Summary Report on the Transactions of the Smelt Working Group in Water Year 2015

Prepared for the Delta Science Program Independent Review
By Bay-Delta Fish and Wildlife Office
U.S. Fish and Wildlife Service, Sacramento, California
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Acronyms and Abbreviations

BDFWO	Bay-Delta Fish and Wildlife Office
BiOp	Central Valley Project/State Water Project Long-term Operations Biological Opinion
Board	State Water Resources Control Board
CDEC	California Data Exchange Center
cfs	cubic feet per second
CVP	Central Valley Project
DAT	Data Assessment Team
DFW	California Department of Fish and Wildlife
DWR	California Department of Water Resources ESA Endangered Species Act
FMWT	Fall Mid-Water Trawl
IEP	Interagency Ecological Program
ITL	Incidental Take Limit
NMFS	National Marine Fisheries Service
OMR	Old and Middle River Flow (combined, in cubic feet per second)
Project(s)	Central Valley Project and State Water Project
Reclamation	U.S. Bureau of Reclamation
RPA	Reasonable and Prudent Alternative
Service	U.S. Fish and Wildlife Service
SKT	Spring Kodiak Trawl Survey
SLS	Smelt Larva Survey
STNS	Summer Townet Survey
SWG	Smelt Working Group
SWP	State Water Project
TUCP	Temporary Urgency Change Petition, issued by State Resources Control Board
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WOMT	Water Operations Management Team
WY	Water Year (October 1 – September 30)
X2	Distance from Golden Gate Bridge to the two parts per thousand isohaline

Cover photo credit: Steve Martarano, U. S. Fish and Wildlife Service

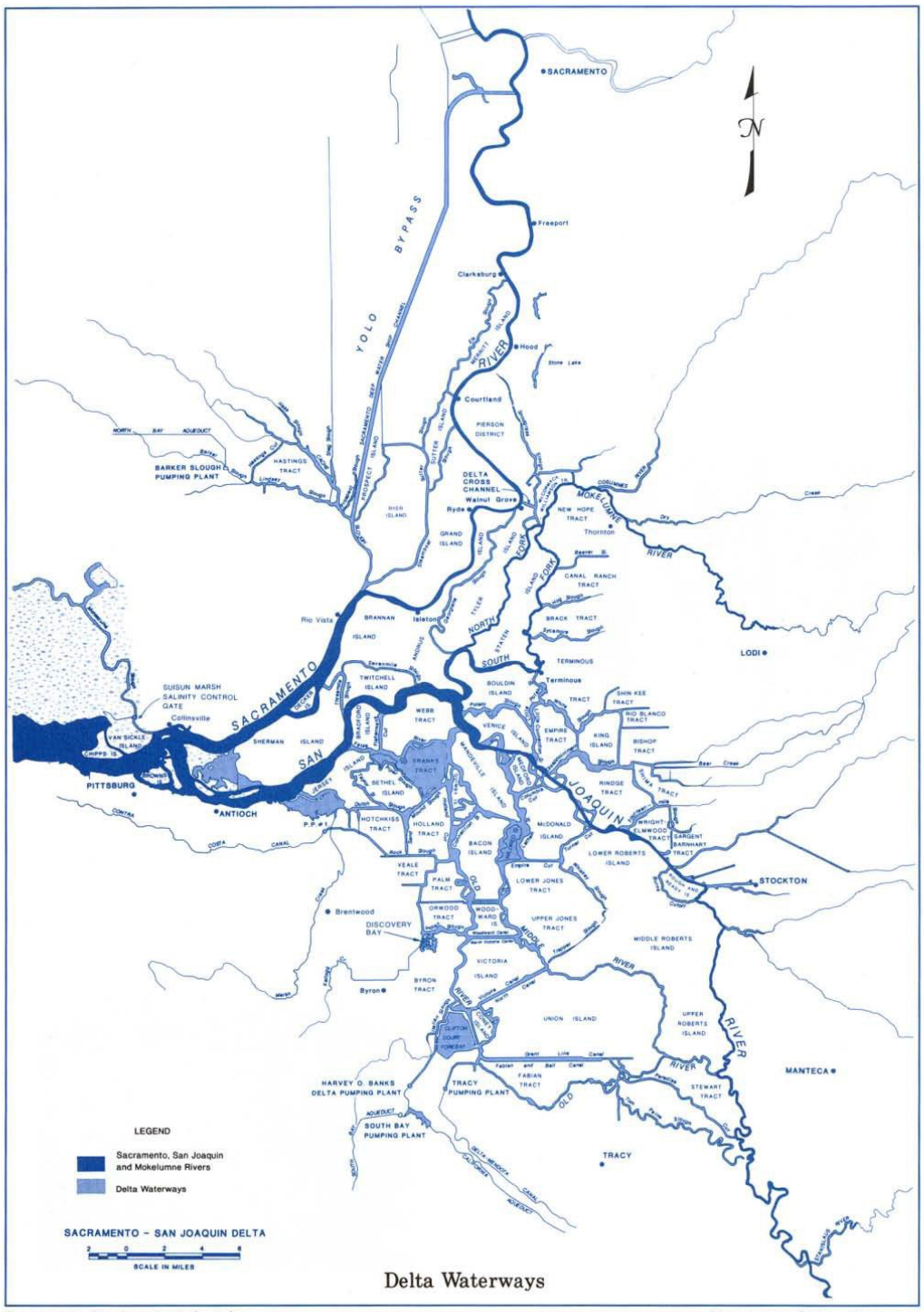

Figure 1. Map of the Sacramento-San Joaquin Delta

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Introduction

The Bay-Delta Fish and Wildlife Office (BDFWO) has prepared this report to summarize the implementation the U.S. Fish and Wildlife Service's (Service) biological opinion on the Central Valley Project (CVP) and State Water Project (SWP) Long-term Operations (BiOp) in Water Year (WY) 2015. In addition to background information pertinent to implementation of the BiOp, this report provides a summary of the transactions of the Smelt Working Group (SWG) during WY 2015. The SWG is a technical team that evaluates biological and technical issues regarding Delta Smelt (*Hypomesus transpacificus*) and develops recommendations for consideration by the Service during implementation of the BiOp's Reasonable and Prudent Alternative (RPA) actions.

Beginning on January 12, 2015, the Service requested that the SWG begin providing advice using the January 12, 2015, Framework for Providing Advice to the Service (Attachment 1). The SWG provided advice periodically throughout WY 2015. The Service issued no determinations for reduced water exports for the protection of Delta Smelt.

Chapter 1. Background

1.1 Consultation Background

The Federal Endangered Species Act (ESA) is primarily administered by the National Marine Fisheries Service (NMFS) and the Service. A biological opinion is the product of an interagency formal consultation under section 7 of the ESA, which provides that "each Federal agency shall, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded or carried out by such agency… is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of [critical] habitat…"

In the December 2008 BiOp to the U.S. Bureau of Reclamation (Reclamation), the Service determined that the coordinated operations of the CVP and SWP, as proposed, would likely to jeopardize the continued existence of the Delta Smelt and adversely modify its critical habitat. The BiOp identified three factors that affect the population resilience and long-term viability of Delta Smelt: 1) direct mortality associated with entrainment of pre-spawning adult Delta Smelt by CVP/SWP operations; 2) direct mortality of larval and early juvenile Delta Smelt associated with entrainment by CVP/SWP operations; and 3) indirect mortality and reduced fitness through reductions to and degradation of Delta habitats by CVP/SWP operations, with the fall as a particular concern (BiOp, p 325). The risk of entrainment increases with increased reverse flows on the Old and Middle rivers (OMR), which occur as a result of Project export pumping. Reverse OMR flows are a proximal cause of entrainment; the position of the two-parts-per-thousand isohaline (termed "$X2$"and measured as kilometers from the Golden Gate Bridge) is a distal cause of entrainment.

In collaboration with Reclamation and the California Department of Water Resources (DWR), the Service developed an RPA to the proposed action. The Service's BiOp for Delta Smelt includes five RPA components to protect all Delta Smelt life stages and minimize impacts to critical habitat. The primary components affecting CVP and SWP operations are Components 1 and 2 (Table 1). Component 1 protects adult Delta Smelt by reducing OMR flows to a range of -1,250 to -5,000 cubic feet per second (cfs) at times when the fish are most vulnerable to entrainment at Project diversions, which can occur as early as December and continue until spawning has begun. Component 2 protects larval and juvenile Delta Smelt by reducing OMR flows to a range of -1,250 to -5,000 cfs at times when these life stages are vulnerable to entrainment. Component 2 is implemented from the onset of spawning to June 30, or when water temperatures reach 25° Celsius, whichever occurs first. Components 1 and 2 are implemented through an adaptive decision process described in the BiOp. More specific information about the implementation of Actions 1 through 3 can be found in Chapter 2. Summary of SWG Discussion and Advice.

Table 1. Component 1 (Actions 1 and 2) and Component 2 (Action 3) of the BiOp's RPA

<table>
<tr><th></th><th></th><th>Objective</th><th>Trigger</th><th>Timing</th><th>OMR Flows</th></tr>
<tr><td rowspan="3">Component 1</td><td>Action 1 (a)</td><td rowspan="2">A fixed duration action to protect pre-spawning adult Delta Smelt from entrainment during the first flush and to provide advantageous hydrodynamic conditions early in the migration period.</td><td>SWG may recommend a start date</td><td>Dec 1 to Dec 20</td><td rowspan="2">-2,000 cfs</td></tr>
<tr><td>Action 1 (b)</td><td>Turbidity or Salvage</td><td>Dec 20 to Action 2</td></tr>
<tr><td>Action 2</td><td>An action implemented using an adaptive process to tailor protection to changing environmental conditions after Action 1. As in Action 1, the intent is to protect pre-spawning adults from entrainment and, to the extent possible, from adverse hydrodynamic conditions</td><td>The end of Action 1 or (if Action 1 is not triggered), the SWG may recommend a start date</td><td>Immediately following Action 1</td><td rowspan="2">-1250 to -5000 cfs</td></tr>
<tr><td>Component 2</td><td>Action 3</td><td>Minimize the number of larval Delta Smelt entrained at the facilities by managing hydrodynamics in the central Delta flow levels pumping rates spanning a time sufficient for protection of larval Delta Smelt. The action is adaptive and flexible within appropriate constraints</td><td>Temperature or Onset of Spawning</td><td>Upon meeting trigger criteria</td></tr>
</table>

1.2 Adaptive Decision Process

Real-time decision making to assist fishery management is a process that promotes flexible decision making and can be adjusted as new data are collected, and as outcomes from management actions and other events become better understood. Sources of uncertainty relative to CVP and SWP operations include hydrologic conditions and the biology and ecology of species. The adaptive decision process allows for minimized impacts to water deliveries and minimized adverse effects to listed species. Decisions regarding CVP and SWP operations to avoid and minimize adverse effects on listed species must consider factors that include public health, safety, water supply reliability, and water quality.

