Status of Delta Smelt

There is generally a high level of concern for delta smelt at present because the population is near its lowest level of abundance ever recorded (Figure 1). The 2013 CDFW Fall Midwater Trawl (FMT) Survey Index was 18, which is a value considered to be indistinguishable from the lowest value of 17 recorded in 2009.

The proposed action will take place in February 2014. Given the warm weather, it is expected that some delta smelt will start spawning during February; spent female delta smelt have been observed during February Spring Kodiak Trawl Surveys (SKTS) in 2003, 2005, and 2012. Thus, adults and eggs are the two life stages expected to be exposed to the proposed action. The first SKTS of 2014 showed a fairly typical pre-spawning distribution of delta smelt, with a large aggregation in Suisun Marsh and consistent detection of fish upstream of the marsh along the Sacramento River corridor and up into Cache Slough, but none in the central or southern Delta (Figure 2). It is assumed that at some point during February, some of these fish will move upstream in preparation for spawning. This expectation is based on the assumption that emergency drought conditions will result in sustained low Delta outflow, which will in turn keep Suisun Marsh too salty for delta smelt to spawn there. Delta smelt often move during “first flush” periods when inflow and turbidity increase on the Sacramento and San Joaquin Rivers (Grimaldo et al. 2009, Sommer et al. 2011). First flush conditions are associated with entrainment at the south Delta fish facilities; however, we do not expect the proposed action to generate first flush conditions. Therefore, we expect that spawning movements will largely remain in the Montezuma Slough-Sacramento River-Cache Slough corridor unless major rain events increase river flows enough to mobilize sediment and disperse it throughout the Delta.

Analytical Framework

The foundation for assessing the effects of the proposed action on delta smelt is based on conceptual models (Baxter et al. 2010) developed by the Interagency Ecological Program (IEP). The basic IEP POD conceptual model (Figure 3) is rooted in classical food web and fisheries ecology. It contains four major components: (1) prior fish abundance, in which abundance history affects current recruitment (i.e., stock-recruitment effects); (2) habitat, in which the amount of water (volume or surface area) with suitable conditions for a species has changed because changes in estuarine water quality variables, disease, and toxic algal blooms in the estuary affect survival and reproduction; (3) top-down effects, in which predation and water project entrainment affect mortality rates; and (4) bottom-up effects, in which consumable resources and food web interactions affect growth and thereby survival and reproduction.

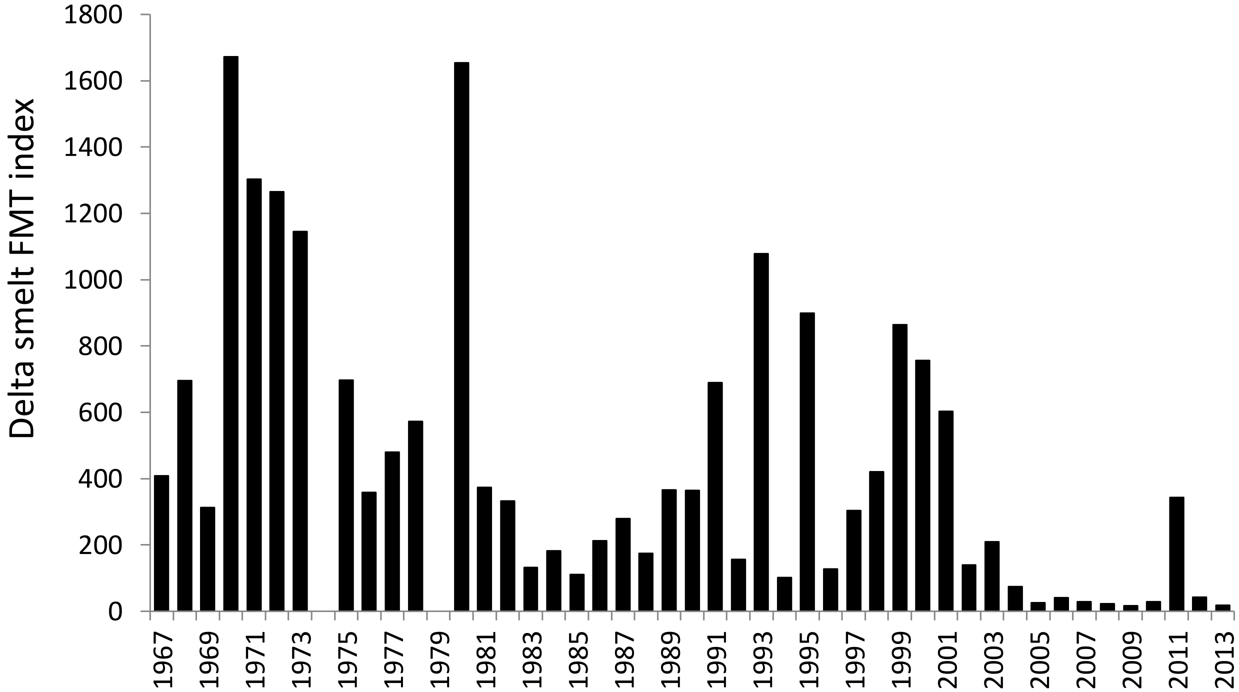

Figure 1. Delta smelt Fall Midwater Trawl abundance indices.

