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STATUS OF DELTA SMELT IN THE SACRAMENTO-SAN JOAQUIN ESTUARY

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The **delta smelt**, *Hypomesus transpacificus,* is a small euryhaline fish that reaches adult sizes of 60-80 mm fork length (Stevens et al.1 1990) and historically was one of the most common fishes in the **Sacramento**-San Joaquin Estuary (Erkkila et al. 1950, Radtke 1966). It is translucent with a silvery, steel-blue streak along its sides. The **delta smelt** resides primarily in and near the low salinity zone (Ganssle 1966, Stevens et al.1 1990, Moyle et al. 1992). It is considered environmentally sensitive because it is endemic to the estuary (Moyle 1976, Stevens et al.1 1990, Moyle et al. 1992), is primarily an annual fish (Moyle 1976, **Sweetnam** and Stevens2 1993), is exclusively planktivorous and dependent on a zooplankton community which has been greatly altered by exotic species (Moyle 1976; Nobriga and Lott3, in preparation; Lott and Nobriga4, in preparation), has low fecundity for a fish with planktonic larvae (Moyle et al. 1992, USFWS5 1995a, Mager6 1996), is easily stressed (Swanson and Cech7 1995, Swanson et al. 1996), and is a poor swimmer (Swanson et al. 1998). Unlike many fishes with similar life histories in the estuary, **delta smelt** abundance is not strongly affected by freshwater outflow (Stevens and Miller 1983) or by the position of the 2‰ isohaline (Jassby et al. 1995); however, population levels are high only in years with moderate to high outflow (USFWS 1995a). **Delta smelt** do not exhibit

1 Stevens, D.E., L.W. Miller, and B.C. Bolster. 1990. A **status** review of the **delta smelt** *(Hypomesus transpacificus)* in California. Candidate **Status** Report 90-2, California Department of Fish and Game, **Sacramento**, California, USA.

2 **Sweetnam** D.A. and D.E. Stevens. 1993. A **status** review of the **delta** smell, *Hypomesus transpacificus,* in California. Candidate Species **Status** Report 93-DS, California Department of Fish and Game, **Sacramento**, California, USA.

3 Nobriga, M.L. and J.L. Lott. In preparation. Feeding ecology and evidence of food limitation in **delta smelt**.

4 Lott J.L. and M.L. Nobriga. In preparation. Feeding ecology of juvenile and adult **delta smelt** in the **Sacramento**-San Joaquin Estuary.

5 USFWS (U.S. Fish and Wildlife Service). 1995a. **Sacramento**-San Joaquin **Delta** Native Fishes Recovery Plan. U.S. Fish and Wildlife Service, Portland, Oregon, USA.

6 Mager, R.C. 1996. Gametogenesis, reproduction, and artificial propogation of **delta smelt**, *Hypomesus transpacificus.* Ph.D. Dissertation, University of California, Davis, California, USA.

'Swanson C. and J.J. Cech. 1995. Environmental tolerances and requirements of the **delta**

smelt, *Hypomesus transpacificus.* Final report to the California Department of Water Resources, Contracts B-59449 and B-58959, **Sacramento**, California, USA.

a strong stock-recruitment relationship as would be expected for a near-annual fish (Stevens et al.1 1990, **Sweetnam** and Stevens21993). Thus, environmental conditions may strongly contribute to population success (Moyle et al. 1992, **Sweetnam** and Stevens2 1993).

A non-native congener from Japan, the wakasagi, *Hypomesus nipponensis,* recently became a permanent resident of the estuary (Aasen et al. 1998) and now competes and hybridizes with **delta smelt** (Stanely et al. 1995, Trenham et al. 1998). The wakasagi entered the estuary after being introduced as a forage fish for salmonids in upstream reservoirs in 1959, when both the **delta smelt** and wakasagi were considered to be *H. olidus* (Wales 1962).

