the location of the species range. **Appendix 1** includes more information on the available known location information.

Approach Used to Create Core Map

The developers compiled available information for the delta smelt from FWS, as well as observation information available from various publicly available sources (including iNaturalist, GBIF and NatureServe). The information compiled for the delta smelt is included in **Appendix 1**. Influential information that impacted the development of the core map included:

- The species range is refined and does not appear to be overly broad;
- Critical habitat aligns with species' range but contains land areas where the species does not reside;
- Occurrence data from other sources are consistent with the species range locations.

The developers used the compiled information to identify the core map type. The developers compared known location data to the range and found that these known locations are consistent with the species range. Based on the narrow range that includes all occurrence data identified by FWS, the developers selected the range to use as the species core map.

Discussion of Approaches and Data that were Considered but not Included in Core Map

Alternative approaches and data not discussed in this documentation were not explored in the development of this interim core map.

Appendix 1. Information Compiled for Species

1. **Recent FWS Documents**

- DELTA SMELT U.S. FISH AND WILDLIFE SERVICE SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM 2023
- 2016 Uplisting Assessment Delta smelt
- 2015 Uplisting assessment for Delta Smelt
- Recovery Plan for the Sacramento-San Joaquin Delta Native Fishes 1996
- ETWP; Critical Habitat Determination for the Delta Smelt 1994

2. **Background information on Species**

- **Status:** Federally listed as endangered in 1993
- **Taxonomy**: FWS Estuarine Fish.
- **Resiliency**: Low
- **Redundancy**: Low
- **Representation**: Low

Species document does not discuss resiliency, redundancy, and representation; however, all inferred low. Species only occurs in a restricted geographic region. "For example, the 2020 population estimate is 5,213 individuals with 95% confidence intervals ranging between 1,241 and 14,710 individuals."

- **Habitat Description**

"Delta smelt are a euryhaline (tolerate a wide range of salinities) species (Moyle 2002, pp. 228–229). In captivity, some Delta smelt can survive in seawater for extended periods (Komoroske et al. 2014, p. 6), however, in the wild they rarely occur in water with more than 10–14 salinity (about one-third seawater) (Bennett 2005, p. 11; Moyle 1992, p. 73). In the Practical Salinity Scale, salinity is defined as a pure ratio, and has no dimensions or units. Feyrer et al. (2007, p. 728) found that relative abundance of delta smelt was related to fall specific conductance (a surrogate for salinity) and water transparency. Delta smelt probably evolved within the naturally turbid (silt and particulate-laden) environment of the estuary's "low salinity zone" (LSZ) where the salinity ranges from approximately 0.5 to 6 (Kimmerer 1998, p.1; Moyle 2002, p. 228) and likely rely on certain levels of background turbidity at different life stages and for certain behaviors. Juvenile and sub adult delta smelt are most common within the LSZ at salinity of less than 1 to about 5 (Bennett 2005, p. 10, Sommer et al. 2011a, p. 8)."

- **Relevant Life History Information:**

"Between December and March (Grimaldo et al. 2009, p.1263; Sommer et al. 2011, p. 12), delta smelt begin to disperse back into freshwater areas where most spawning occurs (Hobbs et al. 2019, p. 5; Murphy and Hamilton 2013, p. 7-13). This movement is thought to be triggered by the first seasonal high outflow event in the Delta (Grimaldo 2009, p. 1259) although the specific cues for this movement are still unresolved. Bennett and Burau (2015, p. 9) found that delta smelt change their movements in response to tides, but could not distinguish the relative importance of turbidity versus changing tidal direction as cues for moving laterally or longitudinally (up- or downstream). In captivity, some delta smelt can survive to age two (Bennett 2005, p. 16, Figure 9). In the wild, most delta smelt die after spawning at age one, but a small contingent of adults may survive to spawn in their second year (Bennett 2005, p. 22). Fecundity is correlated with size. In captivity, age one females spawn between 1,000 to 4,000 eggs while age two females can spawn up to 12,000 eggs (Bennett 2005, p. 15). Adult females can produce multiple egg batches per spawning period if water temperatures stay cool long

