Appendix J

Methods for Assessment of Fish Entrainment in SWP and CVP Exports

Contents

Tables, Figures, and Photographs

Table **At End of Appendix**

Figure **At End of Appendix**

Photograph **At End of Appendix**

Acronyms and Abbreviations

AG	agricultural diversions
BO	Biological Opinion
CCC	Contra Costa Canal
CCF	Clifton Court Forebay
CCWD	Contra Costa Water District
cfs	cubic foot per second
CVP	Central Valley Project
CWT	coded-wire tag
D-1485	State Water Board Decision 1485
D-1641	State Water Board Decision 1641
DCC	Delta Cross Channel
Delta	Sacramento–San Joaquin River Delta
DFG	California Department of Fish and Game
DWR	California Department of Water Resources
E/I	export/inflow
EWA	Environmental Water Account
fish/af	fish per acre-foot
FMWT	fall mid-water trawl
IEP	Interagency Ecological Program
ish/af	fish per acre-foot
JPE	juvenile production estimate
mm	millimeters
NB	North Bay Aqueduct
NOAA Fisheries	National Marine Fisheries Service
OCAP	CVP-SWP Operations Criteria and Plan
PTM	Particle Tracking Model
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
SDIP	South Delta Improvements Program
State Water Board	State Water Resources Control Board
SWP	State Water Project
taf	thousand acre-feet
TNS	tow-net survey
USFWS	U.S. Fish and Wildlife Service
VAMP	Vernalis Adaptive Management Plan
YOY	young-of-the-year

Appendix J

Methods for Assessment of Fish Entrainment in State Water Project and Central Valley Project Exports

Introduction

This appendix describes the methods used to evaluate entrainment impacts of the South Delta Improvements Program (SDIP). Because entrainment of fish depends on the location and abundance (density) of fish, those factors thought to control the timing and distribution of fish species in the Sacramento–San Joaquin River Delta (Delta) are also presented. Results from DSM2 particle tracking simulations are presented as a guide to evaluate the entrainment risk of fish from different locations within the Delta.

Entrainment of fish in water diverted from the Delta has been identified as a primary concern for Chinook salmon, delta smelt, and other fish species (U.S. Fish and Wildlife Service 1996). There are several large water supply and industrial (i.e., cooling water) diversions as well as many small agricultural diversions that have the potential to entrain fish with the diverted water. The Central Valley Project (CVP) and State Water Project (SWP) pumping plants, the two largest diversions from the Delta, entrain thousands of fish annually.

The SDIP includes project actions that potentially affect the number of fish entrained by SWP and CVP pumping and in other Delta diversions. The timing and volume of SWP and CVP pumping are potentially altered with implementation of the SDIP. Construction of barriers at the head of Old River and in other south Delta channels potentially blocks fish movement and alters net and tidal flows that could affect the movement and distribution of fish and subsequent diversion-related mortality.

The environmental conditions that influence entrainment and the mortality of fish attributable to the effects of Delta diversions include:

- abundance, distribution, and movement of fish in the Delta;
- fish behavior in response to variable environmental conditions;
- diversion location, position, volume, duration, and timing (i.e., seasonal, diurnal, tidal phase);

- effects of net and tidal flows on the movement of fish;
- effects of diversions on net and tidal flows;
- direct and indirect (i.e., net and tidal flow) effects of barriers on fish movement;
- efficacy of fish salvage, handling, holding, transport, and release facilities and procedures; and
- predation vulnerability prior to entrainment and associated with salvage facilities and release procedures.

Although entrainment at the CVP and SWP pumping plants is well documented (salvage records), the relationships between variable environmental conditions and the mortality of fish attributable to the effects of diversions and entrainment remain poorly understood. Three possible hypotheses guide the assessment of entrainment effects that are attributable to SDIP actions:

1. The number of fish entrained is directly related to diversion volume and an assumed density of fish in the water diverted. The fish density pattern is assumed to be independent of the pumping rate.
2. The number of fish entrained is related to the interaction between Delta channel tidal hydraulics and fish distribution. Fish are assumed to behave and move as passive particles within the Delta channels.
3. The number of fish entrained is related to the interaction between Delta tidal hydraulics, fish distribution, and fish behavior. Fish are assumed to use hydraulic conditions to expedite movement toward their migration objective (i.e., Suisun Bay).

Entrainment loss attributable to implementation of the SDIP alternatives was assessed using primarily the first hypothesis—that the number of fish entrained is directly related to diversion volume and an assumed density of fish in the water diverted. The assessment method is consistent with methods used for other projects (California Department of Water Resources and Bureau of Reclamation 2001). This results in a linear relationship between fish entrainment and the CVP and SWP diversion volume. However, the method does not account for variable abundance, distribution, and movement of fish in the Delta or fish behavioral responses to changes in the net and tidal flow and salinity distribution, environmental conditions potentially affected by implementation of the SDIP alternatives.

This appendix presents a detailed discussion of the assessment methods based on hypothesis 1 (historical fish density), but also presents alternative assessments of fish entrainment based on hypotheses 2 and 3. The assessments based on hypotheses 2 and 3 illustrate how alternative hypotheses about impact mechanisms can change the impact conclusions.

Central Valley Project and State Water Project Fish Salvage Facilities

The CVP Tracy Fish Facility and the SWP John E. Skinner Fish Protection Facility use a series of primary and secondary louvers to separate fish from the diverted water. The efficiency of these salvage operations depends on the size of the fish, as well as the susceptibility of the fish to handling stresses and predation.

Photograph J-1 shows an aerial view of the CVP Tracy Fish Facility and Photograph J-2 shows the primary louver panels that separate fish from the water entering the DMC intake channel leading to the CVP Tracy Pumping Plant. This facility was originally built in 1955 and was designed to salvage striped bass and Chinook salmon with an efficiency of about 75% for fish larger than 25 millimeters (mm) (1 inch).

Photograph J-3 to J-10 show various parts of the John E. Skinner Fish Protection Facility, which is located between the Clifton Court Forebay (CCF) and the SWP Harvey O. Banks Pumping Plant. The Skinner Fish Facility was designed to follow the CVP Tracy Fish Facility with a primary louver and secondary louver with holding tanks and transport trucks.

Biologists sample for 5 minutes each hour or 10 minutes every 2 hours throughout every day of the year. Species are identified and the fish lengths are measured. Because the biologists count only for 5 minutes each hour, the raw fish counts for each day are expanded (by 12x) to give the daily salvage estimates. The historical salvage data from 1980 to 2002 were summarized and used to estimate fish density for fish species: striped bass, Chinook salmon, delta smelt, splittail, and steelhead trout. There are many other species that are identified, counted, and measured. The entrainment impacts for these five species are used to provide an overall assessment of the impacts from the SDIP alternatives from CVP and SWP pumping.

Central Valley Project and State Water Project Daily Fish Salvage Densities for 1999

The daily salvage for each species is summarized as monthly salvage density (fish/cubic foot per second [cfs]) by dividing the total fish salvaged in a month by the monthly average pumping rate (cfs). These values are equivalent to the number of fish in 60 acre-feet of water, because pumping 1 cfs for a month will be a volume of 60 acre-feet. In the review of 1999 salvage density pattern for these five species, the fish density will be shown as fish/thousand acre-feet (taf). This density value is 16.7 times the fish/cfs values used in the assessment tables in this appendix (1 fish/cfs = 16.7 fish/taf).

Figure J-1 shows the measured daily fish density for the five species at the SWP and the CVP fish facilities for 1999. The historical daily pumping also is shown. The fish salvage patterns indicate that the fish have definite periods of maximum density during the year, and the densities measured at the two fish facilities are often similar. The fish density is shown with a logarithmic scale because the range of fish density is very large.

Figure J-2 shows the measured fish density for Chinook salmon at the SWP and CVP fish facilities and from the San Joaquin River at Mossdale trawl station, which is sampled during the day by California Department of Fish and Game (DFG). During 1999, the head of Old River fish barrier was not installed. The Chinook salmon densities measured at the CVP and SWP fish facilities were similar to the San Joaquin River densities during the months of February–June when the Chinook salmon densities are highest. The lengths in February are consistent with small 35-mm juveniles that have apparently been transported into the Delta with the high flows, while the April, May, and June fish are 85-mm smolts that are apparently migrating toward Suisun Bay and the ocean.

The San Joaquin River diversions through the head of Old River generally go to the CVP pumping first and enter the SWP (i.e., CCF) only if the head of Old River diversion flow is more than the CVP pumping. Nevertheless, both the SWP and CVP densities in 1999 were similar to the San Joaquin River Mossdale densities. Closing the temporary barrier at the head of Old River during the Vernalis Adaptive Management Plan (VAMP) is planned as a measure to reduce the fish salvage density at the CVP and SWP pumps. The effects of predation in CCF are not strongly evident in this 1999 data because the SWP and CVP densities are similar.

Figure J-3 shows the measured density for striped bass at the SWP and CVP fish facilities in 1999. The striped bass fish densities measured at the CVP and SWP fish facilities were very similar and indicate a maximum density during the months of July–September. This is one of the dominant fish species in the salvage records. The median fish length increases with a nearly constant growth rate of about 25 mm/month. The density declines because of active migration toward Suisun Bay and because of mortality (predation) throughout the year. Spawning is generally in April or May, but it takes a month for the juveniles to grow to the minimum length of 20 mm that can be effectively salvaged and counted at the fish facilities.

Figure J-4 shows the measured density for delta smelt at the SWP and CVP fish facilities in 1999. The salvage of delta smelt at the SWP facility was more than 100,000 fish in 1999 (see Table J-7). The delta smelt fish densities measured at the CVP and SWP fish facilities were very similar and indicate a maximum density during the months of May–June. Other years can have high densities in July as well. The median fish length increases with a nearly constant growth rate, but few fish are salvaged after July until February and March, when the adults show up for spawning. Spawning is generally in March or April, but it takes a month for the juveniles to grow to the minimum length of 20 mm that can be effectively salvaged and counted at the fish facilities. Figure J-5 shows the length-frequency results for delta smelt from the 20-mm tow-net surveys for 1999.

Figure J-6 shows the measured density for steelhead and splittail at the SWP and CVP fish facilities in 1999. The steelhead fish densities measured at the CVP and SWP fish facilities were very low and similar and indicate a maximum density during the months of March–May. The splittail densities of adults were highest in March as the fish move upstream to spawn, while the juvenile densities were highest in July and August.

This review of 1999 salvage fish densities from the CVP and SWP fish facilities indicates that there are months with higher densities of fish that reflect the life-stage and migration patterns for each species. Additional years of daily fish salvage density are shown in Appendix B, “Simulation of Environmental Water Account Actions to Reduce Fish Entrainment Losses.”

The SDIP entrainment assessment for the CVP and SWP pumping facilities ignores the potential salvage of these entrained fish and assumes that all diverted fish are “lost.” In addition, following the calculations established by DFG for the “Four-Pumps” agreement of 1986 (California Department of Water Resources 1986), Chinook salmon salvage counts are increased considerably to account for assumed predation losses in CCF.

Assessment of Entrainment of Fish Using Constant Monthly Fish Densities

The basis for assessment method 1 is the hypothesis that the number of fish entrained is directly related to diversion volume and timing and an assumed monthly density of fish in the water diverted. The relationship between diversion and entrainment is assumed to be linear; therefore, a 10% increase in monthly Delta diversions results in a 10% increase in the monthly number of fish entrained.

Diversion Volume

Monthly diversion volumes for CVP and SWP export pumping were simulated with the CALSIM II monthly water resources planning model for water years 1922 through 1994. CALSIM simulates the operations of the SWP and CVP under various assumed hydrologic conditions, demands, regulations, and facility configurations to estimate monthly water deliveries to SWP and CVP water users. A base case without the SDIP was simulated for comparison with the simulated action alternatives. Differences from the base case (i.e., Alternative 1) are analyzed to determine the effect of the proposed SDIP alternatives. The CALSIM model assumptions are the same for both the baseline and the SDIP alternatives, except for the action itself, and the focus of the analysis is the difference in the results. Section 5.1 provides a more complete description of the CALSIM II model and results. Monthly export pumping is given as monthly average flow, in cfs.

The SDIP will not directly change CVP or SWP pumping patterns except when the SWP pumping is already near the current limit of 6,680 cfs. During these periods, the combined CVP and SWP pumping will approach 10,000 cfs. During these months, when the SDIP will allow SWP pumping to increase to 8,500 cfs, the combined pumping could reach 12,000 cfs. This would be a 20% increase in monthly pumping and would result in a 20% increase in the monthly entrainment losses for all fish. The actual simulated changes in combined CVP and SWP pumping are generally much smaller than this maximum increase of 20%. The months with the greatest increase in pumping are generally the summer and fall months of July–October. Because the expected fish density in these months is very low for most of the fish species that require protection, the expected entrainment impacts are generally small.

Fish Density in Diverted Water

Historical salvage estimates for the CVP and SWP fish protection facilities for 1980 to the present were used to estimate the density of fish in the diverted water. The salvage data was obtained from the DFG Web site and FTP site at:

- <http://www.delta.dfg.ca.gov/Data/Salvage/>, and
- <ftp://ftp.delta.dfg.ca.gov/salvage/>.

The historical SWP and CVP monthly pumping (cfs) is given in Tables J-1 and J-2 for the 1980–2002 period when historical salvage data are available. The annul total pumping volume in taf is shown. The monthly pumping patterns for 1980–1995 were controlled by State Water Resources Control Board (State Water Board) Decision 1485 (D-1485), which required reduced pumping in the months of May, June, and July. The pumping patterns after 1996 were controlled by State Water Board Decision 1641 (D-1641), which requires reduced pumping in April, May, and June. These are the months with maximum fish density for many of the important fish species.

The historical salvage of striped bass (one of the most numerous fish in the Delta) at the SWP and CVP fish facilities is given in Tables J-3 and J-4. The highest monthly salvage was generally in the months of May, June, and July. During the 1980s, several million striped bass were salvaged in a month at the SWP facility. The annual total salvage of striped bass at the SWP facility in several years was more than 5 million fish. The CVP salvage of striped bass was generally lower, with more than 1 million striped bass salvaged at the CVP facility in several years, including 2001.

The historical salvage of Chinook salmon at the SWP and CVP fish facilities is given in Tables J-5 and J-6. The highest monthly salvage was generally in the months of April, May, and June. Most of the salvaged Chinook salmon are assumed to be San Joaquin River fall-run. During the 1980s, more than 25,000 Chinook salmon were salvaged in a month at the SWP facility. The annual total salvage of Chinook salmon at the SWP facility in several years was more than 100,000 fish. The CVP salvage of Chinook salmon was sometimes higher than the SWP, perhaps because the majority of the diverted San Joaquin River water enters the CVP facility. More than 100,000 Chinook salmon were salvaged at the CVP facility in several years, including 1998 and 1999.

The historical salvage of delta smelt at the SWP and CVP fish facilities is given in Tables J-7 and J-8. The highest monthly salvage was generally in the months of May, June, and July. However, the delta smelt salvaged in February and March are adults, which may have a greater impact on the population than the juveniles salvaged in later months. The annual total salvage of delta smelt at the SWP facility was more than 20,000 fish in several years, including 1996, 1997, 1999, 2001 and 2002. The CVP salvage of delta smelt was generally lower than the SWP salvage, perhaps because the majority of the CVP water originates from the San Joaquin River where few delta spelt spawn. More than 10,000 delta smelt were salvaged at the CVP facility in several years, including 1999–2002.

The historical salvage of splittail at the SWP and CVP fish facilities is given in Tables J-9 and J-10. The highest monthly salvage was generally in the months of May, June, July, and August. However, the splittail salvaged earlier in the year are adults, which may have a greater impact on the population than the juveniles salvaged in the summer months. Splittail are more abundant in wet years when high flows provide large flooded riverine habitat for spawning and rearing. The annual total salvage of splittail at the SWP facility was more than 1 million fish in several years, including 1986, 1995, and 1998. The CVP salvage of splittail was generally higher than the SWP in these wet years, perhaps because the majority of the CVP water originates from the San Joaquin River where there is good splittail spawning habitat in wet years.

The historical salvage of steelhead trout at the SWP and CVP fish facilities is given in Tables J-11 and J-12. The highest monthly salvage was generally in the months of February, March, and April. There are very few steelhead in either the SWP or CVP salvage. The annual total salvage of steelhead at the SWP facility was more than 10,000 fish in only three years. The CVP salvage of steelhead was generally similar.

Tables J-13 to J-17 give the full range of monthly salvage densities at the SWP and CVP fish facilities, expressed as the fish per monthly average cfs of pumping at CVP and SWP. For example, a fish/cfs value of 60 represents a fish density of 1 fish per acre-foot (fish/af) of water pumped. A value of 600 represents 10 fish per acre-foot. Only striped bass reach densities of 600 fish/cfs (10 fish/af) in a few years during the peak density months of May–July.

Total Chinook salmon densities reach 60 fish/cfs (1 fish/af) in a few years during the peak months of April and May. Delta smelt densities are above 6 fish/cfs (0.1 fish/af) in only a few years during the months of May–July. Splittail reach maximum densities of 60 fish/cfs (1 fish/af) in a few years during the months of

May–July. Steelhead reach maximum densities of 0.6 (0.01 fish/af) in only a few years during the months of February–May.

It has been difficult for biologists to identify hydrologic factors that lead to higher salvage numbers; therefore, the median monthly salvage density pattern has been used for this SDIP entrainment assessment. The SDIP actually used the combined average CVP and SWP salvage density each month to evaluate the changes in entrainment resulting from changes in the SDIP monthly pumping. Any other series of monthly salvage density can be selected for impact assessment; the maximum monthly density will give the largest incremental entrainment impact, although the percentage change will still be equal to the percentage increase in monthly pumping.

For Chinook salmon, entrainment loss is a calculated value that uses the salvage density to estimate the total loss, including predation. The loss values can be much higher than the salvage numbers. Entrainment loss estimates were used for winter-, spring-, fall-, and late fall–run Chinook salmon (1992–2002). Tables J-18 and J-19 provide the monthly salvage densities (fish/cfs) at the SWP and CVP fish facilities for the 1992–2002 period. The median (50%) monthly densities and the maximum monthly fish densities are compared. The loss estimates for Chinook salmon are generally 5 times the salvage density because the DFG methodology assumes an 80% mortality loss within CCF.

The results of the entrainment estimates for each of these fish species is reported in Section 6.1, Fish. The calculated baseline combined entrainment for delta smelt ranges from 10,000 to 50,000 fish per year. The calculated baseline combined entrainment for striped bass ranges from 1 million to 10 million fish per year. The calculated baseline combined entrainment for splittail ranges from 10,000 to 100,000 fish per year. The changes in combined entrainment for the SDIP alternatives are relatively small, and are reported in Section 6.1 and in the tables and figures in Appendix K.

Entrainment impacts from SDIP or any other change in CVP and SWP pumping patterns will be greatest for months with the largest percentage of the historical salvage of that species. Therefore, the selected monthly pattern of assumed salvage density will have a direct effect on the annual calculated change in entrainment. For this first entrainment assessment hypothesis, that the monthly fish density pattern remains constant, the annual species entrainment impact is the sum of the twelve monthly percentage changes in pumping times the percentage of the fish (i.e., relative density) present during each month.

The next sections of the appendix describes methods that might be used to apply the second and third entrainment assessment hypotheses—that the entrainment depends on the interaction of the Delta channel flows and the pumping rates (i.e., the tidal movement of passive fish within the Delta channels), and that the entrainment of fish also depends on the behavior of the fish (e.g., active movement toward Bay, shallow habitat preference).

Population Level Effects

Under NEPA and CEQA, the purpose of the assessment of entrainment effects is to determine whether or not implementation of the SDIP has a significant impact on selected fish populations. For the Endangered Species Act, the assessment needs describe the effect on population abundance, distribution, and production (U.S. Fish and Wildlife Service and National Marine Fisheries Service 1998). Salvage and loss estimates provide an indication of the number of fish potentially affected or the proportional change in the number of fish potentially affected. However, salvage and loss estimates by themselves do not provide information relative to population abundance and distribution.

This section describes the difficult task of translating an observed or simulated pattern of salvage records from the CVP and SWP fish salvage facilities to identify the likely impacts of this loss of fish on the species population. Section 6.1, Fish, describes the conceptual models that are used in the impact assessment for SDIP; major hypotheses linking environmental changes to the mortality (i.e., predation, diversion, contaminants), growth (i.e., temperature, food), reproductive success (i.e., temperature), and movement are evaluated with the simulated monthly changes in these variables (i.e., flow, temperature, salinity, entrainment). This combination of a life-history description and environmental influence hypotheses can be called a “species assessment model.” Species assessment models may begin as conceptual models, but they must become quantitative models if they are to be used for impact assessment of a particular proposed or implemented project.

The quantitative evaluation of population-level effects from entrainment in CVP and SWP exports requires the following basic ingredients:

- The seasonal life-history “trajectory” for the fish population must be described for the Delta and linked to temperature, flow, salinity, and other habitat conditions that may trigger or constrain the population movement and occurrence.
- The feeding, predator avoidance, and migration behavior of the fish must be specifically identified in order to evaluate the vulnerability of the fish to the influences of tidal water movement and diversions.
- The salvage/handling mortality as well as the pre-salvage predation mortality must be determined for the fish species as a function of fish length and other environmental factors (e.g., temperature).
- The “natural” or existing population and rates of growth, predation, mortality, and reproduction must be identified to serve as a comparative baseline for impact assessment.

Several examples will be presented to illustrate the basic assessment approach, describe the wide range of likely vulnerability to entrainment, and highlight the uncertainty in these entrainment evaluations. The entrainment loss can be directly compared with the population estimate as a first evaluation.

Alternatively, the vulnerability of the population to entrainment can be evaluated for each month.

Marine and Estuarine Fish

Fish with a life-history and habitat trajectory that includes only the ocean, San Francisco Bay, or estuarine salinity preferences (i.e., starry flounder) are not expected to be entrained at the south Delta CVP and SWP export pumps. Because only a small fraction of these individuals may “stray” to the pumps, entrainment evaluations are not required for these species. The potential impact from entrainment on these populations is therefore 0%. Increased CVP and SWP pumping will have no direct effect on these species.

San Joaquin River Chinook Salmon

San Joaquin River Chinook salmon (currently, fall-run; historically, spring-run) enter the Delta at Vernalis (sampled in the Mossdale Trawl) and may be diverted at the head of Old River and move directly past the CVP and SWP intake facilities. Fish that continue past the head of Old River toward Stockton may still be diverted into Turner Cut, Middle River, or Old River near Franks Tract and move upstream in these channels toward the export pumps. Only fish migrating with a tidal trigger behavior (i.e., surfing downstream on falling tides) would not travel upstream toward the pumps. The San Joaquin River Chinook salmon are highly vulnerable to entrainment losses.

The entire population moves past Mossdale; therefore, the worst possible entrainment effects can be calculated simply as the fraction of the population that is diverted into Old River times the fraction of the Old River diversion that is subsequently entrained in the CVP and SWP exports. If the combined CVP and SWP pumping is greater than the San Joaquin River inflow, there is a good chance that all of the San Joaquin River fish will be entrained in either the CVP or SWP pumping. So the maximum monthly entrainment is the ratio of export pumping to the San Joaquin River flow. Because this ratio is often greater than 1 during the periods of outmigration, all of this population might be entrained. Historical years with high flows in February or March (fry) and April or May (smolts) provide the only escape from total entrainment. However, if salvage survival is relatively high (50%), some of the population may be safely trucked and released at Antioch.

The proposed head of Old River fish control barrier will allow a controlled (smaller) diversion of the San Joaquin River flow at the head of Old River. This would save fish only if they are not subsequently diverted into Turner Cut, Middle River, and Old River channels. A better understanding of Chinook salmon movement at these Delta channel junctions is needed to estimate the fraction of the fish that may continue down-estuary toward Jersey Point, Chipps Island, and the Bay. Fish will be saved with the head of Old River fish control barrier only if the migration survival from Mossdale to Antioch is higher than the salvage survival. If the salvage survival is higher than the migration survival, allowing the San Joaquin River fish to be collected at the CVP and SWP fish salvage facilities and transported to Antioch will be the preferred migratory trajectory.

The recent VAMP experiments of paired coded-wire tag (CWT) releases with subsequent capture at the salvage facilities, and in the Jersey Point or Chipps Island trawls and the ocean catch recoveries should be processed and evaluated to determine the answers for San Joaquin River Chinook salmon. The VAMP actions to provide additional tributary flows, reduced exports, and a head of Old River fish control barrier, will benefit the San Joaquin River Chinook salmon population only if salvage at CVP and SWP facilities has a lower overall survival than migration through the Delta to Antioch.

The monthly entrainment effects on the San Joaquin River Chinook salmon population are calculated as:

> Population Entrainment Loss = exports/San Joaquin River Flow * Migration Fraction * Salvage Mortality

These effects are evaluated for the months of February, March, April, and May. The salvage mortality is the fraction of the fish that do not survive salvage predation, handling, and release. The migration fraction is the fraction of the population migrating during this month. The exports/San Joaquin River flow are the ratio of exports to Vernalis flow, constrained to be 1 if the exports are greater than the San Joaquin River flow. The net benefit to San Joaquin River Chinook salmon can be determined by comparing the migration mortality to Chipps Island with the salvage mortality.

Splittail

Splittail are assumed to spawn upstream along the San Joaquin River floodplain in years with relatively high spring flows. As the juveniles migrate downstream, they are susceptible to the same high entrainment as described for the San Joaquin River Chinook salmon. A very high fraction of the splittail migrating from the San Joaquin River are likely entrained during the months of peak salvage (i.e., May, June, and July) following years of high spring flows (e.g., 1986, 1995, 1998).

The good news for the splittail population is that a majority of the splittail population spawn in the Sacramento River corridor and are much less vulnerable to entrainment losses. The calculated entrainment loss for splittail is therefore:

> Population Entrainment Loss = San Joaquin River Fraction * Exports/San Joaquin River Flow * Migration Fraction * Salvage Mortality

These effects are evaluated for the months of April, May, June, July, and August. The San Joaquin River fraction is the fraction of the population that spawns along the San Joaquin River corridor.

However, adult splittail are salvaged in the winter months as well. The fraction of the adult population that may move past the CVP and SWP pumping facilities is unknown. Because the adults live for several years, the cumulative entrainment effects should also be considered during a sequence of dry years with relatively low reproduction.

Sacramento River Chinook Salmon

The majority of the Sacramento River Chinook salmon runs (winter, spring, fall, and late-fall) will remain in the Sacramento River corridor and move past Chipps Island safely. The fraction of these fish salvaged (based on CWT recoveries) is generally less than 1%. The National Marine Fisheries Service (NOAA Fisheries) has generally estimated the percentage of these populations salvaged at the CVP and SWP facilities to be less than 2%, and has established 2% incidental take limits in the 2004 CVP-SWP Operations Criteria and Plan (OCAP) Biological Opinion (BO). A 2% take limit for winter-run Chinook salmon has been operative for about 10 years. The recent OCAP BO suggests that the population entrainment impacts from all existing SWP and CVP pumping are about 2%.

The entrainment impact from additional pumping allowed under the SDIP with 8,500 cfs SWP Banks pumping limit (which was included in the CALSIM estimated total pumping for the OCAP BO) would be the fraction of additional pumping to the total pumping in the months when these Chinook salmon runs are migrating through the Delta. For example, assuming the pumping under SDIP was increased by 10% of the total during the months of winter-run outmigration, the winter-run entrainment impact from this additional pumping would be 0.2%. The population entrainment impact would be proportional to the additional pumping fraction, but would be too small to be significant, as the 2% entrainment limit has been established as acceptable (i.e., no jeopardy) by NOAA Fisheries in the OCAP BO.

By the same reasoning, NOAA Fisheries has stated in the OCAP BO that the Environmental Water Account (EWA) export reduction actions can have little effect on the populations of winter-run, spring-run, or steelhead. Closure of the Delta Cross Channel (DCC) or reduction of the diversions into Georgiana Slough may have benefits because the survival of fish remaining in the Sacramento River corridor appears to be higher than the survival of Chinook salmon that enter the central Delta. This effect from reduced central Delta survival on the populations may be much stronger than the CVP and SWP entrainment impacts.

The population effects from the D-1641 DCC closures (since 1995) during November–June can be calculated as:

> Population Effect of DCC Closure = Population Fraction * DCC Diversion Reduction * Central Delta Mortality

These effects are evaluated for the months of December–March (i.e., winter-run migration). Population fraction is the monthly fraction of the population migrating through the Delta. The DCC Diversion Reduction is the reduced fraction of the Sacramento River diverted into the Central Delta. Appendix D indicates that this fraction is about 20% of the Sacramento River flow. Central Delta mortality is the additional mortality for Chinook salmon migrating through the central Delta (San Joaquin River to Antioch), which includes the assumed maximum entrainment loss of 2%. If the DCC closure reduced the Sacramento diversion by 20%, and the additional mortality was 50%, the population effects from the DCC closure would be 10%, if the closure were maintained throughout the migration period. The DCC has always been closed when Sacramento flows were above 30,000 cfs, so there would be no population benefits for these high-flow months.

The annual abundance of juvenile Chinook salmon entering the Delta is based on a modified juvenile production estimate (JPE) (Oppenheim pers. comm.; U.S. Fish and Wildlife Service 2001). The total number of juvenile Chinook salmon entering the Delta is the product of the following elements:

- total number of spawning adults (Pacific Fishery Management Council review of 2002 Ocean Salmon Fisheries: http://www.pcouncil.org/salmon/salsafe02/salsafe02.html);
- female proportion (i.e., 0.783);
- estimated fecundity (5,000 eggs per female);
- survival from egg to juvenile (0.1475); and
- survival of juveniles to the Delta (0.52).

These calculated Chinook salmon juveniles entering the Delta from escapement estimates are shown in Table J-20. The annual production is generally more than 50 million per year. A comparison of the salvaged Chinook salmon at the SWP and CVP fish facilities (Tables J-5 and J-6) indicates that only a relatively small percentage (1% to 5%) of the juvenile Chinook salmon production are entrained at the SWP and CVP pumps.

Steelhead

The number of juvenile steelhead entering the Delta is currently unknown, although the Chipps Island trawl provides an indication of the migration timing and relative abundance of steelhead. Uncertainty in the trawl catch efficiency for these relatively large fish prevents an absolute steelhead population estimate. Effects of entrainment losses on survival of steelhead are assumed to be the same as estimated effects on survival of Chinook salmon. Survival for steelhead is based on survival for Chinook salmon that coincide with timing and river of origin for juvenile steelhead migration.

Threadfin Shad

Threadfin shad are abundant in the Delta and are salvaged in large numbers. They spawn in the summer with a peak in June and July when temperatures are warmer than 20ºC. They typically live for only a few years and reproduce once each summer. They are filter feeders but also pick larger zooplankton when available. They are found in a wide range of salinities but reproduce in freshwater near floating objects. They form large schools and remain vulnerable to entrainment throughout the year. Highest salvage occurs in July and August. Because they spawn within the Delta, estimating the fraction of the population that is entrained is difficult. However, because the reproductive potential for these fish is so great (1,000 to 20,000 eggs/female), the possibility that large entrainment effects might reduce the population is relatively low. They might be used to judge the overall planktonic food resources in the Delta. They have generally declined in abundance since the 1970s.

American Shad

American shad spawn in the rivers upstream of the Delta and rear in the rivers and in the Delta. Juveniles move into the Delta in the months of July and August. Juveniles may rear in the Delta for a couple of years and then emigrate to the ocean. Mature adults reenter the estuary after 3–4 years to adjust to low salinity in the fall, but do not move upstream to spawn until the spring when temperatures exceed 15ºC. Peak spawning occurs at higher temperatures in late May and June. The larvae are planktonic and vulnerable to entrainment for at least several months. Because the majority of the larvae originate from the Sacramento River, entrainment estimates for Sacramento water provides a good estimate of maximum possible entrainment. Because the larvae and small juveniles enter the Delta in the months of July–September, the maximum possible entrainment loss may be 50% (because the export/inflow [E/I] ratio is 65% during these months). Because the reproductive potential for these fish is extremely high (100,000 to 250,000 eggs/female), the possibility that large entrainment effects might reduce the population is relatively low. The 50% of the population remaining in the Sacramento River to Chipps Island and Suisun Bay would not be vulnerable to entrainment losses at the CVP and SWP pumping plants. Because some American shad spawn for a sequence of 2–4 years (to age 7), there is a mixture of year classes in the reproducing runs that may buffer the population.

Striped Bass

Striped bass spawn in the Sacramento River upstream of the Delta and also in the San Joaquin River (within the Delta). The pelagic eggs and larvae move with the river flow into the Delta, so the fraction of the larvae in the flow that moves toward the south Delta CVP and SWP exports is vulnerable to entrainment. The portion of the population that spawn within the San Joaquin River upstream of Jersey Point may also be vulnerable to entrainment because of the high flows moving toward the pumps that carry these eggs and larvae. The juvenile striped bass then move toward the estuarine salinity zone because of higher food densities and perhaps other physiological requirements. The potential entrainment impacts during the months when the larvae and juveniles are generally moving with the water can be calculated as:

Population Entrainment Loss = Larval Fraction * Exports/Sacramento Inflow

for the months of April, May, and June when eggs and larvae are present. Salvage continues in July and August, but the densities are declining and the lengths are increasing. An additional fraction of the striped bass population is being entrained in these later months but not with the total vulnerability that characterizes the larvae months of April, May, and June. The fraction of the population that spawns upstream from Jersey Point is also highly susceptible to entrainment. However, because the E/I ratio is now regulated under D-1641 to a maximum of 35% in these months, the maximum population effect from entrainment of larvae is likely to be 35%.

The 65% of the Sacramento striped bass larvae that move past Chipps Island to Suisun Bay should find suitable habitat and food and will survive and be available for upstream migration and spawning. The striped bass are susceptible to a moderately high entrainment loss, but the entrainment loss including the entrainment of juveniles in July–November should always be less than 50%. Additional spring and summer pumping may increase entrainment loss, but the population effects from entrainment should remain less than 35% in the spring. The export reductions in April and May will reduce the entrainment of striped bass larvae (although salvage counts are low because the larvae size is below the 20 mm minimum necessary for successful salvage), but the effects on the population are not evaluated because the fraction of the juveniles that move out of the south Delta channels by the end of the VAMP period is not identified.

Delta Smelt

There is less of a framework for evaluating the entrainment impacts on delta smelt because the location of spawning and behavior of the juveniles are less well understood. The general life history is described in the unreleased CALFED white paper. The measurements (i.e., densities and lengths) of delta smelt at the salvage facilities and in the IEP monitoring programs (i.e., Kodiak trawl, 20-mm survey, mid-summer tow-net survey [TNS], and fall mid-water trawl [FMWT]) provide a good source of data on the distribution and abundance of delta smelt.

Additional information has been obtained from the delta smelt rearing facility located at the SWP Skinner fish facility.

Delta smelt juveniles with a length of 20 mm begin showing up at the salvage facilities in early May. This suggests that the larvae have been drifting in the water column for at least a month. Spawning is assumed to occur in March, and the larvae of delta smelt spawned upstream of Jersey Point are likely completely entrained during the months of March, April, and May. Salvage loss continues through July of most years, but the lengths are increasing and the densities are declining (like striped bass), suggesting that some portion of the fish may be growing and moving out of the south Delta channels.

The fraction of the delta smelt population that may be lost to entrainment appears to depend on the spawning distribution. All delta smelt spawned in the Sacramento River corridor should not be susceptible to entrainment. This portion of the population is not subject to entrainment loss. Unfortunately, it has not been easy to identify the spawning distribution from the available sampling. Nevertheless, it seems likely that less than 50% of the adult delta smelt are observed (sampled) in the San Joaquin or south Delta regions.

The fraction of the population that may have been saved with the VAMP export reductions in April and May or by the EWA actions has not been determined. The possible losses of delta smelt resulting from the closure of the DCC, which reduces the San Joaquin River flow at Jersey Point and may allow a greater fraction of the larvae from the central delta spawning population to be drawn toward the pumps, has not been evaluated. Finally, the possible increased entrainment loss of delta smelt from the closure of the head of Old River fish control barrier, which increases the movement of water from the central Delta toward the export pumps, has not been identified. Assumptions about the magnitude of these effects on delta smelt entrainment losses are needed.

Longfin Smelt

Longfin smelt prefer estuarine habitat but move upstream to spawn in the winter months. Most of the spawning appears to be downstream of Rio Vista on the Sacramento River and below Medford Island (between Middle River and Columbia Cut) on the San Joaquin River. Usually only a few longfin smelt are salvaged during the summer months of May–August. Most females spawn only once, during the second year, and have an average of 10,000 eggs/female. The preferred salinity for rearing appears to be 2–18 ppt, and the abundance of longfin smelt is correlated with Delta outflow in the spring (i.e., X2) possibly because the fraction being transported to the preferred estuarine habitat is increased.

Longfin smelt abundance in the estuary is much lower than it was in the surveys during the 1960s. Export pumping may have a stronger population effect by reducing Delta outflows during the spring than by direct entrainment losses. Fairly high Delta outflow in the 1995–1999 period, with the X2 objective that requires a minimum Delta outflow of 7,100 cfs (X2 at Collinsville) in the February–June period, was not sufficient to produce much of an increase in the population. Because spawning may occur throughout the Delta, the vulnerability to entrainment is variable. But because the majority of spawning is in the eastern Delta, the vulnerability to entrainment is probably low. Estimating entrainment impacts for longfin smelt will likely be both difficult and uncertain. Entrainment cannot have a large effect under current conditions because very few longfin smelt are salvaged.

Using the DSM2 Particle Tracking Model to Evaluate Fish Entrainment Impacts

The DSM2 Particle Tracking Model (PTM) was used to simulate the effect of SWP and CVP export pumping on Delta channel hydraulics and the movement and entrainment of "virtual" particles released from various locations within the Delta. The percentage of the particles that were entrained after a month of tidal hydraulic movement within the Delta channels was used to evaluate the relative magnitude of entrainment losses (vulnerability) for each region of the Delta. Two study periods were evaluated for PTM entrainment impacts: the full range of conditions during VAMP, and the full range of summer pumping conditions.

The PTM module of DSM2 simulates the transport and fate of individual "particles" traveling throughout the Delta (Smith 1993). The model uses velocity, flow, and level output from the one-dimensional tidal hydraulic model that is saved at a 1-hour interval. Simulated particles move throughout the channel network under the influence of tidal flows and random mixing effects. Appendix D provides additional details about the PTM module.

The PTM simulated entrainment of particles injected at ten locations (Figure J-7). For each location, 1,000 particles were injected over a period of 1 day (last day of previous month). Injecting the particles evenly over a complete tidal cycle helps remove much of the bias associated with selecting an injection time.

Particle movement and entrainment were simulated for a period of 30 days. Simulated particle movement in the Delta and entrainment into diversions and across selected boundary locations (Chipps Island and Martinez) are recorded at the end of each day. Entrainment of particles was simulated for diversion at the North Bay Aqueduct (NB), Contra Costa Canal (CCC), agricultural diversions (AG), and SWP and CVP pumping. Once a particle is entrained or moves downstream of Martinez , it is counted and removed from the system. Particles that move downstream of Chipps Island are counted, but if the particles move back upstream, they are subtracted from the count. The model also tracks the occurrence of particles within groups of channel locations (shaded areas in Figure J-7).

Particles that enter Suisun Marsh and Suisun Bay (i.e., past Chipps Island) are considered to have been safely transported through the Delta. Large cooling water diversions are located at Antioch and Pittsburg, but the entrainment in cooling water intakes is not expected to change with the SDIP. The potential entrainment of particles (and fish) in cooling water intakes has not been included in this particle-tracking analysis.

Particle Tracking Model–Simulated Entrainment of Fish Behaving as Passive Particles

The basis for this entrainment assessment is hypothesis 2, that the number of fish entrained is related to the interaction between Delta channel tidal hydraulics and fish distribution. Key elements of the assessment method include the assumed distribution and abundance of fish in the Delta channels, the effects of diversion on channel flows, and subsequent effects of channel flows on the distribution and movement of fish and exposure to diversion intakes. Fish are assumed to behave and move as passive particles within the water column. The movement and entrainment of particles are described for two separate study periods: (1) the full range of CVP and SWP pumping with Delta outflows of 5,000 cfs, 7,000 cfs, or 12,000 cfs; and (2) the full range of VAMP conditions during spring.

The full range of possible CVP and SWP pumping, from 0 cfs to 15,900 cfs (CVP 4,600 cfs and SWP 10,300 cfs), was simulated for August 1997 tidal and flow conditions. The simulation of the full range of SWP and CVP pumping illustrates entrainment and distribution in the Delta channels over a 30-day period for the following Delta conditions:

- the head of Old River barrier was open;
- there were no temporary barriers in the south Delta channels;
- the Delta Cross Channel gates were open;
- historical tides for August 1977 were used;
- San Joaquin River inflow was 1,500 cfs;
- CVP pumping was 0 cfs or 4,600 cfs;
- SWP pumping was 0 cfs, 3,340 cfs, 6,680 cfs, 8,500 cfs, or 10,300 cfs;
- Contra Costa Water District (CCWD) diversion was 207 cfs, North Bay diversion was 104 cfs;
- agricultural diversions throughout the Delta were 2,871 cfs;
- seepage totaled 974 cfs but did not entrain particles;
- agricultural drainage was 1,329 cfs and so net channel depletion was 2,516 cfs;
- net Delta outflow was held at 5,000 cfs, 7,000 cfs, or 12,000 cfs; and
- Sacramento River inflow was variable to support the specified pumping and outflow.

A total of six combined pumping rates were simulated at each of three Delta outflow values, for a total of 18 conditions. Particles were injected at 10 locations, so a total of 180 PTM cases were simulated for passive particles (and another 180 cases for active particles, which will be described in the next section). Results for some of the injection locations will be described to illustrate the movement and entrainment patterns. The PTM results for the full range of summer pumping and outflow conditions are given in Table J-21 (a–j) for each of the 10 release locations.