To facilitate these water operations decisions, the Project agencies and the Service, NMFS, and the California Department of Fish and Wildlife (DFW) have developed and refined a process to collect data, disseminate information, develop recommendations, make decisions, and provide transparency. This process consists of three types of groups that meet on a recurring basis. Management teams (e.g. the Water Operations Management Team [WOMT]) are made up of management staff from Reclamation, DWR, the Service, NMFS, the U.S. Environmental Protection Agency (USEPA) and DFW. Information teams (e.g. the Data Assessment Team [DAT]) are teams whose role is to disseminate and coordinate information among agencies and stakeholders. Fisheries and Operations Technical Teams (e.g. SWG) are made up of technical staff from state and Federal agencies. These teams review the most up-to-date information on fish status and Delta conditions, and develop recommendations that fishery agencies' management can use in identifying actions to protect listed species. In WY2015, additional teams (including the Real Time Drought Operation Management Team, and the Directors' Meeting) met to discuss and make water management decisions; decisions on water operations were primarily coordinated at the directors' level, rather than through the WOMT process.

The process to identify actions for protection of listed species varies to some degree among species but follows this general outline: a Fisheries or Operations Technical Team compiles and assesses current information regarding species, such as stages of reproductive development, geographic distribution, relative abundance, and physical habitat conditions. The team then provides a recommendation to the agency having the statutory obligation to enforce protection of the species in question. The agency's staff and management then review the recommendation, and in cooperation with Reclamation and DWR, use it as a basis for developing a protective action to minimize adverse effects to listed species by the Projects. The fishery agency with the statutory authority makes the final determination on the protective action. The outcomes of any protective actions that are implemented are monitored and documented, and this information informs future recommended actions (BiOp, pp 27-29).

1.3 Smelt Working Group

The SWG is one of several fisheries technical teams that provide guidance and recommendations on resource management issues. The SWG consists of representatives from the Service, NMFS, DFW, DWR, and Reclamation. The Service chairs the group, and members are assigned by each agency.

The SWG evaluates biological and technical issues regarding Delta Smelt and develops recommendations for consideration by the Service. When the Longfin Smelt (*Spirinchus thaleichthys*) became a California candidate species in 2008, the SWG also began developing recommendations for DFW to minimize adverse effects to Longfin Smelt. The SWG meets regularly during December through June, which is historically when Delta Smelt salvage has occurred. In addition, the Delta Smelt Risk Assessment Matrix (Attachment 2) outlines the conditions when the SWG will convene to evaluate the necessity of protective actions and provide the Service with a recommendation. The SWG will also convene to review Longfin Smelt entrainment risk at the request of DFW (BiOp, pp 30-31).

When the data indicate that smelt may be at risk for entrainment, the SWG may recommend OMR flows within the ranges in the BiOp's RPA to the Service. The Service's staff and managers review the recommendation and, if warranted, use it to develop a determination for modification of water operations that will minimize adverse effects caused by Project operations. This adaptive process continues throughout the winter and spring until smelt are no longer vulnerable to entrainment. SWG meeting notes are made public on the BDFWO website at http://www.fws.gov/sfbaydelta/cvp-swp/smelt_working_group.cfm.

1.4 Delta Smelt Monitoring Data

Most research and monitoring in the Bay-Delta are coordinated through the Interagency Ecological Program (IEP). The IEP is led by state and Federal agencies, and includes university and private partners. There are several monitoring programs that are implemented each year throughout estuary. Each study has the potential to capture Delta Smelt to some degree; four are commonly used to index the abundance and distribution of Delta Smelt (Figure 2).

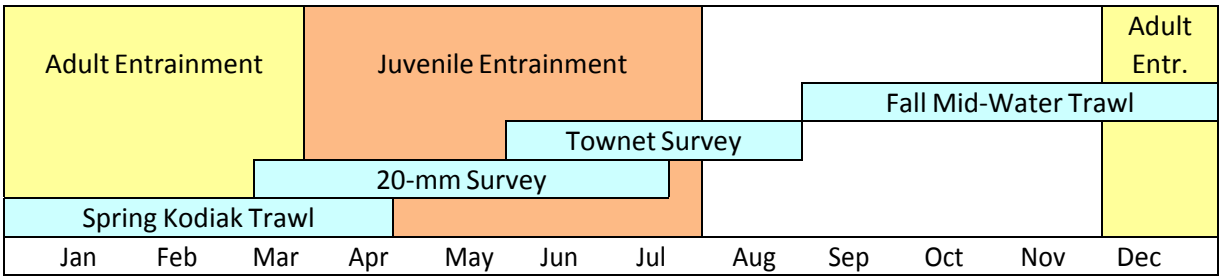


Figure 2. Approximate timetable of the primary surveys used to assess relative abundance and distribution of Delta Smelt

The Fall Mid-Water Trawl (FMWT) and the Summer Townet Survey (STNS) are the two longest-running IEP fish monitoring programs that are used to index Delta Smelt abundance. Two more recent surveys, the 20-mm survey and the Spring Kodiak Trawl (SKT) survey, were specifically designed to sample Delta Smelt relative abundance and distribution. Each of these four sampling programs targets different life stages and encompasses the entire life cycle and distribution. Data from the FMWT (September – December) are used to calculate a relative index of abundance, which is used in the BiOp to calculate allowable incidental take for the Projects. Data from the SKT (January – May) are used to monitor distribution and spawning readiness of adults. Data from the 20-mm survey (March – June) are used to monitor the distribution and relative abundance of post-larval Delta Smelt. Data from the STNS (June – August) are used to monitor the distribution and relative abundance of juvenile Delta Smelt.

Both the state and Federal water Projects utilize behavioral-barrier fish screens designed to route fish away from export water and into a fish salvage facility where they are collected, counted, and trucked to a release site in the Delta. The salvage process was designed for young Chinook Salmon and Striped Bass; Delta Smelt that enter the facility are thought to not survive the release process and are counted as mortality. The fish salvage facilities report Delta Smelt and Longfin Smelt salvage to the Service and publish the data on a public website. (BiOp, pp 143-145, http://www.usbr.gov/mp/cvo/).

Chapter 2. Summary of SWG Discussion and Advice in WY 2015

After an initial organizational meeting on November 24, 2014, the SWG began distributing data and then held regular meetings beginning December 8, 2014; the last meeting was on June 8, 2015. At least one representative from each agency was able to participate on most calls.

Weekly discussion topics included fish salvage at the Projects' fish salvage facilities, DFW and Service biological field surveys, Delta hydrology, expected Project operations for the coming week, status of NMFS biological opinion actions and risk of entrainment for Delta Smelt and Longfin Smelt. Periodic discussion topics included applicable sections of the Service BiOp for Delta Smelt, updates for ongoing field studies, historical survey results, hydrology patterns, water quality requirements, status of emergency drought actions, Delta turbidity modeling results, and the status of temporary Delta barriers.

There were several developments that occurred in WY 2015 that modified the conventional water operations decision process, and SWG's involvement in the process, as described in Section 1.2. Some changes of note were made to the water operations decision process, including the addition of the Directors' Meeting as well as a modification in the way the SWG provided advice to the Service as described in Attachment 1. There was also a change made to the authorized Delta Smelt incidental take number, as described in Attachment 3.

Several topics were frequently discussed at SWG meetings in WY 2015. Some are briefly summarized here; a full description can be found online within the SWG notes (http://www.fws.gov/sfbaydelta/cvp-swp/smelt_working_group.cfm).

As described in Section 1.3, the SWG provides advice to the Service on the risk of entrainment to Delta Smelt. In WY 2015, members regularly discussed the difficulty of assessing risk given the lowest relative abundance of Delta Smelt on record, and the resulting apparent reduction in detectability of the species in field surveys. This issue was regularly mentioned at SWG meetings and was often reflected in their advice to the Service.

In assessing the risk of entrainment, SWG discussed the reliability of using salvage data to indicate Delta Smelt entrainment, given record-low abundance, very low salvage numbers (salvage was rare), and heavy debris loads which periodically overwhelmed the salvage facilities, thus reducing efficiency (i.e. water hyacinth). Although there was no fixed SWG position, there was a general perception that salvage data may not have been as reliable an indicator of Delta Smelt entrainment in 2015 as in past years when abundance was greater.

2.1 Component 1: Adult Entrainment

Adult Incidental Take

The adult Delta Smelt incidental take authorized in the BiOp is based on historical take from the Projects and also uses the FMWT index to scale allowable take to apparent abundance (BiOp, pp 285-288). The FMWT index for Delta Smelt for 2014 was 9. Therefore, using the equation in the BiOp, authorized incidental take for adult Delta Smelt in WY 2015 was 78 fish for both Projects; the BiOp's Concern Level was 58 fish. A new Incidental Take Limit (ITL) was generated from a method proposed by Reclamation to the Service. This approach was presented by Reclamation to the 2014 Independent Science Review panel. Reclamation and the Service incorporated the panel's comments. On January 9, 2015, the Service issued a memo to Reclamation with the new ITL of 196 WY 2015 (Attachment 3).

Action 1

Adult Delta Smelt entrainment generally occurs when pre-spawning migrants enter the central and southern Delta following the first winter pulse of precipitation in the watershed. This event is characterized by the first substantial flow increase of the winter and is generally coincident with an increase in turbidity, also referred to as "first flush". Flow and turbidity are believed to serve as cues for adult Delta Smelt migration.

Action 1 requires OMR flow be managed to no more negative than -2,000 cfs for 14 days. This decrease in reverse OMR flow results in the draw of little to no Sacramento River water into the central and southern Delta and typically allows some portion of the San Joaquin River flow to reach the confluence area. Action 1 is intended to decrease the risk of entrainment of pre-spawning adult Delta Smelt, and improve habitat conditions for the species. Additionally, Action 1 is intended to decrease the risk of entrainment of larval and juvenile Delta Smelt later in the season by allowing environmental cues to encourage the species to spawn in the northern Delta.

In WY2015, the SWG monitored turbidity and Delta hydrology as indicators of the occurrence of the first winter pulse flow in an effort to assess the entrainment risk. The SWG also monitored salvage and survey results as an indicator of relative species abundance and distribution. Due to increased catch from the Early Warning Study, increasing turbidity throughout the system, and increased flows, the SWG recommended an immediate start to Action 1 on December 16, 2014. Subsequent voluntary cutbacks at the export facilities were taken; therefore, there was no determination made to implement Action 1.

Action 2

Action 2 encompasses the period when OMR prescriptions (-1,250 to -5,000 cfs) for pre-spawning adult Delta Smelt are required to protect parental stock prior to reproduction; however, such controls may be relaxed if the main pulse of fish migration has already occurred and adults are maintaining position near selected spawning areas. Action 2 may also be needed to extend protections, consistent with Action 1, in years when the spawning migration period is longer or due to changing environmental conditions. Because conditions are highly variable both between and within years, the SWG monitors environmental conditions including turbidity, flow, and water temperature, as well as relative fish abundance, distribution and spawning readiness, and salvage at the export facilities, to assess the risk of entrainment. The RPA describes a variety of potential recommendations, according to the assessed level of risk (BiOp, pp 354-356).

Action 2 commences automatically following Action 1; however, as Action 1 was not implemented in WY 2015, Action 2 can begin when either the Service or SWG determine that protective OMR flows are necessary. In WY 2015, no water operation reductions for the purpose of protecting Delta Smelt under Action 2 were implemented. A total of 68 adult Delta Smelt were reported salvage for the December-through-March period.