enough and the fish get enough food to support the development of multiple clutches of eggs (Damon et al. 2017, p. 198). Spawning can begin in late January and may continue until water temperatures reach about 20 °C (68 °F), which usually occurs in May or June (Bennett 2005, p. 13). Spawning likely occurs mainly at night with several males attending females that broadcast eggs onto bottom substrate (Bennett 2005, p. 13). Although the full range of usable spawning substrate is unknown, spawning habits of its closest relative, the surf smelt, suggest that sandy substrate may be best (Bennett 2005, p. 17; Sommer et al. 2013, p. 13). In laboratory conditions, eggs typically hatch after 9 to 14 days and larvae begin feeding 5 to 6 days later (Mager et al. 2004, p. 172, Table 1). Larvae are generally most abundant in the Delta from mid-April through May (Bennett 2005, p. 13). Some delta smelt, have been observed spending their entire life cycle in freshwater within the Cache Slough region, including Liberty Island (Sommer et al. 2011, p. 9; Hobbs et al. 2019, p. 5) showing that an alternative life history strategy is possible if habitat parameters are favorable for delta smelt. After several weeks of development, larval surveys indicate that many larvae move downstream until they reach nursery habitat in the LSZ, in part to reach cooler waters (Kimmerer 1998, p. 1; Moyle 2002, p. 228; Dege and Brown 2004, pp. 57–58). Juvenile smelt rear and grow in the LSZ and adjacent fresher water habitats for several months, where they are found in open waters (free of vegetation) (Dege and Brown 2004, pp. 56–58). By the summer, delta smelt exert greater control over their distribution to maintain an association with suitable habitat conditions (Kimmerer 2008, p. 18). Juvenile fish reach 40–50 mm (1.6–2 in) by early August (Erkkila et al. 1950; Ganssle 1966, p.78; Radtke 1966, p.118). Delta smelt reach adult size, 55–70 mm (2.2 – 2.8 in) standard length in 7–9 months (Moyle 2002, p. 228). The abrupt change from a singleage, adult cohort during spawning in spring to a population dominated by juveniles in summer strongly suggests that most adults die shortly after they spawn. Juvenile growth during September to November slows down considerably with a total length increase of only 3–9 mm (0.1 – 0.4 in) over these three months (Moyle 2002, p. 228). During this time period, less food is being produced in the estuary today than was produced historically at the same temperatures. Delta smelt are now 5-10 mm smaller at a given age than they were historically (Sweetnam 1999, p. 25). FWS 2023 p. 4-5

"Delta smelt feed primarily on small planktonic (free-floating) crustaceans, and occasionally on insect larvae (Moyle 2002, p. 228). Historically, the main prey of delta smelt was the copepod Eurytemora affinis and the mysid shrimp Neomysis mercedis (Moyle et al. 1992, p. 70, Table 1). The copepod Pseudodiaptomus forbesi has replaced E. affinis as a major prey source of delta smelt since its introduction into the San Francisco Bay-Delta (Baxter et al. 2008, p. 22). Larval smelt primarily consume the two copepods, Eurytemora affinis and Pseudodiaptomus forbesi, but freshwater copepods of the family Cyclopidae, can also be common prey (Nobriga 2002, p. 156; Slater and Baxter 2014, p. 8). The diversity of prey eaten by delta smelt increases as they grow, adult diets are dominated by adult copepods and somewhat larger crustaceans like amphipods, though many other invertebrates and larval fishes have been observed occasionally in stomach contents (Lott 1998, p. 19)" FWS 2023 p. 4-5

- **Ecology**

"Delta smelt are a euryhaline (tolerate a wide range of salinities) species (Moyle 2002, pp. 228– 229). In captivity, some delta smelt can survive in seawater for extended periods (Komoroske et al. 2014, p. 6), however, in the wild they rarely occur in water with more than 10–14 salinity (about one-third seawater) (Bennett 2005, p. 11; Moyle 1992, p. 73). In the Practical Salinity Scale, salinity is defined as a pure ratio, and has no dimensions or units. Feyrer et al. (2007, p. 728) found that relative abundance of delta smelt was related to fall specific conductance (a surrogate for salinity) and water transparency. Delta smelt probably evolved within the naturally turbid (silt and particulate-laden) environment of the estuary's "low salinity zone" (LSZ) where the salinity ranges from approximately 0.5 to 6 (Kimmerer 1998, p.1;