Particle Tracking Model Entrainment of Passive Particles Injected at Mossdale

Figure J-8 shows the cumulative percentages of particles released in the San Joaquin River at Mossdale that were entrained in Delta diversions and the percentage of particles remaining in the Delta channels with CVP pumping of 4,600 cfs and SWP pumping of 6,680 and a Delta outflow of 5,000 cfs during the 30-day simulation. At a San Joaquin River flow of 1,500 cfs, the passive particles injected at Mossdale are quickly swept into the head of Old River toward the pumps. About 85% enter the south Delta through the head of Old River during the first day. By the second day, 25% of the particles show up at the CVP pumps and about 5% are entrained in agricultural diversions. Some particles remain in the south Delta channels for about 10 days. Table J-21a indicates that about 99% of the particles were entrained during the 30-day period, either at the CVP pumps (71%), agricultural diversions (24%), or in the SWP pumps (4%).

Particles injected at Mossdale are transported down Grant Line Canal and Old River to the CVP pumps. Very few of the particles enter CCF. Low entrainment by the SWP is explained by the tidal hydraulic conditions in Old River between the CCF intake and the CVP intake. The net flow necessary to supply the CVP pumping of 4,600 cfs is generally stronger than tidal ebb flow in Old River at Grant Line Canal. Very few particles move from Grant Line Canal to the CCF intake located 1 mile to the north.

Particle Tracking Model Entrainment of Passive Particles Injected into South Delta Channels

Tables J-21b and J-21f indicate that passive particles released in the south Delta channels in Old River at Middle River and in Woodward Canal had very high entrainment. Reducing the SWP and CVP pumping delayed the rate of entrainment, but entrainment was nearly 100% at the end of the 30-day simulations. This may suggest that short periods of export curtailment (i.e., EWA actions) may not reduce the ultimate entrainment of fish unless they are able to actively leave the south Delta channels during the period of export reduction.

Particle Tracking Model Entrainment of Passive Particles Injected at Turner Cut

Table J-21c indicates that most passive particles injected near Turner Cut were entrained in the SWP pumps and not in the CVP pumps. Turner Cut connects with Middle River and Victoria Canal, channels that lead to Old River just north of the CCF gates. Particles injected at Turner Cut move south in the Delta channels and pass the CCF gates before continuing toward the CVP pumps. For CVP pumping of 4,600 cfs and SWP pumping of 6,680 cfs, the ratio of entrainment at SWP to the entrainment at CVP was about 2:1, although the ratio of SWP to CVP pumping was only about 1.5:1. The total 30-day entrainment of passive particles released at Turner Cut was almost 85% with full permitted CVP and SWP pumping.

Particles injected at Turner Cut initially moved into the San Joaquin River channel and the south Delta channels (i.e., Middle River). About 15% of the particles moved upstream of Turner Cut and toward Stockton, where they were entrapped by low net flow through the Stockton Deep Water Ship Channel through the end of the 30-day simulation. All of the passive particles that initially moved downstream in the San Joaquin River channel were drawn into Middle River or Old River and transported toward the SWP and CVP pumps. The passive particles injected at Turner Cut did not pass Jersey Point.

Entrainment of passive particles injected at Turner Cut increased with pumping. About 10% of the particles are entrained in Delta diversions with no CVP or SWP pumping. About 80% of the particles are entrained for CVP and SWP pumping greater than 10,000 cfs.

Particle Tracking Model Entrainment of Passive Particles Injected at Prisoners Point or Mokelumne River

Table J-21d indicates entrainment was greater than 95% for SWP and CVP pumping in excess of 10,000 cfs and Delta outflow of 5,000 cfs for particles released in the San Joaquin River at Prisoners Point. Entrainment was 70% for CVP pumping of 4,600 cfs and no SWP pumping. A substantial proportion of particles injected at Prisoners Point are entrained because there is not much net flow down the San Joaquin River toward Antioch at this low Delta outflow condition. Entrainment was not reduced for particles released at Prisoners Point for Delta outflow of 7,000 cfs or 12,000 cfs.

Table J-21g indicates that entrainment of passive particles released in the Mokelumne River, downstream of the DCC, was about 90% for all three Delta outflows, and was similar (5% less) to the entrainment of particles released from Prisoners Point.

Particle Tracking Model Entrainment of Passive Particles Injected at Jersey Point

Figure J-9 shows the cumulative percentages of particles released in the San Joaquin River at Jersey Point that were entrained in Delta diversions and the percentage of particles remaining in the Delta channels with CVP pumping of 4,600 cfs and SWP pumping of 6,680 and a Delta outflow of 5,000 cfs during the 30-day simulation. Entrainment of the passive particles injected at Jersey Point was delayed by about 10 days as the particles moved into the south Delta channels. Some moved past Chipps Island after 15 days, and about 12% were past Chipps by the end of the 30-day period. The majority of the particles were in the confluence portion of the Delta.

Table J-21e indicates that entrainment of particles injected at Jersey Point is lower than entrainment of particles injected at Prisoners Point. About 20% of the particles were entrained for CVP pumping of 4,600 cfs and no SWP pumping. Entrainment increased to about 60% for CVP pumping of 4,600 cfs and SWP pumping of 6,680 cfs, with an outflow of 5,000 cfs. A substantial proportion of particles injected at Jersey Point are entrained because there is not much net flow down the San Joaquin River toward Antioch at this low Delta outflow condition. Entrainment with CVP pumping of 4,600 cfs and SWP pumping of 6,680 cfs was reduced to about 55% at an outflow of 7,000 cfs and was reduced to 47% at an outflow of 12,000 cfs. The percentage reaching Chipps Island increased to about 20% at an outflow of 7,000 cfs and about 35% at an outflow of 12,000 cfs.

Particle Tracking Model Entrainment of Passive Particles Injected at Freeport and Rio Vista

Figure J-10 shows the cumulative percentages of particles released in the Sacramento River at Freeport that were entrained in Delta diversions and the percentage of particles remaining in the Delta channels with CVP pumping of 4,600 cfs and SWP pumping of 6,680 and a Delta outflow of 5,000 cfs during the 30-day simulation. At a Sacramento River flow of 17,500 cfs, the passive particles injected at Freeport are diverted (DCC gates open) into the Mokelumne and San Joaquin River channels, and 25% of the particles are in the south Delta channels within 10 days. Entrainment begins and about 35% are entrained in the SWP, 20% in the CVP, and 5% in agricultural diversions at the end of the 30-day period. Only about 15% of the particles move past Chipps Island by the end of the 30-day period.

Table J-21h indicates that a total of 60% were entrained at the end of the 30-day period for an outflow of 5,000 cfs. The entrainment was reduced to about 50% with an outflow of 12,000 cfs. About 20% of the particles remained in Delta channels upstream of Chipps Island, with 14% in Suisun Bay or Suisun Marsh and 6% passing beyond Martinez. Passive particles reached Chipps Island in about 15 days, indicating that with a Delta outflow of only 5,000 cfs there is a considerable travel time between Freeport and Chipps Island.

About 10% of the particles injected at Freeport were entrained in agricultural diversions with zero CVP and SWP pumping. The entrainment with SWP pumping of 8,500 cfs was 65%, so about 5% more of the particles released at Freeport were entrained by the 1,820-cfs increment of SWP pumping, from 6,680 cfs to 8,500 cfs. Closing the DCC is the primary factor in reducing entrainment of passive particles released from Freeport, although no PTM simulations with the DCC closed were performed.

Table J-21i indicates that entrainment of passive particles released at Rio Vista was about 40% for CVP pumping of 4,600 cfs, SWP pumping of 6,680 cfs, and Delta outflow of 5,000 cfs. This is lower than for particles released at Freeport but suggests that a considerable portion of the Sacramento River water at Rio Vista moves through Threemile Slough and toward the pumps when the exports are higher than the outflow.

Simulated Entrainment of Passive Particles Injected at Chipps Island

Table J-21j indicates that with CVP pumping of 4,600 cfs, SWP pumping of 6,680 cfs, and Delta outflow of 5,000 cfs, only about 5.5% of the passive particles injected at Chipps Island are entrained. Entrainment increased to 9% for SWP pumping of 8,500 cfs. A Delta outflow of 7,000 cfs reduces the entrainment only slightly to 5.2%, but a 12,000 cfs outflow reduces the entrainment to about 2%. These passive particles are moving upstream just like the salinity that is found to migrate upstream with the tidal flows and mixing within the Delta during periods of relatively low Delta outflow.

Using Passive Particle Results to Evaluate Fish Entrainment

The PTM results provide a very interesting understanding of how water moves within the Delta tidal channels for a range of river inflows and exports. Assuming that fish behave as passive particles provides a worst-case assessment of how many fish that enter the Delta or spawn within the Delta will be entrained at the CVP, SWP, and agricultural diversions. The increased entrainment from increased pumping will not be linear with pumping. If the pumping is already relatively high, the incremental entrainment of passive particles released from locations near the south Delta pumping plants may not increase by much, because the entrainment loss is already nearly maximum. The “passive” risk of entrainment (from PTM results) can be combined with a general description of when and where the fish enter the Delta or where and when they migrate and spawn to evaluate the likely entrainment potential for a range of monthly flows and export conditions.

The basis for this assessment method is the hypothesis that the number of fish entrained is related to the interaction between Delta channel tidal hydraulics and fish distribution. Fish are assumed to behave and move as passive particles within the water column. Net flow direction and velocity are assumed to influence the movement of larvae and juvenile delta smelt (U.S. Fish and Wildlife Service 1996) and other fish species.

Entrainment of particles injected at inflow locations that represent the distribution of fish species in the Delta are assumed to represent the movement and fate of fish (i.e., entrainment losses). The proportion of particles entrained within the 30-day period provides an estimate of entrainment loss. The fraction of particles passing Chipps Island within the 30-day simulation provides an estimate of survival.

Chinook Salmon

Chinook salmon enter the Delta from the Sacramento, Mokelumne, and San Joaquin Rivers. The proportion of juvenile production from each river basin that enters the Delta at each location is estimated for each month in Table J-23. Entrainment of particles injected at the point where juvenile Chinook salmon enter the Delta is assumed to represent entrainment loss. Injection points used to represent Chinook salmon include the Sacramento River at Freeport (Sacramento River origin), Mokelumne River at Georgiana Slough (Mokelumne River origin), and the San Joaquin River at Mossdale (San Joaquin River origin).

These injection points may not reflect the potential entrainment of juveniles that rear in the Delta. The response of juveniles that rear in the Delta to diversions and subsequent entrainment is currently unknown. For the purpose of the SDIP assessment, entrainment of particles injected at the point where juvenile Chinook salmon enter the Delta is assumed to adequately reflect potential entrainment-related effects for all life stages. The incremental effect of increased SWP pumping, from 6,680 cfs to 8,500 cfs, is assumed to be the largest direct effect of the SDIP alternatives.

Table J-21a suggests that the incremental entrainment of San Joaquin River Chinook salmon for increased SWP pumping (from 6,680 cfs to 8,500 cfs) will be small (1–2%), because almost all Mossdale particles are already entrained at 6,680 cfs. Table J-21g suggests that the increased entrainment of Mokelumne River Chinook salmon will be about 2% at a Delta outflow of 5,000 cfs and 6% at a Delta outflow of 12,000 cfs. Table J-21h suggests that the increased entrainment of Sacramento River Chinook salmon with the DCC open will be 5% with a Delta outflow of 5,000 cfs and will be less than 1% with a Delta outflow of 12,000 cfs. These are the largest possible effects of increased SWP pumping on entrainment of passive particles entering the Delta at these three locations.

The CALSIM–simulated monthly changes in SWP pumping are usually less than this maximum change of 1,820 cfs.

Steelhead

The analysis for steelhead is similar to that described for Chinook salmon. Steelhead enter the Delta from the Sacramento, Mokelumne, and San Joaquin Rivers. The proportion of juvenile production from each river basin that enters the Delta at each location is estimated for each month (Table J-24). Entrainment of particles injected at the point where juvenile steelhead enter the Delta is assumed to represent entrainment loss.

The same potential increase in fish entrainment percentage as was calculated for Chinook salmon for SWP pumping increasing from 6,680 cfs to 8,500 cfs will apply to steelhead entering the Delta at the same locations.

Delta Smelt

Delta smelt may occur throughout the Delta depending on the season and salinity distribution. Entrainment was assessed for larvae and early juveniles and for late juveniles and adults. The proportion of delta smelt in each part of the Delta was estimated for each month from historical summer TNS and FMWT data (Table J-25). Entrainment of particles injected at points located in areas of the Delta where delta smelt occur is assumed to represent entrainment loss. Injection points used to represent delta smelt include Turner Cut, Prisoners Point, Jersey Point, Old River at Middle River, Woodward Canal, Mokelumne River, Freeport, Rio Vista, and Chipps Island.

Splittail

Splittail spawn upstream and are expected to enter the Delta as juveniles at river inflow locations, including the Sacramento, Mokelumne, and San Joaquin Rivers and the Yolo Bypass. The proportion of juvenile production from each river basin that enters the Delta at each location, and the Yolo Bypass, is estimated for each month (Table J-26). Injection points used to represent splittail include the Sacramento River at Freeport, the Sacramento River at Rio Vista (Yolo Bypass origin), Mokelumne River, and the San Joaquin River at Mossdale.

Striped Bass

Striped bass may occur throughout the Delta depending on the season and salinity distribution. Entrainment was assessed for larvae and early juveniles and for late juveniles and adults. The proportion of striped bass in each part of the

Delta is estimated for each month from historical summer TNS and FMWT data (Table J-27). Injection points used to represent striped bass include Turner Cut, Prisoners Point, Jersey Point, Old River at Middle River, Woodward Canal, Mokelumne River, Freeport, Rio Vista, and Chipps Island.

The results of these passive particle–entrainment assessments for each species (hypothesis 2) are discussed briefly in Section 6.1, Fish. These passive particle entrainment impacts are generally smaller than the linear increases from monthly pumping changes that are assumed in assessment hypothesis 1. The SDIP entrainment impact evaluation and mitigation measures were based, however, on the linear increase with pumping hypothesis.

Particle Tracking Model Entrainment during VAMP Conditions

Table J-22 (a–j) gives the results of the PTM simulations for the full range of VAMP conditions. The PTM results for the VAMP period are of particular interest because one of the major assumptions for VAMP is the hypothesis that increased San Joaquin River flow, closure of the head of Old River barrier, and reduction in CVP and SWP pumping will each reduce the entrainment losses of San Joaquin River Chinook salmon and delta smelt that may have spawned in the central or south Delta channels.

The San Joaquin River inflow is specified as one of the five VAMP target flows, and the CVP and SWP pumping is either equal to the San Joaquin River (D-1641 objective) or equal to the VAMP pumping target corresponding to the San Joaquin River inflow. Sacramento River inflow is held constant at 15,000 cfs, and the resulting Delta outflow varies from 14,000 cfs to about 18,000 cfs. Entrainment in Delta diversions was simulated with and without the head of Old River barrier. A total of 20 VAMP conditions were simulated. Particles were injected at 10 locations, so a total of 200 PTM cases were simulated. Results for some of the injection locations are described below.

Particle Tracking Model Results for Mossdale Release during Vernalis Adaptive Management Plan

The San Joaquin River at Mossdale is the primary release location of interest for evaluating the VAMP protections provided by increased flow, closure of the head of Old River, and reduced CVP and SWP exports. During the springtime VAMP conditions (April 15–May 15), higher SWP diversions, even with commensurate San Joaquin River inflow, resulted in higher entrainment. Without the head of Old River barrier, entrainment of passive particles increased from 65% at 2,000 cfs San Joaquin inflow and SWP and CVP pumping to about 80% at 7,000 cfs inflow and pumping. With the head of Old River barrier, entrainment of passive particles was nearly the same as without the barrier. Particles were transported into Old River without the barrier and were transported through Turner Cut and Middle River with the barrier in place.

As with the actual VAMP experiments, it is difficult to determine the relative effects of closing the head of Old River barrier and reduced pumping because the changes are made at the same time. The indications from these particle-tracking simulations are that pumping has the strongest effect on entrainment and that the barrier has little effect on the entrainment of passive particles injected at Mossdale.

Under VAMP conditions, a San Joaquin River inflow of 7,000 cfs and CVP and SWP pumping at 7,000 cfs resulted in entrainment of about 70% of the particles injected at Turner Cut (Table J-22c). Closing the head of Old River barrier increased the simulated entrainment of particles injected at Turner Cut by 10% to 20%. Increased CVP and SWP pumping draws more net flow down Turner Cut, Middle River, and Old River.

During VAMP conditions, with a Delta outflow of more than 15,000 cfs, much less entrainment was simulated for particles injected at Prisoners Point (Table J-22d). About 50% of the passive particles were entrained at a San Joaquin River inflow of 7,000 cfs and SWP and CVP pumping of 7,000 cfs with the head of Old River fish control barrier installed. . Entrainment was reduced to 15% when SWP and CVP pumping were reduced to 3,000 cfs with the head of Old River barrier installed. Entrainment was less than 2% when the barrier was open.

During VAMP conditions, the maximum entrainment of passive particles released at Jersey Point with a Delta outflow of 15,000 cfs was 10% for SWP and CVP pumping of 7,000 cfs with the head of Old River barrier installed (Table J-22f).

During VAMP conditions (i.e., DCC gates closed), the fraction of passive particles injected at Freeport and entering the Mokelumne River channels through Georgiana Slough was reduced. Entrainment at a San Joaquin River inflow and SWP and CVP pumping of 7,000 cfs would be about 10% when the head of Old River barrier is open (Table J-22h). Closing the head of Old River barrier increased the entrainment of passive particles to 15%.

Particle Tracking Model Simulated Entrainment of Fish Actively Moving toward Suisun Bay

The basis for this assessment method is the third entrainment hypothesis that the number of fish entrained is related to the interaction among Delta channel hydraulics, fish distribution, and fish behavior. As for the previous assessment method, key elements of the assessment include the distribution and abundance of fish in the Delta channels, the effects of diversion on channel flows, and subsequent effects of channel flows on the distribution and movement of fish and exposure to diversion intakes. However, particles are given behavior consistent with the migration objective of a given species life stage. That is, individual fish use hydraulic conditions to expedite movement toward their migration objective (e.g., rearing habitat in Suisun Bay). The DSM2 PTM module was used to simulate the effect of SWP and CVP pumping on Delta channel hydraulics and entrainment of actively moving particles.

Tidal level triggering behavior was added to the particle behavior module as described by Miller (2000). The new behavior module allows the user to select particle-positioning criteria based on whether the tide is rising or falling. Level triggering is currently limited to the particle's vertical position. The vertical positioning is based on percentage of channel depth with respect to the bottom of the channel.

Figure J-11 shows that during rising level, particles are instructed to stay between 0 and 10% of the depth as measured from the bottom of the channel. The average velocity in the lowest 10% of depth is assumed to be about 50% of the average velocity for the channel cross section. During the falling level, the particles are instructed to stay between 90 and 100% of the depth as measured from the bottom. The average velocity in the top 10% of the channel is assumed to be 125% of the average velocity for the channel cross section. Particles are therefore simulated to move slowly during flood tides and more rapidly during ebb tides. This behavior has been referred to as *tidal surfing.*

A rise or fall of 1 inch (or more) in a 15-minute time step triggers particle movement to the bottom 10% or top 10% of the channel. Particles are not constrained during periods of level change with less than 1 inch per 15-minute time step (i.e., periods of slack tide). The tidal velocity is generally low during these slack tides.

The primary effect of forcing particles to the surface on ebb tide and to the bottom on flood tide is to accelerate particle movement toward the Bay. Relative to passive particles, increased movement of active particles varies with location, depending on tidal velocity. At Freeport on the Sacramento River, net flow velocity is high relative to tidal velocity. For flow conditions in August 1997, simulated downstream movement of passive particles was about 9.0 miles during the first 24 hours. Simulated downstream movement of active particles was about 10.4 miles during the first 24 hours. At Rio Vista, net flow velocity is lower relative to tidal velocity. Simulated downstream movement of passive particles was about 0.8 mile/day, compared to 5.7 miles/day for active particles. Similarly, movement at Chipps Island was about 1.0 mile/day for passive particles and 8.5 miles/day for active particles.

At Mossdale on the San Joaquin River, simulated downstream movement was the same for passive and active particles, indicating minimal effect of tidal velocity relative to net velocity. At Turner Cut, net flow velocity is lower relative to tidal velocity. Simulated downstream movement of passive particles was about 0.4 mile/day, compared to 2.6 miles/day for active particles. Moving downstream, the effect of tidal velocity on active particle movement increases. Passive particles moved 0.4 mile/day at Prisoners Point compared to

5.1 miles/day for active particles. At Jersey Point, active particles moved 9.4 miles/day compared to 1.5 miles/day for passive particles.

Effects of Tidal Surfing Fish Movement on Entrainment

Entrainment of active (tidal surfing) particles injected at Mossdale is nearly identical to entrainment of passive particles, because almost all of the active particles enter Old River during ebb tide. The active particles are entrained quickly with 95% entrained in Delta diversions in a few days. About 72.5% of the particles are entrained in the CVP diversion, 7.5% at the SWP, and 15% in agricultural diversions. Less than 5% escape past the head of Old River, and none reach Jersey Point by the end of the 30-day simulation. Compared to passive particles, substantially fewer active particles (20%) are entrained in agricultural diversions when the SWP and CVP are not pumping. As SWP and CVP diversions increase and total diversions approach 10,000 cfs, entrainment is similar for active and passive particles.

During the VAMP conditions, entrainment of active particles released at Mossdale is substantially less than entrainment of passive particles. Reduced pumping and installing the head of Old River barrier both reduced entrainment of active tidal surfing particles.

When San Joaquin River inflow is held constant at 1,500 cfs and SWP and CVP pumping exceeds 10,000 cfs, entrainment of active particles substantially increases and exceeds entrainment of passive particles. Lower entrainment of passive particles is attributable to entrapment of passive particles by low net flow in the Stockton Deep Water Ship Channel through the end of the 30-day simulation. Active particles are not entrapped in the Stockton Deep Water Ship Channel, but end up in the CVP and SWP exports.

Under VAMP conditions, entrainment of active particles injected at Turner Cut was less than the entrainment of passive particles. Reduced CVP and SWP pumping substantially reduces entrainment of the active particles. This suggests that active particles at Turner Cut are less susceptible to entrainment at the SWP and CVP pumps than passive particles. Closing the head of Old River barrier had little effect on entrainment of active particles that were injected at Turner Cut.

Entrainment of active particles released from Prisoners Point was about 40% for CVP pumping of 4,600 cfs and SWP pumping of 6,680 cfs. This is considerably less than the entrainment of 95% for passive particles. Entrainment increased to 60% when SWP pumping was increased to 8,500 cfs. This relatively large increase in entrainment reflects a shift to negative net flow at Antioch that reduces the simulated downstream transport of active particles.

Entrainment of active particles injected at Jersey Point was much lower than entrainment of passive particles. Only about 5% of the active particles were entrained with CVP pumping of 4,600 cfs and SWP pumping of 8,500 cfs. Almost 40% of the active particles made it past Chipps Island within 5 days and 90% were past Chipps Island by the fifteenth day of the simulation. About 95% of the active particles passed Chipps Island by the end of the 30-day period.

For CVP pumping of 4,600 cfs, SWP pumping of 6,680 cfs, and Delta outflow of 5,000 cfs, about 15% of the active particles injected at Freeport were entrained in Delta diversions after 30 days. This is substantially less than entrainment for passive particles. Although 40% of the active particles enter the Mokelumne River channels, most of the active tidal surfing particles move down the San Joaquin River toward Antioch. Active particles begin to pass Chipps Island after 5 days, and 80% of the active particles released at Freeport move past Chipps Island by the end of the 30-day period.

Entrainment of active particles released at Freeport was about 15% at SWP pumping of 6,680 cfs and increased to 20% for SWP pumping of 8,500 cfs. With the DCC gates open, the maximum additional entrainment of active particles originating on the Sacramento River apparently will be about 5%.

Using Active Particle Results to Evaluate Fish Entrainment

The basis for this third assessment method is the hypothesis that the number of fish entrained is related to the interaction between Delta channel hydraulics and fish behavior. Particles are given behavior consistent with the migration objective of a given species life stage. That is, individual fish use hydraulic conditions to expedite movement toward their migration objective (e.g., rearing habitat in the Bay).

The injection locations and distribution of Chinook salmon, steelhead, delta smelt, splittail, and striped bass are the same as described in the previous sections for passive particles. Entrainment of active particles injected at inflow locations that represent the distribution of fish species in the Delta are assumed to represent the movement and fate of fish (i.e., entrainment losses). The proportion of particles not entrained provides an estimate of survival.

The purpose of the assessment with active particles is to reflect the potential difference in entrainment when fish are assumed to actively move toward specific destinations. In general, entrainment of active particles is considerably less than entrainment of passive particles. Real fish may be even “smarter” than the tidal trigger simulated for active particles with the PTM, further reducing entrainment as compared to the simulation of passive particle entrainment. Understanding the actual movement and behavior of fish in the Delta will require that all available fish monitoring surveys and special studies be combined into working models of the fish. This would provide the best possible framework for entrainment impact assessment and mitigation measure development and effectiveness evaluation.

Delta Fish Abundance Surveys and Indices

DFG collects the primary fish monitoring samples in the Delta. The four primary surveys are the FMWT, the 20-mm survey, the mid-summer TNS, and the winter Kodiak trawls. These surveys use different net gears that are towed at between 30 and 100 stations to determine the abundance and distribution of the major fish species in the Delta. Details of the sampling techniques can be found in Orsi et al. (1999). The FMWT provides an index of many young-of-the-year (YOY) fish, although it was originally used to track only striped bass abundance. The FMWT index has been collected from about 100 stations since 1959 (45 years). The summer tow-net is used to track the early juvenile striped bass and other spring spawning fish in the Delta. The 20-mm survey has been collected for 10 years, and the winter Kodiak trawls have been collected for just 3 years to track the distribution and abundance of adult delta smelt.

Each survey collects bi-weekly or monthly samples at between 30 and 100 stations within the Delta and Suisun and San Pablo Bays. There are additional otter-trawl and FMWT surveys of the fish, shrimp, and crabs in all regions of San Francisco Bay. Some surveys report the number of fish collected during the survey, and some use a volume weighting to sum the catch to be proportional to the habitat volume represented by the sampling station. The surveys generally provide a single number for each year for each fish species. Not all fish species have an abundance index value; the most abundant fish species or fish of special concern have an abundance index.

When the annual indices are low, the population abundance is assumed to be relatively low, although the sampling success of the gear is not well established. Few biologists have been willing to assign a population estimate to the index values. It is even more difficult to determine the causes for the measured declines or increases between years. Many of the factors that might affect abundance will likely change within the period of spawning, rearing, and migration toward the estuary that produces the population abundance indicated by these juvenile and YOY surveys.

The previous discussion of entrainment vulnerability indicates that pumping will not have a uniform effect on each Delta fish species. Additional pumping may not be the common denominator in the decline of multiple fish species, because several are largely independent of pumping entrainment losses. It may be possible that exports are responsible for indirect changes that influence population abundance in addition to direct entrainment losses. However, pumping itself has been relatively constant for the past 25 years. The annual fish indices certainly do not directly follow the moderate fluctuations in annual CVP and SWP exports.

Spring Kodiak Trawl

The spring Kodiak trawl survey runs every other week beginning January 12. Each “Delta-wide” survey takes 4–5 days and samples 39 stations from the Napa River to Stockton on the San Joaquin River, and Walnut Grove on the Sacramento River. The Delta-wide survey locates the areas of highest delta smelt concentration, and is followed by a supplemental survey 2 weeks later. The supplemental survey is designed to sample these areas of high concentration intensively, to estimate the proportion of ripe, unripe, and spent delta smelt. This survey focuses on adult delta smelt distribution in the months of January–March but has been conducted only since 2002. Figure J-12 shows an example of the Kodiak trawl survey results reported on the DFG website. A relatively high catch per tow (density) is found with the Kodiak trawl compared to other net gear. There is no annual summary value for this survey, although population estimates should be possible.

20-mm Survey

This survey monitors post-larval and early juvenile delta smelt distribution and relative abundance throughout their historical spring range in the Sacramento–San Joaquin Delta and San Francisco Estuary. This survey began in 1995 and gets its name from the smallest size (20 mm) at which delta smelt are retained and readily identifiable at the CVP and SWP fish facilities. The 2004 OCAP BO requires this survey to provide recent time (within 72 hours) information on the distribution and relative abundance of delta smelt throughout the Delta and the upper estuary. Sampling surveys begin in April and run through July. There are 8–10 surveys each year on a fortnightly basis covering about 50 stations throughout the Delta and downstream to the eastern portion of San Pablo Bay and Napa River. Samples are collected using an egg and larval, rigid-opening net constructed of 1,600-µm mesh. Three 10-minute stepped-oblique (bottom to top) tows are made at each station. The catch is reported in a series of bubble plots giving the relative abundance (density) and the combined length-frequency diagrams for each survey.

Figure J-13 shows an example of the delta smelt distribution-abundance “bubble” maps that are reported on the DFG website. Figure J-5 shows the length-frequency diagram from the 20-mm survey for delta smelt in 1999 (all stations combined). The initial period of spawning as well as the growth rate (length) and mortality (decreased abundance) can be deduced from these diagrams. Figure J-14 shows the same length-frequency diagram for striped bass during the 1999 20-mm surveys. Figure J-15 shows the length-frequency diagrams for delta smelt during the 2000 through 2004 20-mm surveys. Variations in the number of fish collected, the timing of spawning, the growth rates, and the survival rates can be identified by comparing these 5 years of recent data from the 20-mm survey.

Summer Tow-Net Survey

Begun in 1959, this survey was developed to provide an index for the abundance of young striped bass by sampling 31 stations from San Pablo Bay through the Delta. The original purpose was to predict recruitment of striped bass to the adult stock but the index has proven valuable in gaging the environmental health of the estuary. Abundance indices for other species have also revealed important trends. This survey is now mandated by the 1995 U.S. Fish and Wildlife Service (USFWS) BO for delta smelt on the operation of the SWP and CVP. This survey is made in the June–August period. Figure J-16 shows the length-frequency diagram for delta smelt and striped bass during the 2003 TNS (this is the only year available on the DFG website).

Figure J-17 shows the annual TNS indices for striped bass and delta smelt from 1967 to 2004. The values are calculated from the average catch during some of the surveys. For striped bass, it the abundance when the juveniles reach an average size of 38 mm. For delta smelt, it is the abundance in the first two surveys of each year. The indices are plotted on a logarithmic scale because the range of abundance is found to be multiplicative for many biological populations. The direct correlation of the tow-net indices with the annual pumping records for 1967–2004, shown in Figure J-18, will be difficult because the variations in the population indices are much greater than the year-to-year variations in pumping. Pumping has gradually increased in the first half of the record, but has been relatively constant since 1985. The indices may be related to Delta outflow, which has a wider range of variation.

Fall Mid-Water Trawl Survey

The original objective of the FMWT survey was to produce an index of monthly abundance of young striped bass, but many other fish are collected. The sum of the monthly indices for the months of September–December is used as the annual FMWT index for selected fish. From 1967 to 1978 the survey period was variable, sometimes starting in July or August, with September the usual starting month. The survey was never run beyond March. In 1980 the survey was shortened to cover the period of September to December because of variability in abundance indices associated with winter storm events (sampling difficulties and high outflow flushing fish into San Pablo Bay). The 100 FMWT stations cover a broad range of habitats. The sampling net has a mouth opening of 12 feet by 12 feet. The mesh size decreases from 8-inch mesh in the forward panel to 0.5-inch mesh at the back end.

Figure J-19 shows the striped bass and delta smelt annual indices from 1967 to 2004. The striped bass index values have generally declined, but the delta smelt index values are more variable. Although the 2004 index was low, there have been other periods with comparable index values. Figure J-20 shows the American shad and longfin smelt index values for 1967–2004. The American shad index has been remarkably constant, while the longfin smelt has shown the greatest range of variation from year to year (i.e., 100 to 100,000).

Life-Stage Evaluations of Delta Fish Populations

The DFG surveys in the Delta continue almost year-round. More of this information should be processed and presented in concert with the salvage records at CVP and SWP, with the Chipps Island, Mossdale, and Sacramento salmon trawls (which collect many other fish), and with the monthly Bay surveys. Several examples of the length-frequency diagrams that are available from the DFG website have been shown here to illustrate this more complete presentation of fish population data. The current reliance on the annual indices alone, which have been calculated to summarize the survey results, has hidden much of the survey information from those seeking to understand and evaluate conditions within the Delta.

Table J-28 gives these annual fish indices and pumping and Delta outflow parameters. Although much statistical testing has been attempted with these annual values, they are unlikely to suddenly explain what causes fish populations within the Delta to fluctuate.

Population estimates from each survey effort should be calculated in addition to the summary abundance indices. This would allow, for example, delta smelt population estimates from the Kodiak trawl data to be directly compared with population estimates from the 20-mm survey, the summer TNS, and the FMWT survey. Annual survival and growth information could be extracted from these consistent population abundance and distribution estimates. The corresponding fish densities for specific regions in the Delta then could be related to the CVP and SWP salvage records, as well as the Chipps Island trawl densities. A more comprehensive and unified fish abundance and distribution evaluation would be the likely result of this additional analysis of the survey data.

Department of Water Resources–Department of Fish and Game Four-Pumps Agreement

The four-pumps agreement between DFG and the California Department of Water Resources (DWR) was signed at the end of 1986 to offset direct losses of striped bass, Chinook salmon, and steelhead caused by the diversion of water by the SWP Harvey O. Banks Delta Pumping Plant. Direct losses are defined as losses from the time fish are diverted into CCF to the time they are returned to the Delta. These losses are assumed to occur, despite efforts to screen fish at the fish salvage facilities, from enhanced predation in CCF and handling mortality. The agreement covers losses beginning in 1986 and was developed as part of the planning effort to install the last four pumping units. The agreement was intended to offset direct losses of all fish, although sufficient information was available only for developing specific measures for Chinook salmon, striped bass, and steelhead. Procedures for calculating losses for these fish each year were developed. An initial funding of $15 million was allocated to cover potential population declines from previous SWP pumping. Priority was to be given to habitat restoration and non-hatchery actions that would compensate for the annual losses. The compensation was based on the cost of hatchery-reared yearling fish, estimated as $1.65 for striped bass and $0.55 for steelhead and salmon. One provision of the agreement states that a plan to reduce predation in CCF will be developed and the accounting procedures adjusted once predation losses are reduced. Another provision was to develop similar accounting procedures for direct losses and compensation measures for other Delta fish (e.g., American shad).

Yearling Equivalents

Appendix A of the agreement provided the accounting procedures for estimating monthly losses and calculating yearling equivalents for striped bass, salmon, and steelhead. An assumed monthly survival to yearling allowed the number of juveniles salvaged each month to be converted to yearling equivalents. For example, striped bass in March are assumed to be yearlings, with a size of about 100 mm (4 inches). Striped bass salvaged in May are only about 25 mm (1 inch) and have an expected survival to the next March of only 0.2%. One yearling striped bass salvaged in March is therefore assumed equivalent to about 500 juvenile striped bass salvaged in May. One Chinook salmon or steelhead yearling (>100 mm) is assumed equivalent to about 5 smolts (50–75 mm) in this "yearling" accounting scheme.

Delta Smelt Equivalents

Although delta smelt were not a species of interest in 1986, they are of great interest now. A similar life-stage tracking procedure could be used to estimate the adult equivalents from the delta smelt salvage records. Because delta smelt females have about 2,000 eggs, a constant monthly mortality of 35% (0.015 daily mortality) would allow 10 smelt to survive to an age of 12 months from each female. If the population in December were used as a annual reference, based on the FMWT data, the December measured salvage would be given an equivalent ratio of 1. The January salvage of adults should be increased by 1.55 to reflect a 65% monthly survival, and the February salvage of adults would be increased by 2.35. Spawning in the delta smelt rearing facility is generally observed in March at a temperature of 10ºC. Only about 30% of the December equivalents will survive to spawn in March, assuming a 65% monthly survival. The juvenile delta smelt salvaged in April would be discounted by a factor of about 0.025 to reflect the low survival to December adult equivalents (1/40). The May salvage would be discounted by a factor of 0.04 (1/25), and the June salvage would be discounted by a factor of 0.065. The July salvage discount factor would be 0.10 (1/10), and the August discount factor would be 0.16. The September discount factor would be 0.25, the October discount factor 0.4, and the November discount factor 0.65.

Using the simulated monthly SWP and CVP pumping to provide the likely distribution of future monthly pumping, with the monthly median delta smelt SWP salvage densities, the average annual delta smelt entrainment for the existing condition (2001 baseline) would be about 20,000 fish/year, with a range of 4,000 fish/year to 32,000 fish/year. For SDIP alternative 2A, the expected average entrainment of delta smelt would increase to 21,000 fish/year, with a range of 4,500 fish/year to 39,000 fish/year. The average entrainment of delta smelt therefore would be increased by about 5%. If these approximate monthly factors for December equivalents were applied to the monthly median delta smelt SWP salvage densities, the average delta smelt entrainment for the existing conditions would be about 5,000 December delta smelt equivalents.

Mitigation Measures to Reduce Fish Entrainment Effects

The increased SDIP entrainment effects can be allowed as part of the SDIP project if appropriate mitigation measures can be developed. In addition to reducing pumping to baseline conditions and EWA actions during periods of high fish densities, the following mitigation measures might be considered.

Mitigation for delta smelt is more difficult than for Chinook salmon and steelhead, which enter the Delta from upstream rivers and can be protected with DCC and head of Old River gate closures. The survival of salvaged Chinook salmon and steelhead may also be greater than for delta smelt. Efforts to improve the survival of delta smelt would mitigate existing conditions pumping as well as SDIP project effects. For delta smelt that spawn in the south or central Delta, a relatively large fraction of the juveniles may be transported to the CVP and SWP pumping. The results of the PTM demonstrate the net tidal movement of water from various Delta locations and the relative vulnerability to entrainment. Juveniles that are spawned in the south or central Delta (e.g., Franks Tract or San Joaquin River channels upstream of Jersey Point) will experience a relatively high entrainment during periods of high pumping. Reductions in pumping cannot move delta smelt out of the south Delta channels but may allow more time for some juveniles to swim downstream toward Suisun Bay.

Improved Salvage and Release of Delta Smelt

The most effective mitigation measure for delta smelt involves improvements in the salvage handling and transport of the salvaged fish back to the Delta channels. Because the adult delta smelt salvaged in the December–March period are the most valuable (i.e., pre-spawned adults), the proposed mitigation will focus on these adult fish. The salvage effectiveness is the highest for these adult delta smelt (75 mm). Modifications to improve the handling and transport survival of these adult delta smelt should be initiated at the CVP and SWP fish salvage facilities as an SDIP project commitment to avoid and minimize impacts on delta smelt.

Even adult delta smelt are among the smaller fish salvaged during the winter months. They are susceptible to crowding and predation losses when held for up to a day in the salvage holding tanks. The delta smelt adults should be separated from the larger fish in a separate holding tank. The release location should be changed to release these adult delta smelt into Delta channels that are more suitable for spawning and rearing than are the current Delta release locations near Antioch and Decker Island. Locations within Suisun Marsh or the Cache Slough channels north of Rio Vista might be preferable.

An average of about 4,000 adult delta smelt are salvaged in the December–March period each year at both the SWP and CVP facilities. A mitigation goal should be established to release 5,000 adult smelt into channels that will support spawning and rearing of juveniles without subsequent entrainment in the south Delta export pumps. The CVP and SWP salvage facilities should be modified to provide separation and release procedures that will maximize the survival of adult delta smelt that find their way into the south Delta during their pre-spawning migration. This mitigation can be compared to “catch and release” regulations that protect trout and steelhead populations while allowing recreational fishing.

Reduce the Clifton Court Forebay Predation Loss

A mitigation measure that could reduce the large assumed predation loss in CCF would benefit adult and juvenile delta smelt and also would reduce the incidental take of Chinook salmon runs and steelhead. Predation in CCF is assumed to cause a major loss of these protected fish. The assumed mortality of 75% was estimated for the four-pumps agreement and has been also used in the October 2004 OCAP NOAA Fisheries BO. This implies that for every Chinook salmon or delta smelt that is salvaged, three other Chinook salmon or delta smelt are eaten by larger fish in CCF. This mitigation measure will reduce this predation loss by a substantial amount, although the benefit from this mitigation measure should be monitored and evaluated by the IEP fish team.

A 2.25–mile-long (12,000-foot-long) rock-wall levee should be constructed along the southern portion of CCF to directly connect the intake gates to the salvage facility with a salvage corridor. The salvage corridor should have a cross section of about 2,500 square feet with a top width of about 250 feet and an average depth of 10 feet (at 0 feet msl) to allow the maximum pumping flow of 10,300 cfs to flow directly from the intake gates to the Skinner fish facility trash rack and louvers. The peak velocity of about 4 ft/sec would transport delta smelt and Chinook salmon to the salvage facility in less than an hour. The transport time during pumping of 5,000 cfs would remain less than 2 hours. This would greatly minimize the exposure of smaller fish to predation by white catfish and striped bass. The average travel time through CCF with pumping of 5,000 cfs is about 2.5 days.

The rock-wall levee construction will allow water to move into and out of storage in the remainder of CCF. A rock size of 4 to 6 inches will provide sufficient pore space to maintain the storage within a few inches of the water level in the salvage corridor. Only the top portion of the levee needs to be constructed of rock; the bottom portion of the levee could be constructed from a sand and clay mixture to provide a foundation for the rock-wall top portion of the salvage corridor. The rock portion of the levee could be just 4 feet deep to provide the recommended “approach” velocity of 0.2 ft/sec for delta smelt along the 12,000 feet of levee. The rock levee should begin at about –5 feet msl and extend upward to 5 feet msl to extent slightly above the maximum water surface elevation that is about 3 feet msl. The cost of this salvage corridor has not yet been calculated, but it is likely to cost less than $40 million and have a substantial fish protection benefit compared to recent EWA expenditures of a similar magnitude.