Among other data, the SWG reviews catch data from the Spring Kodiak Trawl survey in assessing risk of entrainment of adult Delta Smelt. Results from the SKT from 2015 indicated record-low abundance. The very low survey catch was of concern to the SWG, as was the record-low annual abundance index (Figure 3). Please refer to SWG notes for detailed discussion regarding the survey results (http://www.fws.gov/sfbaydelta/cvp-swp/smelt_working_group.cfm).

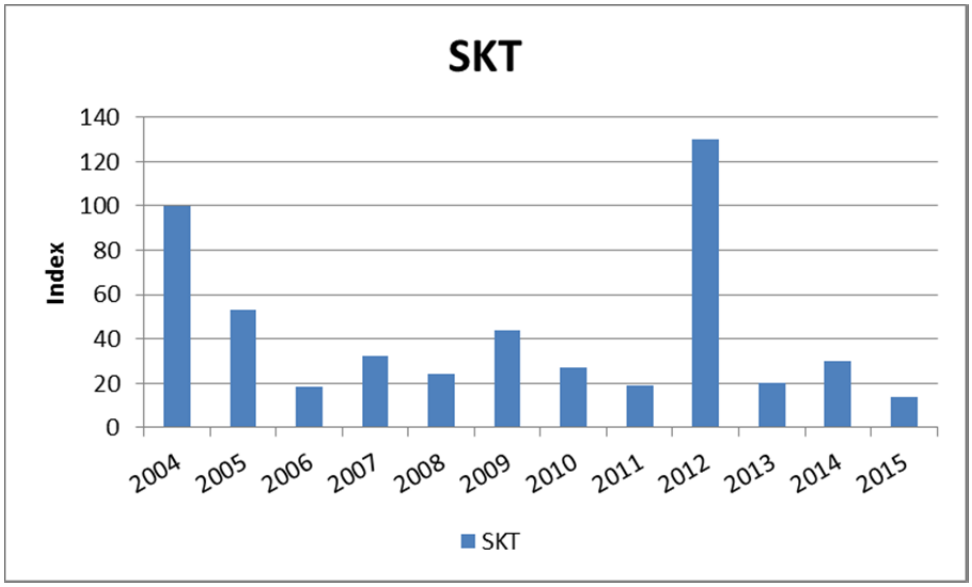


Figure 3. Spring Kodiak Trawl Annual Abundance Index for Delta Smelt, 2004-2015.

2.2 Component 2: Juvenile Entrainment

Juvenile Incidental Take

Incidental take for juvenile Delta Smelt is based upon historic observed take as well as upon apparent abundance (BiOp, pp 289-293) similar to the adult take calculation. Because of the difficulty in identifying larval smelts to species, only Delta Smelt greater than 20 mm in length are counted in salvage. Juvenile take is estimated by month for the April-through-July period. Authorized take for WY 2015 is provided in Table 2.

Table 2. Incidental take for juvenile Delta Smelt at least 20 mm in size, WY 2015, cumulative by month

	Concern Level	Authorized Take	Actual Project Take*
April	3	4	
May	116	173	4
June	296	443	4
July	336	504	4

*Actual Take numbers are the final combined, cumulative salvage data published on California Department of Fish and Wildlife's Salvage Monitoring website at ftp://ftp.dfg.ca.gov/salvage/Daily_Smelt_Summary/SMELT_SALVAGE_TABLES_2015.pdf

Action 3.

Implementation of Action 3 begins when the SWG determines that spawning has begun and larval fish are present in the Delta, following the guidance in the BiOp. It is likely that Delta conditions (primarily water temperature) will be appropriate for the presence of larvae before larvae are detected by routine survey sampling. The SWG monitors water temperature, adult spawning condition (i.e., gonad development based on Delta Smelt collected in field surveys or at the salvage facilities), larval occurrence and distribution to assess the relative risk of entrainment. Action 3 concludes when Delta water temperatures reach a daily average of 25° Celsius at Clifton Court Forebay for three consecutive days, or June 30, whichever occurs first (BiOp pp 357- 359).

In WY 2015, the SWG monitored Delta hydrology and juvenile distribution as indicated by the Smelt Larval Survey (SLS) and 20-mm Survey. No Delta Smelt were collected until SLS surveys #5, when one larva was collected from the Sacramento Deepwater Shipping Channel. Distribution of larvae in SLS #6 indicated presence was in the Sacramento River system and the lower San Joaquin River (total of five larvae). Delta Smelt larvae were detected in all 20-mm Surveys in WY2015. While distribution of Delta Smelt larvae in the 20-mm Survey shifted throughout the season, the majority of the catch occurred at Sacramento River stations. Catches of Delta Smelt for the 20-mm Survey and STNS were at record-low levels, with some surveys returning no catch. The annual abundance index values for both surveys reflect a continued decline in abundance (Figure 4 and Figure 5).

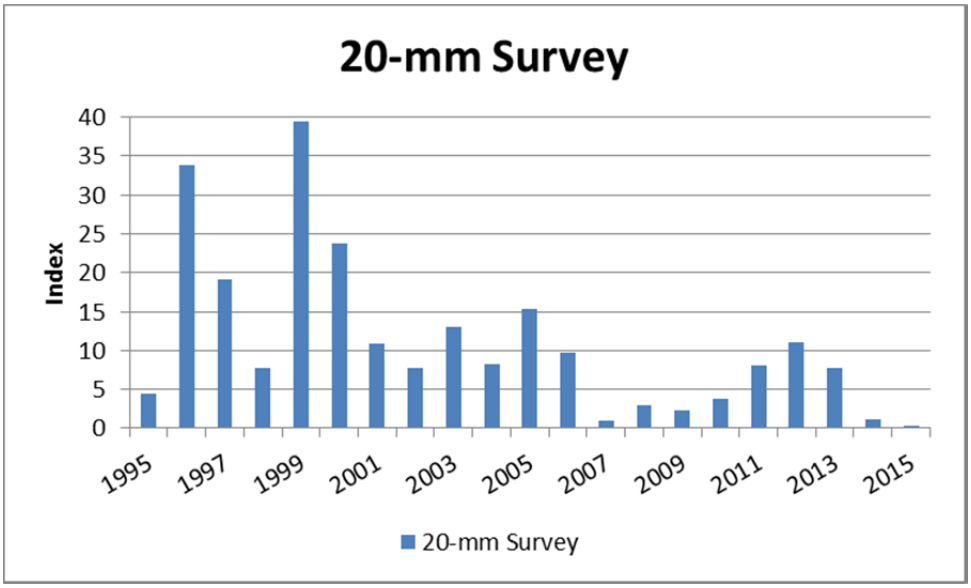


Figure 4. 20-mm Survey Annual Abundance Index for Delta Smelt, 1995-2015

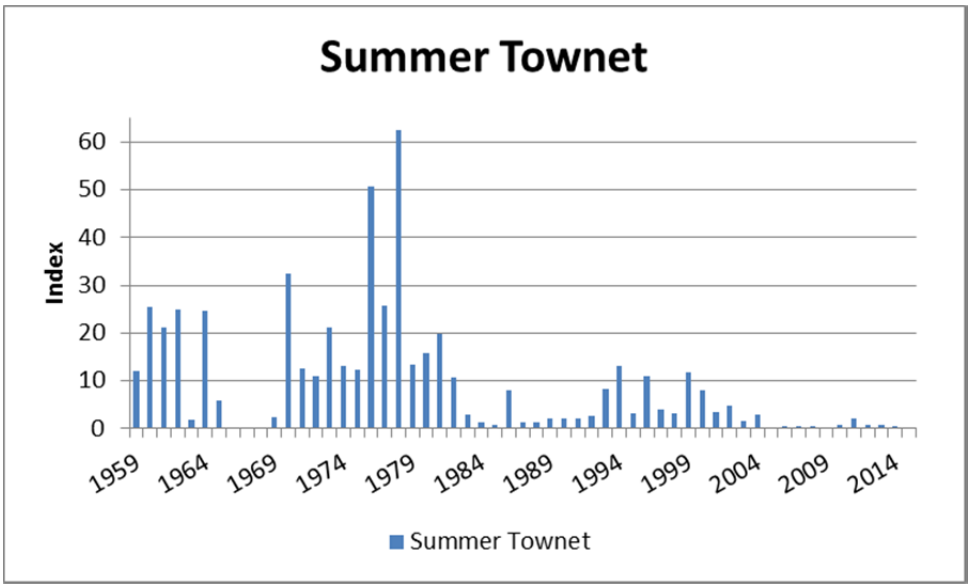


Figure 5. Summer Townet Annual Abundance Index for Delta Smelt, 1959-2015.

On June 11, 2015, the Service notified WOMT that the temperature offramp criteria for juvenile Delta Smelt entrainment protection under Action 3 had been met on June 10, 2015. Therefore, the June 8, 2015, SWG meeting was the last meeting of WY 2015.

To review all SWG meeting notes from WY 2015, please visit http://www.fws.gov/sfbaydelta/cvp-swp/smelt_working_group.cfm

Chapter 3. Water Operations Summary for Water Year 2014

Hydrologic year types in both the Sacramento and San Joaquin river basins were classified as critical in WY 2015. Throughout January, exports were controlled by the State Water Resources Control Board (Board) monthly water quality standards in D-1641. To address extreme drought conditions, a Temporary Urgency Change Petition (TUCP) was approved by the Board on January 31, 2014. The TUCP allowed for the relaxation of some D-1641water quality standards, and controlled exports some of the time from February through June. The OMR flow restriction of -5000 cfs in both the Service and NMFS RPAs partly controlled exports in March. Exports from April through May were subsequently controlled by the export to inflow ratio of 1:1 for April 15-May 15 (NMFS RPA Stanislaus River/Vernalis pulse flows). By early May, D-1641 water quality standards controlled Project operations, and continued to through the end of the SWG season. On June 10, 2014, the temperature off-ramp conditions for RPA Component 2, Action 3 were met. Please refer to Figure 6 for sections 3.1 through 3.3.

3.1 Export Pumping
The combined Projects export rate averaged approximately 6,500 cfs in December, 5,100 cfs in January, 5,000 cfs in February, and 2,900 cfs in March. The remainder of the spring saw a continued lower export rate, with April averaging 1,452 cfs, May averaging 800 cfs, and June averaging 700 cfs.

3.2 River Flows
Storms with rainfall large enough to contribute to river flow and reservoir storage moved through northern California the first couple weeks of December 2014 and very early February 2015. The remainder of WY2015 was marked by a distinct lack of rainfall events. Sacramento River flow at Freeport peaked at approximately 56,000 cfs in early December and at 37,000 cfs in early February. Outside of these rainfall events, river flow remained fairly steady during the 2014/2015 winter, with daily average flows generally remaining between 6,000 and 9,000 cfs.

The San Joaquin River rose to a peak of approximately 1800 cfs in early December. For the remainder of WY2015, the river generally did not rise to greater than 1,000 cfs from late-December through June, with an average flow of approximately 700 cfs. By late June, flow had dropped below the gauge reading (150 cfs).