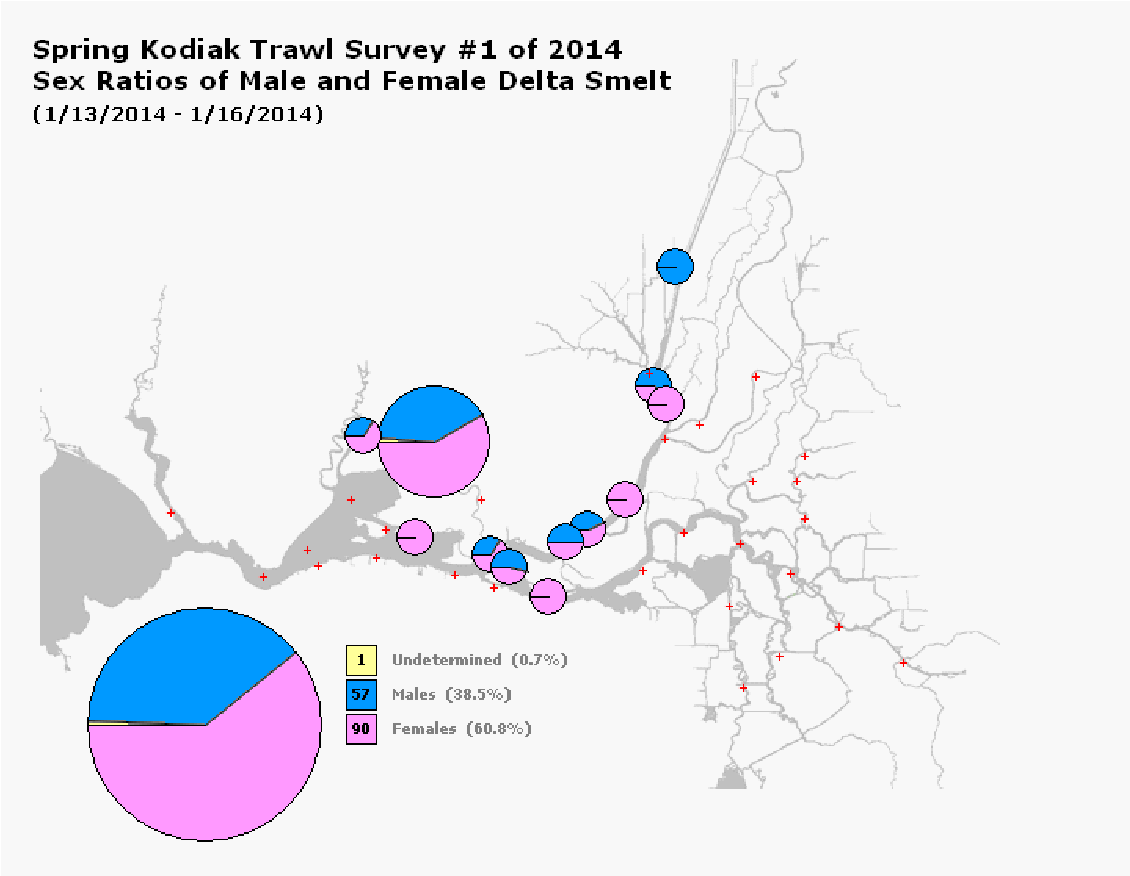

Figure 2. Present distribution of adult delta smelt.