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"Water temperature also affects delta smelt distribution. Swanson et al. (2000, p. 386) reported a minimum temperature tolerance for juvenile delta smelt of 7.5 °C (45.5 °F) (p. 386). The approximate maximum temperature tolerances in captivity by life stage are as follows: larvae: 30 °C (86 °F), late larvae: 29 °C (84.2 °F), juvenile: 29 °C (84.2 °F), adult: 28.2 °C (82.8 °F), post spawned adult: 27.1 °C (Komoroske et al. 2014, p. 7). Tolerance limits are typically measured at the point that delta smelt lose their equilibrium or balance. In the wild, delta smelt are seldom collected from water that approach their physiological tolerance limits (Nobriga et al. 2008, p. 7, Fig 4; Komoroske et al. 2014, p. 9), probably because warm water increases energetic demands (Rose et al. 2013a, p. 1245), which has been shown to cause behavioral impairment and lowered competitive ability in other fishes. 6 Currently available information indicates that delta smelt habitat is most suitable for the fish when low-salinity water is near 20 °C (68 °F), highly turbid, oxygen saturated, low in contaminants, and containing high densities of calanoid copepods (e.g., Moyle 2002, p. 228; Nobriga 2002, pp. 160–163, Feyrer et al. 2007 pp. 728–732). Almost every component listed above has been degraded over time (see five factor analysis)." FWS 2023 p. 5-6

- **Relevant Pesticide Use Sites**

FWS documents note that Bay-Delta waters are listed under the Clean Water Act section 303(d) as impaired for several legacy and currently used pesticides (California Department of Pesticide Regulation 2016, p. 1)." Several areas of the Delta, particularly the San Joaquin River and its tributaries, are impaired due to elevated levels of diazinon and chlorpyrifos (MacCoy et al. 1995, pp. 21–30)." Urban runoff has been reported to be a source of pyrethroid exposure, particularly where treatment facilities do not use tertiary treatment methods (Baxter et.al. 2010, p. 33) FWS 2023 p. 29-30.

- **Threats**

"The primary known threats cited in the 2010 delta smelt uplisting document are: entrainment by State and Federal water export facilities (Factor E), summer and fall increases in salinity due to reductions in freshwater flow and summer and fall increases in water clarity (Factor A), and effects from introduced species, primarily the overbite clam and invasive aquatic weeds particularly, Egeria densa (Factor E). Additional threats included predation (Factor C), entrainment into power plants (Factor E), contaminants (Factor E), and small population size (Factor E). Since the 2010 warranted 12-month finding, we have identified climate change as a threat in the 2012 Candidate Notice of Review. Climate change was not analyzed in the 2010 12- month finding document. Since the 2010 uplisting document, one of the two

power plants within the range of the delta smelt using water for cooling has shut down and power plants are no longer thought to be a threat to the population as a whole. We have identified a number of existing regulatory mechanisms that provide protective measures that affect the stressors acting on the delta smelt. Despite these existing regulatory mechanisms and other conservations efforts, some stressors continue to act on the species such that it is warranted for uplisting under the Act." FWS 2023 p. 12

- **Reclassification Criteria**

No reclassification criteria list available in latest document.

"In 2010, we completed a 12-month finding for delta smelt in which we determined a change in status from threatened to endangered was warranted. The continuing and unabated downward trend in all delta smelt cohorts after 2011 supports that finding. The 2021 CDFW and Service adult abundance estimates are the lowest ever recorded. Although conservation measures are in place to protect the species including the 2019 Biological Opinion, these measures have not been sufficient to halt the decline of the species. Therefore, based on a review of the best scientific and commercial information available, we find that the delta smelt still meets the definition of an endangered species under the Act, and that it warrants reclassification from threatened to endangered. However, at this time, the promulgation of a formal rulemaking to reclassify delta smelt is precluded by higher priority actions." FWS 2023 35
"As a result of our analysis of the best available scientific and commercial information, we have assigned the delta smelt a Listing Priority Number of 2, based on high magnitude and immediacy of threats. While we conclude that reclassifying the species as endangered is still warranted, an immediate proposal to reclassify this species is precluded by other higher priority actions." FWS 2023 35

- **Delisting Criteria**

No delisting criteria list available in latest document.