3.3 Delta Outflow and Winter Pulse
Delta outflow generally parallels Sacramento River flows, depending on the rainfall and snowfall patterns throughout the water year. Delta outflow peaked in mid-December at 60,000 cfs and then dropped to 5,000 to 6,000 cfs for most of January. Outflow peaked again by early February to 40,000 cfs. After this flow event, outflow dropped to below 6,000 cfs and remained below for the majority of the remainder of the WY.

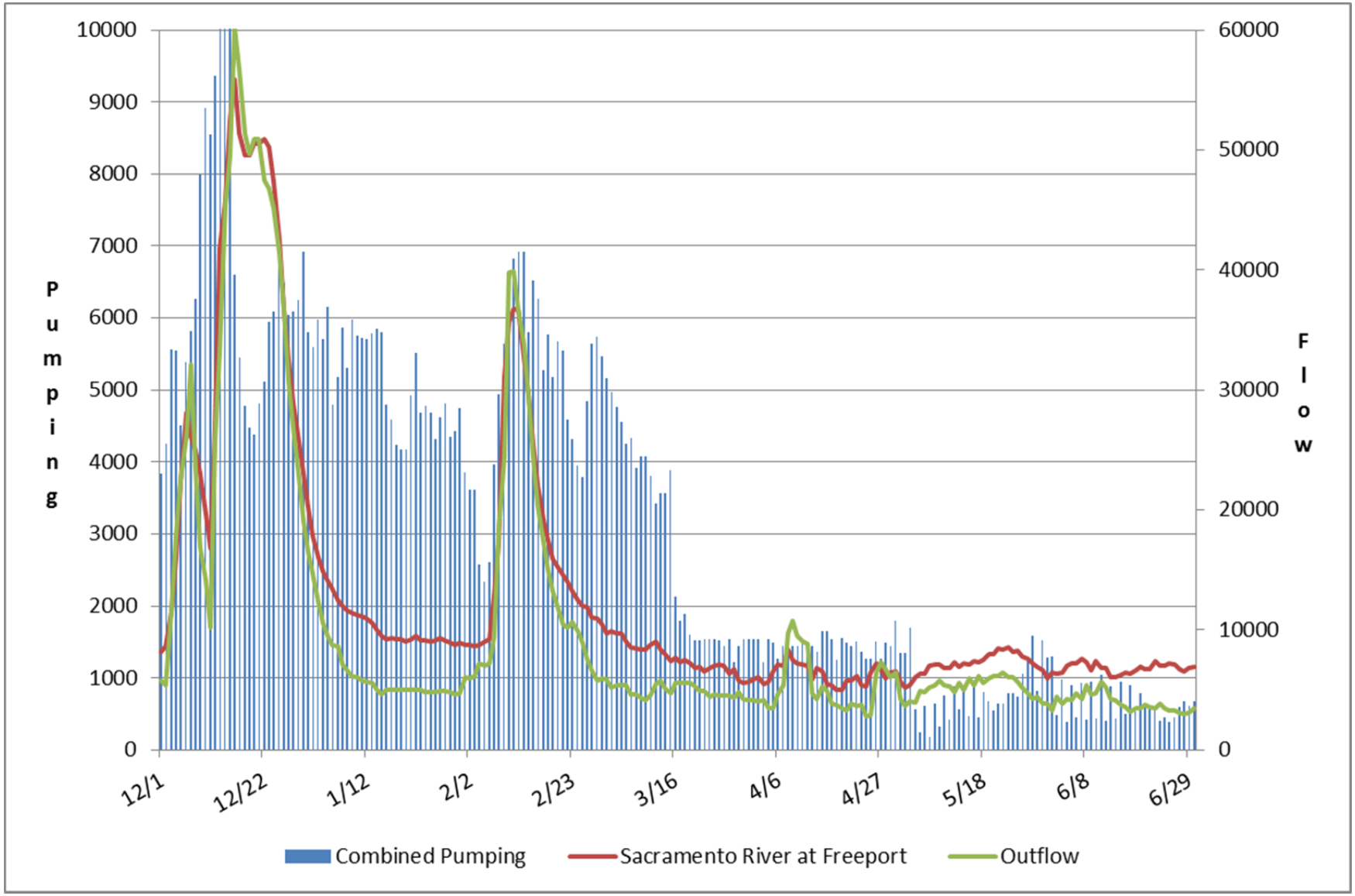


Figure 6. Export pumping, river flow, and outflow levels in WY 2015.

DRAFT
January 12, 2015

Smelt Working Group Framework for providing advice to the Service

The U.S. Fish and Wildlife Service (Service) is requesting that the Smelt Working Group (SWG) provide delta smelt entrainment protection advice in a new format, and has supplied a framework for how to provide the additional information. In summary, the Service's new SWG advice framework provides structure for describing salvage trend, given current conditions. The Service will incorporate the SWG's advice in determinations with regard to any implementation of the biological opinion (BiOp) with regard to the Incidental Take Limit.

As it has in the past, the SWG will continue to compile and interpret real-time information regarding delta and longfin smelt. The SWG will submit its advice in writing to the Service and California Department of Fish and Wildlife if they agree that a protective OMR flow is warranted to reduce smelt entrainment under RPA Components 1 and 2.

PROCESS

- The SWG will, as before, review real-time biological data as they pertain to delta smelt entrainment risk as defined in RPA 1 and 2, including population status, relative abundance and distribution, sexual maturation, Delta conditions, cumulative salvage, and current operations.
- The SWG provides delta smelt entrainment risk advice to the Service, as described below:
- Individual risk narratives for the following flow ranges:
  - -1250 to -2000 cfs
  - -2000 to -3500 cfs
  - -3500 to -5000 cfs
- For each OMR range:
  - What effect would operations in that flow range have on the risk factors that are currently important? Examples of the currently important risk factors are Delta conditions, population status, relative abundance and distribution, sexual maturation, and season (ie. life history stage)
  - What effect would operations in that range have on salvage, relative to recent salvage?
  - What "unknowns" (e.g. weather) might affect risk for operations in this range?
  - If operations in that range would result in increased risk of salvage, how long would that risk persist if average OMR remained within the range?

The Delta Smelt Working Group and the Delta Smelt Risk Assessment Matrix

The delta smelt risk assessment matrix (DSRAM) consists of month by month criteria which, when exceeded will trigger a meeting of the Delta Smelt Working Group (Working Group). The Working Group consists of experts in delta smelt biology from the U.S. Fish and Wildlife Service (Service), U.S. Bureau of Reclamation (Reclamation), U.S. Environmental Protection Agency (EPA), and California Departments of Water Resources (DWR) and Fish and Game (DFG). The purpose of the DSRAM is to take actions to protect delta smelt in a proactive manner prior to salvage events at the Federal and State Delta export facilities. Reclamation and/or DWR are responsible for monitoring the DSRAM criteria and reporting back to the Service and the Working Group. The DSRAM has been modified from the delta smelt decision tree, which was peer-reviewed and presented in the Interagency Ecological Program (IEP) Newsletter. It is the intent of the Service that the DSRAM be sent out for independent peer review. The DSRAM is an adaptive management tool which may be further modified by the Working Group and the interagency Water Management Operations Team (WOMT) as new information becomes available, without undergoing formal reconsultation. An informative link to an existing website will be developed that compiles monitoring data from IEP and DFG to enable members of the Working Group to easily track the progress of the triggering criteria. Data will be updated at least weekly to determine the need for a meeting.

Should a triggering criterion be met or exceeded, Reclamation and/or DWR will inform the members of the Working Group and the Working Group will determine the need to meet. Any member of the Working Group may initiate a meeting of the Working Group at any time. A meeting of the Working Group may consist of an in-person meeting, a conference call, or a discussion by email. If needed, the Working Group will meet prior to the weekly meetings of the DAT and the WOMT and information will be shared with these groups. The Working Group will be available to present management briefings as needed.

If a meeting of the Working Group proves necessary, the group will review the available monitoring and survey data and decide whether to recommend a change in water project operations (referred to as "fish actions"). These potential fish actions are listed in the DSRAM by the months wherein each of these tools generally becomes available. Generally, if the Working Group recommends a fish action, it will be shared with the Data Assessment Team (DAT) during its weekly conference call and forwarded to the WOMT for discussion and potential implementation; however, the Working Group may make recommendations to WOMT at any time. Recommendations will include a discussion of the level of concern for delta smelt and will include a list of the participants in the Working Group discussions. All dissenting opinions and/or discussion points will also be forwarded to the WOMT. The Working Group will meet at least weekly throughout the period in which the triggering criteria are met or exceeded, to determine the need to provide further recommendations to the WOMT.

Notes and findings of Working Group meetings will be submitted to the Service and members of the WOMT for their records. Meeting notes will also be available to the public on the Sacramento Fish and Wildlife Office's web page. The WOMT will respond to the Working Group's recommendations and the actions taken by the WOMT will be summarized by Reclamation and/or DWR annually and submitted to all WOMT agencies.

If an action is taken, the Working Group will follow up on the action to attempt to ascertain its effectiveness. An assessment of effectiveness will be attached to the notes from the Working Group's discussion concerning the action.

Life Stage	Adults	Adults	Adults	Adults and larvae	Adults and larvae	Larvae and juveniles	Larvae and juveniles	Juveniles
Previous Year's Fall Midwater Trawl Recovery Index (1)	Index below 74	Index below 74	Index below 74	Index below 74	Index below 74	Index below 74	Index below 74	Index below 74
Risk of Entrainment (2)				X2 upstream of Chipps Island and temps are ≥ 12°	X2 upstream of Chipps Island and temps are between 12° and 18°C	X2 upstream of Chipps Island and mean delta-wide temps <18°C and south delta temps below 25°C	X2 upstream of Chipps Island and temps are below 25°C	X2 upstream of Chipps Island and temps are below 25°C
Duration of Spawning period (number of days temperatures are between 12 and 18°C) (3)					39 days or less by April 15	50 days or less by May 1		
Spawning Stage as determined by spring Kodiak trawl and/or salvage (4)			Presence of Adults at spawning stage ≥ 4	Adult spawning stage ≥ 4	Adult spawning stage ≥ 4			
smelt distribution (5)	See footnote #5	See footnote #5	See footnote #5	See footnote #5 or negative 20mm centroid or low juvenile abundance	Negative 20mm centroid or low juvenile abundance	Negative 20mm centroid or low juvenile abundance	Negative 20mm centroid or low juvenile abundance	Negative 20mm centroid or low juvenile abundance
Salvage Trigger (6)	Adult concern level calculation	Adult concern level calculation	Adult concern level calculation	Adult concern level calculation		If salvage is above zero	If salvage is above zero	

Tools for Change (7)	**December**	**January**	**February**	**March**	**April**	**May**	**June**	**July**
Export reduction at one or both facilities	X	X	X	X	X	X	X	X
Change in barrier operations						X	X	X
Change in San Joaquin River flows				X	X	X	X	X
Change position of cross channel gates						X	X	

Delta Smelt Risk Assessment Matrix Footnotes (note: the references for the DSRAM are also included in the literature cited section of the biological opinion)

1 The Recovery index is calculated from a subset of the September and October Fall Midwater Trawl sampling (http://www.delta.dfg.ca.gov/). The number in the matrix, 74, is the median value for the 1980-2002 Recovery Index (Figure DS1)

The temperature range of 12 to 18 degrees Celsius is the range in which most successful delta smelt spawning occurs. This has been analyzed by using observed cohorts entering the 20-mm Survey length frequency graphs (1996-2002). Cohorts were defined by having a noticeable peak or signal and occurring over three or more surveys during the rearing season. Back calculations were made using the first survey of that cohort with fish less than 15 mm fork length. Temperature data from IEP's HEC-DSS Time Series Data web site was compiled using three stations representing the south Delta (Mossdale), confluence (Antioch), and north Delta (Rio Vista) and averaged together. Spawning dates for each cohort were back-calculated by applying an average daily growth rate (wild fish) of 0.45 mm/day (Bennett, DFG pers. comm.) and egg incubation period of 8-14 days (Baskerville-Bridges, Lindberg pers. comm.)(Mager et al. 2004) from the median value of the analyzed cohort. Each spawning event was then plotted against temperature over time (Figure DS2.1). While spawning does occur outside of the 12-18 degree range, larval survival is most likely reduced when temperatures are either below (DFG pers. comm.) or above this range (Baskerville-Bridges & DFG pers. comm.).