Additional Closures of the Delta Cross Channel Gates and the Head of Old River Fish Control Barrier

The San Joaquin River Chinook salmon would be substantially protected by the extended closure provided by the SDIP project, which includes a 2-month closure of the head of Old River barrier, from April 1 through May 31. Under existing conditions, a closure of the temporary head of Old River barrier for a 1-month period during VAMP (April 15–May 15) is assumed. San Joaquin River Chinook salmon generally outmigrate as fry in February and March of wet years and migrate as larger smolts in April and May (Figure J-2). The SDIP extended closure of the head of Old River barrier for all of April and May will likely provide some reduction in the CVP and SWP entrainment density of Chinook salmon and thereby increase the survival of San Joaquin River Chinook salmon smolts.

The October 2004 OCAP NOAA Fisheries BO for Chinook salmon and steelhead indicates that the diversion of Sacramento River Chinook salmon can be effectively controlled with closure of the DCC. An effective mitigation measure for export pumping entrainment impacts at the CVP and SWP pumping plants would be to extend the closure of the DCC gates continuously from November 1 through June 30. The DCC gates are already closed for fish protection for half of November, half of December, half of January, all of the February 1–May 20 period, and a portion of the May 21–June 15 period. Extending the closure period for the entire 8-month period would protect a substantial portion of all Sacramento River Chinook salmon. A conservative estimate is that the DCC gate closure will reduce the combined DCC and Georgiana Slough diversion by about 20% of the Sacramento River flow at Freeport for these 60 days of additional DCC closure. The fraction of the population migrating in these windows when DCC is currently open must be estimated to calculate the potential population benefit.

The OCAP BO terms and conditions requires the U.S. Department of the Interior, Bureau of Reclamation (Reclamation) to conduct a study of the effects of DCC closure on water quality that could be used to inform the DCC fish protection team about secondary effects of DCC closure on water quality. Additional days of closure will provide relatively large benefits that can mitigate any increased entrainment losses of these Sacramento River Chinook salmon and steelhead.

Recent Delta Pelagic Species Decline

Interagency Ecological Program Response to Recent Low Fish Abundance Indices

The Interagency Ecological Program (IEP) for the San Francisco Bay/Sacramento–San Joaquin Estuary consists of ten member agencies, three state (DWR, DFG, State Water Board), six federal (USFWS, Reclamation, U.S. Geological Survey, U.S. Army Corps of Engineers, NOAA Fisheries, and U.S. Environmental Protection Agency), and one nongovernment organization (The San Francisco Estuarine Institute). These ten program partners work together to develop a better understanding of the estuary's ecology and the effects of the SWP and CVP operations on the physical, chemical, and biological conditions of the San Francisco Bay–Delta estuary. The IEP mission is to provide information on the factors that affect ecological resources in the Sacramento–San Joaquin estuary to allow more efficient management of the estuary. The specific goals of the IEP follow.

- To provide for the collection and analysis of data needed to understand factors in the Sacramento-San Joaquin estuary controlling the distribution and abundance of selected fish and wildlife resources and make the data readily available to other agencies and the public.
- To comply with permit terms (D-1641) requiring ecological monitoring in the estuary.
- To identify impacts of human activities on the fish and wildlife resources.
- To interpret information produced by the program and from other sources and, to the extent possible, recommend measures to avoid and/or offset adverse impacts of water project operation and other human activities on these resources. To seek consensus for such recommendations, but to report differing recommendations when consensus is not achieved.
- To provide an organizational structure and program resources to assist in planning, coordination, and integration of estuarine studies by other units of cooperating agencies or by other agencies.

In the last few years, the abundance indices calculated from the IEP FMWT survey show marked declines in numerous pelagic (i.e., open-water) fishes in the Delta and Suisun Bay. The abundance indices for 2002–2004 include low values for delta smelt and juvenile striped bass and near-record lows for longfin smelt and threadfin shad (Bryant and Souza 2004). Data from another IEP monitoring survey, the TNS, support the FMWT findings: TNS abundance indices for striped bass and delta smelt were among the lowest indices in the 45-yr record. These fish abundance indices and the corresponding Delta outflow and CVP and SWP pumping values are shown for the 1967–2004 period in Figures J-17 to J-20. In contrast, the San Francisco Bay Study did not show significant declines in its catches of marine/lower estuary species (Hieb et al. 2004; Hieb et al. 2005). Based on these findings, the problem appears to be limited to fish dependent on the upper estuary.

In addition to the declines in fish species, IEP monitoring has also found declining abundance trends for zooplankton with a substantial drop in calanoid copepod abundance in 2004. Calanoid copepods such as *Eurytemora affinis* and *Pseudodiaptomus forbesi* are the primary food for larval pelagic fishes in the upper estuary (Meng and Orsi 1991; Nobriga 2002) as well as older life stages of planktivorous species such as delta smelt (Lott 1998). Conversely, the invasive cyclopoid copepod *Limnoithona tetraspina*, which may be a poor food source for fish and an intraguild predator of calanoid copepods, is increasing in abundance and continues to be the most abundant copepod in the estuary (Mecum 2005).

Conceptual Delta Pelagic Ecosystem Model

There are at least three general factors that may be acting individually or in concert to lower pelagic productivity: (1) toxic effects; (2) exotic species effects; and (3) water project effects. The conceptual model shown in Figure J-21 uses these categories to illustrate the potential pathways by which pelagic species in the Delta could be affected. For each group of "boxes" shown in the model, one or more examples are provided in italics. The arrows show the potential mechanisms by which changes could occur. Note that not all of the organisms shown in each box are necessarily responsible for each of the mechanisms.

Effects from Toxins

Toxins could affect fishes directly or indirectly by reducing lower trophic level quantity or quality. Herbicides could directly affect phytoplankton, zooplankton, and fishes, while insecticides (e.g., pyrethroids) are most likely to affect zooplankton and fish. Toxic effects at lower trophic levels may reduce food supply for fishes and/or their invertebrate prey. Blooms of the blue-green alga (cyanobacteria) *Microcystis aeruginosa* have been observed in the Delta since 1999 (Lehman and Waller 2003). This species often produces toxic metabolites collectively known as microcystins. Microcystins cause cancer in humans and wildlife, including fish (Carmichael 1995), and reduce feeding success in zooplankton (Rohrlack et al. 2005). The switch from organophosphate to pyrethroid pesticides increased substantially through the 1990s (Kuivila presentation to EET Feb 2005). Pyrethroid pesticides have been shown to be less harmful to humans and terrestrial wildlife but more harmful to aquatic organisms. The rising use of organic herbicides and copper-based compounds to control nuisance aquatic weeds and algal blooms in the Delta also may pose a threat to desirable aquatic organisms.

Effects from Exotic Species

The negative effects of invasive exotic species in the estuary have been well established. Some notable examples were the substantial declines in lower trophic level productivity that followed the introduction of *Potamocorbula amurensis* (Nichols et al. 1990; Kimmerer and Orsi 1996; Jassby et al 2002; Feyrer et al. 2003) and the reduced abundance of native nearshore fishes associated with proliferation of *Egeria densa* and centrarchid fishes along Delta shorelines (Brown and Michniuk in press; Nobriga et al. submitted). At this time, there is limited information about quantitative aspects of the estuarine food web needed to estimate *Potamocorbula* grazing rates or predict whether nearshore and pelagic food webs are coupled in ways relevant to the production of pelagic fishes.

Effects from Water Project Operations

Kimmerer (2002) showed that water project operations have resulted in lower winter/spring inflow and higher summer inflow to the Delta. D-1641 X2 objectives have restored some spring inflow, but the E/I objectives have increased summer inflows to meet increasing summer export demands. This shift was implemented based on the assumption that it would be more protective to sensitive early life stages of key estuarine fishes and invertebrates. However, it is possible that high export during summer-winter months has unanticipated food web effects by exporting biomass that would otherwise support the estuarine food web. Total annual exports have been high (above 5 maf/yr) for many of the last 20 years (see Figure J-18), and it is possible that the total volume diverted on an annual basis influences estuarine productivity (Livingston et al. 1997, Jassby et al 2002).

Planned IEP Study Approach for 2005–2006

The overall approach recommended by the IEP for 2005 is an exploratory evaluation of all available information to better define the degree to which toxics, exotic species, and water project operations may be responsible individually or in concert for the recent abundance declines. Resource optimization is a major issue, as each species may have a different group of stressors implicated in its decline, making it difficult to comprehensively evaluate each stressor. The study plan can address multiple factors and/or different factors affecting species in different ways. Stressors that show a major change in the past few years will receive closer scrutiny than those showing earlier changes or more gradual trends. This exploratory approach is not intended as a substitute for a traditional, detailed scientific study; rather it is an initial step that will help identify more focused research studies that will be needed in 2006 and beyond.

Much of the rationale for the study design is based on *temporal*, *spatial*, and *species* contrasts for selected fish and zooplankton. For each contrast, the variables to be evaluated include: abundance, growth rate, and fecundity; and feeding success, condition factor, parasite load, and histopathology (fish only).

The proposed work falls into four general types: (1) an expansion of existing monitoring; (2) analyses of existing data; (3) new studies; and (4) ongoing studies that are expected to produce results relevant to this investigation. The 2005 budget for the IEP is $16.6 million to cover monitoring and special studies. This estimate includes an augmentation of approximately $1.7 million to cover the proposed work.

Expanded Monitoring

The IEP currently has an extensive monitoring program. IEP fish, zooplankton, and water quality monitoring programs will be the source of most of the data and samples used for the present effort. However, certain sampling programs will be augmented to ensure adequate collection of all life stages of pelagic fish. Additional zooplankton sampling that is more closely coordinated with fish sampling will be initiated to ensure detection of significant regional and/or temporal changes in abundance that could affect fishery production. These monitoring augmentations will increase the likelihood of detecting potentially detrimental future events for each target species, but will not likely help identify past changes in fish abundance or distribution.

Analyses of Existing Data

The IEP monitoring dataset represents one of the most comprehensive long-term estuarine datasets in the world. Additional analyses of these data will attempt to integrate and compare the separate surveys with a “life-history” perspective for each target species.

New Laboratory and Field Studies

The core IEP sampling programs do not provide information about certain types of organisms (e.g., blue-green algae), the health and status of some fish and invertebrates, or fecundity. Hence, new laboratory and field studies are proposed to provide additional clues into the type, timing, and location of stressors.

Ongoing Studies

Current information from all ongoing IEP studies will be used in this comprehensive evaluation of potential effects on the pelagic ecosystem in the Delta and Suisun Bay. Some of these studies are directed at evaluating regions of the estuary where fish entrainment is of greatest concern, and evaluating whether changes in the timing of exports since X2 and E/I objectives (1995) have reduced primary production.

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Table J-1. Average Monthly Historical SWP Pumping (cfs) for Water Years 1980–2002

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total (taf)
1980	3,641	4,736	5,859	6,295	3,274	1,150	1,464	1,550	2,996	2,120	4,482	3,996	2,517
1981	2,993	2,473	2,946	4,107	3,530	2,841	4,205	926	265	2,345	4,915	3,173	2,094
1982	3,657	3,158	4,328	3,426	5,608	6,239	6,107	2,881	766	967	3,567	3,071	2,633
1983	3,010	2,595	5,247	6,127	6,271	1,345	122	387	1,818	1,145	2,728	672	1,888
1984	338	752	422	331	1,969	2,561	3,608	2,680	2,995	4,545	4,857	2,206	1,650
1985	1,869	4,004	4,442	1,880	3,592	4,522	3,308	2,993	3,286	4,599	5,502	4,464	2,683
1986	3,573	3,471	5,907	4,985	2,021	726	2,011	2,999	2,999	3,901	5,377	6,299	2,681
1987	3,382	3,039	3,060	2,152	2,723	3,084	2,576	1,999	2,000	4,312	4,965	4,575	2,289
1988	1,693	1,371	4,850	6,231	5,785	4,211	4,288	2,999	2,806	3,252	3,978	3,307	2,707
1989	1,859	2,348	2,892	5,875	3,956	6,028	6,304	2,994	2,016	4,536	6,351	6,137	3,098
1990	6,087	6,069	6,213	6,320	6,317	6,323	5,192	345	308	2,432	3,389	2,475	3,100
1991	2,257	2,178	2,697	2,928	1,763	5,917	4,535	1,281	868	729	2,050	2,215	1,779
1992	3,387	1,075	1,278	3,014	3,528	6,278	1,189	700	943	376	1,482	2,769	1,574
1993	694	1,122	2,767	7,560	5,110	1,944	2,704	1,713	2,025	4,182	6,211	6,403	2,555
1994	6,443	2,584	6,269	3,458	1,917	1,872	329	703	322	1,691	3,409	3,608	1,980
1995	2,760	3,556	3,911	7,456	4,631	503	134	1,253	3,346	5,927	4,713	2,842	2,477
1996	2,948	1,329	6	5,666	2,980	2,831	1,778	2,549	4,966	6,026	6,181	5,797	2,609
1997	5,468	5,857	3,436	736	1,627	2,641	1,776	1,282	2,577	5,243	4,360	5,704	2,462
1998	4,325	4,932	6,826	3,197	131	233	31	703	2,167	3,471	4,297	4,474	2,116
1999	4,795	2,176	2,082	1,388	940	2,973	3,120	1,614	996	6,117	6,658	6,867	2,412
2000	4,936	5,223	3,804	6,440	7,331	5,588	3,178	1,589	4,235	5,842	6,129	6,518	3,673
2001	4,988	5,415	4,753	3,926	4,697	5,867	1,655	550	151	3,524	4,042	3,575	2,604
2002	980	3,229	6,124	6,456	4,943	3,892	2,104	625	2,146	6,222	6,732	4,131	2,874

Table J-2. Average Monthly Historical CVP Pumping (cfs) for Water Years 1980–2002

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total (taf)
1980	3,910	1,031	0	0	2,754	3,236	3,837	2,915	2,863	4,569	4,541	3,509	2,006
1981	3,566	3,852	3,788	4,083	3,656	1,942	3,684	3,136	3,458	4,351	4,110	3,314	2,591
1982	2,111	1,435	785	1,804	3,788	4,123	3,452	2,984	2,935	2,911	4,349	2,065	1,972
1983	2,239	3,337	3,139	3,864	3,947	3,934	3,662	2,823	2,975	3,971	4,266	3,345	2,503
1984	2,081	954	1,604	1,373	3,811	4,283	3,961	2,990	2,985	4,676	4,378	3,118	2,190
1985	3,614	3,893	3,956	3,859	4,039	3,949	3,900	2,991	3,000	4,573	4,376	4,096	2,791
1986	3,927	3,719	3,871	3,881	3,940	2,435	2,783	2,998	2,993	4,450	4,385	4,010	2,618
1987	4,000	3,693	4,010	4,004	4,030	2,379	4,339	2,998	2,998	4,435	4,565	4,284	2,758
1988	3,998	3,931	4,034	4,063	4,098	4,083	4,083	2,971	2,993	4,479	4,531	4,592	2,896
1989	3,547	3,602	4,166	4,183	4,097	4,112	3,987	2,999	2,996	4,739	4,704	4,422	2,871
1990	4,217	4,165	4,113	4,137	4,095	4,109	4,253	2,770	2,987	3,661	3,033	3,195	2,698
1991	1,107	1,588	2,277	1,883	2,606	3,722	2,882	1,277	894	1,633	1,659	1,852	1,408
1992	1,730	2,009	1,855	3,196	2,463	4,094	1,718	846	790	897	989	1,594	1,342
1993	967	1,278	1,219	4,006	4,026	4,082	2,882	1,524	1,990	4,303	4,362	4,379	2,109
1994	4,311	4,240	4,144	2,277	3,870	2,268	1,562	1,123	1,328	2,512	2,440	3,541	2,023
1995	2,480	2,488	3,534	4,141	4,218	2,372	3,326	2,985	4,067	4,463	4,386	4,387	2,582
1996	4,334	4,223	4,273	4,272	3,589	739	2,395	2,074	4,416	4,449	4,379	4,295	2,627
1997	4,196	4,123	4,083	2,022	557	4,344	2,719	1,744	4,439	4,396	4,429	4,322	2,510
1998	4,281	4,201	4,075	3,952	2,956	2,062	1,446	2,320	2,862	4,060	4,371	4,357	2,475
1999	4,162	2,136	33	2,978	4,317	4,108	1,710	1,703	3,336	4,426	4,391	4,279	2,263
2000	4,249	4,195	2,544	3,205	4,108	3,380	2,207	1,263	3,045	4,319	4,386	4,250	2,487
2001	4,208	4,061	3,910	2,737	3,519	1,883	2,177	857	2,997	4,135	4,130	4,081	2,333
2002	3,625	3,756	3,677	4,145	3,604	4,182	2,145	857	2,535	4,355	4,337	4,279	2,506

Table J-3. Monthly Historical Salvage of Striped Bass at the SWP Skinner Fish Facility for 1980–2002

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1980	47,463	120,099	146,766	32,757	8,218	417	269	312	490,985	1,367,670	472,167	88,580	2,775,703
1981	9,274	64,489	120,487	60,038	18,951	4,300	1,432	110,606	319,724	298,111	177,712	6,177	1,191,301
1982	4,082	41,262	63,077	56,587	30,985	14,433	6,750	1,438	19,659	279,532	313,190	32,067	863,062
1983	23,059	28,661	170,137	13,797	7,130	443		6,841	16,897	18,152	39,211	2,502	326,830
1984	340	5,930	19,796	896	1,105	845	1,170	20,806	2,561,150	3,332,583	109,484	14,550	6,068,655
1985	83,868	130,027	119,676	14,836	9,130	3,086	1,311	337,358	2,423,066	883,696	106,632	15,339	4,128,025
1986	4,934	101,565	96,768	35,023	11,044	1,050	159	34,689	6,983,012	6,110,155	362,440	129,027	13,869,866
1987	65,625	63,309	59,126	12,956	15,185	1,770	568	5,583,941	5,062,254	1,105,983	26,879	17,381	12,014,977
1988	271	24,848	199,565	23,197	47,947	4,350	252	102,460	8,492,849	3,736,998	387,058	4,913	13,024,708
1989	4,604	131,921	101,586	23,518	10,469	6,664	1,346	1,613,156	5,164,908	1,977,378	200,165	13,154	9,248,869
1990	5,124	35,595	11,205	53,120	35,925	14,837	564	209,548	194,792	778,605	238,207	9,165	1,586,687
1991	3,296	38,630	17,542	10,953	5,612	4,975	15,457	1,650	1,256,031	461,694	100,723	17,749	1,934,312
1992	5,636	4,183	80,772	26,122	58,901	31,554	439	461,692	1,626,755	113,199	9,149	1,256	2,419,658
1993	62	19,446	16,482	292,278	77,994	1,332	73	438,310	3,790,309	3,577,380	394,974	23,511	8,632,151
1994	5,603	72,316	5,502	1,220	1,121	416	5	146,634	227,138	116,080	9,600	15,508	601,143
1995	251	83,925	20,588	101,357	60,885	796	4	86	83,973	785,010	142,992	7,762	1,287,629
1996	3,264	3,586	191	5,547	928	600	20	6,886	355,963	269,771	6,437	6,806	659,999
1997	50,168	123,016	7,973	2,291	590	162	282	5,049	615,196	120,608	5,349	3,333	934,017
1998	21,717	2,450	165,618	5,876	191	136		6	3,354	96,548	154,342	38,257	488,495
1999	37,626	16,608	2,398	566	126	97	1,145	2,435	95,685	1,078,510	446,634	4,294	1,686,124
2000	1,156	6,585	56,196	7,491	10,136	3,734	324	91,795	1,796,001	833,774	131,601	11,489	2,950,282
2001	324,552	279,346	39,546	4,840	10,878	13,972	4,984	3,606	64,536	266,820	9,996	668	1,023,744
2002	78	87,825	65,798	31,042	26,560	5,228	312	1,173	481,268	300,582	13,339	14,858	1,028,063

Table J-4. Monthly Historical Salvage of Striped Bass at the CVP Tracy Fish Facility for 1980–2002

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1980	70,899	24,850			11,246	3,169	9,116	1,775	177,993	655,002	128,300	63,915	1,146,265
1981	69,132	139,792	68,231	25,975	30,448	10,187	22,613	1,413,715	5,796,925	775,982	98,835	50,415	8,502,250
1982	46,081	50,796	19,712	52,311	70,295	20,812	24,687	8,829	205,092	814,320	350,387	38,017	1,701,339
1983	25,140	52,352	33,462	28,449	21,203	7,063	5,537	2,600	14,928	22,150	75,957	15,446	304,287
1984	1,439	4,586	4,998	3,141	2,566	1,713	7,663	175,569	1,700,672	1,883,149	142,767	30,195	3,958,458
1985	215,335	105,471	86,650	28,783	20,529	9,990	11,626	135,851	657,585	562,714	100,959	21,429	1,956,922
1986	13,198	19,348	35,198	51,540	164,071	10,084	1,974	23,044	2,570,923	1,385,600	251,575	88,746	4,615,301
1987	47,023	64,812	30,601	37,015	23,351	10,769	12,955	1,223,560	818,755	76,836	22,673	17,612	2,385,962
1988	5,891	5,032	21,138	27,490	41,286	20,378	7,834	13,965	400,086	168,670	49,134	18,030	778,934
1989	6,689	4,399	27,516	28,329	33,991	15,215	7,896	186,667	886,116	261,952	29,671	16,490	1,504,931
1990	12,348	3,938	4,582	8,476	15,122	23,107	4,086	173,709	481,853	421,767	76,720	24,305	1,250,013
1991	2,124	1,825	17,064	14,553	21,055	26,536	25,148	26,399	693,284	920,842	75,971	16,447	1,841,248
1992	6,922	3,845	4,533	14,745	167,552	50,952	2,931	1,233,979	458,611	72,035	6,218	11,413	2,033,736
1993	10,319	10,838	6,414	159,612	45,912	34,488	4,050	222,744	2,775,576	1,364,520	57,240	48,312	4,740,025
1994	24,768	20,750	13,902	10,174	15,980	10,920	4,455	29,916	1,186,620	496,932	25,380	14,608	1,854,405
1995	8,328	5,984	8,726	110,652	31,700	9,942	2,514	2,094	19,064	60,882	32,868	27,948	320,702
1996	16,830	8,198	10,056	6,214	7,374	84	1,440	1,962	56,148	37,596	13,624	8,208	167,734
1997	15,982	13,356	14,460	7,344	324	2,568	4,728	98,148	352,692	41,802	12,248	9,408	573,060
1998	9,804	9,652	12,258	17,380	8,004	1,760	420	792	1,608	70,458	37,416	15,840	185,392
1999	3,872	2,664		2,364	2,208	1,371	532	1,461	464,460	234,576	22,216	7,152	742,876
2000	10,344	11,952	3,900	9,240	14,196	2,184	2,340	17,736	334,284	133,764	18,677	14,448	573,065
2001	12,576	43,644	11,112	3,948	16,620	15,148	3,960	174,012	818,191	96,480	8,772	5,880	1,210,343
2002	2,436	16,992	20,244	31,656	26,050	41,352	7,872	7,662	245,052	107,347	10,692	1,623	518,978

Table J-5. Monthly Historical Salvage of Chinook Salmon at the SWP Skinner Fish Facility for 1980–2002

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1980	1,516	5,392	5,249	5,968	383	188	18,668	27,041	22,836	725	22	931	88,919
1981	966	943	1,462	1,756	3,504	6,327	55,039	19,115	352		85		89,549
1982	395	2,937	12,095	6,700	26,805	22,973	28,353	110,299	24,446				235,003
1983		6,086	52,757	12,509	12,758	4,796		1,138	37,445	134			127,623
1984		162			80	1,659	27,260	40,078	46,130	3	575		115,947
1985	10,514	8,859	9,883	121	847	2,261	28,246	96,273	8,768	408		19	166,199
1986	719	1,099	1,952	1,639	13,422	18,900	133,773	176,557	90,240				438,301
1987		153	549	63	405	4,316	40,804	95,002	9,783	573	69	83	151,800
1988	2	16	26,764	2,943	4,235	3,905	44,736	71,008	21,453	1,781	308	24	177,175
1989	39	460	1,016	2,592	170	8,319	49,525	42,859	602		122		105,704
1990	38	755	1,277	2,463	1,103	4,668	17,377	8,964	595	75			37,315
1991	9		42	91	99	4,765	19,904	12,268	680				37,858
1992	72	1,282	9	904	8,445	9,255	1,058	2,365				6	23,396
1993			160	1,622	956	136	1,487	2,626	728	8	84		7,807
1994	22	77	901	193	209	283	269	1,787	20				3,761
1995		10	707	5,048	1,389	18	14	3,505	8,994	184	12		19,881
1996				3,013	280	445	2,637	6,565	1,583	14		6	14,543
1997	3	112	46	18	35	1,674	6,014	2,963	635	30		9	11,539
1998	8	4	463	352	108	4		1,713	1,610	120			4,382
1999	27	10	12	34	844	1,974	23,609	23,654	458	48	44	42	50,756
2000	6	39	59	630	6,825	3,355	20,690	9,144	3,951	33	15	526	45,273
2001	227	52	151	263	1,220	6,422	13,223	6,747					28,305
2002			452	1,083	272	524	1,606	2,096	32		15		6,080

Table J-6. Monthly Historical Salvage of Chinook Salmon at the CVP Tracy Fish Facility for 1980–2002

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1980		745			125	299	93,825	50,063	7,320	1,187			153,564
1981	316	1,328	308	95		1,709	28,907	28,975	5,458				67,096
1982	2,360	488	6,872	2,911	5,414	13,170	6,535	95,864	68,290	295	233		202,432
1983		14,635	12,814	5,952	4,110	6,149	47,667	112,807	31,935	928			236,997
1984	2,302	459	66	162		8,461	86,803	81,617	1,904	990			182,764
1985	10,714	6,671	5,009		7,319	4,540	46,780	59,700	1,633	103			142,469
1986	8,053	3,898	5,060	1,810	401,293	34,146	67,614	189,070	46,166	10,257			767,367
1987	642	75	966	306	504	2,477	47,962	39,077					92,009
1988			2,395	3,726	2,196	1,484	24,196	22,219	205	57			56,478
1989			302	73		6,151	13,539	20,685	2,489				43,239
1990				92	103	71	2,085	2,840	916				6,107
1991					198	2,527	18,360	7,006	292				28,383
1992		2,705	138	510	3,907	18,002	17,349	1,893					44,504
1993			24	36	372	360	5,364	11,688	1,020				18,864
1994	12	492	1,134	256	2,772	1,668	4,293	888	36				11,551
1995	12		2,250	3,852	816	684	9,390	24,516	23,820	1,044			66,384
1996	144		132	864	1,044	96	19,068	15,486	3,072				39,906
1997	24	192	72	192	12	16,296	19,728	13,260	3,860	12	12	24	53,684
1998	48	48	341	49,512	37,752	11,002	12,552	43,872	12,816	180			168,123
1999		84		2,196	38,148	9,773	33,354	36,851	12,252	36	36		132,730
2000	12	96	132	1,212	27,472	7,296	30,024	9,846	1,872	36		204	78,202
2001	36	48	168	276	1,176	2,977	21,804	2,550	516		12		29,563
2002			168	936	204	1,839	9,274	1,766	660	12	12		14,871

Table J-7. Monthly Historical Salvage of Delta Smelt at the SWP Skinner Fish Facility for 1980–2002

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1980	311	1,237		4,607	90	157	229	686	12,181	13,698	7,332	84	40,612
1981	354	338	2,020	10,541	9,111	3,339	3,891	6,170	4,909	6,972		20	47,665
1982	86	361	662	3,372	3,382	2,011	186	50	8	1,251	1,386		12,755
1983	12	466	804	2,507	716	257		69	2,999	764		294	8,888
1984					35	5	77	474	2,423	3,033		24	6,071
1985			321	30	471	490	1,229	1,461	8,073	68		656	12,799
1986			442	929	853	658	522	180	71	112			3,767
1987		43	257	48	144	176	524	117	14,824	1,958	2,697	81	20,869
1988	57		6,294	4,498	415	170		4,929	41,836	3,627			61,826
1989	121	4	510	1,012	107	277	145	1,678	2,702	4,568	896	171	12,191
1990		474		226	623	356	325	1,046	5,190	14,595	58		22,893
1991			7	420	369	951	984	119	6,238	5,337	1,164		15,589
1992	381			119	681	440		1,903	2,367	24			5,915
1993				3,086	1,154	89		15,901	6,265	807	24		27,326
1994			88	16	54	61	217	15,365	5,141	1,497			22,439
1995			42	1,937	457	4							2,440
1996				3,109	846	131	9	19,229	8,445	76			31,845
1997			6		32	146	139	16,760	6,140	216			23,439
1998			257	118		8		4	30	100			517
1999			16	4	110	124	176	38,258	49,332	19,498	36		107,554
2000			66	238	5,491	1,690	282	35,721	40,352	1,249	6	26	85,121
2001	27	70	36	25	1,662	2,740	244	6,756	1,005	6			12,571
2002			781	3,983	112	141		35,637	7,942				48,596

Table J-8. Monthly Historical Salvage of Delta Smelt at the CVP Tracy Fish Facility for 1980–2002

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1980	22,114	167			4,086	7,749	4,005	551	947	2,503	394	1,656	44,172
1981	12,145	3,189	6,395	9,838	11,950	6,206	1,674	91,004	45,913	49,380	49,081	2,879	289,654
1982	1,468	4,895		2,814	6,818	4,041	165	624	2,536		524	917	24,802
1983	772	425		1,851	502		71	55	1,621	958		77	6,332
1984			593			1,676	102	17,826	5,867		897		26,961
1985	152	120	2,454	161	164	60	206	5,733	1,721	3,866	2,177	401	17,215
1986	87			413	418	3			100	288	1,353		2,662
1987	180					543	18,520	13,263				334	32,840
1988		43	1,394	1,831	246			3,620	1,831				8,965
1989	72		100				3,800	2,364	295	803	413	258	8,105
1990	111						5,322	4,917	1,167	152			11,669
1991			142	178		239	440	516				486	2,001
1992					76	406	85	77					644
1993					36	60		888	2,580	240			3,804
1994					120	108	728	16,536	3,660	12			21,164
1995			12	120	24	12	24						192
1996				1,080	444	24	102	10,870	1,020	72			13,612
1997		12	12		48	1,584	1,020	16,068	1,736	12			20,492
1998			24	12	24	584	48		36	24			752
1999				24	1,356	440	234	20,671	24,036	324	12		47,097
2000		24	60	564	2,328	1,056	1,464	13,680	8,772	264			28,212
2001		240	156	156	2,208	1,008	276	6,378	1,320				11,742
2002			348	1,248	168	84	372	11,724	3,984	24			17,952

Table J-9. Monthly Historical Salvage of Splittail at the SWP Skinner Fish Facility for 1980–2002

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1980	48	109	1,272	41,252	63,845	538	1,763	85,453	84,972	15,235	4,814	772	300,073
1981	38		241	804	4,254	3,368	2,818	1,192	13		62		12,790
1982		47	727	12,304	20,884	8,497	3,937	25,232	29,152	15,685	48,782	162	165,409
1983	9		766	366	3,110	1,504		1,346	63,041	9,149	13,382	183	92,856
1984	9			2	680	1,189	3,951	2,962	12,836	32,236	7,928	280	62,073
1985		227	1,220	55	5,879	2,674	4,128	4,083	17,160	2,995	398	164	38,983
1986	106	83		118	294	849	25,170	608,493	467,101	43,455	8,910	4,544	1,159,123
1987	255		1,116	213	1,172	1,978	717	3,777	39,886	5,216	703	174	55,207
1988	29	8	3,220	18,176	14,593	3,790	3,480	2,392	12,168	5,692	180	413	64,141
1989		70	209	459	585	6,643	10,628	10,348	2,832	1,816	10,191	1,612	45,393
1990	78	163	172	1,146	5,797	3,576	1,267	988	267	199			13,653
1991				60	75	2,948	8,571	279	10,510	2,245			24,688
1992	353			172	1,972	2,188	108	32	272		6	4	5,107
1993			13	25,727	5,991	289	222	16,847	7,151	1,610	350	68	58,268
1994	122	88	14	13	28	55		72	73	18	6	12	501
1995				2,331	469	4	2	31,542	2,051,764	99,246	4,828	249	2,190,435
1996	58	24		461	268	183	35	23,248	10,884	1,207	384	56	36,808
1997	46	12	4	15	57	1,571	4,208	592	2,992	899	162	40	10,598
1998	12	12	1,112	448		30	12	10,218	421,899	592,518	14,824	1,256	1,042,341
1999	909	142	12	25	117	703	824	261	504	9,344	1,840	283	14,964
2000	71	43	102	169	3,348	5,590	1,623	19,253	34,763	5,121	452	127	70,662
2001	383	124	60	108	1,948	3,897	3,214	36	36	186	72	66	10,130
2002			555	2,460	852	767	983	50	179	215	53	53	6,167

Table J-10. Monthly Historical Salvage of Splittail at the CVP Tracy Fish Facility for 1980–2002

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1980					195	515	2,363	147,310	53,256	32,197	2,440	181	238,457
1981	161		161	299	1,314	362	7,496	83,501	32,038	2,442	1,057		128,831
1982					9,333	6,064	2,228	5,292	55,888	91,712	27,823	1,869	200,209
1983	77		1,642	1,716	11,874	9,626	3,860	44,833	186,375	54,607	28,709	3,776	347,095
1984	911	14	83	72	3,691	7,824	2,382	8,542	36,097	15,467	2,514		77,597
1985				78	1,615	3,030	1,453	3,362	8,357	10,037	3,444	478	31,854
1986	87	1,297		56	1,343	3,981	37,931	953,254	210,755	17,538	2,754	2,441	1,231,437
1987	777	366	87	795	2,353	1,607	2,291	3,393	750	197	195	230	13,041
1988			132	2,490	658	1,631	3,030	2,572	2,341	1,131			13,985
1989				262	692	3,213	3,820	5,044	1,960	66			15,057
1990						2,665	1,561	949	22,136	2,967			30,278
1991				524	218	3,538	2,778	876	3,573	231			11,738
1992			40	170	1,992	2,101	141	364	2,510		37		7,355
1993				11,412	2,796	1,836	1,662	57,156	57,072	9,396	84	12	141,426
1994		12			196	240	36	132	1,896	324			2,836
1995				648	108	12	132	200,148	2,680,028	254,676	5,616	588	3,141,956
1996	708	288	204	300	948		912	24,014	18,540	3,504	1,140	360	50,918
1997	540	120	60		72	2,388	1,200	5,988	9,756	822	108	48	21,102
1998	24		48	838	252	1,664	6,484	248,964	1,101,960	681,222	8,412	1,332	2,051,200
1999	472	48		252	408	706	89	102	4,920	10,500	372	198	18,067
2000	96	108	24	60	1,126	580	1,644	33,696	21,120	888	132	36	59,510
2001	36		12	24	228	253	540	252	4,860	444	60	72	6,781
2002	12	24	240	804	100	558	877		588	253	12	12	3,480

Table J-11. Monthly Historical Salvage of Steelhead at the SWP Skinner Fish Facility for 1980–2002

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1980		20	23	381	835	74	118	210	80				1,741
1981	33		25	119	1,509	3,088	4,902						9,676
1982			309	792	1,432	1,110	10,965	2,441	179				17,228
1983	17			280	89			256					642
1984						41	357	18					416
1985			22		325	1,221	1,165	647					3,380
1986					139	54	1,328	446					1,967
1987			1,268		69	3,387	976	446					6,146
1988			172	88	2,403	823	2,116	426	25				6,053
1989				46	499	4,767	2,105	404					7,821
1990					1,317	2,195	1,039	19					4,570
1991			41	22	23	5,799	2,692	91					8,668
1992	92	489		148	5,418	3,867	201	33					10,248
1993			16	1,330	8,561	792	353	200					11,252
1994				21	107	154	22	61		15			380
1995	2		4	360	362	78	6	86	117	30			1,045
1996	4			2,009	597	190	192	151	7				3,150
1997		17	17		9	88	101	23					255
1998	28		30	52	16				6				132
1999	39		1	13	7	177	587	195	42	6	4		1,071
2000	6	36	3	730	4,405	791	231	27	56	6			6,291
2001	3	54	83	387	2,932	4,468	258	57					8,242
2002			2	612	537	656	159	22	18	12			2,018

Table J-12. Monthly Historical Salvage of Steelhead at the CVP Tracy Fish Facility for 1980–2002

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1980						90	743	126					959
1981			252	248	1,258	1,008	168	267					3,201
1982								297					297
1983			1,980										1,980
1984		14				146	187	70					417
1985					83	134	127	101					445
1986				26	524	127	505	238	46	45			1,511
1987				143	112	718	776	275					2,024
1988				248		491	1,039	1,646					3,424
1989			139		252	5,051	3,139	1,212					9,793
1990					1,085	2,139	786						4,010
1991				95	109	4,412	1,263	98					5,977
1992				4,216	1,788	2,716	342						9,062
1993					3,480	3,060	684	84	24				7,332
1994			12	30	688	336	127	36	12				1,241
1995			48	12	276	648	228	108	72				1,392
1996				1,008	838	24	264	84	12				2,230
1997			24	12		168	396	60	36	12			708
1998			12	300	180	120	36	48	12	168			876
1999		12		96	324	395	508	161	24				1,520
2000		24	24	451	1,822	396	204	60					2,981
2001		12	12	156	2,388	1,517	468	12	12				4,577
2002				96	402	847	203		24				1,572

Table J-13. Historical Range of Monthly Average Striped Bass Salvage Density (fish/cfs) at SWP and CVP for 1980–2002

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
SWP												
Minimum	0.08	0.50	0.88	0.35	0.13	0.03	0.00	0.01	1.55	15.85	1.04	0.19
10	0.10	2.94	1.91	1.02	0.40	0.21	0.01	0.26	25.21	31.21	2.08	0.59
20	0.48	6.57	5.54	1.47	0.81	0.33	0.03	1.38	81.42	56.44	3.86	1.30
30	0.95	9.78	7.59	2.52	1.43	0.49	0.07	2.37	200.10	106.56	11.09	1.87
40	1.11	16.48	13.81	3.60	2.47	0.65	0.11	6.03	387.05	140.66	21.05	2.61
50	1.46	18.13	16.38	4.00	2.65	0.69	0.16	11.57	632.03	192.14	30.34	3.60
60	2.60	21.52	24.42	5.37	5.37	1.05	0.21	38.88	760.89	291.42	35.97	3.71
70	6.08	25.65	29.14	7.37	5.49	1.38	0.33	115.41	1,302.32	366.47	54.91	4.00
80	8.64	27.67	34.38	8.56	5.64	1.55	0.37	236.94	1,812.62	640.57	67.28	7.45
90	18.13	31.83	41.10	14.41	12.18	2.34	0.96	593.08	2,490.99	831.02	84.30	10.06
Maximum	65.07	56.20	63.18	38.66	16.70	5.03	3.41	2,793.91	3,027.21	1,566.47	105.34	22.17
CVP												
Minimum	0.67	0.95	0.00	0.79	0.51	0.11	0.29	0.34	0.56	5.58	2.12	0.38
10	1.04	1.23	1.62	1.51	0.95	0.44	0.62	0.73	6.56	10.34	2.83	1.72
20	1.90	1.53	2.45	2.41	3.01	0.73	0.84	0.93	65.25	17.34	4.54	2.67
30	2.38	2.16	2.89	3.86	3.93	1.47	1.27	4.00	89.77	24.12	5.80	3.69
40	2.98	2.76	3.21	4.53	4.60	3.47	1.67	8.69	128.90	36.32	7.26	4.07
50	3.36	4.52	4.39	6.56	5.37	4.19	1.82	20.67	161.32	55.27	10.40	4.62
60	3.91	4.96	5.41	7.13	7.29	4.85	1.94	47.59	273.04	116.78	14.06	6.53
70	7.71	9.39	7.23	7.58	8.17	5.13	2.57	60.13	405.36	157.36	23.46	8.12
80	11.54	16.81	8.80	8.94	9.38	6.53	2.98	112.79	697.59	246.97	27.07	10.49
90	19.13	26.49	17.28	25.38	17.13	8.37	5.65	367.17	886.67	315.97	43.15	17.62
Maximum	59.59	36.30	25.12	39.84	68.02	12.45	8.72	1,458.60	1,676.49	563.77	80.56	22.13

Table J-14. Historical Range of Monthly Average Chinook Salmon Salvage Density (fish/cfs) at SWP and CVP for 1980–2002

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
SWP												
Minimum	0.00	0.00	0.00	0.00	0.02	0.02	0.00	1.53	0.00	0.00	0.00	0.00
10	0.00	0.00	0.01	0.03	0.05	0.08	0.19	2.46	0.02	0.00	0.00	0.00
20	0.00	0.00	0.01	0.04	0.07	0.15	0.78	2.66	0.27	0.00	0.00	0.00
30	0.00	0.01	0.03	0.07	0.11	0.37	1.25	3.19	0.34	0.00	0.00	0.00
40	0.00	0.01	0.07	0.11	0.17	0.63	3.38	5.28	0.69	0.00	0.00	0.00
50	0.00	0.03	0.14	0.21	0.24	0.66	4.64	12.27	0.93	0.00	0.00	0.00
60	0.01	0.14	0.19	0.34	0.39	0.83	7.56	14.71	2.08	0.01	0.00	0.00
70	0.02	0.26	0.34	0.43	0.85	1.21	7.91	18.72	3.57	0.03	0.01	0.00
80	0.08	0.71	0.74	0.51	0.97	1.44	9.67	25.04	7.64	0.07	0.01	0.01
90	0.30	1.18	2.68	0.89	2.32	3.30	13.02	37.07	19.56	0.13	0.02	0.02
Maximum	5.63	2.35	10.05	2.04	6.64	26.03	66.52	58.87	31.92	0.55	0.12	0.23
CVP												
Minimum	0.00	0.00	0.00	0.00	0.00	0.02	0.49	0.79	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.01	0.00	0.10	2.06	2.10	0.04	0.00	0.00	0.00
20	0.00	0.00	0.02	0.02	0.03	0.32	3.05	3.98	0.21	0.00	0.00	0.00
30	0.00	0.00	0.04	0.08	0.07	0.58	5.29	7.24	0.32	0.00	0.00	0.00
40	0.00	0.01	0.05	0.11	0.12	0.85	7.08	7.58	0.54	0.00	0.00	0.00
50	0.00	0.02	0.07	0.14	0.29	1.15	7.96	7.80	0.64	0.00	0.00	0.00
60	0.01	0.06	0.08	0.22	0.57	1.57	10.03	10.00	0.84	0.01	0.00	0.00
70	0.02	0.34	0.26	0.44	1.20	2.05	11.43	17.87	1.97	0.03	0.00	0.00
80	0.13	0.63	0.63	0.88	1.72	2.87	13.37	20.97	4.16	0.17	0.00	0.00
90	1.12	1.29	1.30	1.48	8.41	4.27	21.43	31.16	9.76	0.23	0.00	0.00
Maximum	2.96	4.39	8.76	12.53	101.84	14.02	24.45	63.07	23.27	2.31	0.05	0.05