- **Recovery Actions**

"Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California: This multispecies recovery plan, published in 2014, addresses conservation needs for the San Francisco Estuary, with a focus on the following listed plant and terrestrial species: Cirsium hydrophilum var. hydrophilum (Suisun thistle), Cordylanthus mollis ssp. Mollis (soft bird's beak), Suaeda californica (California sea-blite), California clapper rail (Rallus longirostris obsoletus), and salt marsh harvest mouse (Reithrodontomys raviventris). Restoration efforts from this plan are identified in the implementation table of this recovery plan. One of the actions in the plan is to restore 5,000 acres of high quality marsh habitat within the Suisun Bay Recovery Unit. Restoration of this area is expected to help the delta smelt by increasing food web productivity and generally improving the habitat of the delta smelt." FWS 2023 p. 33-34

3. **Description of Species Range**

"Delta smelt are endemic to the upper San Francisco Bay-Delta estuary (Figure 2). The reported range of the Delta smelt has at times extended from Berkeley in the San Francisco Bay to the City of Napa on the

Napa River, throughout Suisun Bay and the Delta, along the axis of the Sacramento River to Knight's Landing and along the axis of the San Joaquin River to the City of Lathrop (Merz et al. 2011, p. 181-182; Vincik and Julienne 2012, p. 173). At all life stages, the western limit of Delta smelt distribution is strongly influenced by the position of the LSZ (Moyle et al. 1992, p. 72; Dege and Brown 2004, p. 56; Sommer et al. 2011, p. 7; Sommer and Mejia 2013, p. 8), although delta smelt commonly use tidal habitats where salinity is lower than 0.5 so their eastern distribution limit is less affected by salinity. Delta smelt of all life stages have been most frequently encountered in an area called the 'North Delta Arc' (see Figure 2 inset). Given the current very low abundance of delta smelt (see Population Indices below), recent information indicates its distribution may be more restricted than what was historically observed. The exceptionally low spring outflow due to the current drought is interacting with low abundance to limit the species' distribution." FWS 2023 p. 6

Figure A1-2. Waterways colored in purple depict the delta smelt distribution described by Merz et al. (2011). FWS has used newer information to expand the transient range of the delta smelt further up the Napa and Sacramento rivers than indicated by Merz et al. (2011). The red polygon depicts the boundary of delta smelt's designated critical habitat. The inset map shows the region known as the North Delta Arc shaded light green.

4. **Critical Habitat**

Designated critical habitat for this species reflects the species' range but contains land areas where the species does not live.

Figure A1-3. Critical Habitat for the delta smelt.

5. **Known Locations**

- Occurrences Described in FWS Documents

"This species occurs in open waters. There are no known land locked populations. The statutory Delta totals 738,000 acres including approximately 538,000 acres of agricultural land uses, 60,000 acres of open water, and 64,000 acres of urban land uses. The remainder of the region presently consists of open space and wildlife habitat." FWS 2023 p. 2

Extant populations:

"Delta smelt are endemic to the upper San Francisco Bay-Delta estuary. The reported range of the Delta smelt has at times extended from Berkeley in the San Francisco Bay to the City of Napa on the Napa River, throughout Suisun Bay and the Delta, along the axis of the Sacramento River to Knight's Landing and along the axis of the San Joaquin River to the City of Lathrop" FWS 2023 p. 6

- Occurrences Described in iNaturalist https://www.inaturalist.org/observations?subview=map&taxon_id=103144, NatureServe (https://explorer.natureserve.org/pro/Welcome) and GBIF (https://www.gbif.org/) were also consistent with the indigenous range (upper San Francisco Bay-Delta estuary) given the data resolution.