Critical thermal maxima for delta smelt was reached at 25.4 degrees Celsius in the laboratory (Swanson et al., 2000); and at temperatures above 25.6 degrees Celsius smelt are no longer found in the delta (DFG, pers. comm.).

Websites for the temperature data: http://iep.water.ca.gov/cgi-bin/dss/dss1.pl?station=RSAN007
http://iep.water.ca.gov/cgi-bin/dss/dss1.pl?station=RSAN087
http://iep.water.ca.gov/cgi-bin/dss/dss1.pl?station=RSAC101

Mager RC, Doroshov SI, Van Eenennaam JP, and Brown RL. 2004. Early Life Stages of Delta Smelt. American Fisheries Society Symposium 39:169-180.

Swanson C, Reid T, Young PS, and Cech JJ. 2000. Comparative environmental tolerances of threatened delta smelt (*Hypomesus transpacificus*) and introduced Wakasagi (*H. nipponensis*) in an altered California estuary. Oecologia 123:384-390.

3 Figure DS3: The working hypothesis for delta smelt is that spawning only occurs when temperatures are suitable during the winter and spring. In years with few days having suitable spawning temperatures, the spawning "window" is limited, so the species produces fewer cohorts of young smelt. When there are fewer

cohorts the risk that mortality sources such as entrainment may substantially reduce population size increases. The figures below were used to help define years when there were relatively few days with suitable temperatures. For April 15 and May 1, the figures show the cumulative spawning days for each year during 1984-2002. The cumulative spawning days for each year were calculated based on the number of days that the mean water temperature for three Delta stations (Antioch; Mossdale and Rio Vista) was in the 12 - 18 C range starting on February 1. The results are plotted in terms of the ranks to identify the lower quartile. In other words, years in the lower quartile represent examples of years with relatively few spawning days.

4 The adult spawning stage is determined by the Spring Kodiak Trawl and/or fish collected at the salvage facilities (http://www.delta.dfg.ca.gov/). A stage greater than or equal to 4 indicates female delta smelt are ripe and ready to spawn or have already spawned (Mager 1996).

Mager RC. 1996. Gametogenesis, Reproduction and Artificial Propogation of Delta Smelt, *Hypomesus transpacificus*. [Dissertation] Davis: University of California, Davis. 115 pages. Published.

5 The spring kodiak trawl will be used to generally evaluate the distribution of adult delta smelt. However, since the spring kodiak trawl is not intended to be a survey for abundance or distribution, no definitive trigger for concern can be determined at this time.
Juveniles (March-July) – distribution of juvenile delta smelt where the centroid is located upstream (negative) or downstream (positive) of the Sacramento-San Joaquin River confluence (Sacramento RKI 81; Figure DS5.1). The 20-mm Survey centroid is calculated by multiplying the observed delta smelt station CPUE (fish/10,000 m3) by a distance parameter in km from Sacramento RKI 81. The summed result (summed over a survey) is divided by the survey CPUE which gives the survey centroid position (Figure DS5.2).

Low juvenile abundance will also be a trigger. When juvenile abundance is low, concern is high. Low abundance is indicated when the total cumulative catch in the 20-mm Survey is less than or equal to the 1995-2003 median value of cumulative 20-mm Survey catch for the same surveys (Table DS5).

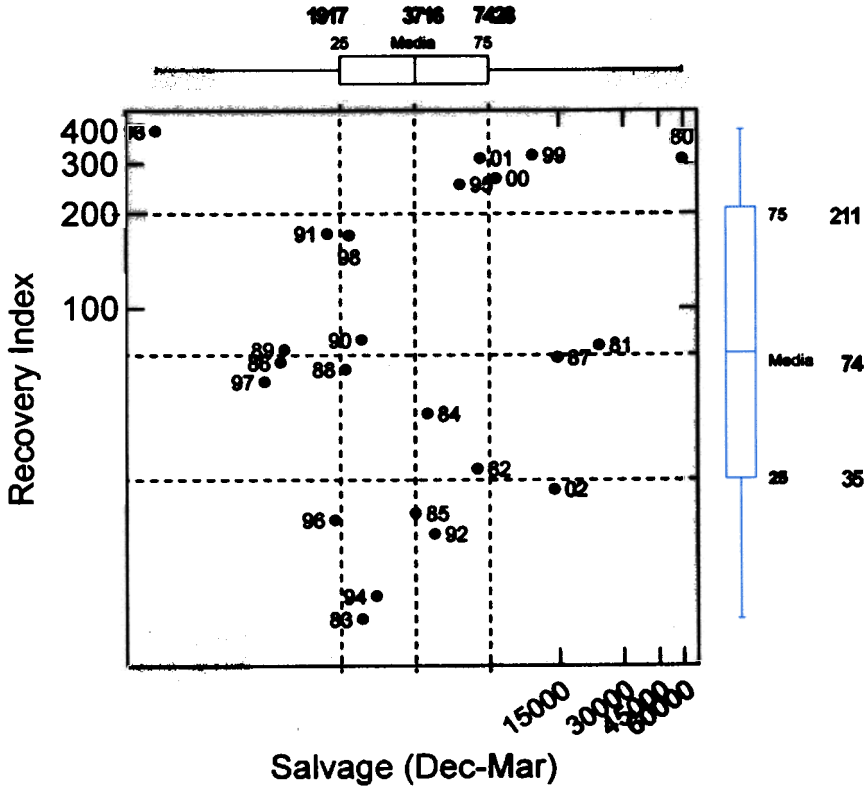
6 Adult salvage trigger: the adult delta smelt salvage trigger period is December through March and the trigger is calculated as the ratio of adult delta smelt salvage to the fall MWT index. This ratio will increase as fish are salvaged during the winter months. If the ratio exceeds the median ratio observed during December-March 1980-2002, then the trigger has been met (see Figure DS6 for more explanation of the calculation)

Juvenile salvage trigger: During May and June, if delta smelt salvage at the SWP/CVP facilities is greater than zero, then the working group will meet. This

is because May and June are the peak months of delta smelt salvage and salvage densities cannot be predicted. Therefore, during these two months, the delta smelt working group expects to meet regularly to look at relevant information such as salvage, delta temperatures, delta hydrology and delta smelt distribution and decide whether to recommend proactive measures to protect these fish.

7 The tools for change are actions that the working group can recommend to the WOMT to help protect delta smelt. Exports may be reduced at one or both of the south delta export facilities and a proposed duration of the reduction would be recommended by the working group. Export reductions and changes in San Joaquin River flows may be covered by B(2) or EWA assets. Details of past fish actions can be found at the Calfed Ops website: http://wwwoco.water.ca.gov/calfedops/index.html; >Operations [year]

Figure DS1



Points are labeled with the year representing the recovery index.
The winter salvage for this analysis starts on December 1 of the recovery index year and continues through March 31 of the following year.

Figure DS2.1. Successful delta smelt spawning periods (shaded blue area) and cohorts (black bars) plotted against water temperature (1996-2002). Spawning periods and cohorts were back calculated using 20-mm Survey catch data. Start of spawning season uses an egg incubation period of 14 d and a growth rate of 0.45 mm/day and end of spawning season 8 d with a growth rate of 0.45 mm/day. Black bars represent the range of 8-14 d egg incubation with a growth rate of 0.45 mm/day from laboratory results. Temperature data (°C) was compiled from IEP's HEC-DSS Time Series Data using mean daily temperatures from the confluence (Antioch), south Delta (Mossdale), north Delta (Rio Vista) and averaged together.

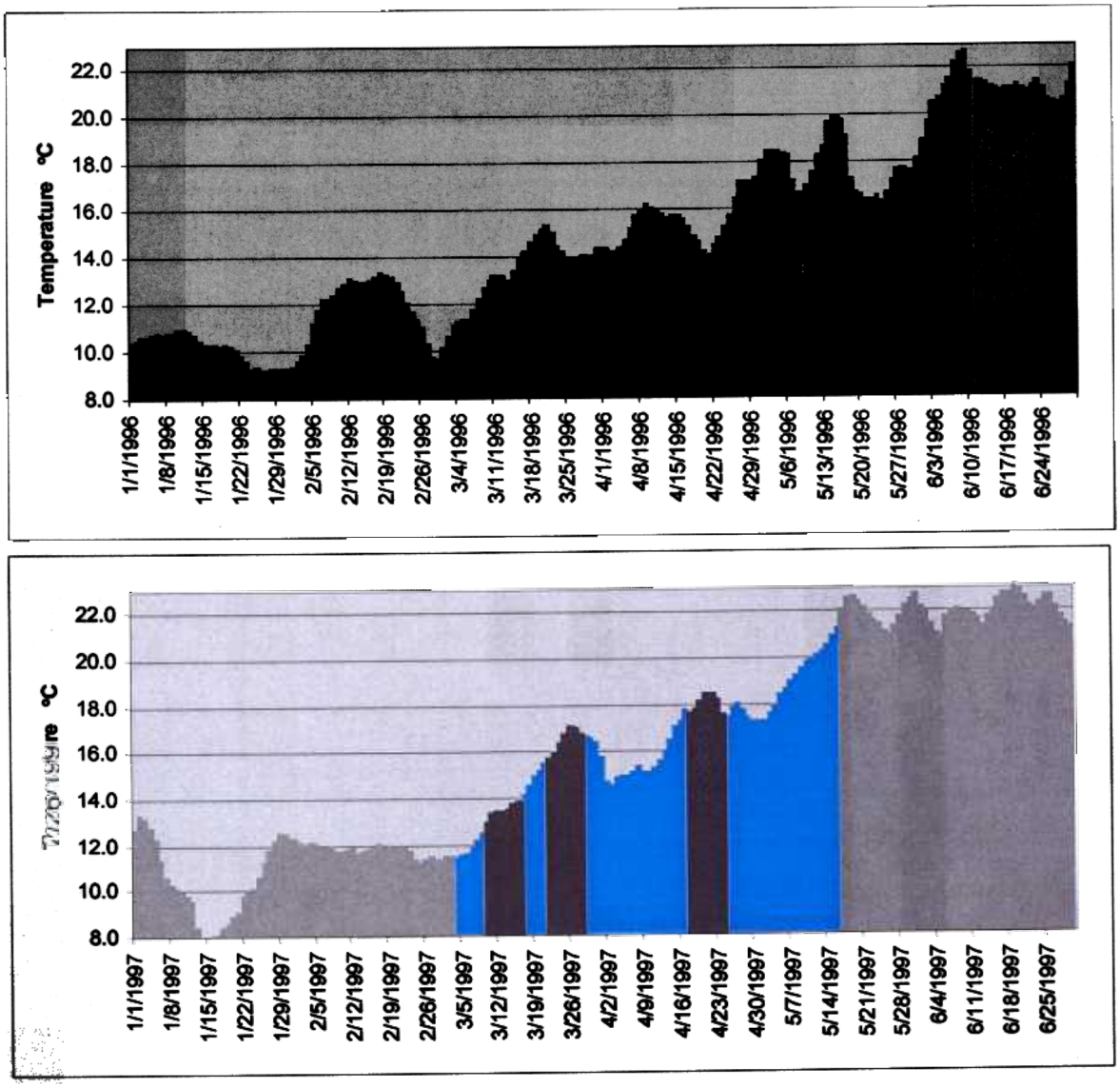


Figure DS2.1 cont.