Table J-15. Historical Range of Monthly Average Delta Smelt Salvage Density (fish/cfs) at SWP and CVP for 1980–2002

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
SWP												
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.02	0.03	0.00	0.03	0.02	0.00	0.00	0.00
20	0.00	0.00	0.00	0.01	0.03	0.04	0.00	0.07	1.02	0.02	0.00	0.00
30	0.00	0.00	0.00	0.03	0.04	0.04	0.00	0.18	1.68	0.04	0.00	0.00
40	0.00	0.00	0.01	0.04	0.09	0.05	0.02	0.48	2.44	0.17	0.00	0.00
50	0.00	0.00	0.01	0.14	0.11	0.06	0.06	1.64	3.09	0.45	0.00	0.00
60	0.00	0.00	0.04	0.20	0.14	0.08	0.08	3.76	4.58	0.71	0.00	0.00
70	0.00	0.01	0.08	0.41	0.22	0.15	0.15	8.24	7.28	1.05	0.00	0.00
80	0.03	0.05	0.14	0.59	0.33	0.26	0.21	12.76	12.76	2.30	0.09	0.01
90	0.08	0.13	0.17	0.73	0.57	0.44	0.35	22.36	16.66	5.44	0.51	0.03
Maximum	0.12	0.26	1.30	2.57	2.58	1.18	0.93	57.02	49.51	7.32	1.64	0.44
CVP												
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.13	0.02	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00	0.01	0.01	0.04	0.33	0.18	0.00	0.00	0.00
40	0.00	0.00	0.00	0.01	0.03	0.03	0.05	0.75	0.38	0.00	0.00	0.00
50	0.00	0.00	0.00	0.04	0.05	0.06	0.13	1.78	0.44	0.01	0.00	0.00
60	0.00	0.00	0.02	0.08	0.09	0.13	0.16	4.59	0.58	0.04	0.00	0.00
70	0.02	0.01	0.04	0.16	0.13	0.29	0.41	6.56	1.04	0.06	0.04	0.04
80	0.04	0.05	0.09	0.29	0.47	0.38	0.58	10.19	1.81	0.13	0.11	0.09
90	0.63	0.16	0.37	0.48	1.31	0.89	1.03	13.38	2.86	0.49	0.29	0.41
Maximum	5.66	3.41	1.69	2.41	3.27	3.20	4.27	29.02	13.28	11.35	11.94	0.87

Table J-16. Historical Range of Monthly Average Splittail Salvage Density (fish/cfs) at SWP and CVP for 1980–2002

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
SWP												
Minimum	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.05	0.05	0.00	0.00	0.00
10	0.00	0.00	0.00	0.02	0.04	0.08	0.02	0.08	0.23	0.02	0.00	0.00
20	0.00	0.00	0.00	0.02	0.09	0.17	0.09	0.18	0.38	0.06	0.01	0.00
30	0.00	0.00	0.00	0.03	0.14	0.30	0.26	0.66	1.04	0.19	0.03	0.01
40	0.01	0.00	0.01	0.05	0.17	0.47	0.36	1.25	2.03	0.40	0.05	0.02
50	0.01	0.01	0.03	0.08	0.41	0.57	0.51	1.89	4.29	0.88	0.07	0.04
60	0.01	0.02	0.07	0.11	0.46	0.60	0.70	3.46	5.82	1.57	0.17	0.04
70	0.02	0.02	0.11	0.19	0.70	0.76	1.14	8.90	15.24	4.69	1.04	0.10
80	0.03	0.03	0.17	0.35	1.19	1.06	1.51	11.20	32.15	7.67	1.62	0.17
90	0.08	0.03	0.26	3.31	2.35	1.16	1.93	23.04	132.20	15.20	3.09	0.27
Maximum	0.19	0.07	0.66	6.55	19.50	1.36	12.52	202.89	613.13	170.71	13.68	0.72
CVP												
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.23	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.03	0.11	0.06	0.15	0.68	0.05	0.00	0.00
20	0.00	0.00	0.00	0.01	0.07	0.14	0.30	0.38	1.45	0.12	0.00	0.00
30	0.00	0.00	0.00	0.02	0.08	0.17	0.38	0.79	1.97	0.17	0.02	0.00
40	0.00	0.00	0.00	0.05	0.12	0.36	0.43	1.13	3.10	0.24	0.03	0.00
50	0.00	0.00	0.01	0.07	0.17	0.51	0.58	1.77	4.20	0.79	0.04	0.01
60	0.01	0.00	0.01	0.08	0.29	0.65	0.62	5.06	7.78	2.19	0.26	0.05
70	0.03	0.01	0.02	0.18	0.38	0.77	0.74	20.18	14.70	2.75	0.55	0.07
80	0.09	0.02	0.04	0.21	0.65	0.89	0.96	33.18	24.83	5.81	0.72	0.13
90	0.16	0.06	0.05	0.43	0.94	1.60	1.84	63.74	68.87	27.95	1.80	0.55
Maximum	0.44	0.35	0.52	2.85	3.01	2.45	13.63	317.97	659.03	167.81	6.73	1.13

Table J-17. Historical Range of Monthly Average Steelhead Salvage Density (fish/cfs) at SWP and CVP for 1980–2002

Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
SWP												
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.01	0.02	0.05	0.01	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.02	0.06	0.07	0.02	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.01	0.06	0.07	0.08	0.05	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.01	0.09	0.13	0.11	0.07	0.00	0.00	0.00	0.00
50	0.00	0.00	0.00	0.02	0.12	0.17	0.16	0.09	0.00	0.00	0.00	0.00
60	0.00	0.00	0.00	0.05	0.20	0.21	0.19	0.12	0.00	0.00	0.00	0.00
70	0.00	0.00	0.01	0.05	0.26	0.37	0.34	0.14	0.01	0.00	0.00	0.00
80	0.00	0.00	0.01	0.10	0.42	0.70	0.45	0.15	0.01	0.00	0.00	0.00
90	0.01	0.01	0.03	0.16	0.62	0.94	0.65	0.22	0.03	0.00	0.00	0.00
Maximum	0.03	0.45	0.41	0.35	1.68	1.10	1.80	0.85	0.23	0.01	0.00	0.00
CVP												
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.03	0.05	0.02	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00	0.02	0.05	0.08	0.03	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.01	0.06	0.09	0.09	0.03	0.00	0.00	0.00	0.00
50	0.00	0.00	0.00	0.02	0.07	0.12	0.15	0.04	0.00	0.00	0.00	0.00
60	0.00	0.00	0.00	0.03	0.12	0.22	0.18	0.05	0.00	0.00	0.00	0.00
70	0.00	0.00	0.00	0.06	0.20	0.39	0.20	0.08	0.01	0.00	0.00	0.00
80	0.00	0.00	0.01	0.06	0.31	0.61	0.23	0.09	0.01	0.00	0.00	0.00
90	0.00	0.01	0.03	0.13	0.63	0.79	0.29	0.10	0.01	0.00	0.00	0.00
Maximum	0.00	0.01	0.63	1.32	0.86	1.23	0.79	0.55	0.02	0.04	0.00	0.00

Table J-18. Median and Maximum Salvage Densities (fish/cfs) at SWP for 1980–2002

Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
50th Percentile												
Delta Smelt	0.00	0.00	0.01	0.14	0.11	0.06	0.06	1.64	3.09	0.45	0.00	0.00
Splittail	0.01	0.01	0.03	0.08	0.41	0.57	0.51	1.89	4.29	0.88	0.07	0.04
Striped Bass	1.46	18.13	16.38	4.00	2.65	0.69	0.16	11.57	632.03	192.14	30.34	3.60
Steelhead	0.00	0.00	0.00	0.02	0.12	0.17	0.16	0.09	0.00	0.00	0.00	0.00
Chinook Salmon, all	0.00	0.03	0.14	0.21	0.24	0.66	4.64	12.27	0.93	0.00	0.00	0.00
1992–2000 only												
Chinook Salmon, all	0.00	0.00	0.03	0.11	0.26	0.16	0.89	2.80	0.32	0.00	0.00	0.00
Fall-run	0.00	0.00	0.00	0.00	0.02	0.01	0.13	2.00	0.29	0.00	0.00	0.00
Late fall–run	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Winter-run	0.00	0.00	0.00	0.02	0.02	0.08	0.02	0.00	0.00	0.00	0.00	0.00
Spring-run	0.00	0.00	0.00	0.00	0.00	0.04	0.62	0.75	0.00	0.00	0.00	0.00
Maximum												
Delta Smelt	0.12	0.26	1.30	2.57	2.58	1.18	0.93	57.02	49.51	7.32	1.64	0.44
Splittail	0.19	0.07	0.66	6.55	19.50	1.36	12.52	202.89	613.13	170.71	13.68	0.72
Striped Bass	65.07	56.20	63.18	38.66	16.70	5.03	3.41	2,793.91	3,027.21	1,566.47	105.34	22.17
Steelhead	0.03	0.45	0.41	0.35	1.68	1.10	1.80	0.85	0.23	0.01	0.00	0.00
Chinook Salmon, all	5.63	2.35	10.05	2.04	6.64	26.03	66.52	58.87	31.92	0.55	0.12	0.23
1992–2000 only												
Chinook Salmon, all	0.05	1.19	0.18	0.68	2.39	1.47	7.99	14.65	2.69	0.03	0.01	0.08
Fall-run	0.04	0.03	0.03	0.17	0.88	0.39	4.72	10.82	1.98	0.03	0.01	0.08
Late fall–run	0.00	0.01	0.17	0.50	0.88	0.56	0.04	0.00	0.01	0.00	0.00	0.00
Winter-run	0.00	0.00	0.06	0.16	0.26	0.58	0.31	0.01	0.00	0.00	0.00	0.00
Spring-run	0.00	0.00	0.00	0.00	0.01	0.61	5.66	3.91	0.70	0.00	0.00	0.00

Table J-19. Median and Maximum Salvage Densities (fish/cfs) at CVP for 1980–2002

Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
50th Percentile												
Delta Smelt	0.00	0.00	0.00	0.04	0.05	0.06	0.13	1.78	0.44	0.01	0.00	0.00
Splittail	0.00	0.00	0.01	0.07	0.17	0.51	0.58	1.77	4.20	0.79	0.04	0.01
Striped Bass	3.36	4.52	4.39	6.56	5.37	4.19	1.82	20.67	161.32	55.27	10.40	4.62
Steelhead	0.00	0.00	0.00	0.02	0.07	0.12	0.15	0.04	0.00	0.00	0.00	0.00
Chinook Salmon, all	0.00	0.02	0.07	0.14	0.29	1.15	7.96	7.80	0.64	0.00	0.00	0.00
1992–2000 only												
Chinook Salmon, all	0.00	0.01	0.05	0.20	0.33	1.58	7.96	7.60	0.61	0.00	0.00	0.00
Fall-run	0.00	0.00	0.00	0.06	0.05	0.12	1.03	4.52	0.59	0.00	0.00	0.00
Late fall–run	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Winter-run	0.00	0.00	0.00	0.01	0.02	0.09	0.06	0.00	0.00	0.00	0.00	0.00
Spring-run	0.00	0.00	0.00	0.00	0.00	0.23	5.16	0.66	0.01	0.00	0.00	0.00
Maximum												
Delta Smelt	5.66	3.41	1.69	2.41	3.27	3.20	4.27	29.02	13.28	11.35	11.94	0.87
Splittail	0.44	0.35	0.52	2.85	3.01	2.45	13.63	317.97	659.03	167.81	6.73	1.13
Striped Bass	59.59	36.30	25.12	39.84	68.02	12.45	8.72	1,458.60	1,676.49	563.77	80.56	22.13
Steelhead	0.00	0.01	0.63	1.32	0.86	1.23	0.79	0.55	0.02	0.04	0.00	0.00
Chinook Salmon, all	2.96	4.39	8.76	12.53	101.84	14.02	24.45	63.07	23.27	2.31	0.05	0.05
1992–2000 only												
Chinook Salmon, all	0.03	1.35	0.64	12.53	12.77	5.34	19.51	21.64	5.86	0.23	0.01	0.05
Fall-run	0.03	0.11	0.15	12.44	12.70	1.70	6.14	18.24	4.53	0.22	0.01	0.04
Late fall–run	0.00	0.02	0.47	0.74	1.00	2.81	0.08	0.00	0.02	0.00	0.00	0.00
Winter-run	0.00	0.01	0.04	0.14	0.30	0.34	1.54	0.02	0.00	0.00	0.00	0.00
Spring-run	0.00	0.00	0.00	0.01	0.02	3.71	13.34	6.85	1.26	0.00	0.00	0.00

Table J-20. Calculated Production of Juvenile Chinook Entering the Delta (from Natural Escapement) for 1970–2002

Year	Total Sacramento Adults	Total Mokelumne Adults	Total San Joaquin Adults	Calculated Juvenile Chinook Entering Delta
1980	125,000	400	5,000	39,156,577
1981	180,500	50	15,900	58,990,104
1982	159,600	1,800	14,000	53,479,957
1983	109,900	1,700	11,100	37,024,586
1984	129,900	50	40,800	51,332,951
1985	230,100	200	72,600	91,165,160
1986	239,900	300	23,200	79,754,501
1987	173,300	100	15,800	56,903,155
1988	232,000	100	20,700	76,571,528
1989	142,000	50	3,200	44,186,276
1990	98,000	50	900	30,133,148
1991	99,100	50	600	30,223,232
1992	75,700	300	1,100	23,511,963
1993	113,800	1,500	2,300	35,613,267
1994	122,500	1,200	5,300	39,246,661
1995	242,700	2,400	1,500	76,841,780
1996	221,000	1,800	8,400	70,115,497
1997	264,600	6,300	19,800	87,711,934
1998	212,200	2,500	12,600	75,340,377
1999	250,300	1,600	8,300	79,934,669
2000	381,400	4,600	36,100	128,399,942
2001	507,400	4,300	21,600	163,893,097
2002	746,700	5,800	24,100	237,011,399

Table J-21a. DSM2 Particle Tracking Results for San Joaquin River at Mossdale Release at Range of CVP and SWP Pumping and Delta Outflows

	Mossdale Release CVP	Mossdale Release SWP	Net Delta Outflow	CVP Entrained	SWP Entrained	CCC Entrained	Ag Diversions Entrained	Total Entrained	South Delta Upstream of the Barriers	South Delta Downstream of the Barriers	SJR Vernalis to Turner Cut	SJR Turner Cut to Jersey Point	Mokelumne River Channels	Sacramento River	Confluence	Past Chipps Island	Past Martinez
No Trigger	0	0	5,000	0.0	0.0	0.3	47.4	47.7	2.6	31.2	1.7	13.0	3.8	0.0	0.0	0.0	0.0
	4,600	0	5,000	51.1	0.0	0.0	32.4	83.5	0.7	1.5	9.9	4.0	0.4	0.0	0.0	0.0	0.0
	4,600	3,340	5,000	66.0	0.0	0.0	27.0	93.0	0.6	0.0	6.4	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	6,680	5,000	71.4	3.4	0.0	24.1	98.9	0.3	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	8,500	5,000	71.2	7.0	0.0	21.4	99.6	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	10,300	5,000	70.2	9.1	0.0	20.5	99.8	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0	0	7,000	0.0	0.0	0.4	45.2	45.6	1.2	33.8	2.4	13.8	3.2	0.0	0.0	0.0	0.0
	4,600	0	7,000	48.7	0.0	0.0	32.8	81.5	0.8	0.9	12.0	4.6	0.2	0.0	0.0	0.0	0.0
	4,600	3,340	7,000	63.9	0.0	0.0	28.7	92.6	0.4	0.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	6,680	7,000	70.7	3.4	0.0	24.7	98.8	0.4	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	8,500	7,000	69.8	7.4	0.0	22.2	99.4	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	10,300	7,000	71.5	8.6	0.0	19.6	99.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0	0	12,000	0.0	0.0	0.5	43.6	44.1	1.9	33.2	2.4	15.9	2.5	0.0	0.0	0.0	0.0
	4,600	0	12,000	47.8	0.0	0.0	33.4	81.2	0.6	1.1	12.0	4.9	0.2	0.0	0.0	0.0	0.0
	4,600	3,340	12,000	63.7	0.0	0.0	29.1	92.8	0.6	0.1	6.5	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	6,680	12,000	71.0	3.3	0.0	23.5	97.8	1.3	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	8,500	12,000	68.9	6.1	0.0	24.6	99.6	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	10,300	12,000	71.2	9.5	0.0	19.2	99.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tidal Trigger	0	0	5,000	0.0	0.0	2.8	17.7	20.5	0.2	10.9	0.0	5.5	1.3	0.0	18.5	42.6	20.5
	4,600	0	5,000	59.1	0.0	0.1	16.3	75.5	0.0	8.3	0.0	4.6	0.2	0.0	7.6	3.5	1.1
	4,600	3,340	5,000	73.3	1.6	0.1	14.8	89.8	0.0	4.9	0.0	4.4	0.2	0.0	0.6	0.1	0.0
	4,600	6,680	5,000	72.5	7.4	0.0	15.1	95.0	0.0	2.7	0.1	2.1	0.1	0.0	0.0	0.0	0.0
	4,600	8,500	5,000	70.5	9.9	0.0	14.1	94.5	0.0	2.1	0.5	2.9	0.0	0.0	0.0	0.0	0.0
	4,600	10,300	5,000	74.2	10.6	0.0	13.8	98.6	0.0	0.0	1.3	0.1	0.0	0.0	0.0	0.0	0.0
	0	0	7,000	0.0	0.0	2.2	18.9	21.1	0.0	12.5	0.0	4.1	1.1	0.0	17.3	43.3	22.1
	4,600	0	7,000	56.6	0.0	0.0	16.6	73.2	0.1	9.3	0.0	4.9	0.0	0.0	7.7	4.6	0.8
	4,600	3,340	7,000	72.5	1.7	0.0	16.4	90.6	0.1	5.0	0.0	2.9	0.1	0.0	1.1	0.2	0.1
	4,600	6,680	7,000	74.5	6.7	0.0	14.2	95.4	0.0	2.4	0.1	2.0	0.1	0.0	0.0	0.0	0.0
	4,600	8,500	7,000	69.9	10.1	0.0	14.9	94.9	0.0	2.2	0.4	2.5	0.0	0.0	0.0	0.0	0.0
	4,600	10,300	7,000	74.9	9.7	0.0	13.4	98.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
	0	0	12,000	0.0	0.0	1.8	17.1	18.9	0.0	11.1	0.0	4.3	0.6	0.0	11.9	52.7	33.5
	4,600	0	12,000	57.1	0.0	0.1	17.0	74.2	0.0	8.1	0.0	4.0	0.2	0.0	7.5	5.9	1.7
	4,600	3,340	12,000	72.2	1.7	0.0	16.1	90.0	0.0	6.1	0.0	2.8	0.3	0.0	0.8	0.0	0.0
	4,600	6,680	12,000	73.0	7.0	0.0	14.5	94.5	0.0	2.7	0.2	2.4	0.2	0.0	0.0	0.0	0.0
	4,600	8,500	12,000	71.8	10.6	0.0	13.6	96.0	0.0	1.0	0.6	2.2	0.2	0.0	0.0	0.0	0.0

Table J-21b. DSM2 Particle Tracking Results for Old River at Middle River Release at Range of CVP and SWP Pumping and Delta Outflows

	Old River at Middle River Release		Net Delta Outflow	CVP Entrained	SWP Entrained	CCC Entrained	Ag Diversions Entrained	Total Entrained	South Delta Upstream of the Barriers	South Delta Downstream of the Barriers	SJR Vernalis to Turner Cut	SJR Turner Cut to Jersey Point	Mokelumne	Sac R at Yolo	Confluence	Past Chipps Island	Past Martinez
No Trigger	CVP	SWP															
	0	0	5,000	0.0	0.0	0.7	69.4	70.1	2.5	27.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	0	5,000	54.3	0.0	0.0	44.6	98.9	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	3,340	5,000	67.6	0.0	0.0	31.7	99.3	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	6,680	5,000	66.4	4.4	0.0	28.7	99.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	8,500	5,000	62.8	8.9	0.0	27.8	99.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	10,300	5,000	67.7	8.0	0.0	24.1	99.8	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0	0	7,000	0.0	0.0	0.4	69.6	70.0	1.6	28.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	0	7,000	53.9	0.0	0.0	44.7	98.6	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	3,340	7,000	67.9	0.0	0.0	31.3	99.2	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	6,680	7,000	67.9	4.3	0.0	27.3	99.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	8,500	7,000	65.0	7.7	0.0	26.9	99.6	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	10,300	7,000	68.5	7.9	0.0	23.6	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0	0	12,000	0.0	0.0	1.1	69.5	70.6	2.5	26.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	0	12,000	56.2	0.0	0.0	43.0	99.2	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	3,340	12,000	68.6	0.0	0.0	30.5	99.1	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	6,680	12,000	67.9	4.1	0.0	27.2	99.2	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	8,500	12,000	63.9	9.3	0.0	26.4	99.6	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	10,300	12,000	67.9	9.3	0.0	22.8	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tidal Trigger	0	0	5,000	0.0	0.0	2.5	40.2	42.7	0.2	16.6	0.0	7.2	0.2	0.0	12.1	20.6	11.7
	4,600	0	5,000	74.9	0.0	0.0	24.8	99.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	3,340	5,000	81.9	0.1	0.0	18.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	6,680	5,000	77.8	6.6	0.0	15.6	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	8,500	5,000	73.9	10.5	0.0	15.6	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	10,300	5,000	75.2	9.7	0.0	15.1	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0	0	7,000	0.0	0.0	3.0	40.0	43.0	0.0	14.9	0.0	6.3	0.3	0.0	12.4	22.9	13.7
	4,600	0	7,000	75.0	0.0	0.0	25.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	3,340	7,000	82.6	0.1	0.0	17.3	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	6,680	7,000	76.6	6.1	0.0	17.3	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	8,500	7,000	74.4	9.9	0.0	15.7	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	10,300	7,000	75.0	10.6	0.0	14.4	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0	0	12,000	0.0	0.0	3.4	41.2	44.6	0.1	15.2	0.0	4.7	0.1	0.0	10.0	24.8	15.8
	4,600	0	12,000	75.9	0.0	0.0	24.1	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	3,340	12,000	82.5	0.0	0.0	17.5	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	6,680	12,000	77.7	6.3	0.0	16.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	8,500	12,000	74.4	10.7	0.0	14.9	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	10,300	12,000	75.0	10.0	0.0	15.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table J-21c. DSM2 Particle Tracking Results for San Joaquin River at Turner Cut Release at Range of CVP and SWP Pumping and Delta Outflows

	Turner Cut Release		Net Delta Outflow	CVP Entrained	SWP Entrained	CCC Entrained	Ag Diversions Entrained	Total Entrained	South Delta Upstream of the Barriers	South Delta Downstream of the Barriers	SJR Vernalis to Turner Cut	SJR Turner Cut to Jersey Point	Mokelumne	Sacramento River	Confluence	Past Chipps Island	Past Martinez
No	CVP	SWP															
Trigger	0	0	5,000	0.0	0.0	1.4	6.8	8.2	0.0	55.1	0.0	25.7	7.2	0.0	3.6	0.1	0.0
	4,600	0	5,000	76.1	0.0	0.4	6.7	83.2	0.4	13.3	0.1	3.0	0.0	0.0	0.0	0.0	0.0
	4,600	3,340	5,000	43.3	37.2	0.0	6.6	87.1	0.1	6.4	4.1	2.1	0.2	0.0	0.0	0.0	0.0
	4,600	6,680	5,000	26.7	52.0	0.0	5.1	83.8	0.0	3.5	11.4	1.3	0.0	0.0	0.0	0.0	0.0
	4,600	8,500	5,000	24.8	51.9	0.0	5.7	82.4	0.0	3.5	13.3	0.8	0.0	0.0	0.0	0.0	0.0
	4,600	10,300	5,000	18.3	55.9	0.0	3.9	78.1	0.7	3.2	17.6	0.4	0.0	0.0	0.0	0.0	0.0
	0	0	7,000	0.0	0.0	2.1	7.7	9.8	0.0	55.8	0.0	24.5	4.3	0.1	5.3	0.2	0.1
	4,600	0	7,000	76.0	0.0	0.1	8.3	84.4	0.0	12.9	0.0	2.5	0.2	0.0	0.0	0.0	0.0
	4,600	3,340	7,000	45.0	36.9	0.0	5.2	87.1	0.0	5.9	4.8	2.2	0.0	0.0	0.0	0.0	0.0
	4,600	6,680	7,000	28.3	50.0	0.0	4.9	83.2	0.0	3.4	12.1	1.3	0.0	0.0	0.0	0.0	0.0
	4,600	8,500	7,000	22.9	50.9	0.0	6.2	80.0	0.0	3.0	16.5	0.4	0.1	0.0	0.0	0.0	0.0
	4,600	10,300	7,000	20.3	54.9	0.0	5.1	80.3	0.1	1.4	18.1	0.0	0.0	0.0	0.0	0.0	0.0
	0	0	12,000	0.0	0.0	2.1	6.5	8.6	0.2	57.5	0.0	24.2	2.3	0.0	6.4	0.7	0.0
	4,600	0	12,000	77.7	0.0	0.2	5.9	83.8	0.4	13.0	0.3	2.4	0.1	0.0	0.0	0.0	0.0
	4,600	3,340	12,000	44.1	37.0	0.0	6.4	87.5	0.0	5.9	4.5	2.1	0.0	0.0	0.0	0.0	0.0
	4,600	6,680	12,000	27.4	52.6	0.0	5.2	85.2	0.0	2.7	11.1	1.0	0.0	0.0	0.0	0.0	0.0
	4,600	8,500	12,000	23.5	50.4	0.0	6.5	80.4	0.0	3.3	15.7	0.6	0.0	0.0	0.0	0.0	0.0
	4,600	10,300	12,000	18.0	54.9	0.0	5.5	78.4	0.4	3.8	17.2	0.2	0.0	0.0	0.0	0.0	0.0
Tidal	0	0	5,000	0.0	0.0	0.0	2.3	2.3	0.0	0.1	0.0	0.3	0.0	0.0	2.5	94.1	87.5
Trigger	4,600	0	5,000	13.0	0.0	0.7	2.2	15.9	0.0	9.7	0.0	1.6	0.0	0.0	8.3	63.7	48.5
	4,600	3,340	5,000	32.2	27.5	1.0	4.3	65.0	0.0	7.6	0.0	1.4	0.0	0.0	5.5	20.4	12.8
	4,600	6,680	5,000	31.1	57.4	0.3	3.3	92.1	0.0	2.8	0.0	1.1	0.0	0.0	1.4	2.5	1.3
	4,600	8,500	5,000	25.8	68.4	0.1	2.3	96.6	0.0	2.3	0.0	0.9	0.0	0.0	0.1	0.1	0.0
	4,600	10,300	5,000	25.7	70.2	0.0	3.3	99.2	0.0	0.4	0.0	0.4	0.0	0.0	0.0	0.0	0.0
	0	0	7,000	0.0	0.0	0.0	2.5	2.5	0.0	0.3	0.0	0.0	0.0	0.0	1.1	95.2	90.0
	4,600	0	7,000	13.8	0.0	0.8	2.5	17.1	0.0	9.1	0.0	1.0	0.0	0.0	7.3	65.0	53.4
	4,600	3,340	7,000	32.5	27.7	0.9	2.8	63.9	0.0	6.9	0.0	1.3	0.0	0.0	5.3	22.4	16.6
	4,600	6,680	7,000	32.8	56.4	0.2	2.7	92.1	0.1	3.0	0.0	0.9	0.1	0.0	1.1	2.7	1.2
	4,600	8,500	7,000	26.5	67.5	0.0	2.6	96.6	0.0	1.9	0.0	0.7	0.0	0.0	0.3	0.5	0.2
	4,600	10,300	7,000	25.4	70.8	0.1	2.9	99.2	0.1	0.5	0.0	0.2	0.0	0.0	0.0	0.0	0.0
	0	0	12,000	0.0	0.0	0.0	2.3	2.3	0.0	0.3	0.0	0.0	0.0	0.0	0.7	95.6	91.9
	4,600	0	12,000	13.5	0.0	0.6	1.9	16.0	0.0	8.9	0.0	1.2	0.0	0.0	4.9	67.9	59.9
	4,600	3,340	12,000	32.5	28.6	0.9	3.2	65.2	0.0	7.4	0.0	1.2	0.0	0.0	4.6	21.5	16.7
	4,600	6,680	12,000	31.8	56.4	0.2	3.6	92.0	0.0	3.6	0.0	0.9	0.0	0.0	0.9	2.5	1.4
	4,600	8,500	12,000	27.2	67.2	0.1	3.0	97.5	0.0	1.2	0.0	0.3	0.0	0.0	0.3	0.7	0.5
	4,600	10,300	12,000	26.3	70.5	0.0	2.2	99.0	0.0	0.7	0.0	0.3	0.0	0.0	0.0	0.0	0.0

Table J-21d. DSM2 Particle Tracking Results for SJR at Prisoners Point Release at Range of CVP and SWP Pumping and Delta Outflows

	Prisoners Point Release		Net Delta Outflow	CVP Entrained	SWP Entrained	CCC Entrained	Ag Diversions Entrained	Total Entrained	South Delta Upstream of the Barriers	South Delta Downstream of the Barriers	SJR Vernalis to Turner Cut	SJR Turner Cut to Jersey Point	Mokelumne	Sac R at Yolo	Confluence	Past Chipps Island	Past Martinez
No Trigger	CVP	SWP															
	0	0	5,000	0.0	0.0	1.1	2.1	3.2	0.1	31.9	0.0	21.7	2.0	0.7	33.4	6.7	1.6
	4,600	0	5,000	61.4	0.0	2.5	3.9	67.8	0.1	16.2	0.0	4.7	0.5	0.0	8.0	2.7	1.0
	4,600	3,340	5,000	47.0	36.8	1.4	3.6	88.8	0.1	5.5	0.5	1.2	0.1	0.0	3.0	0.7	0.2
	4,600	6,680	5,000	33.3	58.4	0.9	3.1	95.7	0.0	1.4	1.0	0.6	0.0	0.0	0.5	0.6	0.2
	4,600	8,500	5,000	30.3	61.9	0.8	3.8	96.8	0.0	0.9	1.2	0.2	0.0	0.0	0.3	0.6	0.2
	4,600	10,300	5,000	27.1	66.9	0.4	3.5	97.9	0.0	0.3	1.6	0.0	0.1	0.0	0.1	0.0	0.0
	0	0	7,000	0.0	0.0	1.8	1.3	3.1	0.0	30.8	0.0	14.5	1.6	0.1	36.8	12.7	2.6
	4,600	0	7,000	62.4	0.0	2.6	3.7	68.7	0.5	14.8	0.0	3.7	0.1	0.0	8.0	4.1	1.0
	4,600	3,340	7,000	46.5	36.7	1.6	3.6	88.4	0.0	4.6	0.6	2.1	0.1	0.0	2.6	1.5	0.4
	4,600	6,680	7,000	34.8	55.8	1.0	3.9	95.5	0.0	1.3	0.9	0.4	0.0	0.0	1.4	0.5	0.0
	4,600	8,500	7,000	29.5	63.3	0.6	3.3	96.7	0.0	0.8	1.2	0.2	0.0	0.0	0.8	0.3	0.2
	4,600	10,300	7,000	23.8	69.1	0.6	3.0	96.5	0.0	0.8	2.2	0.2	0.0	0.0	0.1	0.2	0.1
	0	0	12,000	0.0	0.0	1.1	1.5	2.6	0.0	21.8	0.0	8.5	0.4	0.0	31.9	34.2	15.0
	4,600	0	12,000	59.5	0.0	2.4	3.3	65.2	0.0	12.9	0.0	3.9	0.2	0.0	9.2	8.6	3.4
	4,600	3,340	12,000	44.7	36.2	1.9	3.7	86.5	0.1	5.3	0.3	1.6	0.1	0.0	2.9	3.2	1.1
	4,600	6,680	12,000	34.2	55.8	1.1	3.3	94.4	0.0	1.8	1.4	0.3	0.0	0.0	1.1	1.0	0.5
	4,600	8,500	12,000	27.1	64.6	0.8	3.7	96.2	0.0	0.4	1.8	0.3	0.0	0.0	0.6	0.7	0.4
	4,600	10,300	12,000	23.8	70.2	0.5	2.3	96.8	0.0	0.6	1.6	0.2	0.0	0.0	0.3	0.5	0.4
Tidal Trigger	0	0	5,000	0.0	0.0	0.0	0.5	0.5	0.0	0.2	0.0	0.1	0.0	0.0	0.8	97.6	95.3
	4,600	0	5,000	2.4	0.0	0.9	0.7	4.0	0.0	1.3	0.0	0.2	0.0	0.0	1.2	93.0	89.7
	4,600	3,340	5,000	9.8	6.9	1.2	1.0	18.9	0.0	2.1	0.0	0.1	0.0	0.0	2.0	76.2	73.1
	4,600	6,680	5,000	15.0	24.2	1.3	2.0	42.5	0.0	1.1	0.0	0.3	0.0	0.0	1.2	54.2	51.4
	4,600	8,500	5,000	17.4	41.9	1.7	1.8	62.8	0.0	1.2	0.0	0.2	0.0	0.0	1.0	34.6	32.9
	4,600	10,300	5,000	17.4	50.2	1.6	1.5	70.7	0.0	0.8	0.0	0.0	0.0	0.0	0.5	27.7	25.7
	0	0	7,000	0.0	0.0	0.0	0.6	0.6	0.0	0.1	0.0	0.0	0.0	0.0	0.4	98.4	97.7
	4,600	0	7,000	3.7	0.0	0.5	0.7	4.9	0.0	0.8	0.0	0.1	0.0	0.0	1.0	92.8	90.2
	4,600	3,340	7,000	9.9	7.6	1.4	0.9	19.8	0.0	1.1	0.0	0.1	0.0	0.0	1.2	77.5	74.6
	4,600	6,680	7,000	13.5	25.1	1.9	1.0	41.5	0.0	1.4	0.0	0.0	0.0	0.0	1.5	55.0	53.5
	4,600	8,500	7,000	17.5	38.7	2.0	1.4	59.6	0.0	1.8	0.0	0.2	0.0	0.0	0.6	37.4	35.4
	4,600	10,300	7,000	16.3	51.3	1.7	1.8	71.1	0.0	0.5	0.0	0.1	0.0	0.0	1.3	26.7	24.9
	0	0	12,000	0.0	0.0	0.0	0.3	0.3	0.0	0.3	0.0	0.0	0.0	0.0	0.1	98.3	98.4
	4,600	0	12,000	2.8	0.0	0.6	0.5	3.9	0.0	0.3	0.0	0.1	0.0	0.0	0.6	94.3	93.8
	4,600	3,340	12,000	9.6	9.0	0.9	1.3	20.8	0.0	1.1	0.0	0.0	0.0	0.0	0.4	77.2	76.3
	4,600	6,680	12,000	12.9	23.0	1.4	1.2	38.5	0.0	1.0	0.0	0.2	0.0	0.0	0.6	59.0	57.2
	4,600	8,500	12,000	17.2	35.5	1.3	1.1	55.1	0.0	0.6	0.0	0.2	0.0	0.0	1.1	42.5	40.8
	4,600	10,300	12,000	15.5	51.4	1.4	1.7	70.0	0.0	0.5	0.0	0.0	0.0	0.0	0.4	28.8	27.9

Table J-21e. DSM2 Particle Tracking Results for San Joaquin River at Jersey Point Release at Range of CVP and SWP Pumping and Delta Outflows

	Jersey Point Release		Net Delta Outflow	CVP Entrained	SWP Entrained	CCC Entrained	Ag Diversions Entrained	Total Entrained	South Delta Upstream of the Barriers	South Delta Downstream of the Barriers	SJR Vernalis to Turner Cut	SJR Turner Cut to Jersey Point	Mokelumne	Sac R at Yolo	Confluence	Past Chipps Island	Past Martinez
No Trigger	CVP	SWP															
	0	0	5,000	0.0	0.0	0.5	1.2	1.7	0.0	12.0	0.0	9.8	0.4	0.9	40.7	34.3	13.3
	4,600	0	5,000	13.8	0.0	1.9	3.1	18.8	0.1	16.5	0.0	7.8	0.5	0.0	33.6	22.2	9.0
	4,600	3,340	5,000	22.0	13.7	1.7	2.7	40.1	0.1	14.3	0.0	5.5	0.5	0.0	22.7	16.6	7.6
	4,600	6,680	5,000	22.2	33.3	2.0	3.6	61.1	0.0	10.0	0.1	3.3	0.3	0.0	12.7	12.4	4.0
	4,600	8,500	5,000	19.6	43.6	1.8	2.2	67.2	0.1	7.3	0.4	2.7	0.2	0.0	9.7	12.4	5.7
	4,600	10,300	5,000	19.5	54.0	2.0	2.6	78.1	0.0	4.9	0.1	1.6	0.1	0.0	6.3	8.9	4.8
	0	0	7,000	0.0	0.0	0.3	1.4	1.7	0.0	8.1	0.0	4.2	0.1	0.0	36.5	48.4	20.4
	4,600	0	7,000	12.1	0.0	1.5	1.5	15.1	0.1	11.1	0.0	4.5	0.2	0.0	31.5	36.7	17.0
	4,600	3,340	7,000	18.0	12.9	1.4	1.8	34.1	0.0	12.8	0.1	5.0	0.4	0.0	19.2	28.1	11.8
	4,600	6,680	7,000	18.1	33.3	1.8	2.9	56.1	0.1	8.0	0.1	3.5	0.4	0.0	11.5	20.2	9.8
	4,600	8,500	7,000	18.7	42.8	2.0	1.9	65.4	0.0	7.9	0.1	2.3	0.1	0.0	7.5	16.7	8.5
	4,600	10,300	7,000	17.0	51.2	1.7	2.0	71.9	0.1	5.4	0.3	2.4	0.0	0.0	6.6	13.2	6.7
	0	0	12,000	0.0	0.0	0.0	0.8	0.8	0.0	3.0	0.0	0.6	0.2	0.0	14.0	80.3	48.9
	4,600	0	12,000	8.7	0.0	1.1	1.0	10.8	0.0	4.9	0.0	1.7	0.0	0.0	14.0	67.6	39.1
	4,600	3,340	12,000	14.1	9.6	1.6	1.5	26.8	0.0	7.8	0.0	2.9	0.1	0.0	13.0	48.8	27.4
	4,600	6,680	12,000	16.7	27.3	1.5	1.8	47.3	0.1	6.3	0.0	3.2	0.1	0.0	7.6	35.0	21.3
	4,600	8,500	12,000	17.1	35.8	1.8	2.0	56.7	0.0	5.7	0.0	1.8	0.1	0.0	6.2	29.3	19.2
	4,600	10,300	12,000	14.4	45.6	2.5	1.5	64.0	0.0	5.2	0.2	1.1	0.1	0.0	5.7	23.4	14.7
Tidal Trigger	0	0	5,000	0.0	0.0	0.0	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	98.8	98.9
	4,600	0	5,000	0.2	0.0	0.0	0.1	0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.1	98.7	98.6
	4,600	3,340	5,000	1.0	0.5	0.2	0.3	2.0	0.0	0.3	0.0	0.1	0.0	0.0	0.0	97.0	97.1
	4,600	6,680	5,000	1.7	2.3	0.1	0.4	4.5	0.0	0.2	0.0	0.0	0.0	0.0	0.3	94.6	94.4
	4,600	8,500	5,000	1.6	3.1	0.5	0.3	5.5	0.0	0.1	0.0	0.0	0.0	0.0	0.3	93.4	93.2
	4,600	10,300	5,000	2.0	4.1	0.0	0.3	6.4	0.0	0.2	0.0	0.0	0.0	0.0	0.2	92.9	92.3
	0	0	7,000	0.0	0.0	0.0	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	98.7	99.1
	4,600	0	7,000	0.5	0.0	0.2	0.5	1.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	98.0	98.5
	4,600	3,340	7,000	1.5	0.4	0.0	0.4	2.3	0.0	0.1	0.0	0.0	0.0	0.0	0.0	97.2	97.2
	4,600	6,680	7,000	2.1	2.1	0.2	0.4	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.2	94.1	94.3
	4,600	8,500	7,000	1.9	2.7	0.3	0.5	5.4	0.0	0.0	0.0	0.1	0.0	0.0	0.2	93.8	93.9
	4,600	10,300	7,000	1.6	3.6	0.0	0.1	5.3	0.0	0.1	0.0	0.0	0.0	0.0	0.4	93.0	93.3
	0	0	12,000	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.2	99.5
	4,600	0	12,000	0.2	0.0	0.1	0.1	0.4	0.0	0.1	0.0	0.0	0.0	0.0	0.0	98.0	99.1
	4,600	3,340	12,000	0.2	0.6	0.2	0.2	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	97.9	98.4
	4,600	6,680	12,000	1.2	1.7	0.2	0.0	3.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	95.8	96.5
	4,600	8,500	12,000	1.9	2.3	0.2	0.4	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.1	94.2	94.6
	4,600	10,300	12,000	2.0	2.8	0.2	0.2	5.2	0.0	0.1	0.0	0.0	0.0	0.0	0.1	94.0	94.5