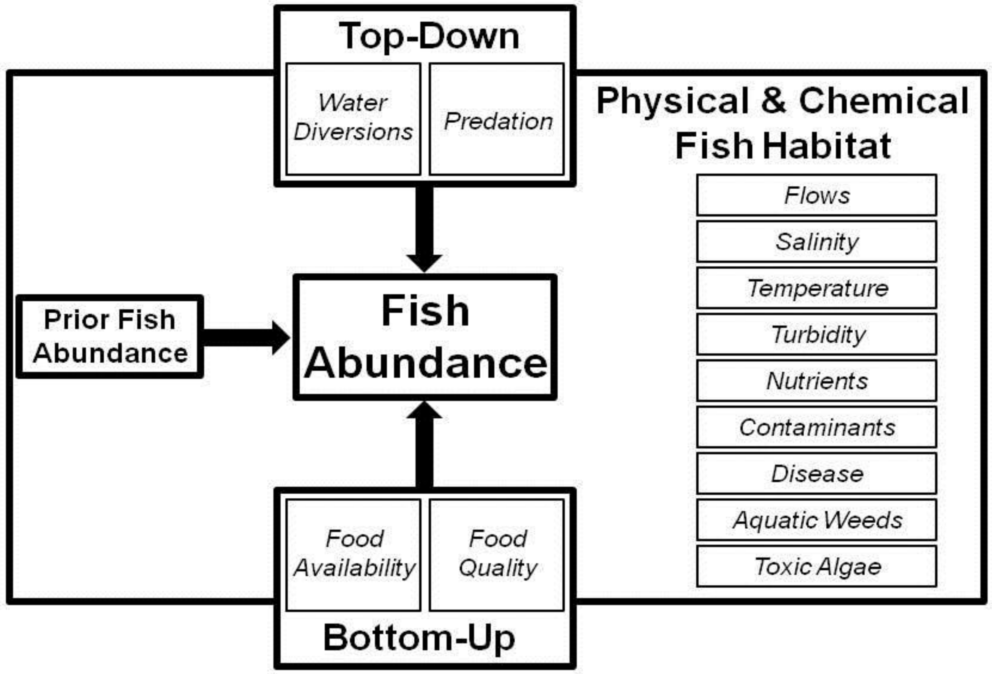

Figure 3. The basic IEP conceptual model for the pelagic organism decline.

The IEP Delta smelt species model (Figure 4) identifies key seasonal drivers in red, with proximal causes and effects in yellow. In winter, entrainment is posited to affect the population through direct mortality. The number of adult spawners affects population dynamics in two primary ways. First, potential reproductive output is proportional to the number adult female spawners. This generality would not be true if maternal investment in egg batch size varied strongly from year to year, which is presently unknown. However, based on annual fork lengths of fish collected in the SKT it does not appear that egg batch size should have varied much in the POD years. For delta smelt, which are now considered seasonal indeterminant spawners (i.e., they spawn multiple times), total reproductive output of an individual female should vary with number of eggs per batch, and the length of the spawning window (the number of days with suitable water temperatures for spawning), which will influence the number of batches produced. Obviously, reproductive output will be higher in years when adult females are larger, abundances are higher, and the spawning window is prolonged such that multiple batches are produced. Note that maximum reproductive output of the adult population at the beginning of spawning is not often realized due to mortality arising from density-dependent (e.g., food limitation or predation) or density-independent (e.g., entrainment, contaminants) mechanisms. The size of the spawning stock also directly influences total egg production. Recent investigation of the annual FMWT index values plotted versus the previous years' FMWT index shows that the population has been in downward trend. The exception was in 2011, when the FMWT index rebounded to pre-POD levels, indicating the population is still able to respond to favorable conditions.

The proposed action would modify delta outflow during February 2014 from 7,100 cfs to a level within the range of 3,000-4,500 cfs. Evaluating the effects of the proposed action is challenging because the condition is unprecedented and few data exist from which to base a quantitative effects analysis. A particular challenge is isolating the effects of outflow during a single month on delta smelt. Specifically, it would not be scientifically credible to apply assumptions about effects in a single month to historical data and previously published analyses that are based on multi-month averages (Kimmerer 2002). Therefore, the analysis of the proposed action is primarily qualitative in nature. Some limited quantitative analyses are provided primarily as background material for consideration should the low outflow conditions persist through the spring.