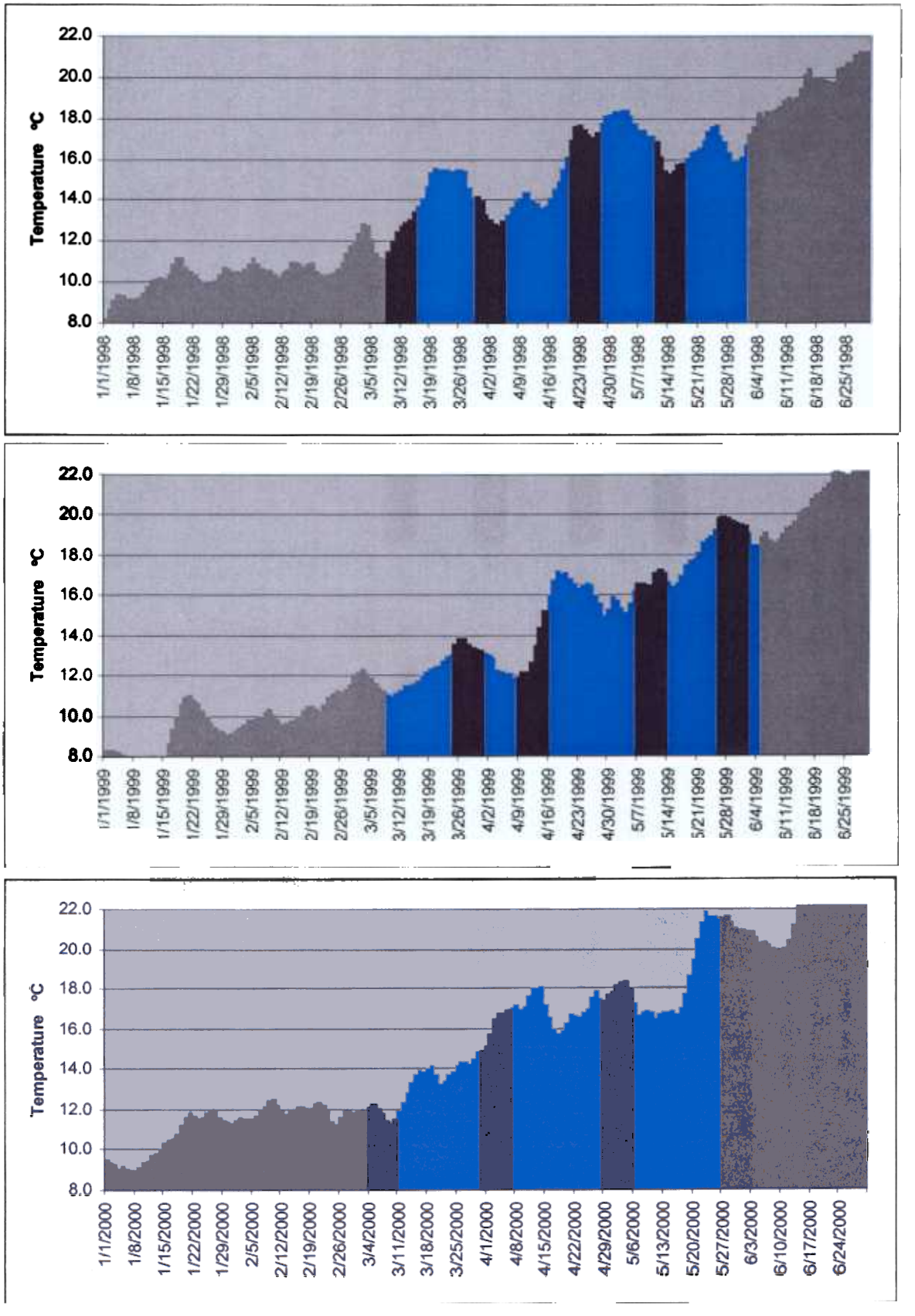


Figure DS2.1 cont.

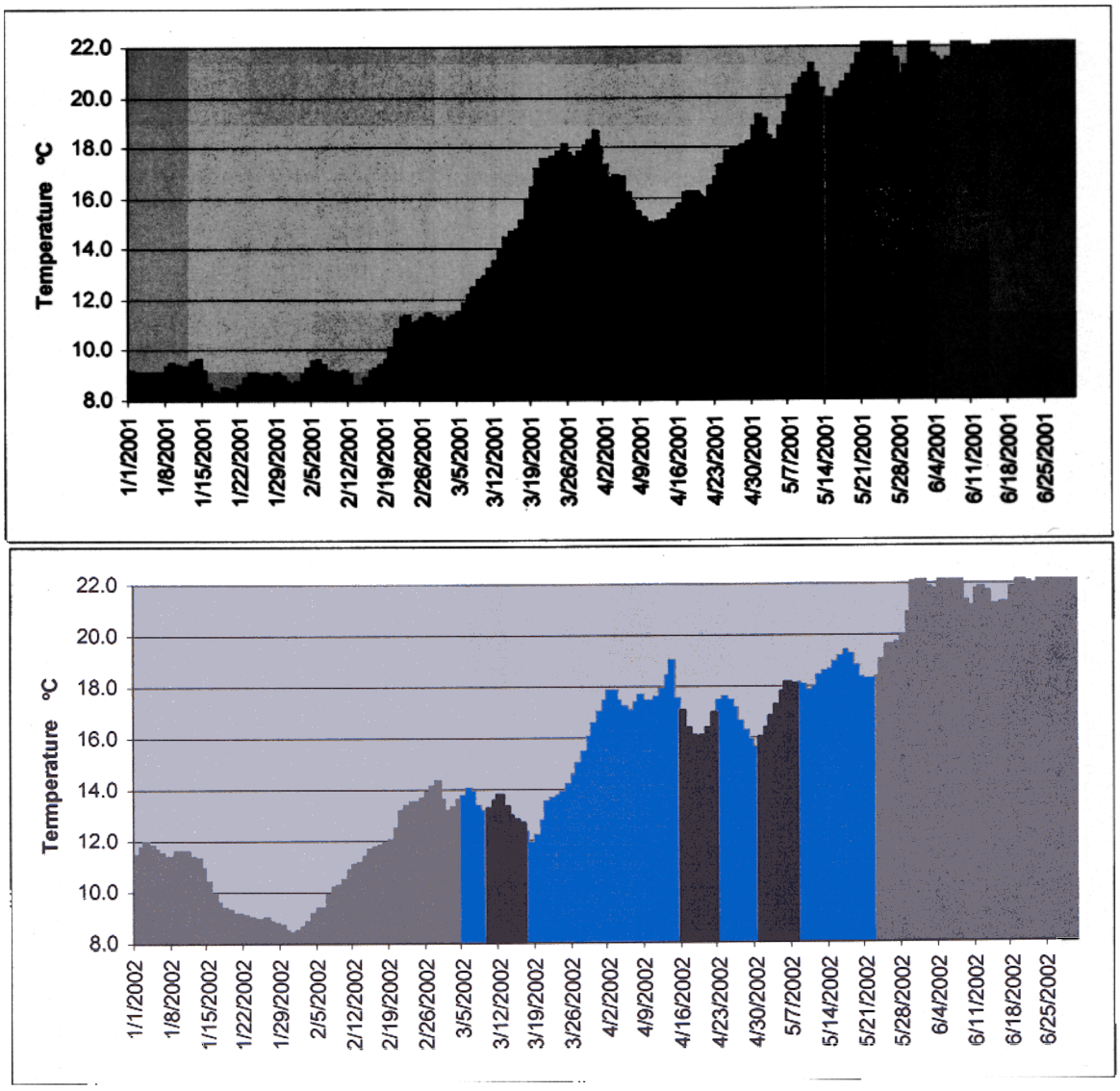
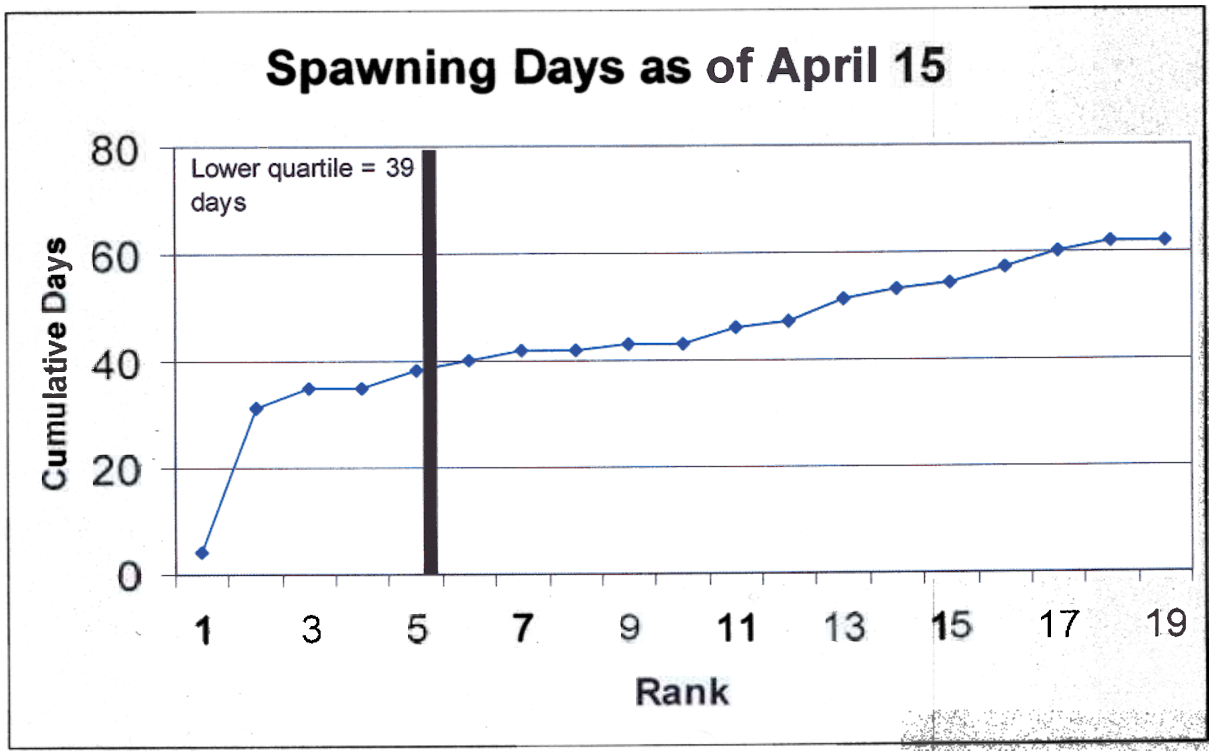


Figure DS3.