The **delta smelt** was listed as "threatened" under the Federal Endangered Species Act on 5 March 1993 (USFWS8 1993) and was also listed as "threatened" pursuant to the California Endangered Species Act on 9 December 1993. Diversion of freshwater outflow by the State and Federal Water Projects has been changed to protect **delta smelt** (USFWS9 1995b) and new water quality standards were enacted by the State in 1995 to provide better habitat conditions in the spring, in part for **delta smelt** (SWRCB101995; for a history of water development impacts, see Arthur et al. 1996).

Information from 5 trawl surveys, a beach seine survey, and fish salvage at State Water Project and Federal Central Valley Project fish screens documented temporal trends that resulted in the listing of the species (USFWS8 1993). Four of these data sets are presented here (Fig. 1). Historically, **delta smelt** abundance fluctuated annually, but from the late 1970s or early 1980s to 1992, abundance was consistently low (**Sweetnam** and Stevens21993). Since 1992, abundance has varied dramatically between years and surveys (Fig. 1). Most recently, the 1998 summer townet abundance index was 3.3, which is relatively low (Fig. la). The fall midwater trawl index was only moderately low, at 417.6, in 1998 (Fig. lb). Chipps Island trawl catches were low in 1998 and have been consistently low since 1984, except for 1996 (Fig. lc). Salvage at the State Water Project (Fig. Id) and Central Valley Project has remained low due to take restrictions in place since 1993 (USFWS9 1995b) and may no longer track abundance trends.

Since the early 1990s, mean fork length of adult **delta smelt** captured by the fall midwater trawl survey has declined significantly ($t = 55.9$; $df = 5,100$; $P < 0.001$), from 63.0 mm in 1975-1991 to 53.9 mm in 1992-1997 (Fig. 2). Potential causes of this apparent change in growth rate are being investigated.

8USFWS. 1993. Final rule listing the **delta smelt** as a threatened species. Federal Register, 5 March 1993 (58 FR 12854).

9 USFWS. 1995b. Formal consultation and conference on effects of long-term operation of the Central Valley Project and the State Water Project on the threatened **delta smelt**, **delta smelt** critical habitat, and proposed threatened **Sacramento** splittail. U.S. Fish and

Wildlife Service, Portland Oregon, USA.
10 SWRCB (State Water Resources Control Board). 1995. Water Quality Control Plan for the San Francisco Bay/**Sacramento**-San Joaquin Estuary, 95-1WR, May 1995. **Sacramento**, California, USA.