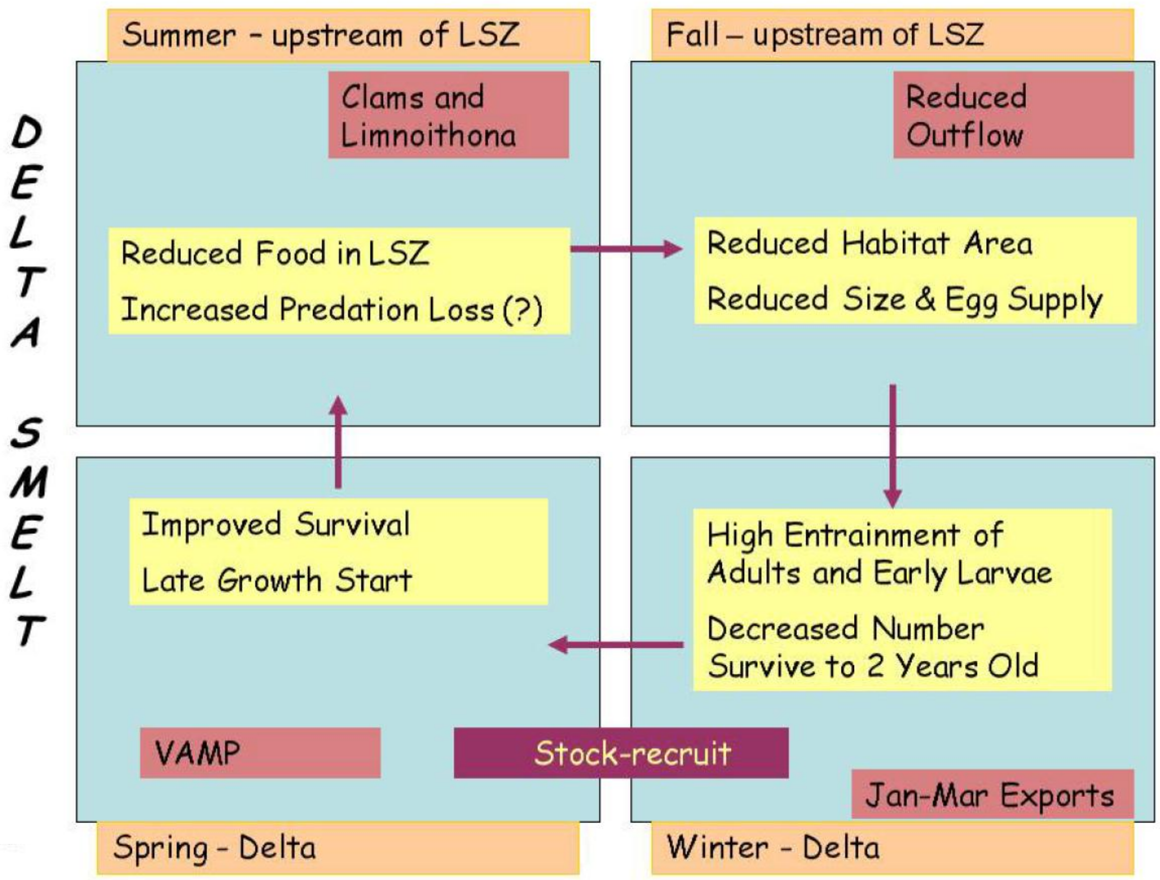

Figure 4. The basic IEP delta smelt species model for the pelagic organism decline.

Effects Analysis

Contextualizing Outflow under the Proposed Action

Including 2014, there have been a total of 12 water years with a critical designation since 1929 (Figure 5). Mean February outflow in these critical water years has ranged from a high of 30,274 cfs in 1934 to a low of 3,039 cfs in 1988 (Figure 5 and Figure 6). The range of outflow of the proposed action (3,000-4,500 cfs) and the D-1641 standard (7,100 cfs) all more closely resemble the drought years of 1976, 1977, 1988, 1990 and 1991 than the other years in the record (Figure 6).

Adult Delta Smelt Entrainment

It is expected that adult delta smelt entrainment will be very low and will stay well under the established ITL based on projected OMR flows and the expectation that adult smelt will mostly remain distributed in the north Delta arc under the expected outflow conditions.

Delta Smelt Spawning

Water temperature drives the timing of delta smelt spawning. Delta outflow in the proposed action will not modify Delta water temperatures, which are principally driven by ambient air temperature (Wagner et al. 2011). It is likely that many delta smelt that spawn in February during the proposed action could survive 1-2 additional months and spawn again should water temperatures remain suitable into April.

Delta Smelt Population Growth Rate

Delta smelt population growth rate can be characterized as the ratio $FMT/FMT_{\text{previous year}}$. Delta smelt population growth rates are typically relatively poor during droughts (Figure 7). Thus, delta smelt will likely exhibit a negative population growth rate in 2014. There is substantial variability in population growth rates in critical years, having even been positive in three of the seven critical years during which the FMT has been conducted (Figure 7). Furthermore, there is no simple discernible relationship between delta smelt population growth rate and mean February-June delta outflow (Figure 8). Thus, although odds are that the population will decline in 2014, it is uncertain whether the proposed action will exacerbate the anticipated negative population growth rate.