Table J-21f. DSM2 Particle Tracking Results for Woodward Canal Release at Range of CVP and SWP Pumping and Delta Outflows

	Woodward Canal Release		Net Delta Outflow	CVP Entrained	SWP Entrained	CCC Entrained	Ag Diversions Entrained	Total Entrained	South Delta Upstream of the Barriers	South Delta Downstream of the Barriers	SJR Vernalis to Turner Cut	SJR Turner Cut to Jersey Point	Mokelumne	Sac R at Yolo	Confluence	Past Chipps Island	Past Martinez
No Trigger	CVP	SWP															
	0	0	5,000	0.0	0.0	19.5	30.6	50.1	2.0	42.3	0.0	1.9	0.1	0.0	3.6	0.0	0.0
	4,600	0	5,000	95.2	0.0	0.0	3.7	98.9	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	3,340	5,000	50.1	43.8	0.0	5.7	99.6	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	6,680	5,000	40.2	56.9	0.0	2.8	99.9	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	8,500	5,000	35.0	60.1	0.0	4.8	99.9	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	10,300	5,000	23.9	74.0	0.0	2.0	99.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0	0	7,000	0.0	0.0	21.3	28.9	50.2	1.9	43.6	0.0	1.0	0.2	0.0	2.9	0.2	0.0
	4,600	0	7,000	95.1	0.0	0.0	3.6	98.7	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	3,340	7,000	51.0	43.6	0.0	5.3	99.9	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	6,680	7,000	40.1	56.7	0.0	3.2	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	8,500	7,000	35.1	60.7	0.0	4.2	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	10,300	7,000	24.6	73.3	0.0	2.1	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0	0	12,000	0.0	0.0	22.9	27.0	49.9	1.7	41.3	0.0	0.8	0.1	0.0	5.4	0.6	0.1
	4,600	0	12,000	95.3	0.0	0.0	3.2	98.5	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	3,340	12,000	49.4	43.4	0.0	7.1	99.9	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	6,680	12,000	40.0	57.0	0.0	2.8	99.8	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	8,500	12,000	36.1	59.6	0.0	4.3	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	10,300	12,000	24.3	73.6	0.0	2.0	99.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tidal Trigger	0	0	5,000	0.0	0.0	1.9	3.9	5.8	0.0	11.7	0.0	8.3	0.0	0.0	19.2	54.3	33.3
	4,600	0	5,000	95.6	0.0	0.0	3.3	98.9	0.2	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	3,340	5,000	51.4	44.1	0.0	4.4	99.9	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	6,680	5,000	37.9	59.7	0.0	2.4	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	8,500	5,000	35.9	59.9	0.0	4.1	99.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	10,300	5,000	26.9	71.3	0.0	1.8	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0	0	7,000	0.0	0.0	2.0	4.0	6.0	0.0	12.0	0.0	6.8	0.3	0.0	18.7	55.6	35.4
	4,600	0	7,000	94.6	0.0	0.1	4.0	98.7	0.1	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	3,340	7,000	51.0	44.0	0.0	5.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	6,680	7,000	37.4	60.2	0.0	2.4	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	8,500	7,000	36.4	59.3	0.0	4.3	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	10,300	7,000	27.0	70.9	0.0	2.0	99.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0	0	12,000	0.0	0.0	1.6	3.6	5.2	0.0	10.2	0.0	4.8	0.1	0.0	16.5	62.7	44.8
	4,600	0	12,000	95.5	0.0	0.0	3.2	98.7	0.1	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	3,340	12,000	49.2	44.2	0.0	6.6	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	6,680	12,000	38.3	59.2	0.0	2.5	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	8,500	12,000	36.4	59.3	0.0	4.3	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4,600	10,300	12,000	27.5	70.7	0.0	1.8	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table J-21g. DSM2 Particle Tracking Results for Mokelumne River Release at Range of CVP and SWP Pumping and Delta Outflows

	Mokelumne River Release CVP	Mokelumne River Release SWP	Net Delta Outflow	CVP Entrained	SWP Entrained	CCC Entrained	Ag Diversions Entrained	Total Entrained	South Delta Upstream of the Barriers	South Delta Downstream of the Barriers	SJR Vernalis to Turner Cut	SJR Turner Cut to Jersey Point	Mokelumne	Sac R at Yolo	Confluence	Past Chipps Island	Past Martinez
No Trigger	0	0	5,000	0.0	0.0	0.9	6.0	6.9	0.0	28.6	0.0	20.4	6.3	0.8	31.6	5.3	0.7
	4,600	0	5,000	43.7	0.0	2.7	6.0	52.4	0.6	21.2	0.1	8.0	2.3	0.0	12.6	2.8	0.6
	4,600	3,340	5,000	40.5	29.6	3.1	4.2	77.4	0.1	9.8	0.4	4.3	1.3	0.0	4.7	1.9	0.7
	4,600	6,680	5,000	32.0	53.6	2.1	4.0	91.7	0.0	3.2	0.6	1.6	0.3	0.0	2.1	0.5	0.2
	4,600	8,500	5,000	27.1	61.3	1.8	3.6	93.8	0.0	1.9	1.1	0.9	0.5	0.0	1.4	0.4	0.2
	4,600	10,300	5,000	24.4	66.3	1.5	3.1	95.3	0.0	1.7	1.2	0.4	0.1	0.0	1.0	0.3	0.0
	0	0	7,000	0.0	0.0	0.3	4.5	4.8	0.0	27.3	0.0	14.7	5.2	0.1	36.4	11.1	2.9
	4,600	0	7,000	41.9	0.0	3.6	5.1	50.6	0.0	20.5	0.0	6.3	2.4	0.0	14.2	5.8	1.4
	4,600	3,340	7,000	38.8	29.2	2.6	5.0	75.6	0.1	9.7	0.3	3.3	1.3	0.0	5.9	3.7	1.2
	4,600	6,680	7,000	29.0	53.6	2.3	3.6	88.5	0.0	3.5	1.0	1.2	0.7	0.0	3.9	1.2	0.1
	4,600	8,500	7,000	27.5	61.4	1.6	3.0	93.5	0.0	1.7	0.8	0.8	0.3	0.0	1.9	1.0	0.4
	4,600	10,300	7,000	23.4	67.9	1.7	2.0	95.0	0.0	1.3	1.3	0.3	0.3	0.0	1.7	0.0	0.0
	0	0	12,000	0.0	0.0	0.6	2.7	3.3	0.0	18.7	0.0	6.7	1.8	0.0	32.6	36.0	11.8
	4,600	0	12,000	36.5	0.0	2.9	3.8	43.2	0.0	15.2	0.0	5.2	1.3	0.0	16.2	18.9	7.5
	4,600	3,340	12,000	36.2	27.8	2.4	4.8	71.2	0.0	10.3	0.2	2.2	1.1	0.0	5.9	9.1	3.9
	4,600	6,680	12,000	29.1	52.8	1.7	3.4	87.0	0.0	3.5	0.6	1.5	0.4	0.0	2.7	4.2	1.6
	4,600	8,500	12,000	28.8	59.6	1.7	2.5	92.6	0.0	1.3	1.2	1.0	0.4	0.0	1.6	1.9	0.7
	4,600	10,300	12,000	23.8	65.8	1.9	2.9	94.4	0.0	0.7	1.9	0.3	0.0	0.0	1.2	1.5	0.9
Tidal Trigger	0	0	5,000	0.0	0.0	0.0	1.2	1.2	0.0	0.3	0.0	0.1	0.0	0.0	1.4	96.3	92.2
	4,600	0	5,000	1.6	0.0	0.3	1.0	2.9	0.0	1.6	0.0	0.5	0.0	0.0	1.1	93.2	90.1
	4,600	3,340	5,000	5.3	4.1	0.9	1.7	12.0	0.0	0.8	0.0	0.0	0.0	0.0	0.9	85.1	82.8
	4,600	6,680	5,000	11.2	13.8	0.8	1.4	27.2	0.0	0.6	0.0	0.1	0.0	0.0	1.1	70.0	66.9
	4,600	8,500	5,000	9.6	19.7	1.1	1.0	31.4	0.0	1.1	0.0	0.1	0.1	0.0	0.8	66.2	62.4
	4,600	10,300	5,000	11.4	31.6	1.4	1.5	45.9	0.0	0.6	0.0	0.0	0.0	0.0	1.0	52.1	49.3
	0	0	7,000	0.0	0.0	0.0	1.3	1.3	0.0	0.2	0.0	0.0	0.0	0.0	0.5	97.0	94.6
	4,600	0	7,000	1.5	0.0	0.4	0.7	2.6	0.0	1.1	0.0	0.0	0.0	0.0	0.8	94.4	91.9
	4,600	3,340	7,000	5.3	4.5	0.8	0.7	11.3	0.0	0.5	0.0	0.1	0.0	0.0	0.6	86.8	84.9
	4,600	6,680	7,000	8.1	11.7	1.0	1.2	22.0	0.0	0.7	0.0	0.2	0.0	0.0	1.5	75.1	72.8
	4,600	8,500	7,000	10.6	21.7	0.9	1.3	34.5	0.0	0.3	0.0	0.0	0.0	0.0	1.1	64.0	61.9
	4,600	10,300	7,000	11.8	29.9	1.3	1.5	44.5	0.0	1.0	0.0	0.1	0.0	0.0	1.2	52.5	50.6
	0	0	12,000	0.0	0.0	0.0	0.9	0.9	0.0	0.1	0.0	0.1	0.0	0.0	0.4	97.8	98.1
	4,600	0	12,000	0.9	0.0	0.2	0.3	1.4	0.0	0.2	0.0	0.0	0.0	0.0	0.9	96.5	95.8
	4,600	3,340	12,000	3.6	3.3	0.2	0.9	8.0	0.0	0.7	0.0	0.2	0.0	0.0	0.8	89.7	89.1
	4,600	6,680	12,000	7.8	11.9	0.9	1.0	21.6	0.0	0.2	0.0	0.0	0.0	0.0	0.2	77.4	76.2
	4,600	8,500	12,000	9.2	20.3	1.1	1.2	31.8	0.0	0.5	0.0	0.2	0.0	0.0	0.5	66.4	65.6
	4,600	10,300	12,000	10.3	29.2	1.4	0.7	41.6	0.0	0.5	0.0	0.2	0.1	0.0	0.0	57.2	55.7

Table J-21h. DSM2 Particle Tracking Results for Sacramento River at Freeport Release at Range of CVP and SWP Pumping and Delta Outflows

	Freeport Release		Net Delta Outflow	CVP Entrained	SWP Entrained	CCC Entrained	Ag Diversions Entrained	Total Entrained	South Delta Upstream of the Barriers	South Delta Downstream of the Barriers	SJR Vernalis to Turner Cut	SJR Turner Cut to Jersey Point	Mokelumne	Sac R at Yolo	Confluence	Past Chipps Island	Past Martinez
No Trigger	CVP	SWP															
	0	0	5,000	0.0	0.0	0.2	11.0	11.2	0.0	19.5	0.0	16.0	4.8	8.3	33.9	4.4	0.4
	4,600	0	5,000	22.8	0.0	1.4	6.7	30.9	0.1	20.6	0.0	8.1	2.2	4.3	23.0	8.8	2.0
	4,600	3,340	5,000	23.7	17.3	1.5	6.8	49.3	0.0	12.8	0.2	4.4	2.2	3.4	16.8	9.9	3.8
	4,600	6,680	5,000	19.4	34.1	0.9	5.1	59.5	0.0	7.7	0.4	3.6	0.8	4.3	10.2	12.7	5.9
	4,600	8,500	5,000	19.0	40.6	1.3	3.7	64.6	0.0	6.3	1.3	2.5	0.8	2.7	9.4	11.8	4.7
	4,600	10,300	5,000	17.5	44.6	0.6	3.7	66.4	0.0	4.8	1.2	1.9	1.0	2.2	8.5	12.8	5.5
	0	0	7,000	0.0	0.0	0.5	9.1	9.6	0.0	18.7	0.0	13.1	4.1	6.1	35.6	11.3	2.5
	4,600	0	7,000	23.5	0.0	1.3	5.4	30.2	0.3	17.5	0.0	6.7	2.2	4.3	20.5	17.1	6.4
	4,600	3,340	7,000	23.6	15.2	1.0	4.9	44.7	0.0	12.1	0.4	3.7	1.4	3.5	16.3	16.9	6.3
	4,600	6,680	7,000	18.2	31.4	1.6	4.5	55.7	0.1	7.7	0.8	2.5	1.6	2.4	11.4	16.8	7.7
	4,600	8,500	7,000	17.5	37.9	1.2	3.2	59.8	0.0	5.1	0.7	2.5	0.4	2.3	8.9	19.5	9.2
	4,600	10,300	7,000	15.7	43.9	0.9	4.3	64.8	0.0	4.9	1.1	1.7	0.5	1.7	7.7	17.3	10.4
	0	0	12,000	0.0	0.0	0.5	4.5	5.0	0.0	11.8	0.0	5.2	1.4	4.2	27.8	42.3	18.8
	4,600	0	12,000	18.4	0.0	1.2	3.9	23.5	0.1	10.4	0.0	2.8	1.8	2.5	15.8	41.4	20.7
	4,600	3,340	12,000	18.1	13.5	1.2	3.1	35.9	0.0	8.2	0.3	2.8	1.0	2.5	10.0	38.6	21.4
	4,600	6,680	12,000	17.9	28.6	1.1	3.5	51.1	0.0	4.5	0.7	1.5	0.2	1.2	6.3	33.2	20.5
	4,600	8,500	12,000	15.3	31.5	1.0	3.6	51.4	0.0	3.5	0.9	1.6	0.5	1.8	6.2	32.9	22.0
	4,600	10,300	12,000	10.6	40.1	0.6	3.1	54.4	0.0	3.5	1.3	1.6	0.3	2.1	5.3	30.8	20.2
Tidal Trigger	0	0	5,000	0.0	0.0	0.0	1.9	1.9	0.0	0.3	0.0	0.2	0.0	0.0	0.5	96.3	93.9
	4,600	0	5,000	1.1	0.0	0.1	0.4	1.6	0.0	0.7	0.0	0.2	0.0	0.0	1.6	95.7	92.7
	4,460	3,340	5,000	3.4	2.5	0.3	1.0	7.2	0.0	2.1	0.0	0.3	0.1	0.0	0.9	89.0	86.0
	4,600	6,680	5,000	4.5	8.5	0.5	0.8	14.3	0.0	1.1	0.0	0.2	0.1	0.0	1.0	82.4	81.0
	4,600	8,500	5,000	6.3	11.7	0.7	0.7	19.4	0.0	0.8	0.0	0.1	0.0	0.0	0.9	77.9	75.9
	4,600	10,300	5,000	5.0	15.8	0.4	1.2	22.4	0.0	0.6	0.0	0.3	0.0	0.0	0.6	75.9	73.5
	0	0	7,000	0.0	0.0	0.0	1.0	1.0	0.0	0.1	0.0	0.0	0.0	0.0	1.1	96.8	93.8
	4,600	0	7,000	0.5	0.0	0.1	0.3	0.9	0.0	0.9	0.0	0.3	0.1	0.0	0.8	96.3	93.2
	4,460	3,340	7,000	2.9	2.5	0.4	0.5	6.3	0.0	1.6	0.0	0.3	0.2	0.0	0.6	90.4	88.1
	4,600	6,680	7,000	5.7	8.5	0.7	0.8	15.7	0.0	0.4	0.0	0.0	0.0	0.0	0.6	83.0	81.2
	4,600	8,500	7,000	6.0	12.4	0.3	0.8	19.5	0.0	0.4	0.0	0.0	0.1	0.0	0.7	78.6	77.9
	4,600	10,300	7,000	5.5	13.7	0.3	0.6	20.1	0.0	0.9	0.0	0.0	0.0	0.0	0.5	77.7	77.2
	0	0	12,000	0.0	0.0	0.0	0.5	0.5	0.0	0.0	0.0	0.0	0.1	0.0	0.7	98.0	98.0
	4,600	0	12,000	0.3	0.0	0.1	0.2	0.6	0.0	0.8	0.0	0.0	0.0	0.0	0.4	97.1	97.1
	4,460	3,340	12,000	3.5	1.7	0.3	0.7	6.2	0.0	1.1	0.0	0.3	0.1	0.0	0.4	91.0	91.2
	4,600	6,680	12,000	3.9	6.6	0.3	0.3	11.1	0.0	0.9	0.0	0.1	0.1	0.0	0.1	86.8	86.7
	4,600	8,500	12,000	4.2	10.2	0.3	0.1	14.8	0.0	0.1	0.0	0.0	0.0	0.0	0.0	84.3	84.2
	4,600	10,300	12,000	4.0	12.5	0.5	0.0	17.0	0.0	0.3	0.0	0.0	0.1	0.0	0.4	81.4	81.7

Table J-21i. DSM2 Particle Tracking Results for Sacramento River at Rio Vista Release at Range of CVP and SWP Pumping and Delta Outflows

	Rio Vista Release CVP	Rio Vista Release SWP	Net Delta Outflow	CVP Entrained	SWP Entrained	CCC Entrained	Ag Diversions Entrained	Total Entrained	South Delta Upstream of the Barriers	South Delta Downstream of the Barriers	SJR Vernalis to Turner Cut	SJR Turner Cut to Jersey Point	Mokelumne	Sacramento River	Confluence	Past Chipps Island	Past Martinez
No Trigger	0	0	5,000	0.0	0.0	0.0	3.2	3.2	0.0	11.0	0.0	10.0	0.3	5.0	51.4	17.7	4.0
	4,600	0	5,000	10.8	0.0	1.0	2.4	14.2	0.0	15.6	0.0	9.1	0.9	0.9	35.9	22.2	8.9
	4,600	3,340	5,000	14.6	9.9	1.1	3.0	28.6	0.1	14.1	0.1	6.7	0.2	0.3	23.6	25.8	12.5
	4,600	6,680	5,000	14.5	24.2	0.9	2.1	41.7	0.0	7.7	0.0	5.1	0.5	0.0	17.5	27.3	12.0
	4,600	8,500	5,000	13.2	26.7	1.0	1.9	42.8	0.0	10.4	0.1	3.4	0.3	0.2	15.1	27.2	13.7
	4,600	10,300	5,000	14.7	36.3	1.3	1.9	54.2	0.0	6.4	0.3	3.4	0.3	0.3	12.4	22.6	11.8
	0	0	7,000	0.0	0.0	0.1	1.6	1.7	0.0	11.3	0.0	6.4	0.1	2.2	45.9	31.5	10.1
	4,600	0	7,000	7.2	0.0	1.0	1.4	9.6	0.0	12.0	0.0	5.1	0.3	0.3	29.8	42.2	17.4
	4,600	3,340	7,000	11.7	8.5	1.4	1.9	23.5	0.0	9.5	0.0	4.5	0.3	0.3	24.4	36.8	17.1
	4,600	6,680	7,000	12.3	17.1	1.1	1.5	32.0	0.0	7.6	0.0	3.6	0.4	0.1	16.9	38.8	19.2
	4,600	8,500	7,000	14.4	26.1	1.1	2.1	43.7	0.1	8.2	0.2	2.5	0.0	0.1	12.6	32.3	17.4
	4,600	10,300	7,000	12.9	31.1	1.2	1.5	46.7	0.1	6.0	0.2	2.7	0.1	0.0	11.4	32.6	19.1
	0	0	12,000	0.0	0.0	0.0	0.9	0.9	0.0	3.4	0.0	0.7	0.1	0.4	17.9	75.0	40.8
	4,600	0	12,000	4.4	0.0	0.9	0.9	6.2	0.0	4.3	0.0	1.5	0.1	0.1	14.7	72.8	43.6
	4,600	3,340	12,000	8.7	5.0	0.6	1.7	16.0	0.0	4.6	0.0	1.2	0.2	0.1	11.4	65.5	40.1
	4,600	6,680	12,000	9.3	13.2	1.4	1.4	25.3	0.1	5.2	0.0	1.9	0.1	0.1	7.6	59.1	36.8
	4,600	8,500	12,000	10.2	18.1	1.3	1.3	30.9	0.0	3.0	0.2	1.9	0.2	0.0	6.8	56.5	37.3
	4,600	10,300	12,000	9.7	22.8	1.0	1.2	34.7	0.0	4.4	0.4	2.0	0.0	0.0	7.1	50.9	35.4
Tidal Trigger	0	0	5,000	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	98.9	98.5
	4,600	0	5,000	0.2	0.0	0.1	0.7	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	98.2	98.4
	4,600	3,340	5,000	0.3	0.1	0.1	0.1	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	98.4	98.9
	4,600	6,680	5,000	0.3	0.5	0.1	0.1	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	98.1	98.5
	4,600	8,500	5,000	0.5	1.0	0.2	0.3	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	97.6	97.3
	4,600	10,300	5,000	0.6	1.3	0.1	0.3	2.3	0.0	0.1	0.0	0.0	0.0	0.0	0.1	97.2	96.9
	0	0	7,000	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	98.9	99.2
	4,600	0	7,000	0.3	0.0	0.0	0.1	0.4	0.0	0.2	0.0	0.0	0.0	0.0	0.1	98.5	98.7
	4,600	3,340	7,000	0.0	0.1	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.0	99.4
	4,600	6,680	7,000	0.2	0.4	0.1	0.2	0.9	0.0	0.1	0.0	0.0	0.0	0.0	0.0	98.2	98.3
	4,600	8,500	7,000	0.5	0.7	0.0	0.4	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	97.8	97.9
	4,600	10,300	7,000	0.5	0.8	0.1	0.3	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	97.4	97.4
	0	0	12,000	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	98.5	99.8
	4,600	0	12,000	0.1	0.0	0.1	0.1	0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.0	98.8	99.3
	4,600	3,340	12,000	0.0	0.2	0.0	0.3	0.5	0.0	0.1	0.0	0.0	0.0	0.0	0.1	98.4	99.2
	4,600	6,680	12,000	0.2	0.5	0.0	0.4	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	98.2	98.8
	4,600	8,500	12,000	0.3	0.5	0.2	0.4	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	97.3	98.4
	4,600	10,300	12,000	0.3	0.5	0.0	0.2	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	97.5	98.6

Table J-21j. DSM2 Particle Tracking Results for Chipps Island Release at Range of CVP and SWP Pumping and Delta Outflows

	Chipps Island Release		Net Delta Outflow	CVP Entrained	SWP Entrained	CCC Entrained	Ag Diversions Entrained	Total Entrained	South Delta Upstream of the Barriers	South Delta Downstream of the Barriers	SJR Vernalis to Turner Cut	SJR Turner Cut to Jersey Point	Mokelumne	Sac R at Yolo	Confluence	Past Chipps Island	Past Martinez
	CVP	SWP															
No Trigger	0	0	5,000	0.0	0.0	0.0	0.1	0.1	0.0	0.8	0.0	0.7	0.0	0.0	20.6	23.0	47.7
	4,600	0	5,000	0.3	0.0	0.0	0.2	0.5	0.0	2.1	0.0	1.2	0.1	0.0	20.0	21.6	47.2
	4,600	3,340	5,000	1.1	0.6	0.1	0.1	1.9	0.0	2.8	0.0	2.3	0.0	0.0	20.7	17.4	47.0
	4,600	6,680	5,000	2.4	2.6	0.2	0.3	5.5	0.0	5.8	0.0	3.3	0.2	0.0	18.0	12.9	43.3
	4,600	8,500	5,000	2.9	5.3	0.2	0.6	9.0	0.0	4.0	0.0	3.6	0.3	0.0	16.3	12.4	44.4
	4,600	10,300	5,000	3.5	7.9	0.2	0.4	12.0	0.1	4.7	0.1	3.0	0.1	0.0	14.4	11.2	43.6
	0	0	7,000	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.0	11.1	34.2	60.1
	4,600	0	7,000	0.4	0.0	0.1	0.2	0.7	0.0	0.6	0.0	0.5	0.0	0.0	12.6	30.9	59.0
	4,600	3,340	7,000	0.8	0.3	0.1	0.2	1.4	0.0	1.6	0.0	0.5	0.1	0.0	13.3	28.6	55.7
	4,600	6,680	7,000	2.4	2.3	0.2	0.3	5.2	0.0	2.7	0.0	0.8	0.0	0.0	12.3	24.7	54.5
	4,600	8,500	7,000	2.4	4.9	0.1	0.4	7.8	0.0	2.5	0.1	1.1	0.0	0.0	11.4	22.6	56.7
	4,600	10,300	7,000	2.8	5.8	0.5	0.1	9.2	0.0	2.6	0.2	1.7	0.0	0.0	12.0	20.0	55.1
	0	0	12,000	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	2.7	42.1	76.8
	4,600	0	12,000	0.1	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	2.6	42.1	75.8
	4,600	3,340	12,000	0.1	0.2	0.1	0.3	0.7	0.0	0.8	0.0	0.0	0.0	0.0	4.0	39.8	71.7
	4,600	6,680	12,000	0.6	0.8	0.1	0.0	1.5	0.0	1.0	0.0	0.6	0.0	0.0	3.1	39.0	73.5
	4,600	8,500	12,000	1.4	1.5	0.1	0.2	3.2	0.0	2.0	0.0	0.9	0.0	0.0	3.1	35.3	69.8
	4,600	10,300	12,000	1.6	2.2	0.0	0.3	4.1	0.0	2.3	0.0	0.7	0.0	0.0	3.1	34.5	70.1
Tidal Trigger	0	0	5,000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.7	99.9
	4,600	0	5,000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.8	100.0
	4,600	3,340	5,000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.7	99.9
	4,600	6,680	5,000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.6	100.0
	4,600	8,500	5,000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.9	100.0
	4,600	10,300	5,000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.7	100.0
	0	0	7,000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.6	99.8
	4,600	0	7,000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.5	99.9
	4,600	3,340	7,000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.7	99.8
	4,600	6,680	7,000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.6	100.0
	4,600	8,500	7,000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.6	100.0
	4,600	10,300	7,000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.6	99.8
	0	0	12,000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.6	99.9
	4,600	0	12,000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.7	99.9
	4,600	3,340	12,000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.7	100.0
	4,600	6,680	12,000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.2	99.9
	4,600	8,500	12,000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.7	100.0
	4,600	10,300	12,000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.8	100.0

Table J-22a. DSM2 Particle Tracking Results for San Joaquin River at Mossdale (Node 6) Release for Range of VAMP Conditions

	CVP	SWP	Head of Old River Barrier	SJR Flow	Delta Outflow	CVP Entrained	SWP Entrained	CCC Entrained	Ag Diversions Entrained	Total Entrained	South Delta Upstream of the Barriers	South Delta Downstream of the Barriers	SJR Vernalis to Turner Cut	SJR Turner Cut to Jersey Point	Mokelumne	Sacramento River	Confluence	Past Chipps Island	Past Martinez
Passive	750	750	In	2,000	14,737	12.3	5.0	1.3	8.1	26.7	4.8	46.2	0.3	7.0	10.4	0.0	4.1	0.4	0.0
Reduced	750	750	In	3,200	15,937	12.3	5.5	1.9	8.5	28.2	4.4	36.2	0.0	7.1	7.2	0.0	12.0	4.8	1.4
Pumping	750	750	In	4,450	17,187	11.1	5.0	2.5	8.6	27.2	5.9	28.0	0.3	6.5	3.3	0.0	15.3	13.4	6.0
	1,125	1,125	In	5,700	17,687	14.5	8.8	1.8	17.1	42.2	8.2	17.8	0.1	4.0	0.8	0.0	12.5	14.1	6.1
	1,500	1,500	In	7,000	18,237	16.7	12.0	1.9	24.9	55.5	5.0	11.7	0.0	1.9	0.7	0.0	10.2	14.9	8.1
Passive	1,000	1,000	In	2,000	14,237	18.4	8.6	1.3	10.0	38.3	3.9	37.8	0.4	5.1	11.3	0.0	3.1	0.1	0.0
Full	1,600	1,600	In	3,200	14,237	28.5	20.2	1.8	9.2	59.7	3.4	19.9	0.1	3.7	7.4	0.0	3.9	1.8	0.9
Pumping	2,225	2,225	In	4,450	14,237	31.6	26.2	2.0	9.0	68.8	4.3	13.9	0.0	3.6	2.4	0.0	4.9	2.1	0.6
	2,850	2,850	In	5,700	14,237	32.0	27.0	1.3	14.8	75.1	6.6	7.7	0.2	2.2	1.4	0.0	3.2	3.5	1.8
	3,500	3,500	In	7,000	14,237	27.8	29.0	1.0	21.7	79.5	6.0	5.8	0.0	2.1	0.9	0.0	4.2	1.5	0.2
Passive	750	750	Out	2,000	14,737	38.3	3.6	0.2	17.1	59.2	1.5	24.6	1.9	7.5	5.3	0.0	0.0	0.0	0.0
Reduced	750	750	Out	3,200	15,937	27.9	9.9	0.5	12.8	51.1	1.0	30.8	0.5	7.1	6.6	0.0	2.4	0.5	0.0
Pumping	750	750	Out	4,450	17,187	17.4	15.0	0.3	10.2	42.9	0.1	31.3	0.6	7.5	7.3	0.0	8.0	2.2	0.6
	1,125	1,125	Out	5,700	17,687	19.9	20.1	1.1	6.7	47.8	0.0	25.7	0.2	6.3	3.6	0.0	11.3	5.0	1.4
	1,500	1,500	Out	7,000	18,237	20.7	22.8	0.5	5.2	49.2	0.1	22.5	0.0	5.1	3.2	0.0	12.1	7.7	2.5
Passive	1,000	1,000	Out	2,000	14,237	38.3	3.6	0.2	17.1	59.2	0.7	21.1	1.2	8.0	4.1	0.0	0.0	0.0	0.0
Full	1,600	1,600	Out	3,200	14,237	27.9	9.9	0.5	12.8	51.1	1.4	22.2	0.3	3.0	5.2	0.0	0.4	0.1	0.0
Pumping	2,225	2,225	Out	4,450	14,237	17.4	15.0	0.3	10.2	42.9	0.0	15.6	0.4	2.4	5.5	0.0	1.6	0.3	0.0
	2,850	2,850	Out	5,700	14,237	19.9	20.1	1.1	6.7	47.8	0.0	10.3	0.1	3.0	5.0	0.0	2.0	0.9	0.3
	3,500	3,500	Out	7,000	14,237	20.7	22.8	0.5	5.2	49.2	0.0	10.3	0.1	2.0	3.1	0.0	2.3	0.8	0.2
Tidal	750	750	In	2,000	14,737	0.0	0.0	0.1	1.8	1.9	0.0	5.4	0.0	2.2	0.1	0.0	5.1	84.5	79.8
Reduced	750	750	In	3,200	15,937	0.0	0.0	0.1	0.8	0.9	0.0	4.3	0.0	0.9	0.6	0.0	3.8	88.7	84.7
Pumping	750	750	In	4,450	17,187	0.0	0.1	0.0	2.4	2.5	0.9	1.9	0.0	1.0	0.0	0.0	2.5	89.9	88.5
	1,125	1,125	In	5,700	17,687	2.5	0.3	0.4	10.2	13.4	2.4	2.5	0.0	0.2	0.0	0.0	2.0	78.8	78.2
	1,500	1,500	In	7,000	18,237	14.3	1.9	0.5	9.4	26.1	1.7	3.4	0.0	0.0	0.0	0.0	0.9	67.2	66.8
Tidal	1,000	1,000	In	2,000	14,237	0.4	0.3	0.4	2.1	3.2	0.0	6.7	0.0	2.0	0.5	0.0	5.6	81.5	75.3
Full	1,600	1,600	In	3,200	14,237	3.8	3.6	0.9	0.9	9.2	0.0	6.0	0.0	1.3	0.3	0.0	3.9	78.4	74.5
Pumping	2,225	2,225	In	4,450	14,237	9.8	7.7	1.0	2.5	21.0	1.1	4.4	0.0	0.2	0.1	0.0	1.9	70.6	68.7
	2,850	2,850	In	5,700	14,237	14.5	10.3	0.6	10.0	35.4	3.0	2.9	0.0	0.1	0.0	0.0	1.9	56.4	54.3
	3,500	3,500	In	7,000	14,237	27.7	14.1	0.6	10.5	52.9	1.9	2.0	0.0	0.0	0.0	0.0	0.2	42.5	41.8
Tidal	750	750	Out	2,000	14,737	28.8	13.4	0.1	9.2	51.5	0.0	7.0	0.0	1.4	0.6	0.0	6.0	33.2	25.5
Reduced	750	750	Out	3,200	15,937	17.8	15.0	0.6	6.1	39.5	0.1	8.6	0.0	1.9	0.5	0.0	2.5	46.6	43.0
Pumping	750	750	Out	4,450	17,187	11.9	7.7	0.9	4.2	24.7	0.0	7.7	0.0	1.7	0.2	0.0	4.6	60.9	56.8
	1,125	1,125	Out	5,700	17,687	13.8	11.5	1.2	3.3	29.8	0.0	6.6	0.0	1.0	0.3	0.0	4.3	57.3	53.7
	1,500	1,500	Out	7,000	18,237	15.7	13.6	1.0	2.5	32.8	0.0	4.9	0.0	1.0	0.1	0.0	2.1	58.5	55.5
Tidal	1,000	1,000	Out	2,000	14,237	28.8	13.4	0.1	9.2	51.5	0.0	4.5	0.0	0.8	0.5	0.0	5.2	33.6	23.8
Full	1,600	1,600	Out	3,200	14,237	17.8	15.0	0.6	6.1	39.5	0.0	2.5	0.0	1.5	0.4	0.0	3.3	38.3	34.1
Pumping	2,225	2,225	Out	4,450	14,237	11.9	7.7	0.9	4.2	24.7	0.0	3.8	0.0	1.2	0.4	0.0	1.9	40.1	37.3
	2,850	2,850	Out	5,700	14,237	13.8	11.5	1.2	3.3	29.8	0.0	3.4	0.0	0.5	0.0	0.0	1.9	40.7	38.2
	3,500	3,500	Out	7,000	14,237	15.7	13.6	1.0	2.5	32.8	0.0	2.4	0.0	0.3	0.2	0.0	0.8	39.8	38.2

Table J-22b. DSM2 Particle Tracking Results for Old River at Middle River (Node 52) Release for Range of VAMP Conditions

	CVP	SWP	Head of Old River Barrier	SJR Flow	Delta Outflow	CVP Entrained	SWP Entrained	CCC Entrained	Ag Diversions Entrained	Total Entrained	South Delta Upstream of the Barriers	South Delta Downstream of the Barriers	SJR Vernalis to Turner Cut	SJR Turner Cut to Jersey Point	Mokelumne	Sacramento River	Confluence	Past Chipps Island	Past Martinez
Passive	750	750	In	2,000	14,737	0.0	0.0	0.0	73.2	73.2	26.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reduced	750	750	In	3,200	15,937	0.0	0.0	0.0	74.0	74.0	26.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pumping	750	750	In	4,450	17,187	0.0	0.0	0.0	80.8	80.8	19.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1,125	1,125	In	5,700	17,687	0.1	0.0	0.0	85.6	85.7	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1,500	1,500	In	7,000	18,237	12.0	0.0	0.0	79.2	91.2	8.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passive	1,000	1,000	In	2,000	14,237	0.0	0.0	0.0	72.5	72.5	27.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Full	1,600	1,600	In	3,200	14,237	0.0	0.0	0.0	71.8	71.8	28.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pumping	2,225	2,225	In	4,450	14,237	0.0	0.0	0.0	78.4	78.4	21.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2,850	2,850	In	5,700	14,237	0.0	0.0	0.0	83.9	83.9	16.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3,500	3,500	In	7,000	14,237	19.8	0.0	0.0	71.1	90.9	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passive	750	750	Out	2,000	14,737	62.5	6.9	0.0	27.4	96.8	0.9	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reduced	750	750	Out	3,200	15,937	48.2	25.0	0.0	16.5	89.7	1.7	8.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pumping	750	750	Out	4,450	17,187	30.0	31.5	0.8	15.9	78.2	0.3	21.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1,125	1,125	Out	5,700	17,687	37.0	40.4	0.1	12.4	89.9	0.2	9.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1,500	1,500	Out	7,000	18,237	40.0	44.6	0.2	10.0	94.8	0.2	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passive	1,000	1,000	Out	2,000	14,237	62.5	6.9	0.0	27.4	96.8	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Full	1,600	1,600	Out	3,200	14,237	48.2	25.0	0.0	16.5	89.7	1.7	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pumping	2,225	2,225	Out	4,450	14,237	30.0	31.5	0.8	15.9	78.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2,850	2,850	Out	5,700	14,237	37.0	40.4	0.1	12.4	89.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3,500	3,500	Out	7,000	14,237	40.0	44.6	0.2	10.0	94.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tidal	750	750	In	2,000	14,737	4.7	0.0	0.0	77.5	82.2	16.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reduced	750	750	In	3,200	15,937	4.2	0.0	0.0	77.8	82.0	16.6	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pumping	750	750	In	4,450	17,187	8.6	0.0	0.0	77.7	86.3	12.8	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1,125	1,125	In	5,700	17,687	46.8	0.0	0.0	47.2	94.0	5.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1,500	1,500	In	7,000	18,237	68.8	0.0	0.0	29.2	98.0	1.6	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tidal	1,000	1,000	In	2,000	14,237	5.6	0.0	0.0	75.5	81.1	18.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Full	1,600	1,600	In	3,200	14,237	7.1	0.0	0.0	74.6	81.7	17.5	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pumping	2,225	2,225	In	4,450	14,237	11.4	0.0	0.0	76.3	87.7	11.5	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2,850	2,850	In	5,700	14,237	45.7	0.0	0.0	49.1	94.8	4.7	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3,500	3,500	In	7,000	14,237	66.7	0.0	0.0	30.5	97.2	2.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tidal	750	750	Out	2,000	14,737	48.8	23.5	0.3	15.6	88.2	0.0	11.5	0.0	0.2	0.0	0.0	0.1	0.0	0.0
Reduced	750	750	Out	3,200	15,937	27.6	28.1	2.2	10.0	67.9	0.0	18.0	0.0	1.3	0.2	0.0	3.4	9.1	7.5
Pumping	750	750	Out	4,450	17,187	24.0	11.6	2.3	9.9	47.8	0.0	13.7	0.0	3.6	0.3	0.0	6.8	27.6	22.9
	1,125	1,125	Out	5,700	17,687	28.9	20.8	2.3	7.9	59.9	0.0	10.0	0.0	1.7	0.3	0.0	6.4	21.3	17.6
	1,500	1,500	Out	7,000	18,237	32.8	26.2	1.7	6.8	67.5	0.0	8.5	0.0	1.5	0.0	0.0	3.4	18.9	15.7
Tidal	1,000	1,000	Out	2,000	14,237	48.8	23.5	0.3	15.6	88.2	0.1	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Full	1,600	1,600	Out	3,200	14,237	27.6	28.1	2.2	10.0	67.9	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pumping	2,225	2,225	Out	4,450	14,237	24.0	11.6	2.3	9.9	47.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2,850	2,850	Out	5,700	14,237	28.9	20.8	2.3	7.9	59.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3,500	3,500	Out	7,000	14,237	32.8	26.2	1.7	6.8	67.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table J-22c. DSM2 Particle Tracking Results for San Joaquin River at Turner Cut (Node 26) Release for Range of VAMP Conditions