Spawning Days as of April 15
Lower quartile = 39 days
Cumulative Days
0
20
40
60
80
1
3
5
7
9
11
13
15
17
19
Rank

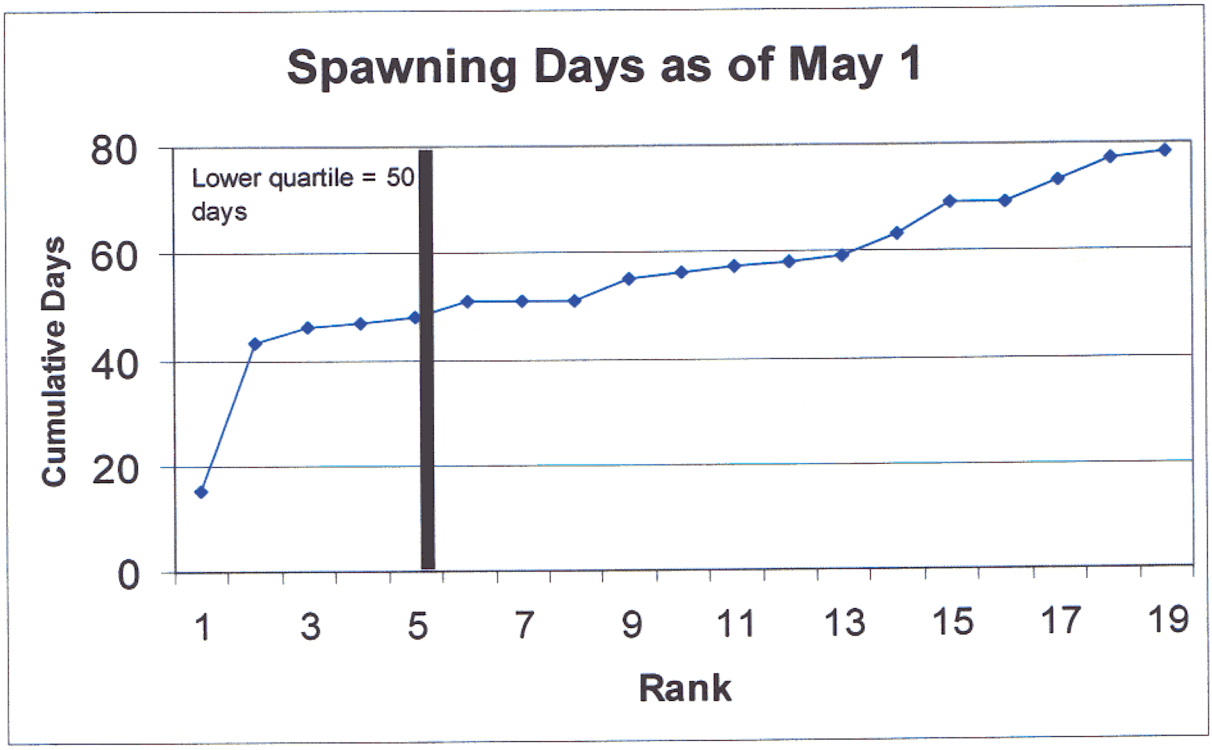

Spawning Days as of May 1
Lower quartile = 50 days
Cumulative Days
0
20
40
60
80
1
3
5
7
9
11
13
15
17
19
Rank

Figure DS5.1. A 20-mm Survey delta smelt bubble plot map with calculated centroid position from the confluence of Sacramento-San Joaquin Rivers with one standard deviation.

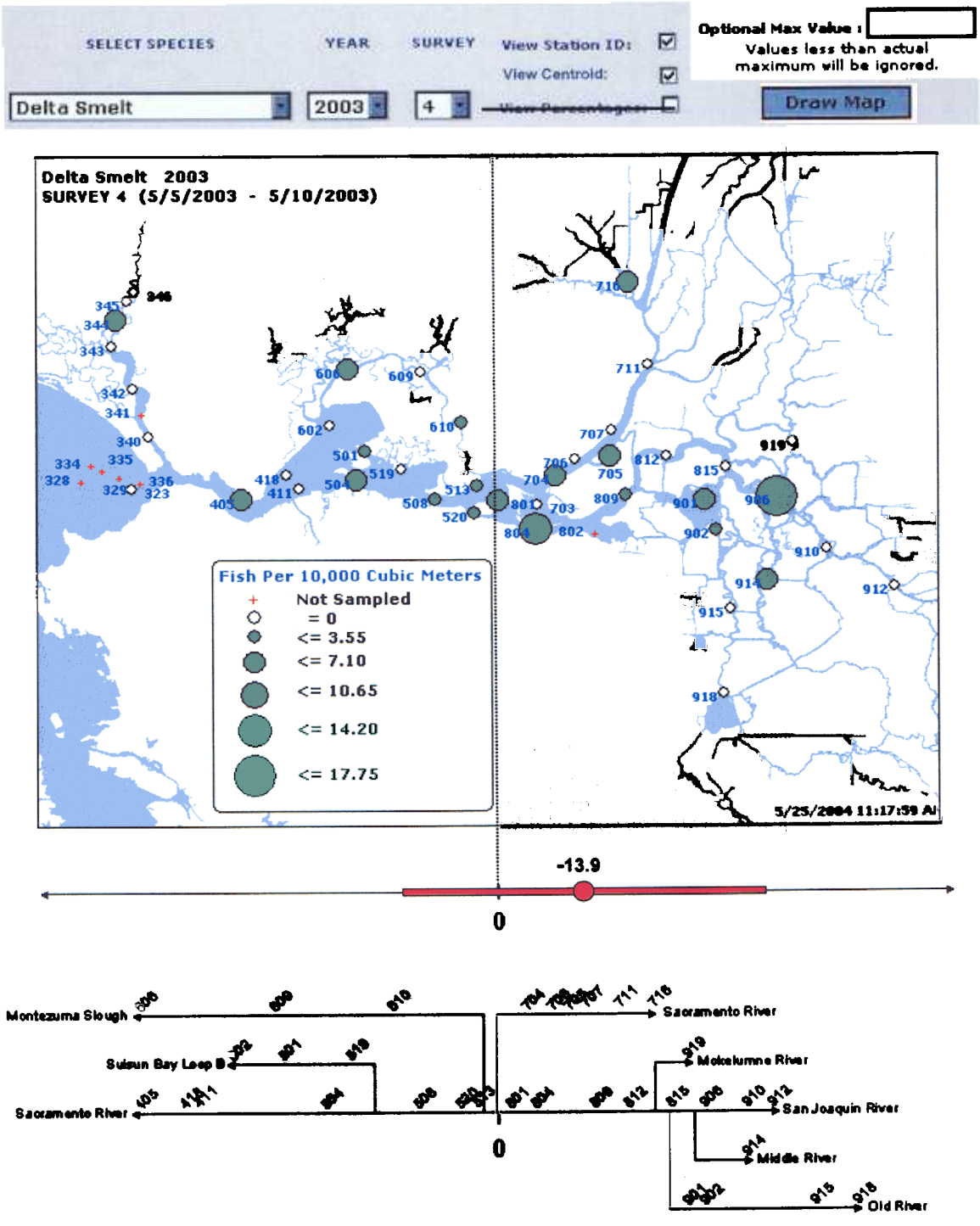


Figure DS5.2. Historic juvenile centroid position (20-mm Survey) with one standard deviation.

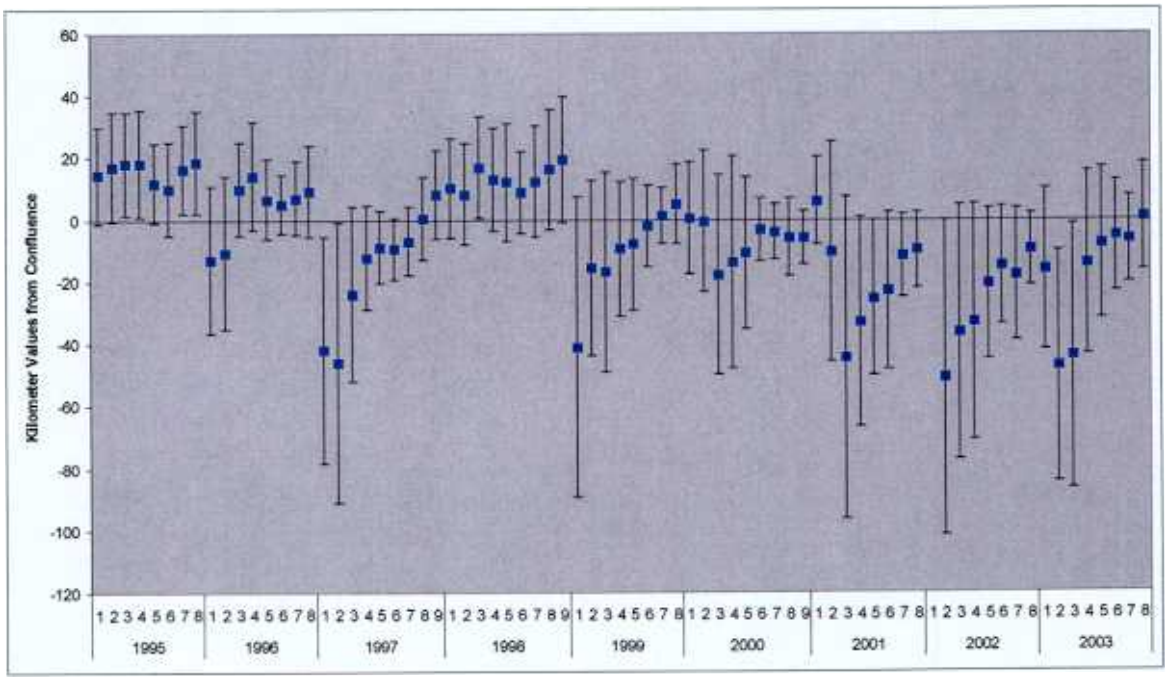


Table DS5. Median values of cumulative catch from the 20-mm Survey. When cumulative catch per survey during a season is at or below the calculated value, concern is high.

	survey 1	survey 2	survey 3	survey 4	survey 5	survey 6	survey 7	survey 8
Median Value	12	40	144	188	346	500	924	1019