Delta Smelt Recruitment

Long-term trends in delta smelt recruitment can be characterized as the ratio TNS index/FMT $\text{index}_{\text{previous year}}$. As expected based on population growth rate, delta smelt recruitment has typically been relatively poor during droughts. There is no simple discernible relationship between delta smelt recruitment and mean February-June delta outflow (Figure 9; Kimmerer

2002; Bennett 2005). Thus it is uncertain if the proposed action will further exacerbate the anticipated poor recruitment for delta smelt in 2014.

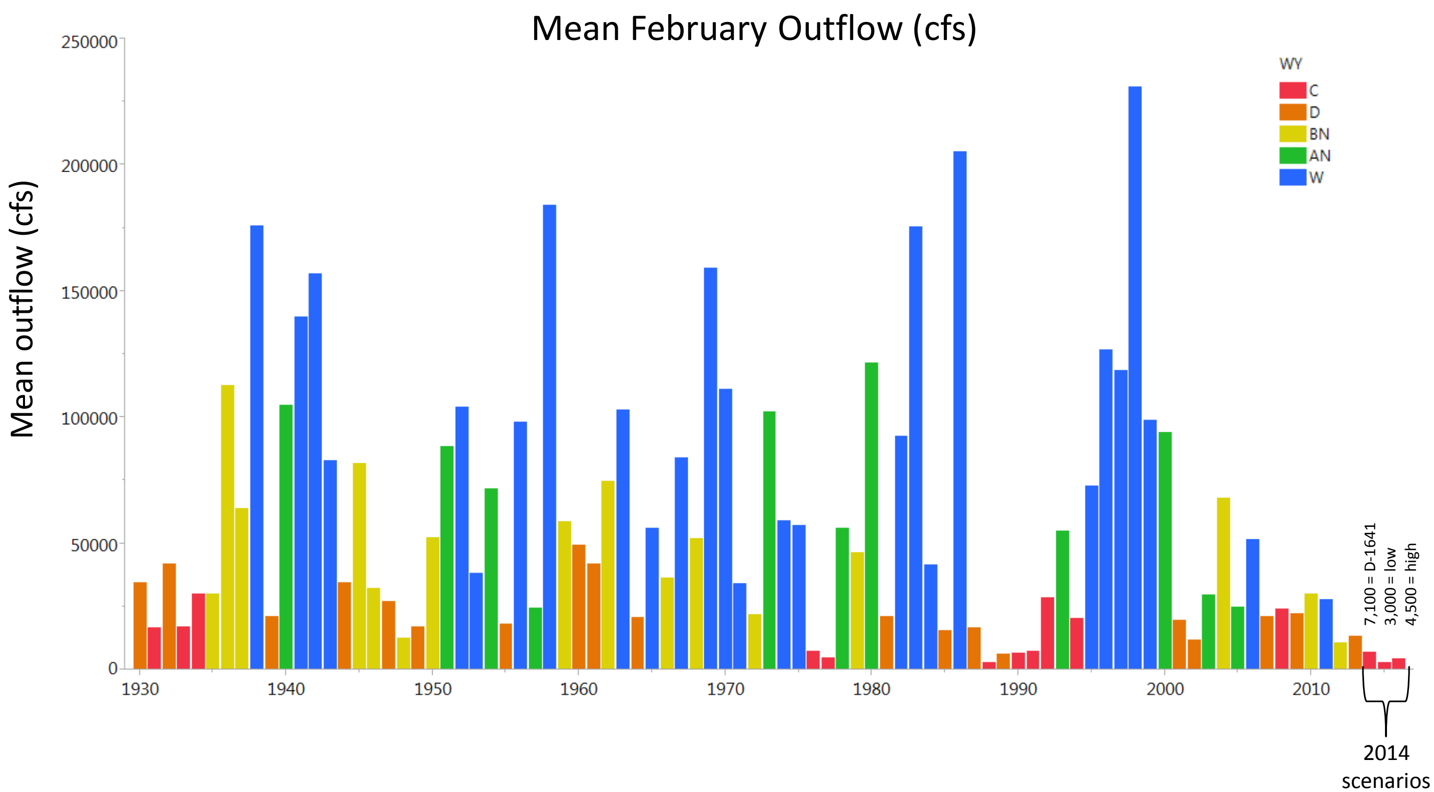

Figure 5. Mean February delta outflow for water years 1929-2013, including February outflow scenarios for 2014.