	CVP	SWP	Head of Old River Barrier	SJR Flow	Delta Outflow	CVP Entrained	SWP Entrained	CCC Entrained	Ag Diversions Entrained	Total Entrained	South Delta Upstream of the Barriers	South Delta Downstream of the Barriers	SJR Vernalis to Turner Cut	SJR Turner Cut to Jersey Point	Mokelumne	Sacramento River	Confluence	Past Chipps Island	Past Martinez
Passive	750	750	In	2,000	14,737	17.5	5.9	2.1	10.1	35.6	4.8	38.8	0.0	5.1	5.9	0.0	5.8	4.0	1.8
Reduced	750	750	In	3,200	15,937	16.4	7.3	2.1	8.7	34.5	5.7	31.9	0.0	7.5	2.0	0.0	11.1	7.2	2.8
Pumping	750	750	In	4,450	17,187	14.8	7.0	2.4	8.4	32.6	3.2	29.2	0.0	4.1	1.0	0.0	15.0	14.5	6.4
	1,125	1,125	In	5,700	17,687	19.4	13.0	2.1	8.4	42.9	2.8	18.9	0.0	2.4	0.2	0.0	13.5	18.9	9.6
	1,500	1,500	In	7,000	18,237	22.4	16.4	2.6	7.1	48.5	1.6	11.1	0.0	1.1	0.1	0.0	11.5	25.4	14.3
Passive	1,000	1,000	In	2,000	14,237	22.2	11.9	1.0	9.1	44.2	4.3	36.0	0.0	5.0	4.3	0.0	4.1	2.1	0.6
Full	1,600	1,600	In	3,200	14,237	32.7	25.3	1.2	7.8	67.0	3.1	17.2	0.0	2.9	3.2	0.0	4.5	2.1	0.7
Pumping	2,225	2,225	In	4,450	14,237	35.8	33.7	0.9	6.6	77.0	2.1	10.5	0.0	1.5	0.8	0.0	4.8	3.3	1.0
	2,850	2,850	In	5,700	14,237	38.6	36.4	1.2	7.8	84.0	1.0	6.0	0.0	2.4	0.0	0.0	3.6	3.0	1.3
	3,500	3,500	In	7,000	14,237	40.4	36.7	0.9	6.4	84.4	1.3	6.6	0.0	1.1	0.0	0.0	3.7	2.9	1.0
Passive	750	750	Out	2,000	14,737	1.0	2.4	1.7	3.4	8.5	0.7	66.4	0.0	12.0	7.7	0.0	3.9	0.8	0.3
Reduced	750	750	Out	3,200	15,937	0.1	0.4	1.7	2.8	5.0	0.0	54.8	0.0	12.8	9.1	0.0	13.5	4.6	1.6
Pumping	750	750	Out	4,450	17,187	0.0	0.0	0.9	1.9	2.8	0.0	41.3	0.0	14.2	7.7	0.0	20.0	13.5	5.4
	1,125	1,125	Out	5,700	17,687	0.0	0.0	1.8	1.8	3.6	0.0	36.9	0.0	12.9	2.8	0.0	23.6	19.8	9.0
	1,500	1,500	Out	7,000	18,237	0.0	0.1	1.9	1.5	3.5	0.0	34.9	0.0	9.2	2.0	0.0	22.0	27.8	14.0
Passive	1,000	1,000	Out	2,000	14,237	1.0	2.4	1.7	3.4	8.5	1.0	59.8	0.0	9.9	6.2	0.0	2.5	0.8	0.3
Full	1,600	1,600	Out	3,200	14,237	0.1	0.4	1.7	2.8	5.0	0.3	42.6	0.0	7.2	7.9	0.0	3.0	1.4	0.9
Pumping	2,225	2,225	Out	4,450	14,237	0.0	0.0	0.9	1.9	2.8	0.0	28.2	0.0	4.0	5.1	0.0	5.9	2.0	0.9
	2,850	2,850	Out	5,700	14,237	0.0	0.0	1.8	1.8	3.6	0.0	19.4	0.0	3.4	4.3	0.0	4.4	1.8	0.9
	3,500	3,500	Out	7,000	14,237	0.0	0.1	1.9	1.5	3.5	0.0	16.5	0.0	3.4	1.3	0.0	4.5	1.5	0.7
Tidal	750	750	In	2,000	14,737	0.0	0.0	0.0	0.7	0.7	0.0	2.2	0.0	0.5	0.0	0.0	1.9	93.9	91.6
Reduced	750	750	In	3,200	15,937	0.0	0.0	0.1	0.6	0.7	0.0	2.8	0.0	0.4	0.0	0.0	1.3	93.8	93.4
Pumping	750	750	In	4,450	17,187	0.0	0.1	0.2	0.3	0.6	0.0	1.4	0.0	0.1	0.0	0.0	1.6	95.2	94.8
	1,125	1,125	In	5,700	17,687	0.9	0.5	0.2	0.4	2.0	0.0	2.8	0.0	0.4	0.0	0.0	0.8	93.2	92.7
	1,500	1,500	In	7,000	18,237	4.0	1.8	0.6	0.4	6.8	0.0	1.3	0.0	0.3	0.0	0.0	0.7	89.8	89.4
Tidal	1,000	1,000	In	2,000	14,237	0.4	0.1	0.2	0.4	1.1	0.0	4.4	0.0	1.0	0.0	0.0	2.9	90.0	87.2
Full	1,600	1,600	In	3,200	14,237	5.1	3.2	1.0	1.0	10.3	0.0	3.8	0.0	0.4	0.0	0.0	1.2	83.6	81.2
Pumping	2,225	2,225	In	4,450	14,237	11.3	8.1	0.6	0.6	20.6	0.1	2.3	0.0	0.1	0.0	0.0	0.4	75.9	74.6
	2,850	2,850	In	5,700	14,237	15.3	12.6	0.7	1.4	30.0	0.0	1.8	0.0	0.0	0.0	0.0	0.7	67.1	66.0
	3,500	3,500	In	7,000	14,237	18.6	16.2	1.3	1.0	37.1	0.1	0.7	0.0	0.1	0.0	0.0	0.1	61.4	60.4
Tidal	750	750	Out	2,000	14,737	0.0	0.0	0.0	0.7	0.7	0.0	0.8	0.0	0.4	0.0	0.0	1.8	95.5	92.5
Reduced	750	750	Out	3,200	15,937	0.0	0.0	0.0	0.5	0.5	0.0	0.4	0.0	0.4	0.1	0.0	1.0	96.8	95.3
Pumping	750	750	Out	4,450	17,187	0.0	0.0	0.0	0.5	0.5	0.0	0.5	0.0	0.0	0.0	0.0	0.5	97.8	96.8
	1,125	1,125	Out	5,700	17,687	0.0	0.0	0.0	0.6	0.6	0.0	0.3	0.0	0.0	0.0	0.0	0.3	97.6	97.6
	1,500	1,500	Out	7,000	18,237	0.0	0.0	0.0	0.5	0.5	0.0	0.2	0.0	0.0	0.0	0.0	0.2	98.5	98.2
Tidal	1,000	1,000	Out	2,000	14,237	0.0	0.0	0.0	0.7	0.7	0.0	1.8	0.0	0.6	0.1	0.0	2.2	93.6	89.8
Full	1,600	1,600	Out	3,200	14,237	0.0	0.0	0.0	0.5	0.5	0.0	2.6	0.0	0.4	0.0	0.0	2.2	93.1	88.8
Pumping	2,225	2,225	Out	4,450	14,237	0.0	0.0	0.0	0.5	0.5	0.0	4.1	0.0	0.6	0.1	0.0	1.8	90.0	88.1
	2,850	2,850	Out	5,700	14,237	0.0	0.0	0.0	0.6	0.6	0.0	5.8	0.0	0.5	0.0	0.0	2.5	85.9	83.4
	3,500	3,500	Out	7,000	14,237	0.0	0.0	0.0	0.5	0.5	0.0	3.1	0.0	0.3	0.0	0.0	2.7	84.1	82.1

Table J-22d. DSM2 Particle Tracking Results for San Joaquin River at Prisoner's Point (Node 37) Release for Range of VAMP Conditions

	CVP	SWP	Head of Old River Barrier	SJR Flow	Delta Outflow	CVP Entrained	SWP Entrained	CCC Entrained	Ag Diversions Entrained	Total Entrained	South Delta Upstream of the Barriers	South Delta Downstream of the Barriers	SJR Vernalis to Turner Cut	SJR Turner Cut to Jersey Point	Mokelumne	Sacramento River	Confluence	Past Chipps Island	Past Martinez
Passive	750	750	In	2,000	14,737	5.6	1.6	2.5	3.9	13.6	1.6	28.8	0.0	7.6	1.6	0.0	18.9	27.0	14.8
Reduced	750	750	In	3,200	15,937	5.5	1.6	2.2	3.2	12.5	1.7	17.6	0.0	4.5	0.1	0.0	21.4	41.5	23.3
Pumping	750	750	In	4,450	17,187	3.3	1.3	2.4	3.0	10.0	1.0	13.8	0.0	2.8	0.1	0.0	19.6	51.9	32.3
	1,125	1,125	In	5,700	17,687	4.9	3.3	1.9	2.4	12.5	1.4	9.8	0.0	2.4	0.1	0.0	15.6	56.8	36.0
	1,500	1,500	In	7,000	18,237	6.0	3.8	2.6	2.7	15.1	1.0	7.3	0.0	1.2	0.0	0.0	12.0	62.9	41.0
Passive	1,000	1,000	In	2,000	14,237	9.5	4.7	3.1	5.2	22.5	2.9	26.2	0.0	6.5	0.5	0.0	18.0	23.2	12.7
Full	1,600	1,600	In	3,200	14,237	14.6	11.0	2.9	3.7	32.2	2.1	17.7	0.0	6.3	0.9	0.0	17.0	23.3	12.3
Pumping	2,225	2,225	In	4,450	14,237	18.2	16.8	3.1	3.9	42.0	0.5	13.2	0.0	4.0	0.4	0.0	17.5	21.7	11.2
	2,850	2,850	In	5,700	14,237	19.5	18.4	3.4	5.3	46.6	1.1	9.6	0.0	3.5	0.0	0.0	15.6	23.3	12.7
	3,500	3,500	In	7,000	14,237	23.5	19.4	2.8	4.4	50.1	0.5	8.3	0.0	2.2	0.2	0.0	15.0	23.6	13.7
Passive	750	750	Out	2,000	14,737	0.4	0.6	2.4	1.8	5.2	0.0	35.3	0.0	9.9	3.0	0.0	20.1	25.9	14.4
Reduced	750	750	Out	3,200	15,937	0.0	0.1	1.7	1.7	3.5	0.0	23.5	0.0	8.7	0.8	0.0	23.2	39.5	23.1
Pumping	750	750	Out	4,450	17,187	0.0	0.0	0.5	0.6	1.1	0.0	15.8	0.0	5.7	0.6	0.0	20.3	56.0	33.0
	1,125	1,125	Out	5,700	17,687	0.0	0.0	1.7	0.8	2.5	0.0	11.4	0.0	3.8	0.5	0.0	22.9	57.8	35.0
	1,500	1,500	Out	7,000	18,237	0.0	0.0	0.6	1.0	1.6	0.0	9.5	0.0	3.0	0.2	0.0	20.0	64.8	41.2
Passive	1,000	1,000	Out	2,000	14,237	0.4	0.6	2.4	1.8	5.2	0.5	35.8	0.0	8.8	2.0	0.0	19.4	22.8	11.6
Full	1,600	1,600	Out	3,200	14,237	0.0	0.1	1.7	1.7	3.5	0.1	28.8	0.0	8.5	1.4	0.0	20.0	23.8	11.5
Pumping	2,225	2,225	Out	4,450	14,237	0.0	0.0	0.5	0.6	1.1	0.0	25.9	0.0	6.8	1.6	0.0	17.6	23.1	13.3
	2,850	2,850	Out	5,700	14,237	0.0	0.0	1.7	0.8	2.5	0.0	19.1	0.0	7.5	0.7	0.0	15.8	25.9	15.3
	3,500	3,500	Out	7,000	14,237	0.0	0.0	0.6	1.0	1.6	0.0	14.8	0.0	6.7	0.7	0.0	17.4	25.3	14.6
Tidal	750	750	In	2,000	14,737	0.0	0.0	0.0	0.1	0.1	0.0	0.3	0.0	0.0	0.0	0.0	0.3	98.3	98.7
Reduced	750	750	In	3,200	15,937	0.0	0.0	0.0	0.3	0.3	0.0	0.3	0.0	0.1	0.0	0.0	0.5	97.9	98.4
Pumping	750	750	In	4,450	17,187	0.0	0.0	0.1	0.3	0.4	0.0	0.1	0.0	0.1	0.0	0.0	0.4	98.4	98.5
	1,125	1,125	In	5,700	17,687	0.0	0.1	0.2	0.3	0.6	0.0	0.2	0.0	0.2	0.0	0.0	0.1	97.6	98.3
	1,500	1,500	In	7,000	18,237	0.3	0.1	0.0	0.0	0.4	0.0	0.2	0.0	0.1	0.0	0.0	0.3	98.1	98.7
Tidal	1,000	1,000	In	2,000	14,237	0.0	0.1	0.1	0.3	0.5	0.0	0.0	0.0	0.3	0.0	0.0	0.8	97.3	97.4
Full	1,600	1,600	In	3,200	14,237	0.7	0.2	0.2	0.1	1.2	0.1	0.6	0.0	0.0	0.0	0.0	0.5	96.7	96.9
Pumping	2,225	2,225	In	4,450	14,237	1.9	0.7	0.5	0.4	3.5	0.0	0.5	0.0	0.2	0.0	0.0	0.3	94.3	94.7
	2,850	2,850	In	5,700	14,237	3.1	1.6	0.5	0.5	5.7	0.1	0.4	0.0	0.0	0.0	0.0	0.3	92.4	92.8
	3,500	3,500	In	7,000	14,237	4.2	3.2	0.7	0.3	8.4	0.0	0.2	0.0	0.0	0.0	0.0	0.3	90.1	90.8
Tidal	750	750	Out	2,000	14,737	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3	99.0	98.6
Reduced	750	750	Out	3,200	15,937	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.5	98.8	98.6
Pumping	750	750	Out	4,450	17,187	0.0	0.0	0.0	0.5	0.5	0.0	0.1	0.0	0.0	0.0	0.0	0.0	98.2	99.0
	1,125	1,125	Out	5,700	17,687	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	98.7	99.5
	1,500	1,500	Out	7,000	18,237	0.0	0.0	0.0	0.1	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	98.4	99.3
Tidal	1,000	1,000	Out	2,000	14,237	0.0	0.0	0.0	0.1	0.1	0.0	0.5	0.0	0.0	0.0	0.0	0.1	97.8	97.5
Full	1,600	1,600	Out	3,200	14,237	0.0	0.0	0.0	0.2	0.2	0.0	0.4	0.0	0.3	0.0	0.0	0.9	97.4	97.2
Pumping	2,225	2,225	Out	4,450	14,237	0.0	0.0	0.0	0.5	0.5	0.0	0.6	0.0	0.2	0.0	0.0	0.6	97.7	97.7
	2,850	2,850	Out	5,700	14,237	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.1	0.0	0.0	0.6	97.4	97.4
	3,500	3,500	Out	7,000	14,237	0.0	0.0	0.0	0.1	0.1	0.0	0.5	0.0	0.0	0.0	0.0	0.2	97.4	97.4

Table J-22e. DSM2 Particle Tracking Results for San Joaquin River at Jersey Point (Node 44) Release for Range of VAMP Conditions

	CVP	SWP	Head of Old River Barrier	SJR Flow	Delta Outflow	CVP Entrained	SWP Entrained	CCC Entrained	Ag Diversions Entrained	Total Entrained	South Delta Upstream of the Barriers	South Delta Downstream of the Barriers	SJR Vernalis to Turner Cut	SJR Turner Cut to Jersey Point	Mokelumne	Sacramento River	Confluence	Past Chipps Island	Past Martinez
Passive	750	750	In	2,000	14,737	0.2	0.1	1.2	0.6	2.1	0.4	5.7	0.0	1.6	0.2	0.0	8.1	80.7	60.3
Reduced	750	750	In	3,200	15,937	0.3	0.1	0.3	0.3	1.0	0.6	3.2	0.0	1.3	0.0	0.0	8.0	84.5	64.4
Pumping	750	750	In	4,450	17,187	0.1	0.1	0.4	0.2	0.8	0.0	2.9	0.0	0.8	0.0	0.0	3.5	90.7	74.3
	1,125	1,125	In	5,700	17,687	0.7	0.4	0.0	0.3	1.4	0.2	1.0	0.0	0.2	0.0	0.0	2.7	93.6	75.0
	1,500	1,500	In	7,000	18,237	0.6	0.2	0.1	0.8	1.7	0.1	1.0	0.0	0.1	0.0	0.0	3.1	92.4	76.8
Passive	1,000	1,000	In	2,000	14,237	1.3	0.5	0.5	0.8	3.1	0.3	5.4	0.0	1.1	0.3	0.0	9.9	78.3	57.4
Full	1,600	1,600	In	3,200	14,237	2.3	1.0	0.8	0.7	4.8	0.3	4.4	0.0	2.2	0.0	0.0	10.3	76.2	53.9
Pumping	2,225	2,225	In	4,450	14,237	3.0	1.9	0.5	1.6	7.0	0.3	3.9	0.0	1.5	0.1	0.0	8.7	76.9	55.2
	2,850	2,850	In	5,700	14,237	4.2	2.3	0.5	0.6	7.6	0.3	3.2	0.0	0.6	0.0	0.0	8.6	78.4	56.5
	3,500	3,500	In	7,000	14,237	4.5	3.9	0.4	0.9	9.7	0.2	3.0	0.0	0.7	0.0	0.0	10.1	75.1	54.0
Passive	750	750	Out	2,000	14,737	0.0	0.0	0.2	0.4	0.6	0.0	4.5	0.0	2.3	0.4	0.0	9.4	81.7	61.6
Reduced	750	750	Out	3,200	15,937	0.0	0.0	0.6	0.3	0.9	0.0	4.1	0.0	1.3	0.0	0.0	6.2	85.9	67.7
Pumping	750	750	Out	4,450	17,187	0.0	0.0	0.2	0.1	0.3	0.0	1.4	0.0	0.4	0.1	0.0	4.0	92.1	72.9
	1,125	1,125	Out	5,700	17,687	0.0	0.0	0.2	0.3	0.5	0.0	1.3	0.0	0.1	0.0	0.0	4.4	91.5	74.2
	1,500	1,500	Out	7,000	18,237	0.0	0.0	0.3	0.2	0.5	0.0	0.9	0.0	0.1	0.0	0.0	3.0	94.1	76.8
Passive	1,000	1,000	Out	2,000	14,237	0.0	0.0	0.2	0.4	0.6	0.0	4.6	0.0	2.6	0.3	0.0	12.1	77.0	55.2
Full	1,600	1,600	Out	3,200	14,237	0.0	0.0	0.6	0.3	0.9	0.0	5.3	0.0	2.5	0.2	0.0	10.8	78.3	56.8
Pumping	2,225	2,225	Out	4,450	14,237	0.0	0.0	0.2	0.1	0.3	0.0	4.5	0.0	1.7	0.2	0.0	11.3	77.4	57.0
	2,850	2,850	Out	5,700	14,237	0.0	0.0	0.2	0.3	0.5	0.0	4.0	0.0	2.1	0.4	0.0	11.1	77.0	54.3
	3,500	3,500	Out	7,000	14,237	0.0	0.0	0.3	0.2	0.5	0.0	4.0	0.0	1.1	0.2	0.0	10.1	77.4	56.9
Tidal	750	750	In	2,000	14,737	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	99.2	99.8
Reduced	750	750	In	3,200	15,937	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.2	99.9
Pumping	750	750	In	4,450	17,187	0.0	0.1	0.0	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	98.9	99.7
	1,125	1,125	In	5,700	17,687	0.0	0.1	0.1	0.1	0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.0	99.0	99.3
	1,500	1,500	In	7,000	18,237	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	99.5	99.7
Tidal	1,000	1,000	In	2,000	14,237	0.0	0.1	0.0	0.1	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.1	99.0	99.5
Full	1,600	1,600	In	3,200	14,237	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.1	0.0	0.0	0.1	98.7	99.4
Pumping	2,225	2,225	In	4,450	14,237	0.0	0.1	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.0	99.6
	2,850	2,850	In	5,700	14,237	0.3	0.2	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.0	99.1
	3,500	3,500	In	7,000	14,237	0.6	0.2	0.0	0.2	1.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	98.2	98.6
Tidal	750	750	Out	2,000	14,737	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.3	99.7
Reduced	750	750	Out	3,200	15,937	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.2	99.9
Pumping	750	750	Out	4,450	17,187	0.0	0.0	0.0	0.2	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.1	98.9	99.6
	1,125	1,125	Out	5,700	17,687	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	99.9
	1,500	1,500	Out	7,000	18,237	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.0	99.9
Tidal	1,000	1,000	Out	2,000	14,237	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	99.0	99.4
Full	1,600	1,600	Out	3,200	14,237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	98.8	99.5
Pumping	2,225	2,225	Out	4,450	14,237	0.0	0.0	0.0	0.2	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	99.2	99.8
	2,850	2,850	Out	5,700	14,237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	98.6	99.5
	3,500	3,500	Out	7,000	14,237	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.7	99.6

Table J-22f. DSM2 Particle Tracking Results for Woodward Canal (Node 194) Release for Range of VAMP Conditions

	CVP	SWP	Head of Old River Barrier	SJR Flow	Delta Outflow	CVP Entrained	SWP Entrained	CCC Entrained	Ag Diversions Entrained	Total Entrained	South Delta Upstream of the Barriers	South Delta Downstream of the Barriers	SJR Vernalis to Turner Cut	SJR Turner Cut to Jersey Point	Mokelumne	Sacramento River	Confluence	Past Chipps Island	Past Martinez
Passive	750	750	In	2,000	14,737	31.5	30.3	0.0	24.3	86.1	2.0	11.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reduced	750	750	In	3,200	15,937	32.0	29.8	0.0	24.7	86.5	1.6	11.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pumping	750	750	In	4,450	17,187	30.7	26.9	0.0	28.3	85.9	2.2	11.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1,125	1,125	In	5,700	17,687	35.2	36.5	0.0	20.7	92.4	1.8	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1,500	1,500	In	7,000	18,237	41.1	37.5	0.0	18.3	96.9	1.2	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passive	1,000	1,000	In	2,000	14,237	37.0	32.9	0.0	21.6	91.5	1.7	6.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Full	1,600	1,600	In	3,200	14,237	38.3	41.0	0.0	16.8	96.1	1.4	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pumping	2,225	2,225	In	4,450	14,237	43.6	43.6	0.0	10.6	97.8	1.5	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2,850	2,850	In	5,700	14,237	49.6	43.1	0.0	6.6	99.3	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3,500	3,500	In	7,000	14,237	49.4	45.0	0.0	4.6	99.0	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passive	750	750	Out	2,000	14,737	9.5	44.1	0.2	18.5	72.3	1.3	26.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reduced	750	750	Out	3,200	15,937	0.4	23.7	3.1	24.6	51.8	0.4	47.5	0.0	0.1	0.0	0.0	0.2	0.0	0.0
Pumping	750	750	Out	4,450	17,187	0.0	0.5	17.7	23.5	41.7	0.0	51.9	0.0	1.6	0.1	0.0	3.6	1.1	0.3
	1,125	1,125	Out	5,700	17,687	0.0	4.4	15.4	19.4	39.2	0.0	56.5	0.0	1.3	0.1	0.0	2.5	0.4	0.0
	1,500	1,500	Out	7,000	18,237	0.1	9.4	12.1	24.0	45.6	0.0	50.9	0.0	0.9	0.1	0.0	1.7	0.8	0.1
Passive	1,000	1,000	Out	2,000	14,237	9.5	44.1	0.2	18.5	72.3	1.0	13.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Full	1,600	1,600	Out	3,200	14,237	0.4	23.7	3.1	24.6	51.8	0.7	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pumping	2,225	2,225	Out	4,450	14,237	0.0	0.5	17.7	23.5	41.7	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2,850	2,850	Out	5,700	14,237	0.0	4.4	15.4	19.4	39.2	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3,500	3,500	Out	7,000	14,237	0.1	9.4	12.1	24.0	45.6	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tidal	750	750	In	2,000	14,737	32.7	30.3	2.9	12.0	77.9	0.3	19.5	0.0	0.0	0.0	0.0	0.7	1.5	1.1
Reduced	750	750	In	3,200	15,937	28.9	32.6	2.8	12.4	76.7	0.1	20.3	0.0	0.3	0.0	0.0	0.7	1.9	1.6
Pumping	750	750	In	4,450	17,187	30.4	31.4	2.1	14.4	78.3	0.3	19.1	0.0	0.2	0.0	0.0	0.4	1.7	1.1
	1,125	1,125	In	5,700	17,687	39.0	44.0	0.6	8.9	92.5	0.0	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	1,500	1,500	In	7,000	18,237	42.3	46.0	0.1	8.6	97.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Tidal	1,000	1,000	In	2,000	14,237	38.0	41.4	0.5	9.5	89.4	0.0	10.5	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Full	1,600	1,600	In	3,200	14,237	47.0	45.0	0.0	6.4	98.4	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pumping	2,225	2,225	In	4,450	14,237	49.6	46.3	0.0	3.5	99.4	0.1	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2,850	2,850	In	5,700	14,237	50.8	45.8	0.0	3.1	99.7	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3,500	3,500	In	7,000	14,237	52.0	45.5	0.0	2.3	99.8	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tidal	750	750	Out	2,000	14,737	0.0	0.4	4.8	7.6	12.8	0.0	29.5	0.0	7.3	0.5	0.0	12.5	37.1	29.3
Reduced	750	750	Out	3,200	15,937	0.0	0.0	2.4	2.1	4.5	0.0	15.9	0.0	8.4	0.3	0.0	14.5	55.8	44.5
Pumping	750	750	Out	4,450	17,187	0.0	0.0	0.6	5.9	6.5	0.0	10.2	0.0	5.0	0.3	0.0	11.9	65.5	55.4
	1,125	1,125	Out	5,700	17,687	0.0	0.0	1.0	1.9	2.9	0.0	9.4	0.0	4.3	0.2	0.0	12.5	70.0	58.8
	1,500	1,500	Out	7,000	18,237	0.0	0.0	0.8	2.1	2.9	0.0	9.5	0.0	5.1	0.4	0.0	11.5	69.8	59.7
Tidal	1,000	1,000	Out	2,000	14,237	0.0	0.4	4.8	7.6	12.8	0.0	28.9	0.0	3.2	0.3	0.0	6.6	20.6	15.6
Full	1,600	1,600	Out	3,200	14,237	0.0	0.0	2.4	2.1	4.5	0.0	11.5	0.0	0.3	0.1	0.0	1.3	2.2	1.4
Pumping	2,225	2,225	Out	4,450	14,237	0.0	0.0	0.6	5.9	6.5	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2,850	2,850	Out	5,700	14,237	0.0	0.0	1.0	1.9	2.9	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3,500	3,500	Out	7,000	14,237	0.0	0.0	0.8	2.1	2.9	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table J-22g. DSM2 Particle Tracking Results for Mokelumne River (Node 285) Release for Range of VAMP Conditions

	CVP	SWP	Head of Old River Barrier	SJR Flow	Delta Outflow	CVP Entrained	SWP Entrained	CCC Entrained	Ag Diversions Entrained	Total Entrained	South Delta Upstream of the Barriers	South Delta Downstream of the Barriers	SJR Vernalis to Turner Cut	SJR Turner Cut to Jersey Point	Mokelumne	Sacramento River	Confluence	Past Chipps Island	Past Martinez
Passive	750	750	In	2,000	14,737	5.3	1.4	2.7	2.7	12.1	2.1	29.0	0.0	10.2	1.7	0.0	21.0	23.6	11.7
Reduced	750	750	In	3,200	15,937	4.3	1.2	1.6	2.1	9.2	1.5	22.9	0.0	7.1	1.0	0.0	25.0	32.7	16.9
Pumping	750	750	In	4,450	17,187	3.1	0.9	1.5	2.4	7.9	1.0	17.2	0.0	4.7	0.1	0.0	20.9	47.3	25.9
	1,125	1,125	In	5,700	17,687	5.3	2.5	2.5	2.4	12.7	1.4	12.0	0.0	3.3	0.1	0.0	20.9	48.8	28.9
	1,500	1,500	In	7,000	18,237	6.1	4.2	2.5	3.5	16.3	0.9	7.9	0.0	1.8	0.0	0.0	17.3	54.4	33.2
Passive	1,000	1,000	In	2,000	14,237	7.4	3.3	2.3	3.7	16.7	2.8	30.6	0.0	9.2	1.7	0.0	20.1	18.7	8.8
Full	1,600	1,600	In	3,200	14,237	13.2	7.9	2.7	4.4	28.2	1.3	22.5	0.0	7.4	1.1	0.0	18.2	21.1	11.4
Pumping	2,225	2,225	In	4,450	14,237	16.4	14.0	2.2	4.5	37.1	2.0	16.5	0.0	6.7	0.6	0.0	16.8	19.9	10.3
	2,850	2,850	In	5,700	14,237	18.6	15.0	3.0	4.5	41.1	1.3	14.2	0.0	5.0	0.6	0.0	16.2	21.6	10.5
	3,500	3,500	In	7,000	14,237	22.2	19.6	2.9	4.4	49.1	1.1	12.9	0.0	3.3	0.2	0.0	15.2	17.9	8.4
Passive	750	750	Out	2,000	14,737	0.1	0.2	2.0	1.7	4.0	0.2	31.5	0.0	13.8	4.8	0.0	21.0	24.6	11.5
Reduced	750	750	Out	3,200	15,937	0.1	0.1	1.4	0.9	2.5	0.0	27.6	0.0	10.1	2.2	0.0	24.6	32.6	17.0
Pumping	750	750	Out	4,450	17,187	0.0	0.0	0.5	0.7	1.2	0.0	20.0	0.0	7.5	0.8	0.0	26.2	43.5	23.5
	1,125	1,125	Out	5,700	17,687	0.0	0.0	0.7	0.9	1.6	0.0	15.1	0.0	6.2	0.4	0.0	24.4	51.1	31.1
	1,500	1,500	Out	7,000	18,237	0.0	0.0	0.6	0.9	1.5	0.0	13.6	0.0	4.9	0.2	0.0	23.6	55.5	34.5
Passive	1,000	1,000	Out	2,000	14,237	0.1	0.2	2.0	1.7	4.0	0.2	38.4	0.0	14.0	5.5	0.0	18.8	16.2	8.8
Full	1,600	1,600	Out	3,200	14,237	0.1	0.1	1.4	0.9	2.5	0.2	34.0	0.0	9.6	2.3	0.0	19.3	20.9	10.0
Pumping	2,225	2,225	Out	4,450	14,237	0.0	0.0	0.5	0.7	1.2	0.0	28.9	0.0	9.8	2.0	0.0	17.0	21.3	10.9
	2,850	2,850	Out	5,700	14,237	0.0	0.0	0.7	0.9	1.6	0.0	22.7	0.0	9.7	1.5	0.0	16.8	21.8	10.6
	3,500	3,500	Out	7,000	14,237	0.0	0.0	0.6	0.9	1.5	0.0	20.9	0.0	7.2	1.4	0.0	16.8	20.7	11.4
Tidal	750	750	In	2,000	14,737	0.0	0.0	0.0	0.3	0.3	0.0	0.4	0.0	0.0	0.0	0.0	0.3	98.2	97.7
Reduced	750	750	In	3,200	15,937	0.0	0.0	0.0	0.5	0.5	0.0	0.1	0.0	0.1	0.0	0.0	0.8	97.5	97.8
Pumping	750	750	In	4,450	17,187	0.0	0.0	0.0	0.3	0.3	0.0	0.3	0.0	0.0	0.0	0.0	0.5	97.9	97.8
	1,125	1,125	In	5,700	17,687	0.0	0.1	0.0	0.3	0.4	0.0	0.1	0.0	0.2	0.0	0.0	0.1	98.3	98.7
	1,500	1,500	In	7,000	18,237	0.5	0.2	0.4	0.4	1.5	0.0	0.3	0.0	0.1	0.0	0.0	0.2	96.9	97.6
Tidal	1,000	1,000	In	2,000	14,237	0.0	0.0	0.1	0.2	0.3	0.0	0.2	0.0	0.2	0.0	0.0	0.5	98.3	97.3
Full	1,600	1,600	In	3,200	14,237	0.8	0.5	0.4	0.4	2.1	0.0	0.6	0.0	0.2	0.0	0.0	0.6	95.8	95.4
Pumping	2,225	2,225	In	4,450	14,237	1.3	0.6	0.2	0.3	2.4	0.0	0.7	0.0	0.0	0.0	0.0	0.7	95.8	95.6
	2,850	2,850	In	5,700	14,237	2.2	1.9	0.3	0.4	4.8	0.0	0.4	0.0	0.0	0.0	0.0	0.5	93.8	93.6
	3,500	3,500	In	7,000	14,237	3.4	3.0	0.8	0.7	7.9	0.0	0.4	0.0	0.2	0.0	0.0	0.2	90.4	90.5
Tidal	750	750	Out	2,000	14,737	0.0	0.0	0.0	0.3	0.3	0.0	0.6	0.0	0.0	0.0	0.0	0.7	97.5	96.6
Reduced	750	750	Out	3,200	15,937	0.0	0.0	0.0	0.2	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.4	98.6	98.4
Pumping	750	750	Out	4,450	17,187	0.0	0.0	0.0	0.2	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	99.1	98.8
	1,125	1,125	Out	5,700	17,687	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.0	0.1	0.0	0.0	0.5	97.8	98.4
	1,500	1,500	Out	7,000	18,237	0.0	0.0	0.0	0.2	0.2	0.0	0.1	0.0	0.1	0.0	0.0	0.4	98.5	99.1
Tidal	1,000	1,000	Out	2,000	14,237	0.0	0.0	0.0	0.3	0.3	0.0	0.4	0.0	0.0	0.0	0.0	1.0	97.6	97.2
Full	1,600	1,600	Out	3,200	14,237	0.0	0.0	0.0	0.2	0.2	0.0	0.9	0.0	0.0	0.0	0.0	0.7	97.5	96.5
Pumping	2,225	2,225	Out	4,450	14,237	0.0	0.0	0.0	0.2	0.2	0.0	0.8	0.0	0.4	0.0	0.0	0.9	96.8	96.2
	2,850	2,850	Out	5,700	14,237	0.0	0.0	0.0	0.4	0.4	0.0	0.7	0.0	0.3	0.0	0.0	0.3	96.3	97.0
	3,500	3,500	Out	7,000	14,237	0.0	0.0	0.0	0.2	0.2	0.0	0.5	0.0	0.2	0.0	0.0	0.4	97.2	96.0

Table J-22h. DSM2 Particle Tracking Results for Sacramento River at Freeport (Node 335) Release for Range of VAMP Conditions

	CVP	SWP	Head of Old River Barrier	SJR Flow	Delta Outflow	CVP Entrained	SWP Entrained	CCC Entrained	Ag Diversions Entrained	Total Entrained	South Delta Upstream of the Barriers	South Delta Downstream of the Barriers	SJR Vernalis to Turner Cut	SJR Turner Cut to Jersey Point	Mokelumne	Sacramento River	Confluence	Past Chipps Island	Past Martinez
Passive	750	750	In	2,000	14,737	1.7	0.4	0.9	2.5	5.5	0.5	9.3	0.0	2.5	0.5	3.5	14.2	63.0	44.0
Reduced	750	750	In	3,200	15,937	0.9	0.1	0.6	2.4	4.0	0.4	5.7	0.0	2.2	0.2	3.6	9.6	72.9	52.7
Pumping	750	750	In	4,450	17,187	0.8	0.2	0.6	2.1	3.7	0.2	3.4	0.0	1.1	0.2	3.0	9.8	77.0	55.5
	1,125	1,125	In	5,700	17,687	1.3	0.6	0.5	1.8	4.2	0.4	3.8	0.0	1.1	0.2	3.4	7.1	78.5	56.9
	1,500	1,500	In	7,000	18,237	1.6	1.2	0.3	2.0	5.1	0.5	3.3	0.0	0.3	0.0	3.6	6.8	79.0	61.2
Passive	1,000	1,000	In	2,000	14,237	2.1	1.1	1.1	1.8	6.1	0.9	10.6	0.0	2.9	0.5	3.1	13.2	61.8	41.5
Full	1,600	1,600	In	3,200	14,237	3.3	2.6	0.9	2.7	9.5	0.5	7.9	0.0	2.2	0.4	3.0	13.3	62.0	45.2
Pumping	2,225	2,225	In	4,450	14,237	5.3	4.6	0.9	2.8	13.6	0.5	7.7	0.0	2.3	0.2	3.8	12.4	58.1	41.3
	2,850	2,850	In	5,700	14,237	5.8	4.4	0.8	2.1	13.1	0.4	5.6	0.0	2.0	0.2	3.6	10.5	62.9	42.8
	3,500	3,500	In	7,000	14,237	6.1	5.2	0.7	3.5	15.5	0.2	5.5	0.0	1.5	0.1	4.2	11.1	60.2	41.3
Passive	750	750	Out	2,000	14,737	0.1	0.1	0.9	1.3	2.4	0.0	10.6	0.0	3.3	1.3	2.8	11.4	67.0	43.7
Reduced	750	750	Out	3,200	15,937	0.0	0.1	0.5	1.4	2.0	0.0	6.1	0.0	3.3	0.7	3.6	11.3	71.4	47.9
Pumping	750	750	Out	4,450	17,187	0.0	0.0	0.0	1.3	1.3	0.0	5.8	0.0	2.0	0.1	3.2	9.5	77.0	57.7
	1,125	1,125	Out	5,700	17,687	0.0	0.0	0.2	1.3	1.5	0.0	3.3	0.0	1.7	0.0	3.5	10.0	78.3	58.6
	1,500	1,500	Out	7,000	18,237	0.0	0.0	0.3	1.3	1.6	0.0	3.3	0.0	1.1	0.1	3.6	7.5	80.9	62.3
Passive	1,000	1,000	Out	2,000	14,237	0.1	0.1	0.9	1.3	2.4	0.0	11.6	0.0	4.0	1.1	3.1	13.5	60.7	40.3
Full	1,600	1,600	Out	3,200	14,237	0.0	0.1	0.5	1.4	2.0	0.0	9.8	0.0	4.1	1.3	2.8	13.7	61.8	40.7
Pumping	2,225	2,225	Out	4,450	14,237	0.0	0.0	0.0	1.3	1.3	0.0	8.1	0.0	3.3	0.6	3.5	13.0	61.4	43.2
	2,850	2,850	Out	5,700	14,237	0.0	0.0	0.2	1.3	1.5	0.0	7.7	0.0	3.0	0.3	2.6	14.3	61.4	42.3
	3,500	3,500	Out	7,000	14,237	0.0	0.0	0.3	1.3	1.6	0.0	6.9	0.0	2.8	0.1	3.6	13.4	61.5	41.9
Tidal	750	750	In	2,000	14,737	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	98.3	99.1
Reduced	750	750	In	3,200	15,937	0.0	0.0	0.1	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	98.7	99.0
Pumping	750	750	In	4,450	17,187	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	97.9	99.4
	1,125	1,125	In	5,700	17,687	0.0	0.0	0.1	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.2	99.7
	1,500	1,500	In	7,000	18,237	0.0	0.1	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	98.3	99.3
Tidal	1,000	1,000	In	2,000	14,237	0.0	0.0	0.1	0.2	0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.1	98.7	99.1
Full	1,600	1,600	In	3,200	14,237	0.2	0.1	0.0	0.0	0.3	0.0	0.2	0.0	0.0	0.0	0.0	0.3	98.5	98.8
Pumping	2,225	2,225	In	4,450	14,237	0.3	0.2	0.1	0.0	0.6	0.0	0.1	0.0	0.0	0.0	0.0	0.0	98.3	98.8
	2,850	2,850	In	5,700	14,237	0.7	0.3	0.0	0.2	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	98.0	98.7
	3,500	3,500	In	7,000	14,237	1.1	0.5	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.2	97.2	97.7
Tidal	750	750	Out	2,000	14,737	0.0	0.0	0.0	0.2	0.2	0.0	0.1	0.0	0.0	0.1	0.0	0.0	98.1	99.4
Reduced	750	750	Out	3,200	15,937	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	98.9	99.5
Pumping	750	750	Out	4,450	17,187	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.1	98.1	99.6
	1,125	1,125	Out	5,700	17,687	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	98.6	99.7
	1,500	1,500	Out	7,000	18,237	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	99.0	99.8
Tidal	1,000	1,000	Out	2,000	14,237	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.1	99.3
Full	1,600	1,600	Out	3,200	14,237	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.1	0.0	0.0	0.2	98.5	99.0
Pumping	2,225	2,225	Out	4,450	14,237	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.3	98.4	99.2
	2,850	2,850	Out	5,700	14,237	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.2	97.9	99.2
	3,500	3,500	Out	7,000	14,237	0.0	0.0	0.0	0.1	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	98.2	98.6

Table J-22i. DSM2 Particle Tracking Results for Sacramento River at Rio Vista (Node 350) Release for Range of VAMP Conditions

	CVP	SWP	Head of Old River Barrier	SJR Flow	Delta Outflow	CVP Entrained	SWP Entrained	CCC Entrained	Ag Diversions Entrained	Total Entrained	South Delta Upstream of the Barriers	South Delta Downstream of the Barriers	SJR Vernalis to Turner Cut	SJR Turner Cut to Jersey Point	Mokelumne	Sacramento River	Confluence	Past Chipps Island	Past Martinez
Passive	750	750	In	2,000	14,737	0.1	0.1	0.5	0.5	1.2	0.2	4.6	0.0	1.4	0.1	0.1	7.2	84.0	63.7
Reduced	750	750	In	3,200	15,937	0.4	0.1	0.5	0.5	1.5	0.1	2.3	0.0	0.5	0.0	0.0	6.5	87.3	67.8
Pumping	750	750	In	4,450	17,187	0.3	0.1	0.1	0.4	0.9	0.2	2.3	0.0	0.7	0.0	0.0	3.9	90.8	73.5
	1,125	1,125	In	5,700	17,687	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.4	46.9	89.3
	1,500	1,500	In	7,000	18,237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	47.2	89.9
Passive	1,000	1,000	In	2,000	14,237	0.7	0.4	0.4	0.6	2.1	0.6	5.3	0.0	1.4	0.0	0.1	10.4	79.0	57.4
Full	1,600	1,600	In	3,200	14,237	1.3	0.8	0.5	0.9	3.5	0.2	4.4	0.0	1.4	0.0	0.0	10.7	79.0	58.4
Pumping	2,225	2,225	In	4,450	14,237	2.3	1.8	0.5	0.7	5.3	0.1	3.2	0.0	1.5	0.0	0.0	10.8	77.9	56.1
	2,850	2,850	In	5,700	14,237	2.1	2.1	0.4	0.7	5.3	0.1	3.6	0.0	1.1	0.0	0.0	9.3	79.2	60.8
	3,500	3,500	In	7,000	14,237	2.8	2.5	0.5	0.9	6.7	0.4	2.7	0.0	1.1	0.0	0.0	7.5	80.7	59.1
Passive	750	750	Out	2,000	14,737	0.0	0.1	0.3	0.2	0.6	0.0	5.2	0.0	1.5	0.2	0.0	8.8	82.6	60.9
Reduced	750	750	Out	3,200	15,937	0.0	0.1	0.0	0.3	0.4	0.0	2.6	0.0	0.8	0.2	0.0	6.7	88.5	67.6
Pumping	750	750	Out	4,450	17,187	0.0	0.0	0.0	0.2	0.2	0.0	1.4	0.0	0.7	0.0	0.0	5.3	91.7	73.6
	1,125	1,125	Out	5,700	17,687	0.0	0.0	0.1	0.4	0.5	0.0	1.2	0.0	0.2	0.1	0.0	3.8	92.9	74.1
	1,500	1,500	Out	7,000	18,237	0.0	0.0	0.1	0.5	0.6	0.0	1.3	0.0	0.3	0.1	0.0	3.8	92.6	76.2
Passive	1,000	1,000	Out	2,000	14,237	0.0	0.1	0.3	0.2	0.6	0.0	5.2	0.0	1.8	0.2	0.0	9.5	80.6	58.4
Full	1,600	1,600	Out	3,200	14,237	0.0	0.1	0.0	0.3	0.4	0.0	4.2	0.0	1.8	0.1	0.0	9.5	80.9	60.6
Pumping	2,225	2,225	Out	4,450	14,237	0.0	0.0	0.0	0.2	0.2	0.0	3.7	0.0	1.9	0.3	0.0	10.4	80.9	58.6
	2,850	2,850	Out	5,700	14,237	0.0	0.0	0.1	0.4	0.5	0.0	3.8	0.0	1.5	0.2	0.0	11.1	78.2	57.7
	3,500	3,500	Out	7,000	14,237	0.0	0.0	0.1	0.5	0.6	0.0	4.1	0.0	2.0	0.0	0.0	9.4	80.0	59.5
Tidal	750	750	In	2,000	14,737	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.1	0.0	0.0	0.0	99.6	99.7
Reduced	750	750	In	3,200	15,937	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.1	99.6
Pumping	750	750	In	4,450	17,187	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.1	99.8
	1,125	1,125	In	5,700	17,687	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.0	100.0
	1,500	1,500	In	7,000	18,237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.6	99.9
Tidal	1,000	1,000	In	2,000	14,237	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	98.8	99.5
Full	1,600	1,600	In	3,200	14,237	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	99.1	99.8
Pumping	2,225	2,225	In	4,450	14,237	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.6	99.9
	2,850	2,850	In	5,700	14,237	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.1	99.7
	3,500	3,500	In	7,000	14,237	0.0	0.1	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.0	99.8
Tidal	750	750	Out	2,000	14,737	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.2	99.9
Reduced	750	750	Out	3,200	15,937	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.1	99.8
Pumping	750	750	Out	4,450	17,187	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.0	99.9
	1,125	1,125	Out	5,700	17,687	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.1	99.9
	1,500	1,500	Out	7,000	18,237	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	98.9	99.8
Tidal	1,000	1,000	Out	2,000	14,237	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	98.7	99.6
Full	1,600	1,600	Out	3,200	14,237	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	98.9	99.7
Pumping	2,225	2,225	Out	4,450	14,237	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	98.7	99.8
	2,850	2,850	Out	5,700	14,237	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	98.7	99.8
	3,500	3,500	Out	7,000	14,237	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	98.9	99.7