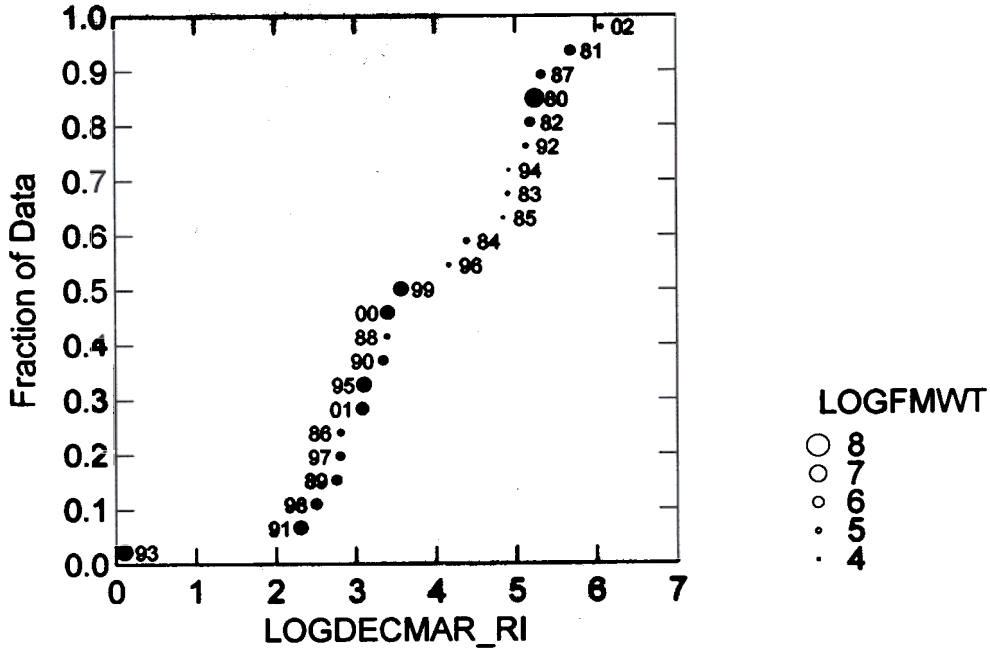
Figure DS6

The objective is to quantify a level of concern for adult delta smelt during the winter that is based upon the number of fish salvaged and the overall abundance of delta smelt. Our trigger reflects that when abundance is low and salvage is high concern is high, and conversely when abundance is high and salvage is low that concern is low.

Below is a Quantile plot of the ratio of winter salvage to the MWT recovery index (ln(winter salvage/recovery index)). Winter salvage is defined as the total salvage from December through March. In the figure below, the size of the bubbles is proportional to the log of the fall midwater trawl to demonstrate that concern may be high in years of

high or low fall abundance. The resulting quartiles of the ratio are as follows: 25% =: 2.950; 50%= 3.575; 75% 5.029.
Using this approach to calculate winter concern levels, all years above the 1999 point in the graph would have been years of concern. In other words, these are the years in which we may have recommended some protection. Comparing it to the protection afforded adult delta smelt in the winter by the 1995 Biological Opinion: "red light" was, or would have been, reached in fewer winters (1980, 1981, 1982, 1984 and 1999) .

The median was selected as the measure of concern and will be calculated by:
concern level = anti ln(3.575)* Recovery index



The goal for the DSRAM is to avoid the upper quartile of the above graph, which the Working Group thinks will avoid salvage events that are high relative to fall abundance. Actions may be taken prior to major salvage events.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Southwest Region
2800 Cottage Way, Suite W-2606
Sacramento, California 95825

IN REPLY REFER TO:
FWS/R8/FAC

JAN - 9 2015

Memorandum

To: Regional Director, Bureau of Reclamation, Mid-Pacific Region
Sacramento, California

From: Regional Director, Fish and Wildlife Service, Pacific Southwest Region
Sacramento, California

Subject: Reinitiation of Consultation on the 2008 FWS OCAP Biological Opinion and Conveyance of Revised Incidental Take for the 2015 Water Year

This memorandum acknowledges, and accepts, your request, dated January 9, 2015, to re-initiate the Endangered Species Act Section 7(a)(2) consultation on the 2008 FWS Biological Opinion (2008 BO) on Coordinated Long-Term Operation of the Central Valley Project (CVP) and State Water Project (SWP). Reclamation requested reinitiation of Section 7 consultation on the estimated adult Delta Smelt incidental take authorization for WY 2015 associated with implementation of the CVP and SWP. The event that triggered the need to re-initiate consultation was incidental take of Delta Smelt, a threatened species, during the course of water operations that were conducted in accordance with the 2008 opinion.

While in re-initiation, the Service will work with the Bureau of Reclamation (Reclamation) to determine if any modifications are needed to current operations to lessen the likelihood of unanticipated incidental take of Delta Smelt.

As requested, this memorandum includes our response to your earlier request to consider Reclamation's Cumulative Salvage Index (CSI) proposed alternative method to calculate take likely to occur while implementing the Reasonable and Prudent Alternative of the 2008 BO (hereafter "alternative method").

The alternative method was reviewed by the Independent Review Panel for the 2014 Long-term Operation Biological Opinions (LOBO) Annual Science Review in a report to the Delta Science Program. The panel was critical of both the alternative method and the method prescribed in the 2008 BO. In the opinion of the panel, because both methods rely on a relationship between the Fall Midwater Trawl and winter salvage, neither effectively links entrainment take to impacts at the population level. The panel observed that there is substantial uncertainty associated with both the Biological Opinion and alternative method of calculating CSI and when this uncertainty is considered, values generated by each method are not statistically distinguishable. Consequently, the

panel concluded it had no basis to recommend replacement of the current method with the alternative method. However, the report also did not find the alternative method to be poorer than the method prescribed in the Biological Opinion.

Given the panel's conclusions, the Service believes that the present method of estimating incidental take is in need of revision along the lines recommended by the panel. Specifically, a new approach is needed that directly estimates entrainment loss as a proportion of the population, or, alternatively, that allows measurement of entrainment in terms of number of fish lost due to the effects of export pumping while also providing improved overall population size estimation; the combination would allow entrainment loss to be expressed as a proportion of the population. There are several approaches to accomplishing this that are currently under development that the Service is aware of. They include work underway by the Service to develop a Delta Smelt Life Cycle Model, and its off-shoot studies; also, there is pertinent work proposed by the Smelt Scoping Team as part of the Collaborative Science and Adaptive Management Process. None of these efforts has at the present time yielded a mature product that is suitable for application to address this issue.

The Service has reviewed Reclamation's proposal in light of the panel report, and has concluded that the alternative method, with modification, represents a viable interim approach to addressing incidental take while a new method conforming to the requirements set forth above is developed. This conclusion is based on the following analysis. First, the alternative method represents the same approach to incidental take estimation as the method set forth in the Biological Opinion, with the exception that the alternative method relies on a calculation based on a larger sample of data. Hence, the approach is congruent with the method the Service has already analyzed. Second, the panel's analysis and the Service's own internal analysis reveal that the CSI statistic as used in both the Biological Opinion and the alternative method is extremely noisy, making substantially different numerical CSI values statistically indistinguishable from one another. Third, a flaw the panel identified as unique to the alternative method approach, that involves the joint use of modeled Old and Middle River (OMR) flow data in conjunction with historical Secchi depth measurements, is mitigable via a method provided by the panel. The Service has followed the advice of the panel, as described below.

To fix a flaw in Reclamation's alternative method, the independent panel suggested the use of a Monte Carlo procedure to make predictions of future CSI values for a variety of OMR and Secchi combinations using the alternative method model for CSI. A description of the steps taken to implement that procedure, as well as the resulting estimated distribution of CSI, is described in the attachment.

For water year 2015, the current method resulted in an allowable incidental take (expanded number, rounded to the next higher integer) of adult Delta Smelt of 78 and an early warning value of 58 adult Delta Smelt (75% of 78). Given the considerations set forth above, the Service has decided to use the current method and the result of 78 adult Delta Smelt as the early warning indicator and the result from alternative method, as modified by the application of the Monte Carlo method, of 196 adult Delta Smelt as the allowable incidental take of adult Delta Smelt for Water Year 2015. If the early warning indicator of 78 adult Delta Smelt is reached, Reclamation, working with State partners, should closely monitor environmental conditions and water operations to ensure entrainment events do not result in incidental take (expanded number) that exceeds 196 adult Delta Smelt this year.

As our initial response to your request, the Service approves implementation of the proposed CSI and associated ITL changes described above. This is intended to be incorporated as an interim measure to be used until it can be replaced with a proportional entrainment method as described above. Although this revised calculation results in a higher estimate of the take that could occur in this water year due to project operations as restrained by the 2008 BO and its Reasonable and Prudent Alternative (RPA), the BO and RPA's restraints, as well as its conclusions about the effects of the projects, are not changed by the this interim measure. The Service understands the importance of continued operation of the Projects in this year to meet health and safety and other critical needs, we will work with you through this reinitiation of section 7 consultation as Water Year 2015 hydrology and drought response actions continue to develop.

Attachment

Attachment: Monte Carlo Correction Recommended by the Independent Review Panel

In their 2014 report, the Independent Review Panel for the 2014 Long-term Operation Biological Opinions (LOBO) Annual Science Review suggested the Service might improve the alternative method. Their advice was to "...repeatedly choose random, independent values of Secchi and OMR from their respective distributions, which could be estimated from the 18-year record. The random (OMR, Secchi) pairs would then be inserted into the regression model, to repeatedly predict CSI." (Page 28, paragraph 3) Given that there are 18 of each used to fit the model, there are 18*18 = 324 unique combinations, all equally likely. If one draws at random, repeatedly and without replacement, from each set of 18 numbers, i.e., a Monte Carlo procedure, the asymptotic distribution of results is simply the frequency histogram of the 324 predictions.

The 18 pairs of OMR and Secchi values used to make predictions were taken from Table 1 of the 19 September 2014 MWD draft proposal (titled "Proposal for Calculating Cumulative Salvage Index Values Used for Estimating Take Likely to Occur under the USFWS Old and Middle River Flow RPA for Adult Delta Smelt"). The values are listed below.

OMR:
-5589.760 -4185.090 -2385.090 -1085.170 -898.787 -5151.930 -5409.310 -7304.400 -8458.510 -8557.460 -5395.440 -1955.200 -5855.620 -3643.160 -3291.360 -4646.170 -2412.670 -3538.800

Secchi
25.0 64.7 10.9 34.6 33.9 51.0 37.5 37.8 28.2 29.7 50.2 30.5 57.9 25.3 71.2 57.5 65.4 62.3

Predictions of CSI were made with the following model:
CSI predicted = 10^(1.6411352331 - 0.0298007791*OMR - 0.0001078126*Secchi)

The table below also lists the percentiles and the corresponding Incidental Take Limit (rounded values) assuming a FMWT Index value of 9.

Percentile	5%	10%	25%	50%	75%	80%	90%
CSI	0.89	1.20	2.33	7.64	17.91	21.81	33.68
2015 ITL	8	11	21	69	161	196	303