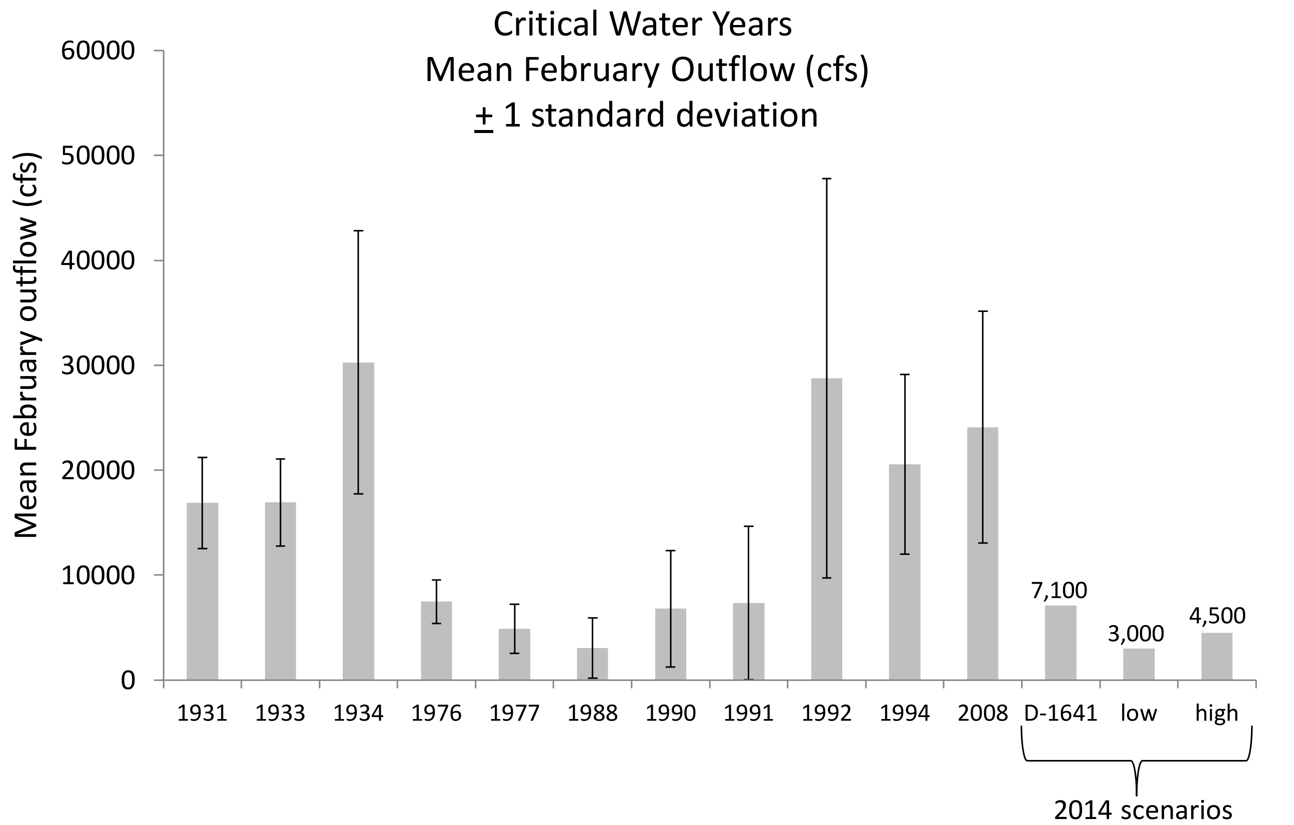

Figure 6. Mean February delta outflow for critical water years, including February outflow scenarios for 2014.