Table J-22j. DSM2 Particle Tracking Results for Chipps Island (Node 356) Release for Range of VAMP Conditions

	CVP	SWP	Head of Old River Barrier	SJR Flow	Delta Outflow	CVP Entrained	SWP Entrained	CCC Entrained	Ag Diversions Entrained	Total Entrained	South Delta Upstream of the Barriers	South Delta Downstream of the Barriers	SJR Vernalis to Turner Cut	SJR Turner Cut to Jersey Point	Mokelumne	Sacramento River	Confluence	Past Chipps Island	Past Martinez
Passive	750	750	In	2,000	14,737	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	46.7	84.8
Reduced	750	750	In	3,200	15,937	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	47.3	88.9
Pumping	750	750	In	4,450	17,187	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	47.7	87.9
	1,125	1,125	In	5,700	17,687	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.4	46.9	89.3
	1,500	1,500	In	7,000	18,237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	47.2	89.9
Passive	1,000	1,000	In	2,000	14,237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	46.6	84.7
Full	1,600	1,600	In	3,200	14,237	0.0	0.0	0.0	0.2	0.2	0.0	0.1	0.0	0.0	0.0	0.0	1.0	46.4	85.9
Pumping	2,225	2,225	In	4,450	14,237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	1.9	45.7	84.1
	2,850	2,850	In	5,700	14,237	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1.2	46.2	84.6
	3,500	3,500	In	7,000	14,237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	46.3	85.6
Passive	750	750	Out	2,000	14,737	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1.5	45.7	84.9
Reduced	750	750	Out	3,200	15,937	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	46.9	85.2
Pumping	750	750	Out	4,450	17,187	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	47.4	87.8
	1,125	1,125	Out	5,700	17,687	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	47.3	89.2
	1,500	1,500	Out	7,000	18,237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	47.6	90.1
Passive	1,000	1,000	Out	2,000	14,237	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1.5	45.8	82.4
Full	1,600	1,600	Out	3,200	14,237	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	1.1	46.2	85.6
Pumping	2,225	2,225	Out	4,450	14,237	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1.2	46.2	84.7
	2,850	2,850	Out	5,700	14,237	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1.1	46.4	87.0
	3,500	3,500	Out	7,000	14,237	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	2.0	45.3	84.5
Tidal	750	750	In	2,000	14,737	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.7	100.0
Reduced	750	750	In	3,200	15,937	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.6	99.9
Pumping	750	750	In	4,450	17,187	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.0	100.0
	1,125	1,125	In	5,700	17,687	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.0	100.0
	1,500	1,500	In	7,000	18,237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.6	99.9
Tidal	1,000	1,000	In	2,000	14,237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.6	100.0
Full	1,600	1,600	In	3,200	14,237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.8	100.0
Pumping	2,225	2,225	In	4,450	14,237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.7	99.9
	2,850	2,850	In	5,700	14,237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.8	100.0
	3,500	3,500	In	7,000	14,237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.7	100.0
Tidal	750	750	Out	2,000	14,737	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.6	100.0
Reduced	750	750	Out	3,200	15,937	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.9	99.9
Pumping	750	750	Out	4,450	17,187	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.8	100.0
	1,125	1,125	Out	5,700	17,687	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.8	100.0
	1,500	1,500	Out	7,000	18,237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.8	100.0
Tidal	1,000	1,000	Out	2,000	14,237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.8	100.0
Full	1,600	1,600	Out	3,200	14,237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.7	100.0
Pumping	2,225	2,225	Out	4,450	14,237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.7	99.9
	2,850	2,850	Out	5,700	14,237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.9	99.9
	3,500	3,500	Out	7,000	14,237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.0	100.0

Table J-23. The Proportion of Juvenile Chinook Salmon Production Entering the Delta from the Sacramento, Mokelumne, and San Joaquin Rivers by Month

Month	Sacramento River[1,2]	Fall-Run[3]	Spring-Run[3]	Winter-Run[3]	Late Fall–Run[3]	Mokelumne River[4]	San Joaquin River[5]
January	11.93	14.23	3.03	17.37	13.73	40.91	2
February	8.76	12.55	0.00	18.56	1.96	30.91	9
March	26.27	22.59	52.53	36.53	0.00	10.91	3
April	8.50	6.28	43.43	0.60	0.00	2.73	35
May	11.55	25.52	1.01	0.00	0.00	10.00	48
June	0.13	0.42	0.00	0.00	0.00	0.00	4
July	0.00	0.00	0.00	0.00	0.00	0.00	0.00
August	3.68	1.26	0.00	0.00	0.00	0.00	0.00
September	4.31	0.42	0.00	0.00	1.96	0.00	0.00
October	5.58	9.21	0.00	0.00	3.92	2.73	0.00
November	8.63	7.53	0.00	2.99	33.33	0.91	0.00
December	10.66	0.00	0.00	23.95	45.10	0.91	0.00

Notes:
[1] Mid-water trawl data.
[2] All runs combined.
[3] Runs from the Sacramento River basin only.
[4] Rotary Screw Trap data from EBMUD from December 1997 to August 1998.
[5] Kodiak Trawl data from Mossdale from January 1999 to June 2003.
Source: <http://sarabande.water.ca.gov:8000/~bdtdb/dwr1.html>.

TableJ-24. The Proportion of Juvenile Steelhead Production Entering the Delta from the Sacramento, Mokelumne, and San Joaquin Rivers by Month

Month	Sacramento[1]	Mokelumne[2]	San Joaquin[3]
January	4.79	44.28	Present
February	31.74	0.73	Present
March	60.48	2.80	Present
April	0.00	4.62	Present
May	0.00	2.68	Present
June	0.00	4.74	Present
July	0.00	5.60	Absent
August	0.00	0.49	Absent
September	1.20	0.00	Absent
October	0.00	0.00	Absent
November	1.20	0.00	Present
December	0.60	34.06	Present

Notes:
[1] Rotary Screw Trap Data from Knights Landing.
[2] Rotary Screw Trap data from EBMUD from December 1997 to August 1998.
[3] Not enough data available for quantitative assessment, so months where fish captured are identified.
Source: <http://sarabande.water.ca.gov:8000/~bdtdb/dwr1.html>.

Table J-25a. The Seasonal Distribution (in Percentage) of Early Juvenile Delta Smelt Based on Sampling for the Summer Tow-Net Index

Month	Confluence/Suisun	Sacramento	Mokelumne	San Joaquin	South Delta
June	83	0	1	8	8
July	96	0	0	2	2
August	100	0	0	0	0

Table J-25b. The Seasonal Distribution (in Percentage) of Late Juvenile and Adult Delta Smelt Based on Sampling for the Mid-Water Trawl Index

Month	Confluence/Suisun	Sacramento	Mokelumne	San Joaquin	South Delta
January	93	3	0	1	3
February	87	3	3	1	6
March	78	6	6	2	9
April	72	22	6	0	0
May	–	–	–	–	–
June	–	–	–	–	–
July	–	–	–	–	–
August	99	1	0	0	0
September	99	1	0	0	0
October	97	2	0	0	1
November	96	3	0	0	1
December	97	2	0	0	1

Table J-26. The Proportion of Juvenile Splittail Production Entering the Delta from the Sacramento, Mokelumne, and San Joaquin Rivers by Month

Month	Sacramento River			
	Kodiak trawl[1]	Mid-water trawl[2]	Beach seine[3]	San Joaquin River[4]
January		4.31%		0.09%
February		12.06%	0.00%	0.06%
March		11.97%	0.22%	0.20%
April	56.92	0.23%	2.65%	3.64%
May	37.69	5.48%	41.26%	44.87%
June	5.38	56.45%	38.35%	50.02%
July		9.50%	15.48%	1.07%
August			1.87%	0.04%
September			0.00%	0
December			0.17%	0

Notes:

[1] Kodiak Trawl data at Georgiana Slough in 1996.

[2] Mid-water trawl data from Georgiana Slough, Clarksburg, Hood, and Courtland from 1976 to 1981 and 1990, 1993.

[3] Beach seine data from Georgiana Slough, Clarksburg, and Delta Cross Channel, from 1992 to 2003.

[4] Kodiak Trawl data from Mossdale from January 1999 to December 2002

Data Source: <http://sarabande.water.ca.gov:8000/~bdtdb/dwr1.html>.

Table J-27a. The Seasonal Distribution of Early Juvenile Striped Bass Based on Sampling for the Summer Tow-Net Index from 1985 to 2002

Month	Suisun	Sacramento	San Joaquin
January	0.00	0.00	0.00
February	0.00	0.00	0.00
March	0.00	0.00	0.00
April	0.00	0.00	0.00
May	0.00	0.00	0.00
June	36.82	64.15	48.17
July	38.08	30.69	29.98
August	22.36	5.16	21.85
September	2.75	0.00	0.00
October	0.00	0.00	0.00
November	0.00	0.00	0.00
December	0.00	0.00	0.00

Source: <http://sarabande.water.ca.gov:8000/~bdtdb/dwr1.html>.

Table J-27b. The Seasonal Distribution of Juvenile Striped Bass Based on Sampling for the Mid-Water Trawl Index

Month	Confluence/Suisun[1]	Sacramento[2]	Mokelumne[3]	San Joaquin[2]	South Delta[4]
January	16.82%	15.84%	Present	16.92	14.80%
February	8.65%	1.01%	Present	4.77%	1.30%
March	7.11%	5.55%	Present	4.02%	1.06%
April	0.24%	0	0	0.42%	0
May	0.06%	1.82%	0	0	0
June	0.04%	0	0	0.20%	0
July	0	0.31%	0	0	0
August	4.76%	11.17%	Present	7.33%	22.80%
September	14.57%	18.94%	Present	24.78%	34.46%
October	7.90%	23.69%	Present	19.31%	10.35%
November	15.82%	15.65%	Present	16.10%	14.63%
December	24.02%	6.02%	Present	6.16%	0.61%

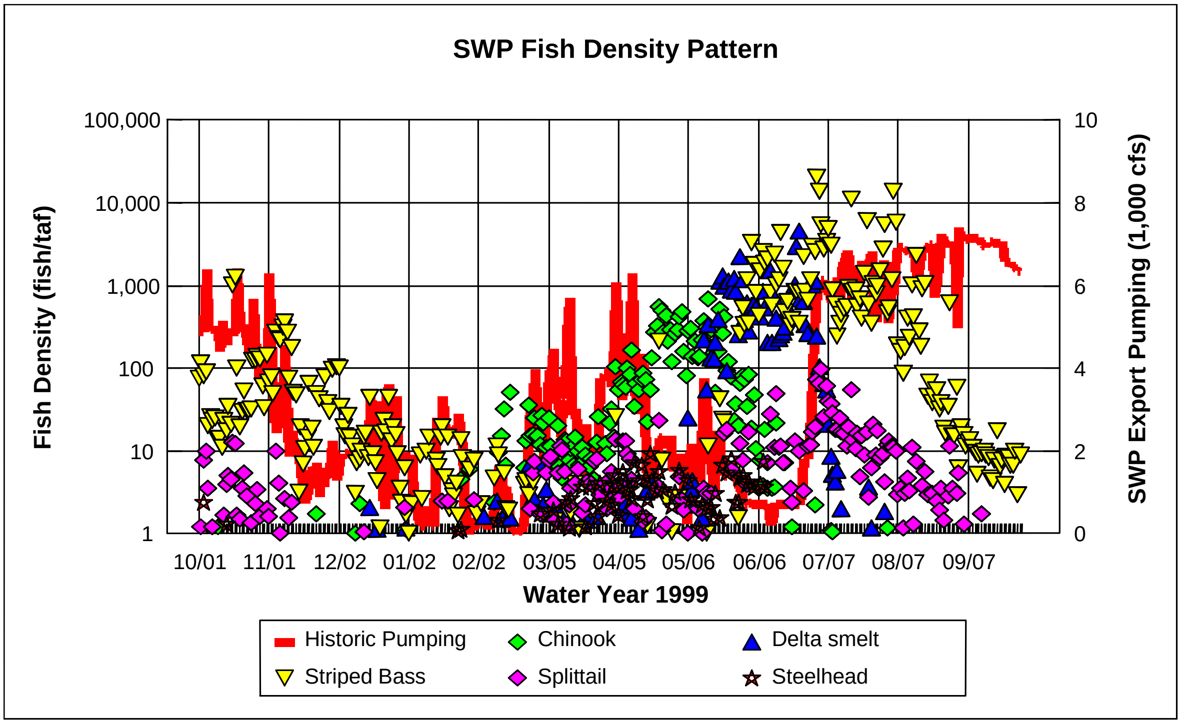
Notes:
[1] from 1967 – 1973 and 1991 – 2002.
[2] from 1990 – 2002.
[3] from 1991 – 2002, Not enough data to quantify.
[4] from 1967 – 1973 and 1991 – 2001.
Source: <http://sarabande.water.ca.gov:8000/~bdtdb/dwr1.html>.

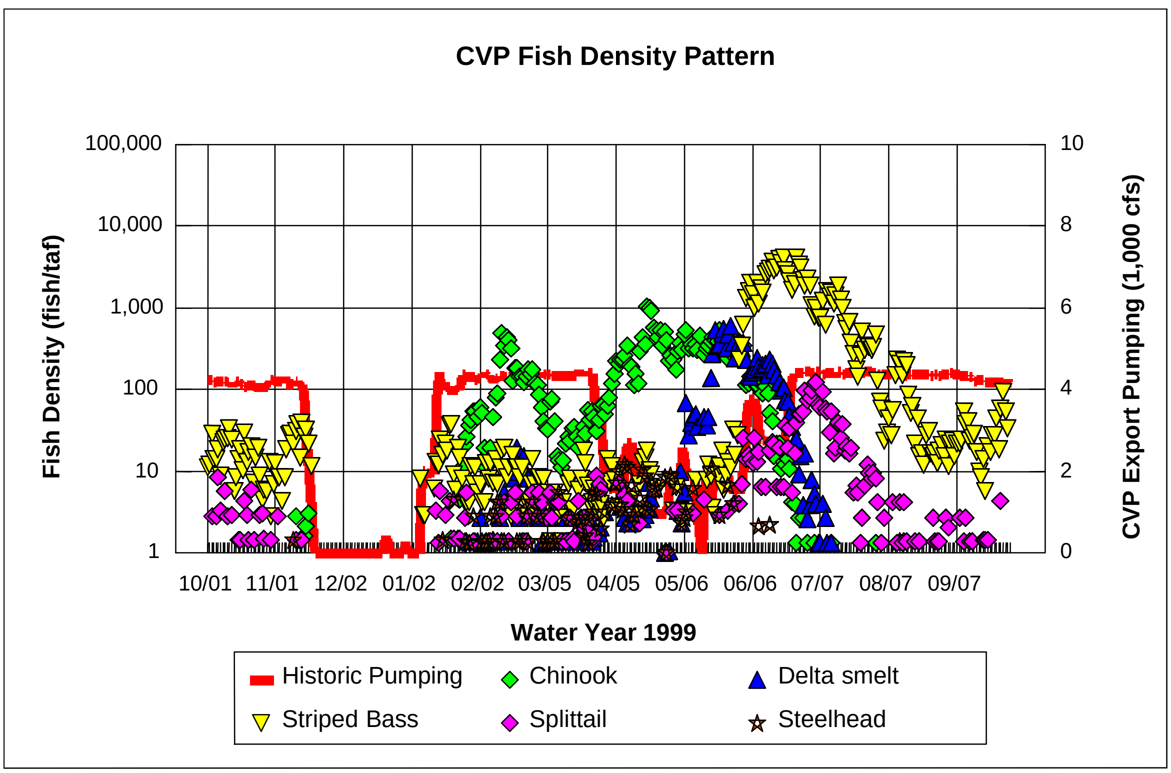
Table J-28a. Annual Delta Outflow, CVP and SWP Pumping, and Annual Fish Survey Index Values

Year	Delta Outflow (taf)	CVP Pumping (taf)	SWP Pumping (taf)	Total Pumping (taf)	Summer Tow-Net Survey: Delta Smelt Total Index	Striped Bass: Delta	Striped Bass: Suisun	Striped Bass: Total Index
1959	12,039	1,336	0	1,336	12.1	30.7	3	33.7
1960	9,707	1,384	0	1,384	25.4	32	13.6	45.6
1961	9,687	1,483	0	1,483	21.3	25.2	6.4	31.6
1962	14,139	1,350	0	1,350	24.9	46.8	32.1	78.9
1963	26,969	1,338	0	1,338	1.8	38.2	43.5	81.7
1964	10,384	1,644	0	1,644	24.6	54.7	20.7	75.4
1965	29,347	1,467	0	1,467	6	49.4	67.8	117.2
1966	13,449	1,593	0	1,593	–	–	–	–
1967	33,515	1,252	0	1,252	–	35.1	73.6	108.7
1968	12,507	1,995	473	2,468	–	39.6	17.7	57.3
1969	38,883	1,844	1,031	2,875	2.5	33.6	40.2	73.8
1970	30,290	1,652	416	2,067	32.5	36.6	41.9	78.5
1971	23,191	1,917	913	2,830	12.5	24.6	45	69.6
1972	9,261	2,348	1,093	3,441	11.1	13.4	21.1	34.5
1973	24,609	1,846	1,518	3,364	21.3	15.6	47.1	62.7
1974	37,482	2,445	1,915	4,360	13	17.4	63.4	80.8
1975	20,043	2,353	1,552	3,904	12.2	23.4	42.1	65.5
1976	6,583	3,013	1,827	4,839	50.6	21.1	14.8	35.9
1977	2,539	1,281	797	2,078	25.8	8.3	0.7	9
1978	21,467	2,270	2,080	4,350	62.5	16.5	13.1	29.6
1979	11,555	2,287	2,182	4,470	13.3	5.4	11.5	16.9
1980	28,501	2,007	2,516	4,523	15.8	2.8	11.2	14
1981	7,908	2,591	2,130	4,720	19.8	15.4	13.7	29.1
1982	41,230	1,975	2,644	4,619	10.7	9.5	39.2	48.7
1983	64,643	2,505	1,894	4,399	2.9	–	–	–
1984	30,592	2,185	1,642	3,827	1.2	6.3	20	26.3
1985	8,453	2,790	2,679	5,469	0.9	2.2	4.1	6.3
1986	30,493	2,618	2,666	5,284	7.9	23.8	41.1	64.9
1987	6,105	2,759	2,282	5,041	1.4	7.3	5.3	12.6
1988	4,409	2,887	2,700	5,588	1.2	3.9	0.7	4.6
1989	6,599	2,869	3,096	5,965	2.2	3.1	2	5.1
1990	3,967	2,699	3,107	5,806	2.2	2.8	1.5	4.3
1991	4,371	1,411	1,774	3,184	2	3.8	1.6	5.4
1992	5,207	1,338	1,569	2,907	2.6	6.6	4	10.6
1993	19,114	2,113	2,556	4,669	8.2	10.8	12.6	23.4
1994	6,010	2,028	1,968	3,996	13	7	3.6	10.6
1995	41,827	2,581	2,475	5,056	3.2	–	–	–
1996	25,482	2,618	2,590	5,208	11.1	0.5	1.6	2.1
1997	33,713	2,501	2,461	4,962	4	1	0.6	1.6
1998	43,570	2,474	2,110	4,584	3.3	0.1	1.6	1.7
1999	22,571	2,267	2,397	4,664	11.9	0.7	1.5	2.2
2000	18,186	2,483	3,654	6,137	8	2.8	2.7	5.5
2001	6,976	2,335	2,603	4,938	3.5	2.4	1	3.4
2002	9,191	2,505	2,874	5,379	4.7	–	–	–
2003	14,050	2,685	3,458	6,143	1.6	0.3	1.2	1.5
2004	14,896	2,717	3,245	5,962	2.9	0.5	0.3	0.8

Table J-28b. Annual Delta Outflow, CVP and SWP Pumping, and Annual Fish Survey Index Values

	Delta Smelt Fall Mid-Water Trawl Survey					Striped Bass Fall Mid-Water Trawl Survey					American Shad Fall Mid-Water Trawl Survey					Longfin Smelt Fall Mid-Water Trawl Survey				
Year	Sept	Oct	Nov	Dec	Total	Sept	Oct	Nov	Dec	Total	Sept	Oct	Nov	Dec	Total	Sept	Oct	Nov	Dec	Total
1959	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1960	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1961	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1962	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1963	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1964	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1965	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1966	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1967	93	165	31	125	414	12,111	3,788	1,852	2,287	20,038	1,505	1,117	612	206	3,440	15,485	49,995	7,482	8,828	81,790
1968	234	253	120	89	696	1,711	1,439	644	349	4,143	268	286	140	71	765	1,408	771	452	669	3,300
1969	148	78	56	33	315	4,048	1,621	1,451	1,280	8,400	1,579	1,172	816	460	4,027	35,804	9,980	8,085	6,190	60,059
1970	742	342	82	507	1,673	2,288	1,822	2,751	1,432	8,293	366	254	178	69	867	889	410	1,067	4,169	6,535
1971	197	471	428	207	1,303	4,004	1,855	1,354	2,296	9,509	357	488	403	258	1,506	2,442	5,722	5,022	2,801	15,987
1972	572	470	81	142	1,265	3,172	977	1,377	605	6,131	140	56	112	30	338	138	118	106	398	760
1973	308	312	198	327	1,145	1,517	441	1,005	1,324	4,287	599	193	211	82	1,085	2,795	1,237	808	1,057	5,897
1974	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1975	290	214	102	91	697	1,772	681	1,284	811	4,548	1,240	587	486	178	2,491	318	598	1,198	705	2,819
1976	70	42	121	127	360	237	117	243	177	774	96	69	102	80	347	15	12	90	541	658
1977	98	243	52	88	481	307	204	180	192	883	126	147	233	144	650	29	17	83	81	210
1978	167	65	31	309	572	1,118	561	339	587	2,605	830	1,063	332	221	2,446	1,800	1,173	1,450	2,252	6,675
1979	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1980	369	274	587	423	1,653	715	384	102	268	1,469	1,284	1,697	524	401	3,906	15,202	6,071	3,527	6,355	31,155
1981	132	27	54	161	374	583	913	1,037	1,995	4,531	286	522	349	277	1,434	222	398	179	1,403	2,202
1982	45	47	76	162	330	1,476	938	924	1,113	4,451	2,246	1,609	1,313	210	5,378	7,899	13,962	27,812	12,876	62,549
1983	2	28	78	24	132	1,934	1,994	5,272	3,276	12,476	962	852	958	177	2,949	152	3,106	5,407	3,210	11,875
1984	47	44	67	24	182	1,287	2,666	1,374	1,254	6,581	292	172	290	92	846	328	2,612	2,602	1,917	7,459
1985	41	24	28	17	110	125	825	58	752	1,760	316	332	564	386	1,598	20	31	219	722	992
1986	92	15	34	71	212	2,706	532	508	197	3,943	694	567	313	286	1,860	972	1,543	1,857	1,788	6,160
1987	71	40	69	100	280	603	169	206	372	1,350	261	292	222	124	899	134	70	384	932	1,520
1988	58	67	19	30	174	106	98	129	144	477	805	310	300	135	1,550	16	17	207	551	791
1989	88	75	158	45	366	154	152	76	60	442	569	339	592	378	1,878	11	32	37	376	456
1990	109	50	188	17	364	234	235	398	454	1,321	1,494	947	1,369	507	4,317	10	1	81	151	243
1991	126	249	279	35	689	262	128	115	439	944	1,076	780	872	260	2,988	8	7	27	92	134
1992	72	3	57	24	156	621	246	546	632	2,045	755	530	463	262	2,014	3	–	12	61	76
1993	375	470	94	139	1,078	509	513	281	254	1,557	1,972	1,567	908	710	5,157	99	112	128	459	798
1994	65	12	7	18	102	206	188	206	659	1,259	439	387	391	117	1,334	4	10	79	452	545
1995	120	349	352	78	899	116	137	141	90	484	3,255	2,276	808	573	6,912	5,867	931	1,520	328	8,646
1996	19	23	13	72	127	71	46	32	243	392	1,806	1,072	941	523	4,342	5	27	14	1,342	1,388
1997	15	109	71	108	303	287	143	69	69	568	265	565	639	1,125	2,594	106	51	194	339	690
1998	238	97	15	70	420	234	290	126	574	1,224	1,318	2,093	515	214	4,140	149	1,578	2,032	2,895	6,654
1999	198	380	114	172	864	154	68	134	185	541	346	155	145	69	715	1,953	2,736	330	223	5,242
2000	430	128	56	142	756	93	156	90	51	390	253	326	126	59	764	1,635	49	938	816	3,438
2001	75	481	17	30	603	181	217	114	219	731	337	239	110	78	764	74	46	27	100	247
2002	20	46	29	44	139	18	20	13	20	71	372	831	334	382	1,919	127	144	182	254	707
2003	15	136	17	42	210	32	34	24	18	108	3,345	2,947	1,279	1,789	9,360	10	62	77	42	191
2004	26	18	23	7	74	16	16	6	15	53	680	83	78	106	947	44	8	9	129	190





Note: Fish density (fish/taf) is shown with logarithmic scale.

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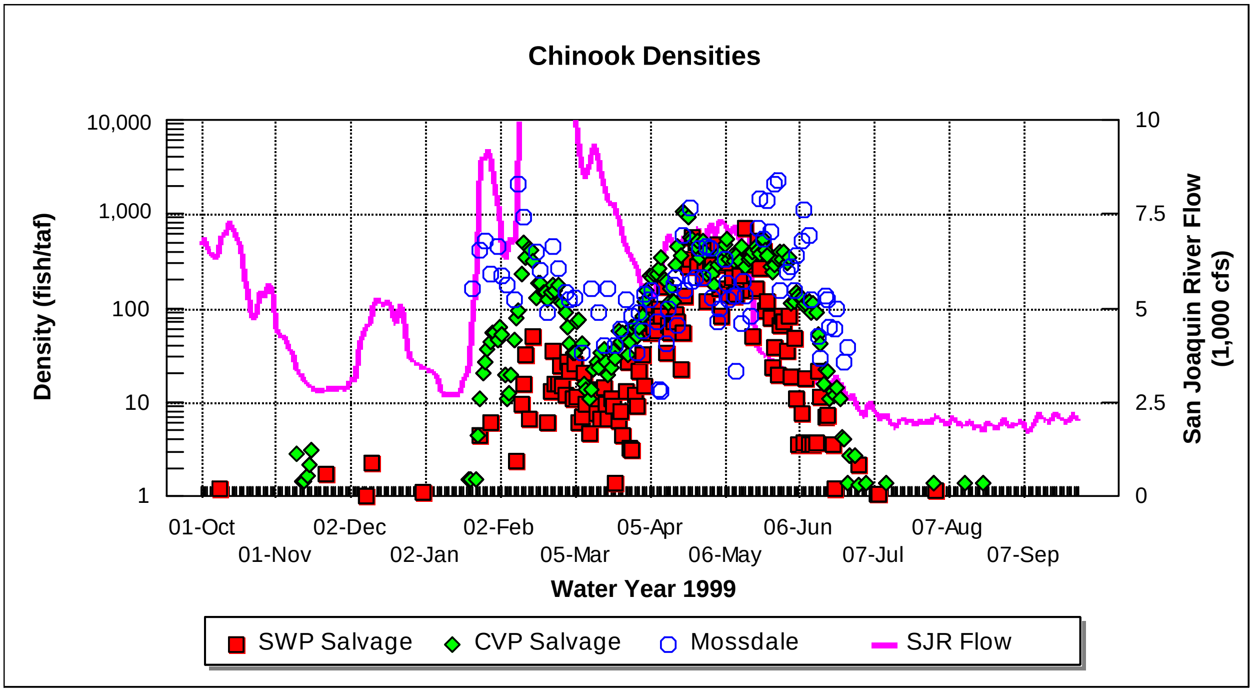
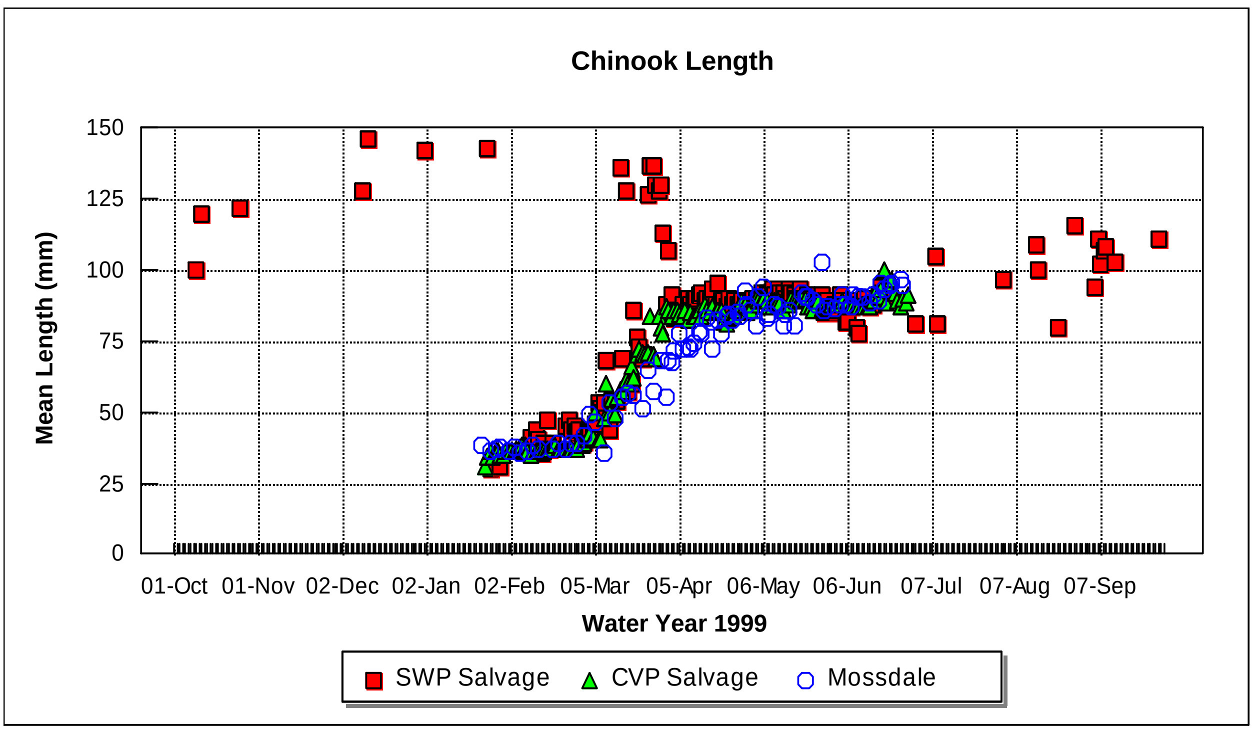
Figure J-1

Daily SWP and CVP Pumping and Fish Salvage Density for Water Year 1999





02053.02 101

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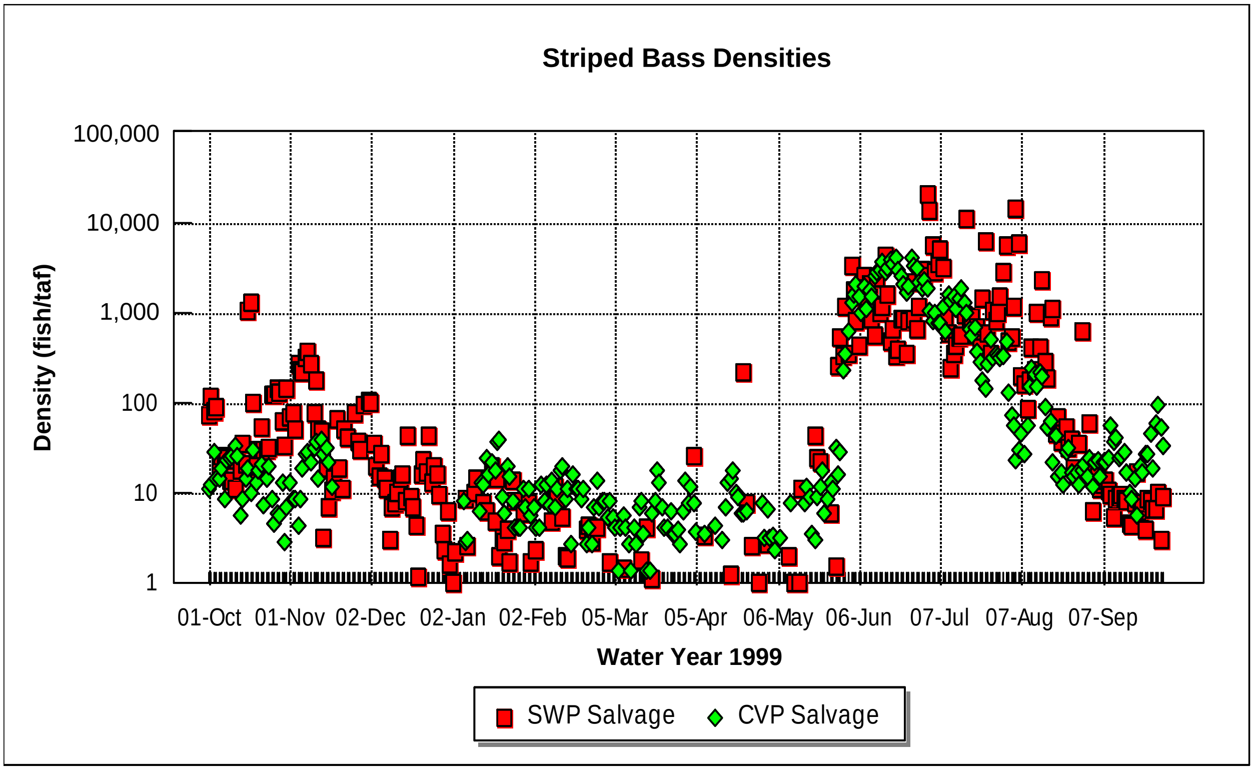
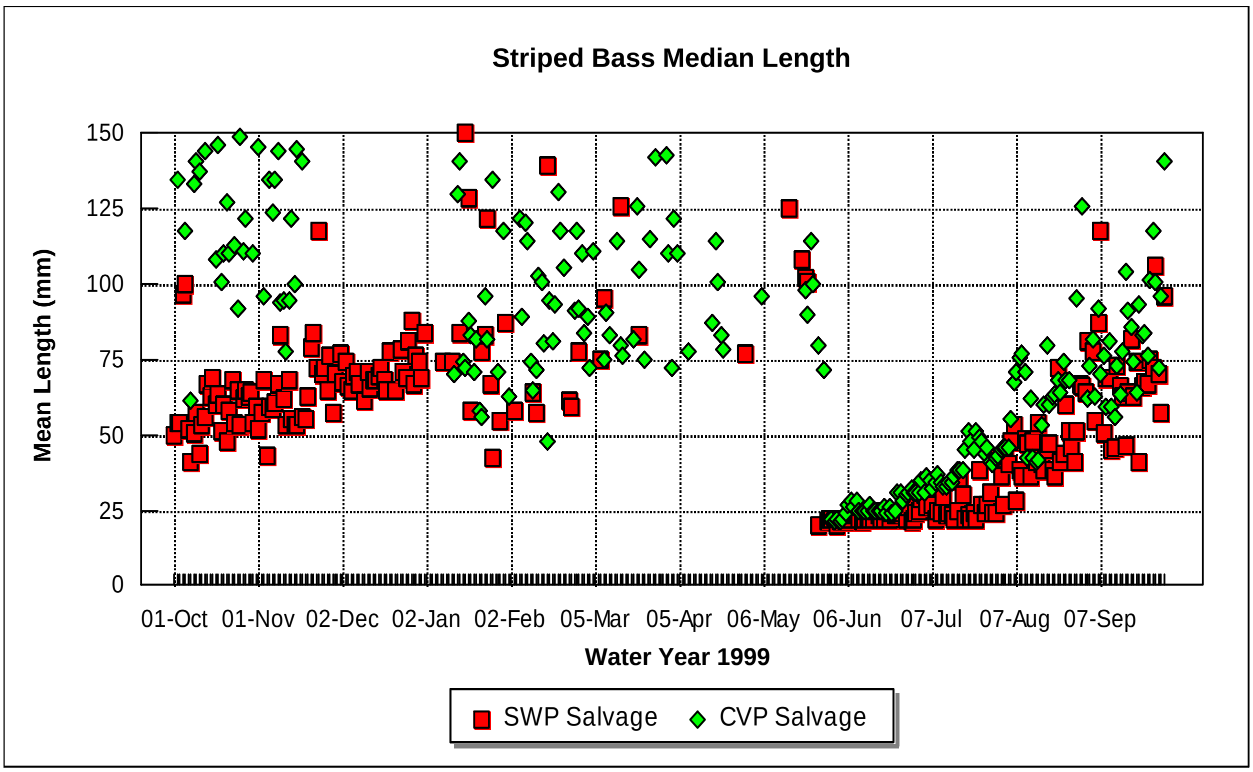
Figure J-2

Measured Chinook Fish Density (fish/taf) and Average Length (mm) in the San Joaquin River at Mossdale and at the SWP and CVP Fish Facilities in Water Year 1999





02053.02 101

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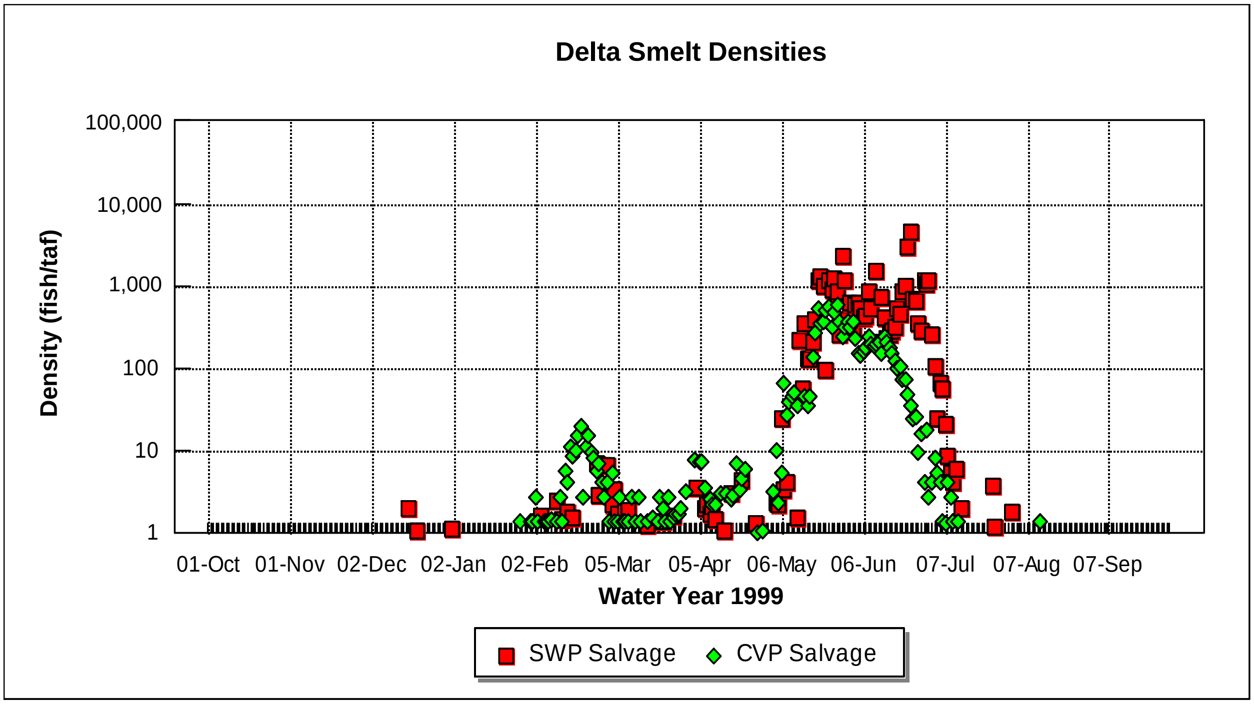
Figures J-3