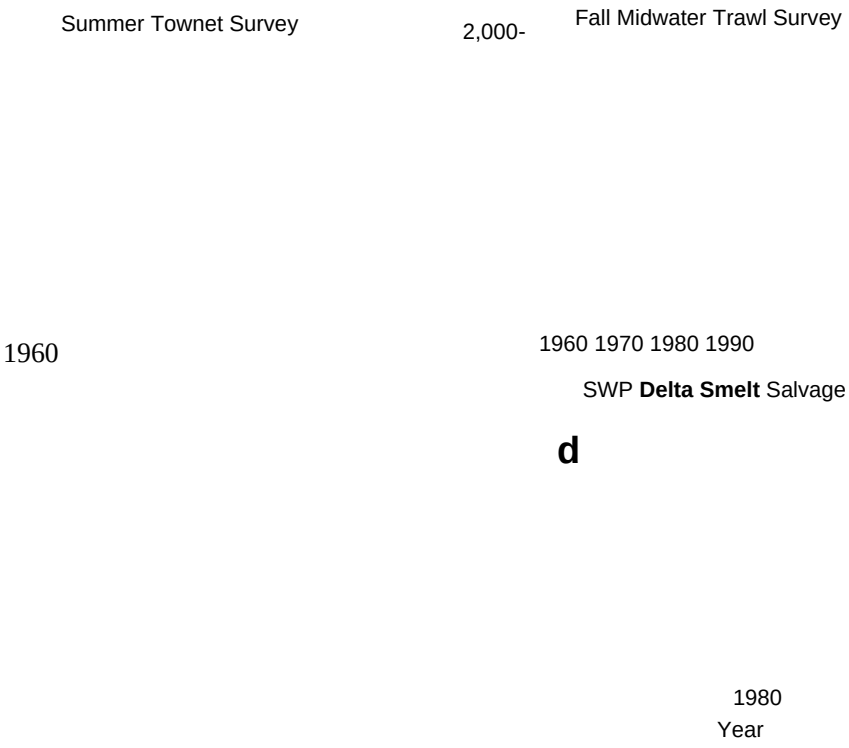

Figure 1. Trends in **delta smelt** abundance as measured by a) the summer townet survey, b) the fall midwater trawl survey, c) the Chipps Island trawl survey, and d) salvage at the State Water Project (SWP). Asterisks represent the 1st year of sampling. See **Sweetnam** and Stevens2 (1993) for a description of each survey.

Distribution of **delta smelt** in the estuary is strongly related to freshwater outflow (Stevens et al.1 1990, Moyle et al. 1992, **Sweetnam** and Stevens2 1993). In low outflow years, **delta smelt** are concentrated above the confluence of the **Sacramento** and San Joaquin rivers, whereas in higher outflow years the distribution extends through Suisun Bay (Fig. 3). Because the potential for entrainment, prédation, pollutant exposure, and competition with wakasagi is greater in low outflow years (Moyle et al. 1992, **Sweetnam** and Stevens21993, Bennett and Moyle 1996), recovery criteria for **delta smelt** include distribution requirements (USFWS5 1995a).

Current research is focused on evaluation of the relative importance of potential mechanisms affecting **delta smelt** abundance, with the understanding that many of these mechanisms may act in concert or synergistically (**Sweetnam** and Stevens21993, Bennett and Moyle 1995).

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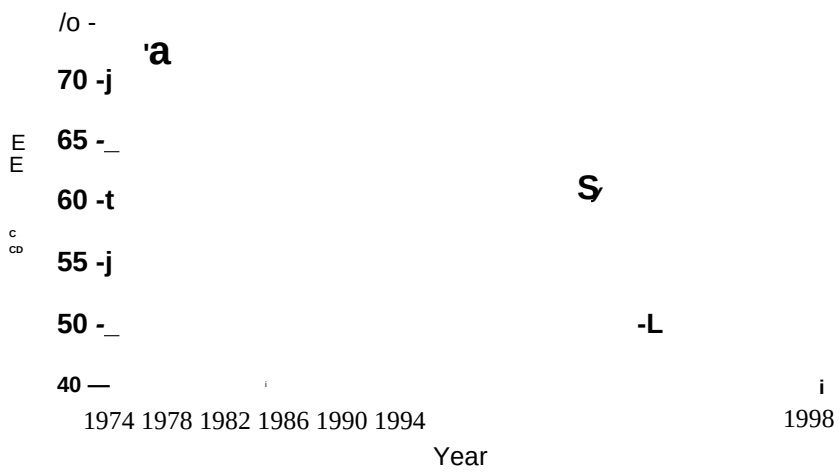

1992-1997

500

Figure 2. a) Average fork length of **delta smelt** collected in the fall midwater trawl survey from 1975 to1997. Barsequal±1 SD. b) Length-frequency histograms of **delta** smeltfor2periods:1975-1991 and 1992-1997. Bell-shaped curves represent normalized length-frequency distributions and box plots depict median values (center lines), 25th and 75lh percentiles (boxes), and 10th and 90,h percentiles (whiskers).

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Figure 3. Mean **delta smelt** catch in the summer townet survey from 1959 to 1995 by water year type: a) low freshwater outflow years, b) high outflow years. Arrows represent mean X2 isohaline (2%o bottom salinity) position in kilometers from the Golden Gate Bridge (GGB) from February to June. Low outflow years include 1959-62, 64, 66, 68, 72, 76, 77, 79, 81, 85, 87-92, and 94.

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