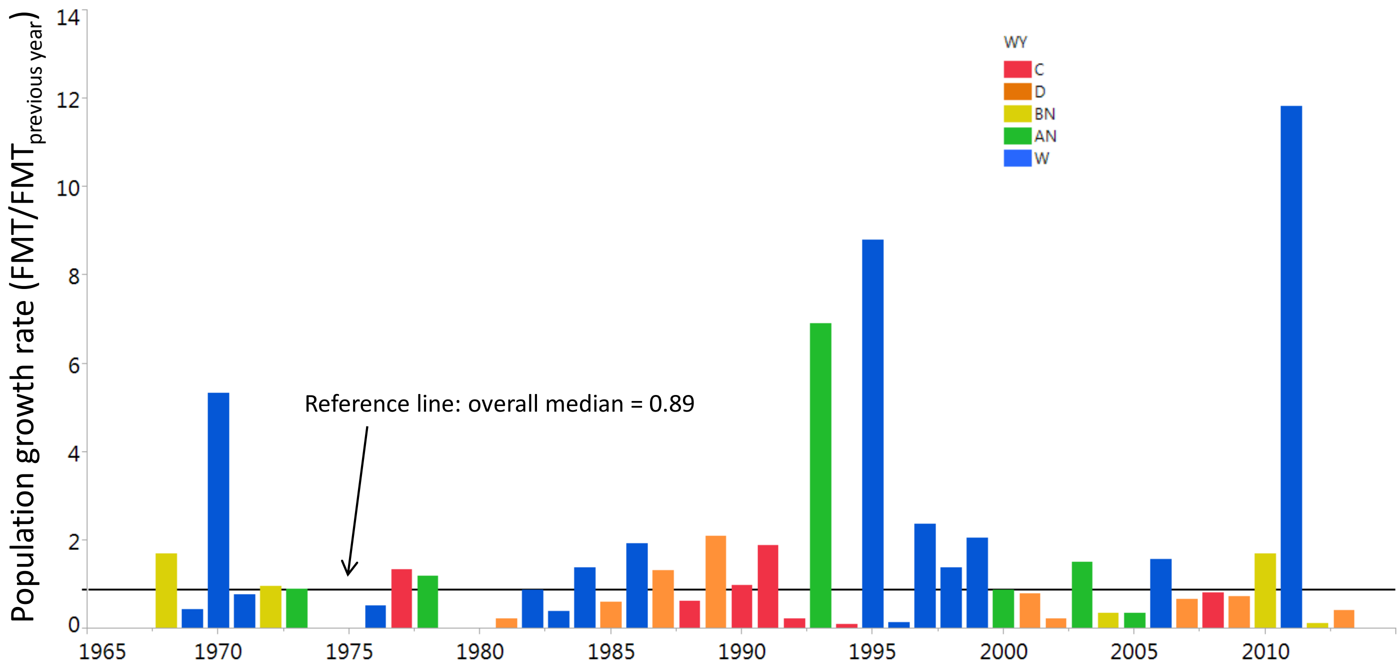

Figure 7. Time series of population growth rate of delta smelt.

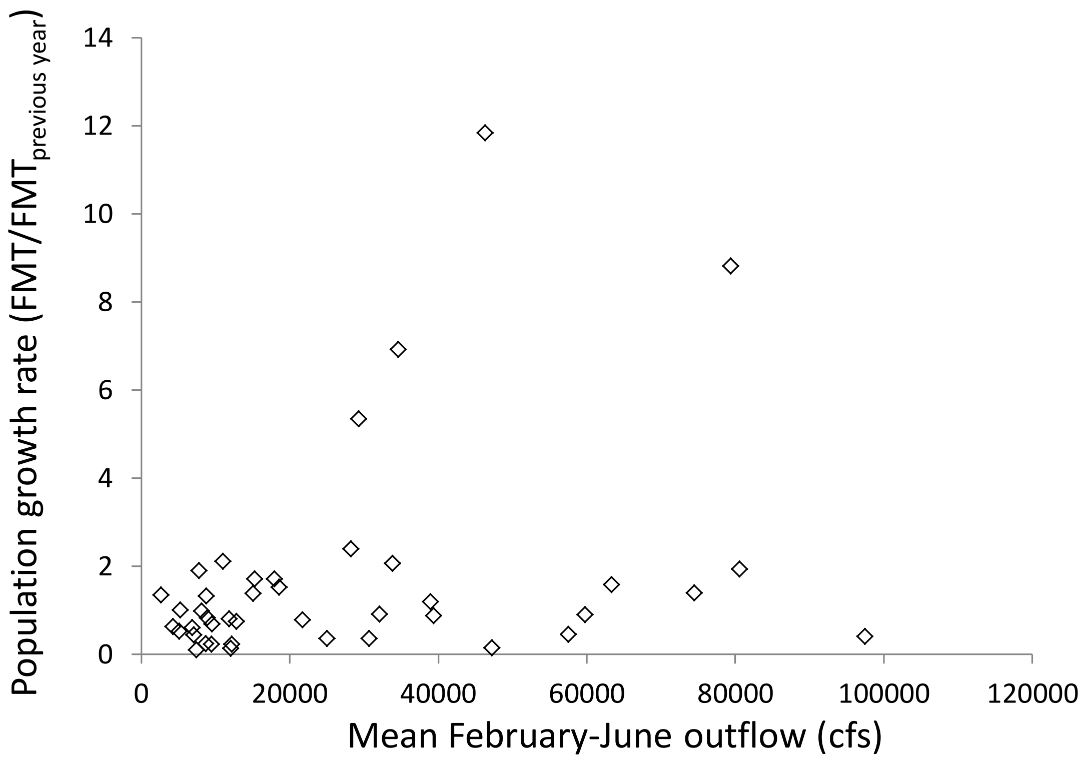

Figure 8. Mean February-June delta outflow plotted against population growth rate of delta smelt.

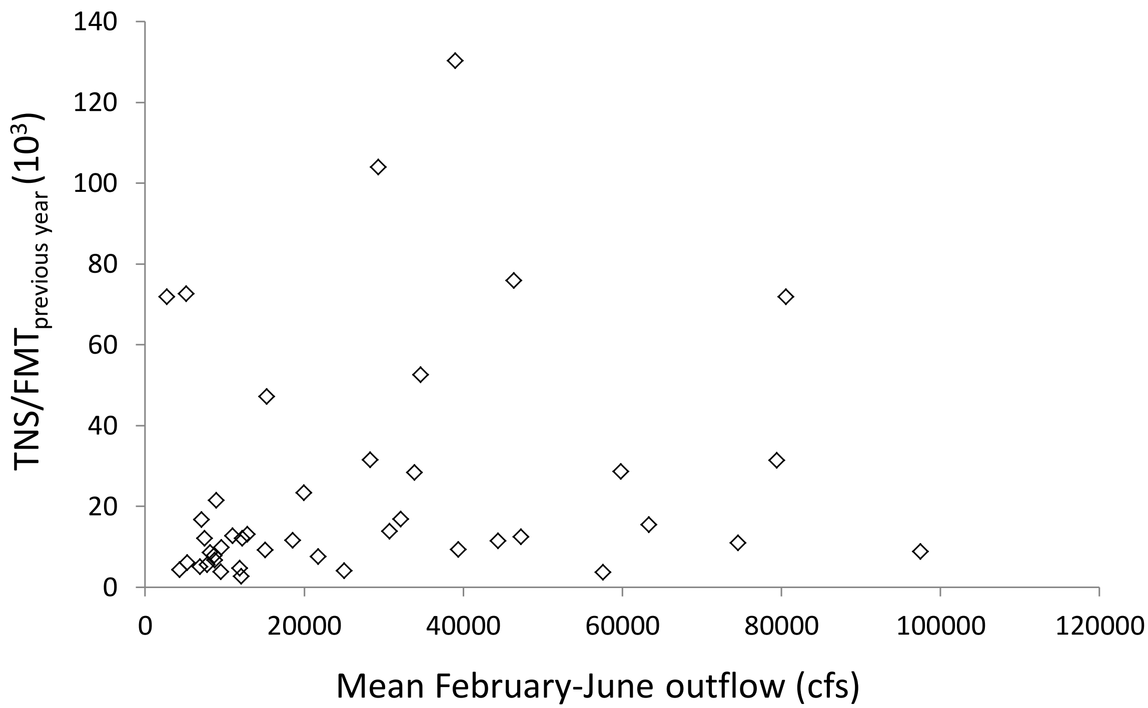

Figure 9. Mean February-June delta outflow plotted against the ratio TNS/FMT$_{previous\ year}$.

Discussion

Extreme drought conditions are well known to stress the aquatic resources of the San Francisco estuary and its watershed. Thus, the present drought condition and the proposed action are likely to stress the delta smelt population. However, the available data are insufficient to isolate the effects of reduced outflow for a single month during a drought on the delta smelt population. Thus, although the proposed action is likely to be stressful to the delta smelt population, quantitatively estimating the incremental effect of February outflow under the proposed action (3,000-4,500 cfs) relative to 7,100 cfs is impossible.

No Delta Smelt have been salvaged this water year at the South Delta fish facilities. This is expected due to the low turbidity observed throughout the central and southern Delta. For example, the first Spring Kodiak Trawl survey (1/13/14-1/14/14) collected 148 Delta Smelt, with over half the catch in the Suisun Bay region, with the rest in Cache Slough Complex and the lower Sacramento River and confluence region (Figure 2). The SKT is conducted on a monthly basis, with the second survey planned for the week of February 10. Adult Delta Smelt are highly unlikely to shift their distribution towards the South Delta unless a first flush event occurs and turbidity is dispersed into the southern Delta (Grimaldo et al. 2009). As the proposed operations will involve conditions of reduced exports and outflow, it is highly unlikely that delta smelt distribution will change in a way that increases their entrainment risk.

The status of delta smelt will be closely monitored during the proposed action. Key oversight groups (e.g. Smelt Working Group; WOMT) will continue to evaluate conditions on a weekly basis, or more frequently if necessary. Under the proposed modified operations, the IEP will continue to monitor abundance and distribution of delta smelt. There are also plans underway by the USFWS to conduct additional trawling designed to closely monitor entrainment risk to delta smelt. Additionally, DWR is currently working on a contract to expedite the implementation of the SmeltCAM, a promising new monitoring tool with multiple applications (e.g. take reduction, habitat assessments).

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