Measured Striped Bass Fish Density (fish/taf) and Average Length (mm) at the SWP and CVP Fish Facilities in Water Year 1999



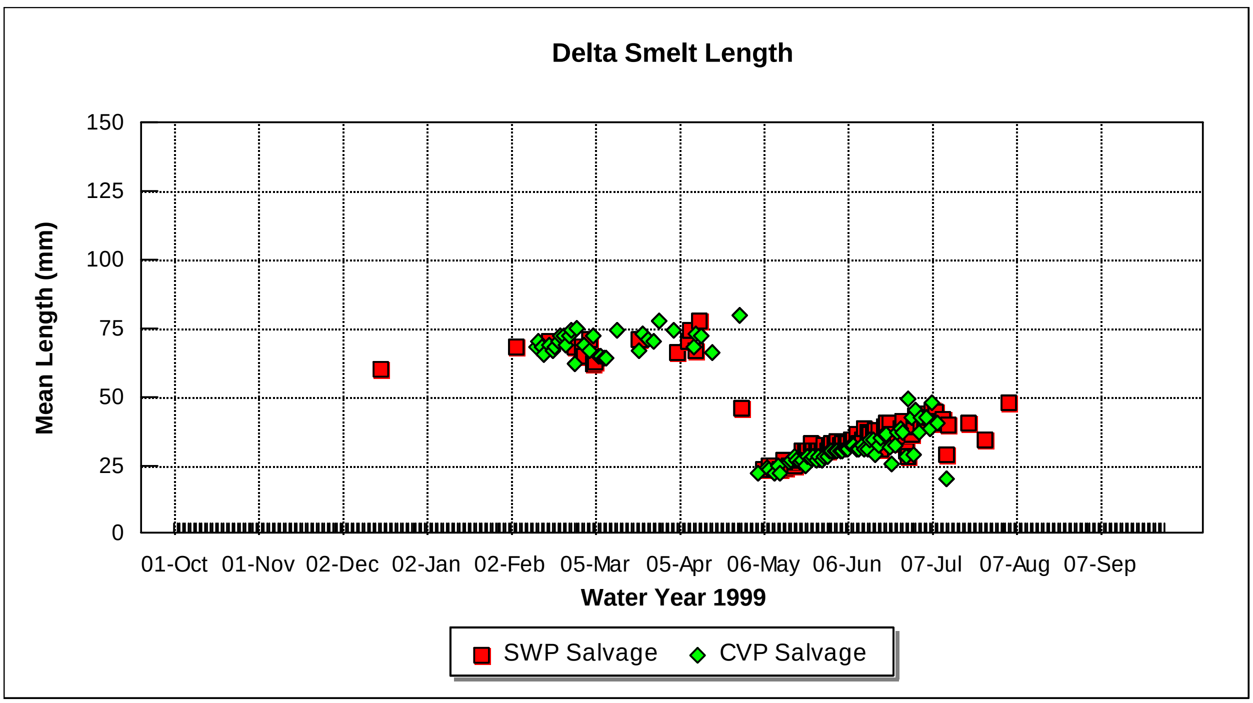


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Figure J-4

Measured Delta Smelt Fish Density (fish/taf) and Average Length (mm) at the SWP and CVP Fish Facilities in Water Year 1999

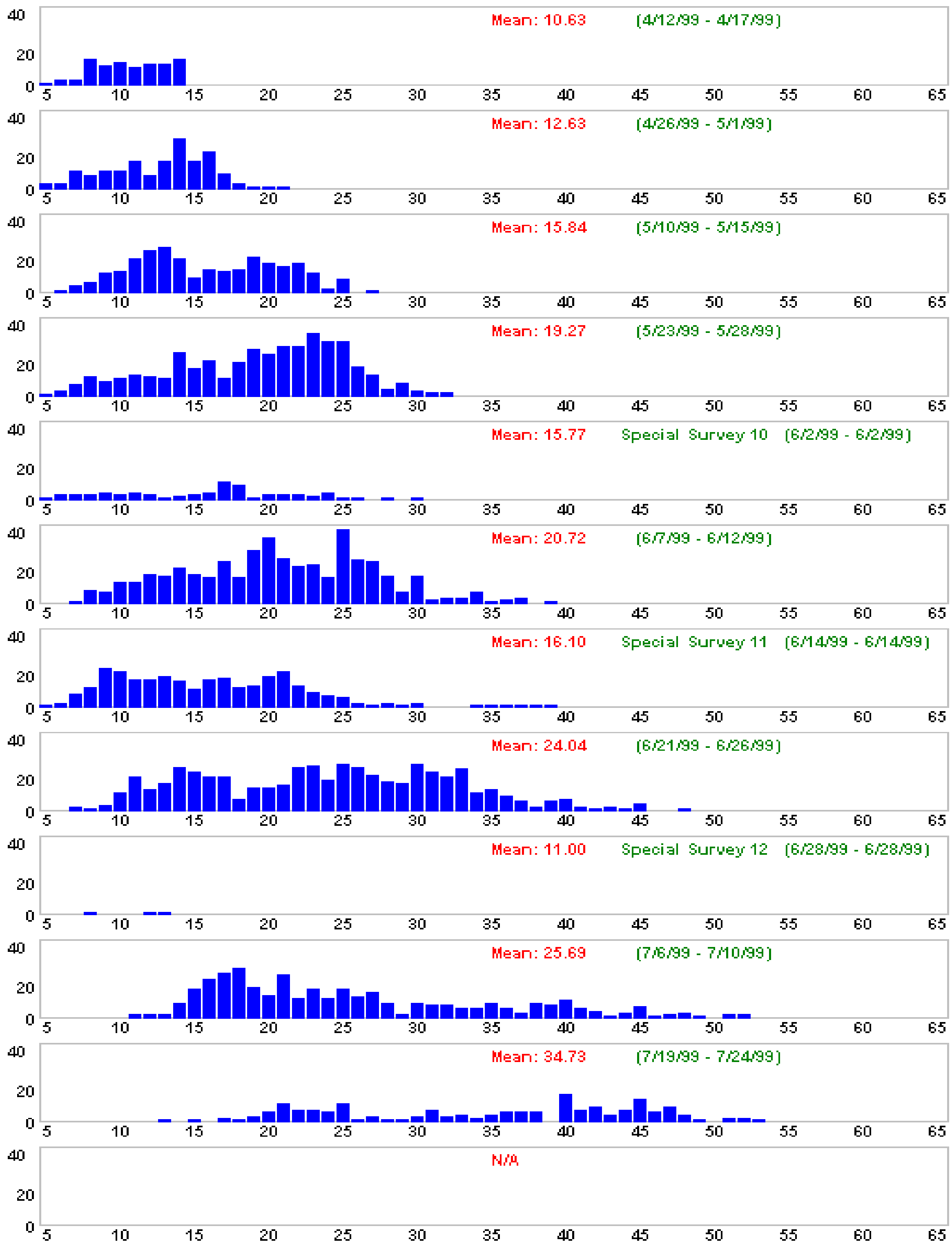

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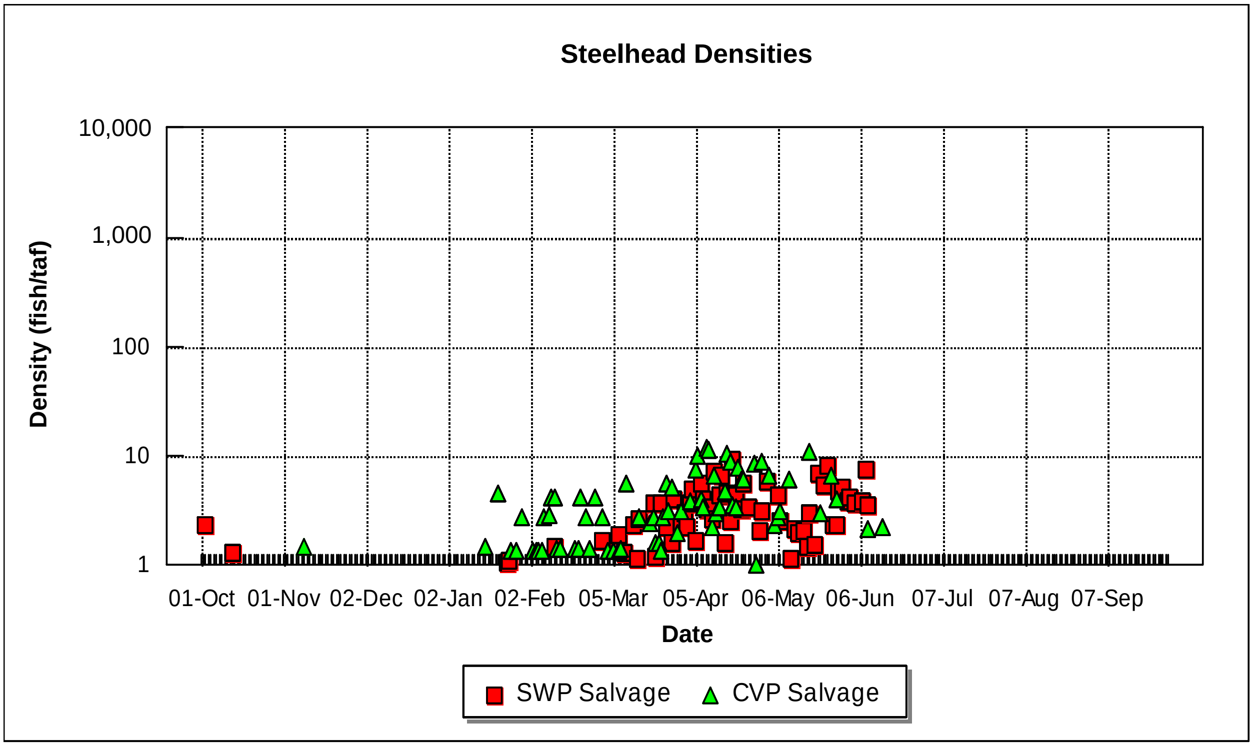
Figure J-5

Length-Frequency Results from the Delta Smelt 20-Millimeter Net Surveys in 1999



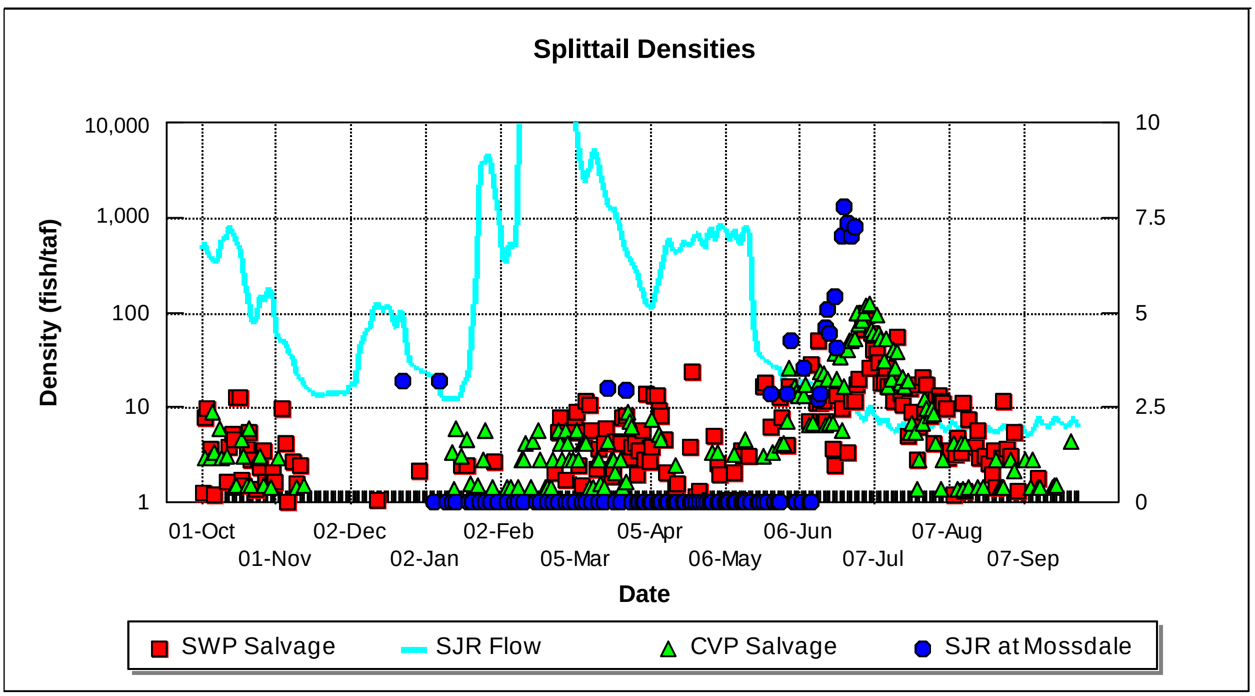


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Figure J-6

Measured Steelhead and Splittail Fish Density (fish/taf) at the SWP and CVP Fish Facilities in Water Year 1999

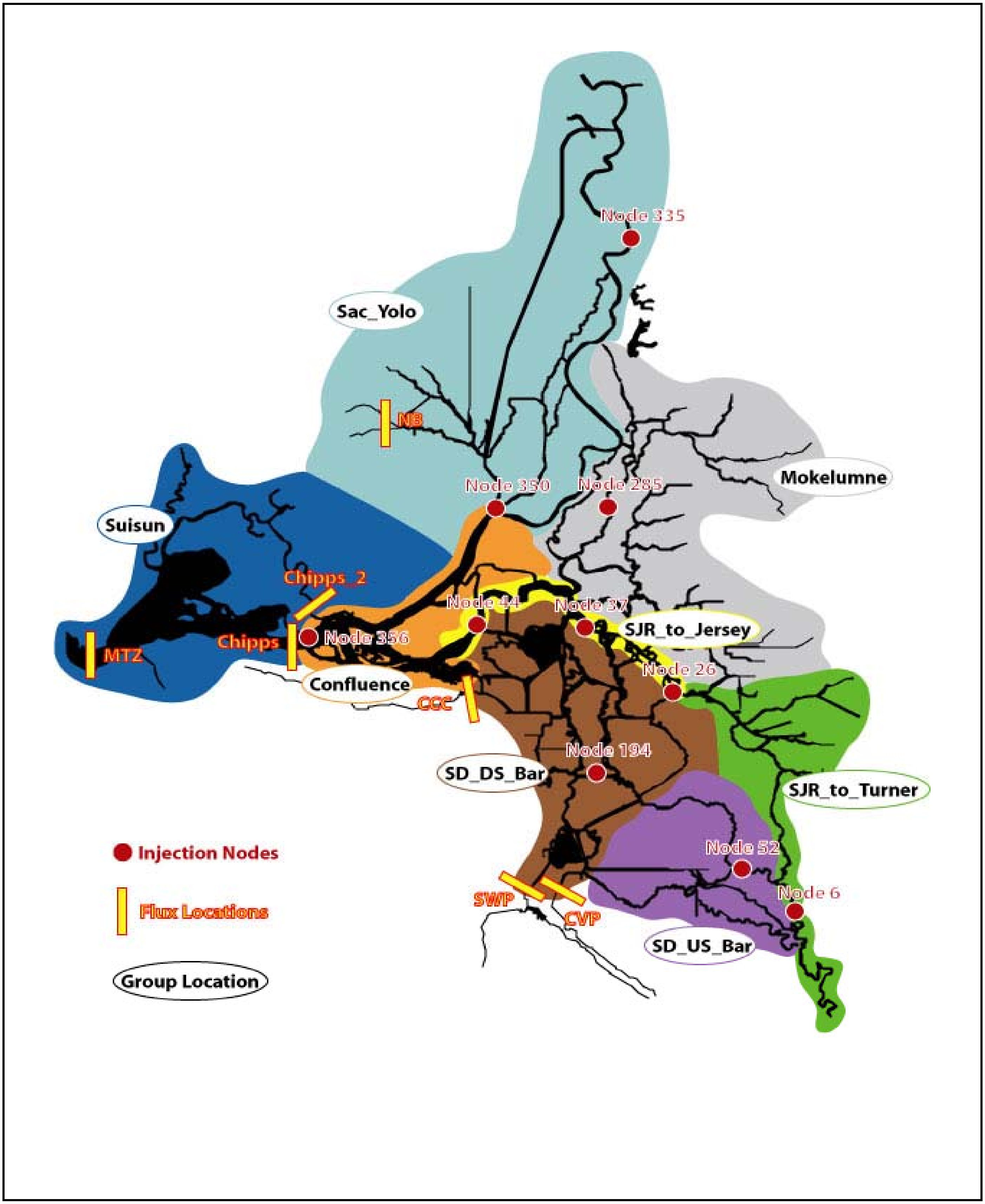

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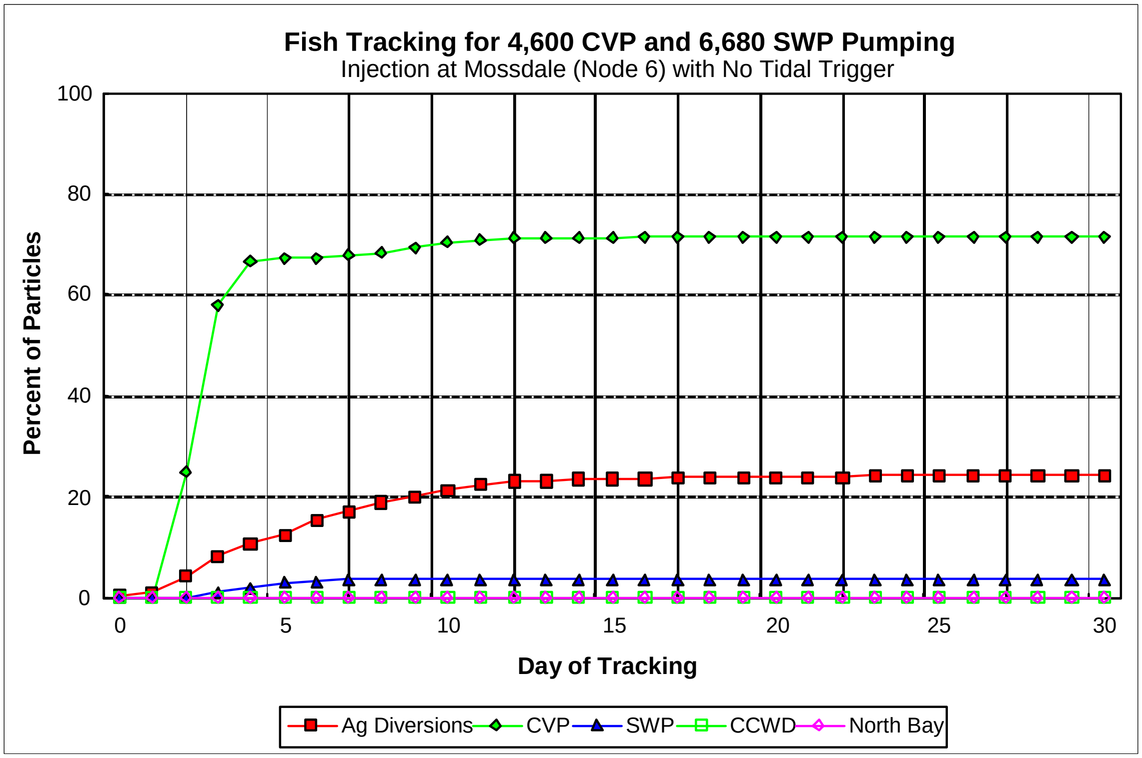
Figure J-7

Particle Tracking Model (PTM) Injection Locations, Entrainment, Passage, and Channel Regions Used to Track Movement and Entrainment of Particles



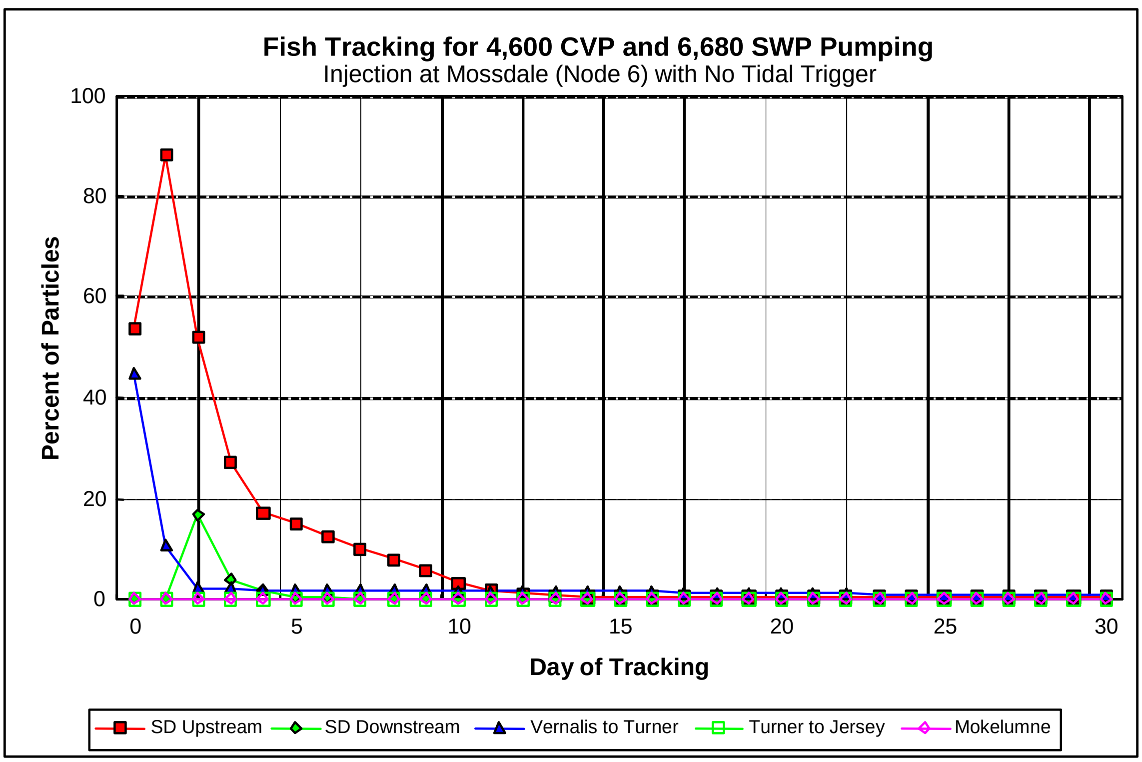


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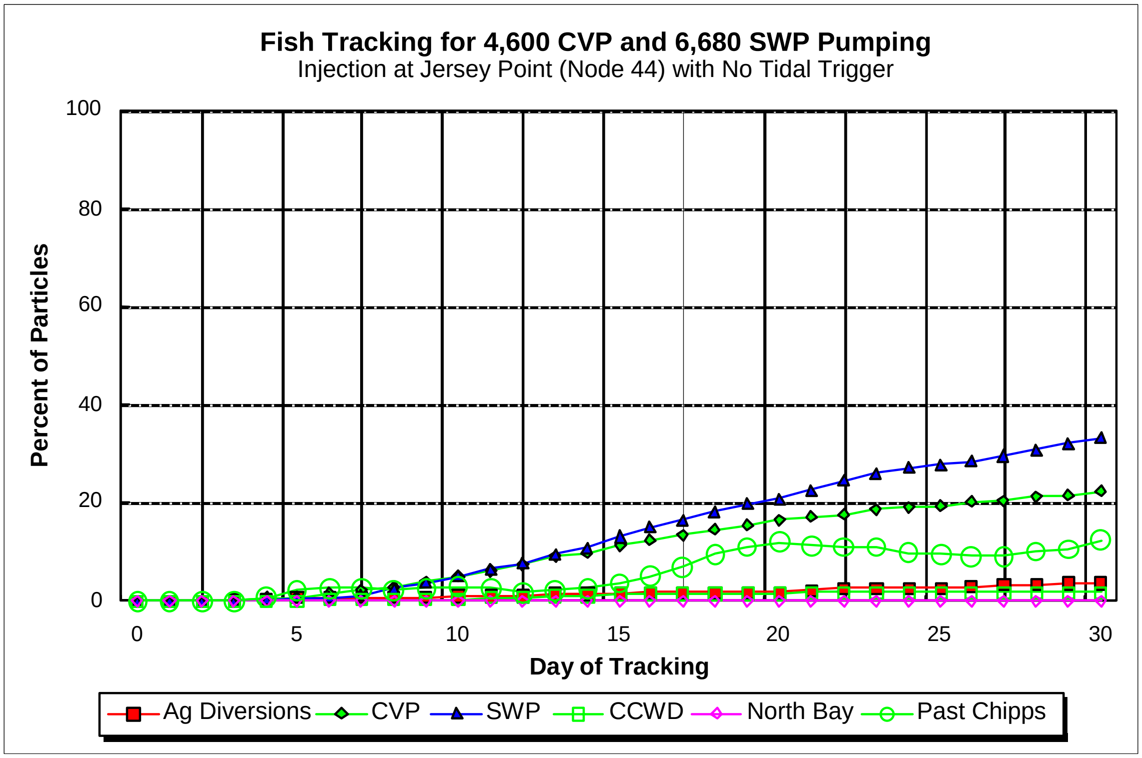
Figure J-8

PTM Results Showing Daily Tracking of Passive Particles Release at Mossdale with San Joaquin River Flow of 1500 cfs, CVP Pumping of 4,600 cfs, SWP Pumping of 6,680 cfs, and Delta Outflow of 5,000 cfs



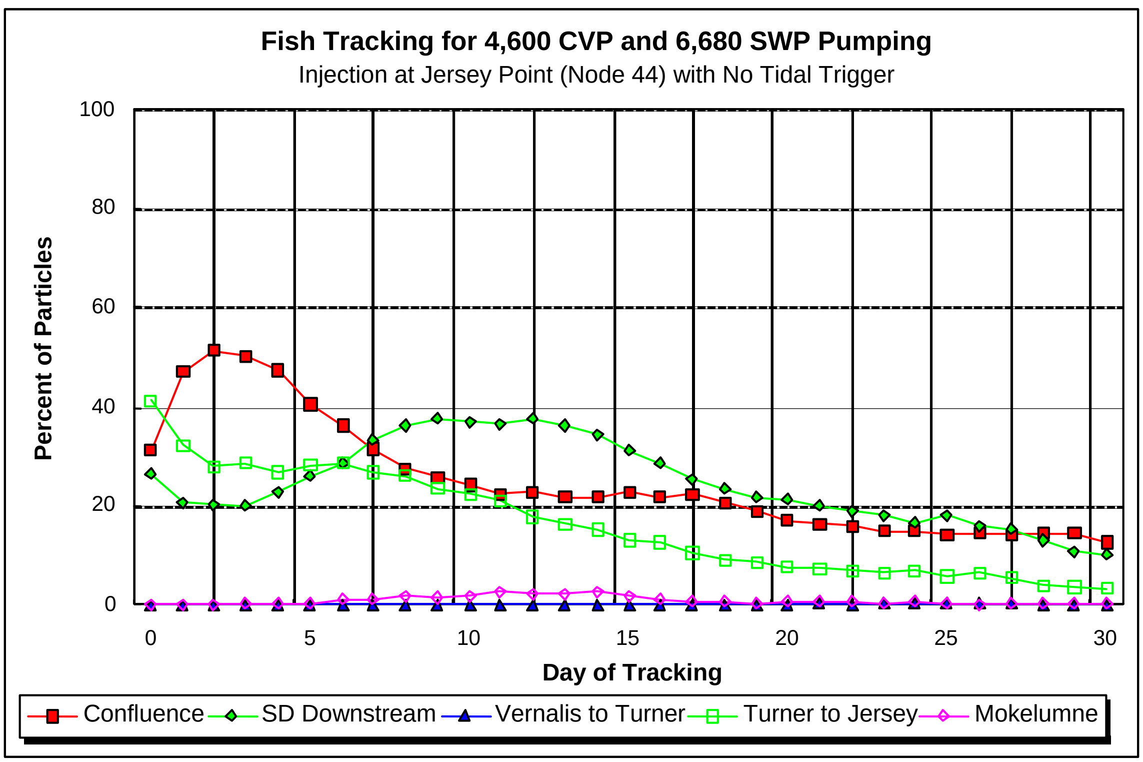


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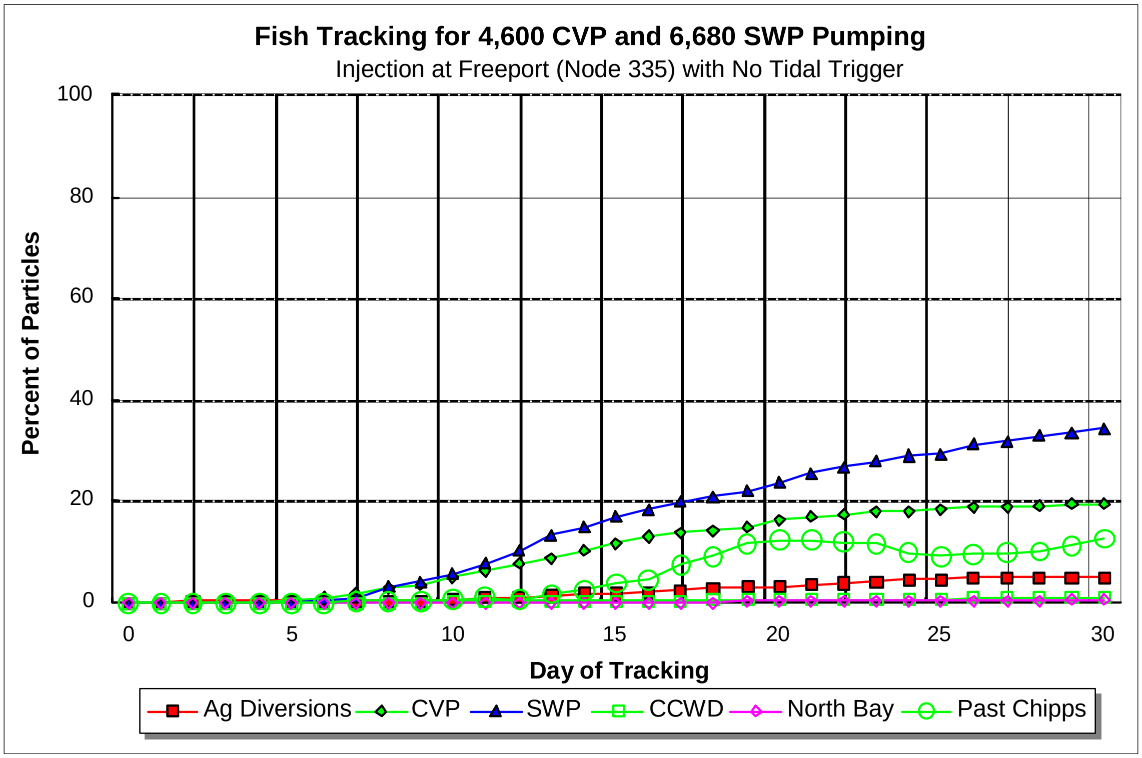
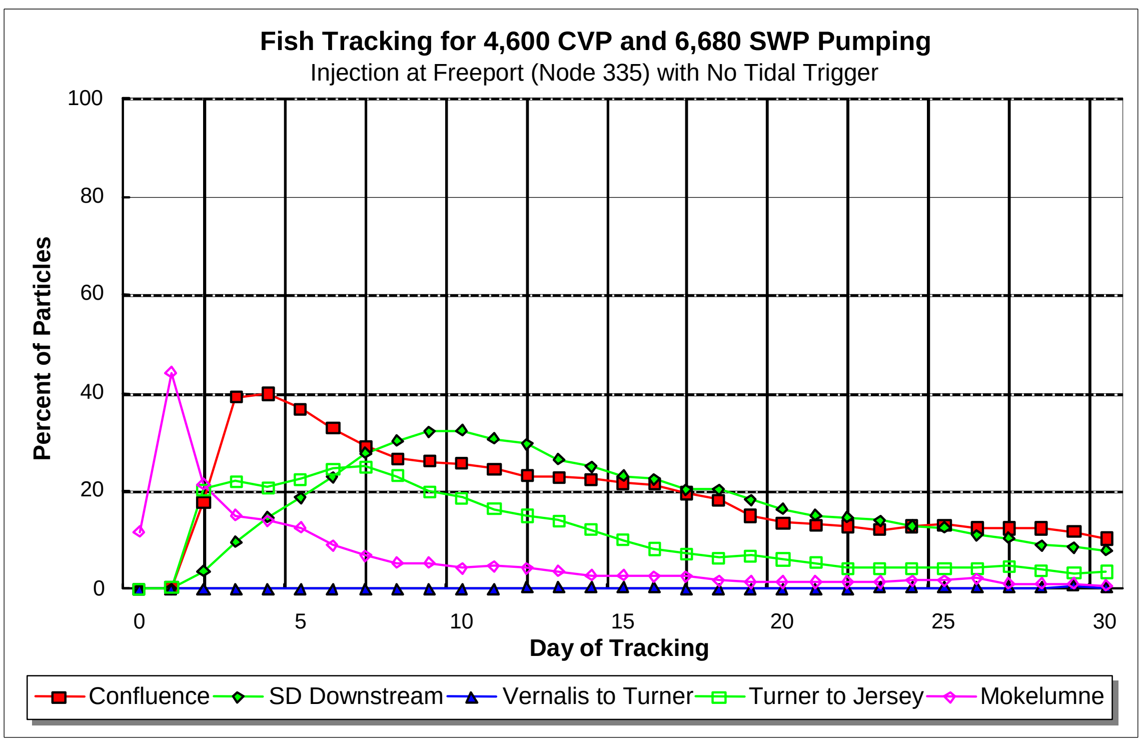
Figure J-9

PTM Results Showing Daily Tracking of Passive Particles Release at Jersey Point with Sacramento River Flow of 17,500 cfs, Delta Cross Channel Open, CVP Pumping of 4,600 cfs, SWP Pumping of 6,680 cfs, and Delta Outflow of 5,000 cfs





02053.02 101

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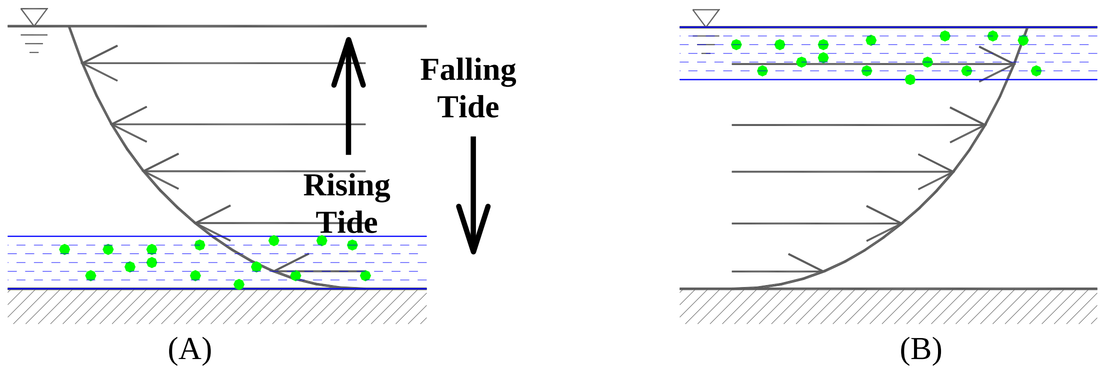
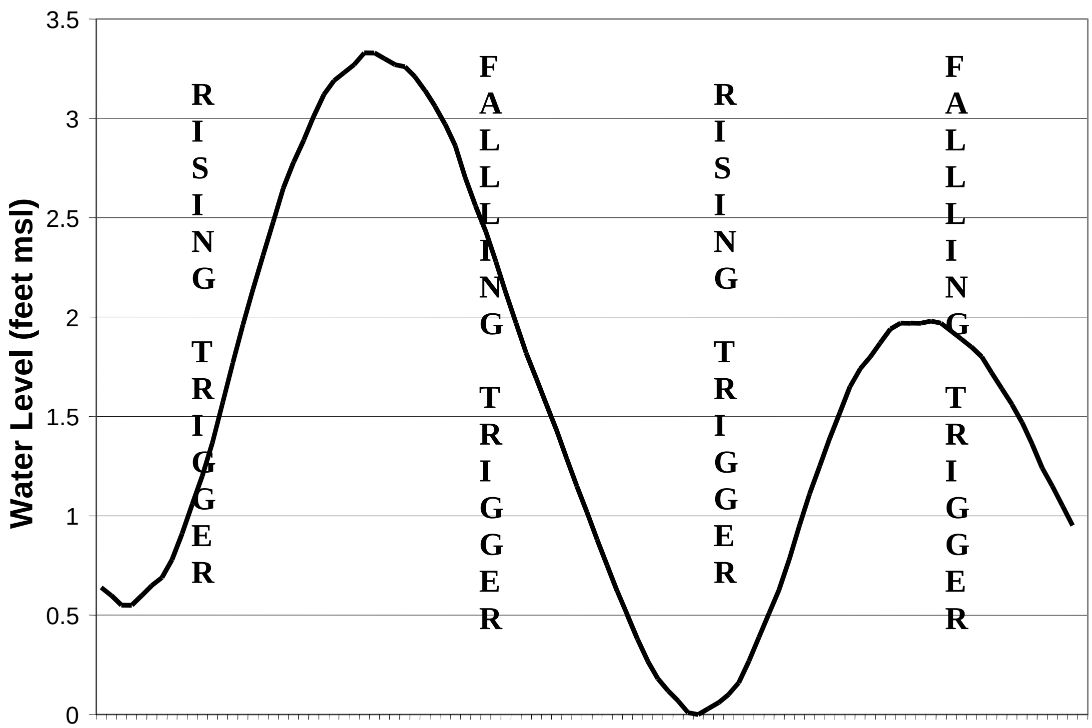
Figure J-10

PTM Results Showing Daily Tracking of Passive Particles Release at Freeport with Sacramento River Flow of 17,500 cfs, Delta Cross Channel Open, CVP Pumping of 4,600 cfs, SWP Pumping of 6,680 cfs, and Delta Outflow of 5,000 cfs



A. Example of positioning of water level–triggered active particles associated with: (A) rising water level, and (B) falling water level.



B. Example of water level trigger implementation.

Figure J-11

PTM Vertical Positioning for Tidal Trigger of Particle Movement

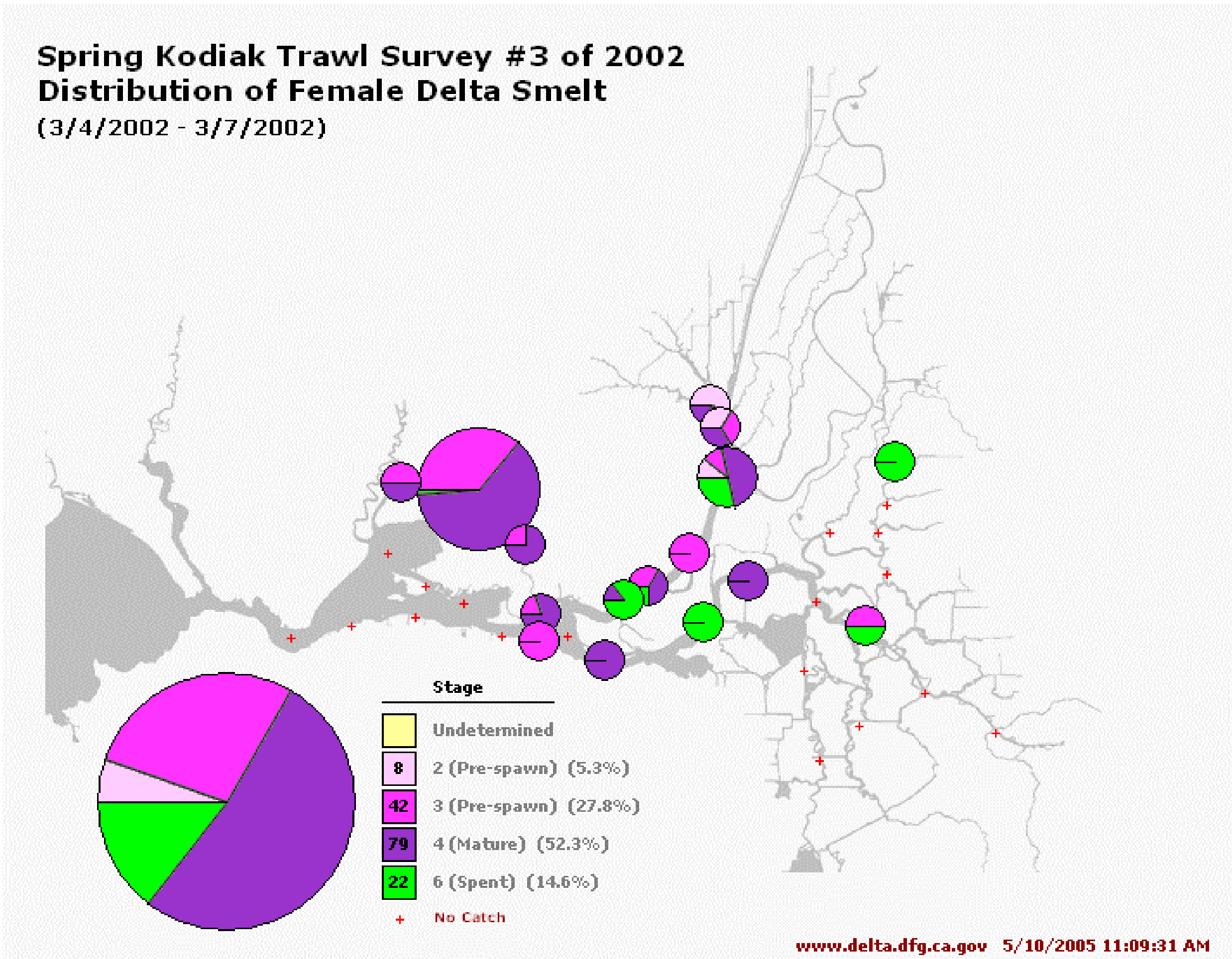


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Figure J-12

Example of Spring Kodiak Trawl Distribution and Abundance Maps for Female Delta Smelt from the 30 Stations in the Delta and Suisun Bay in March 2002

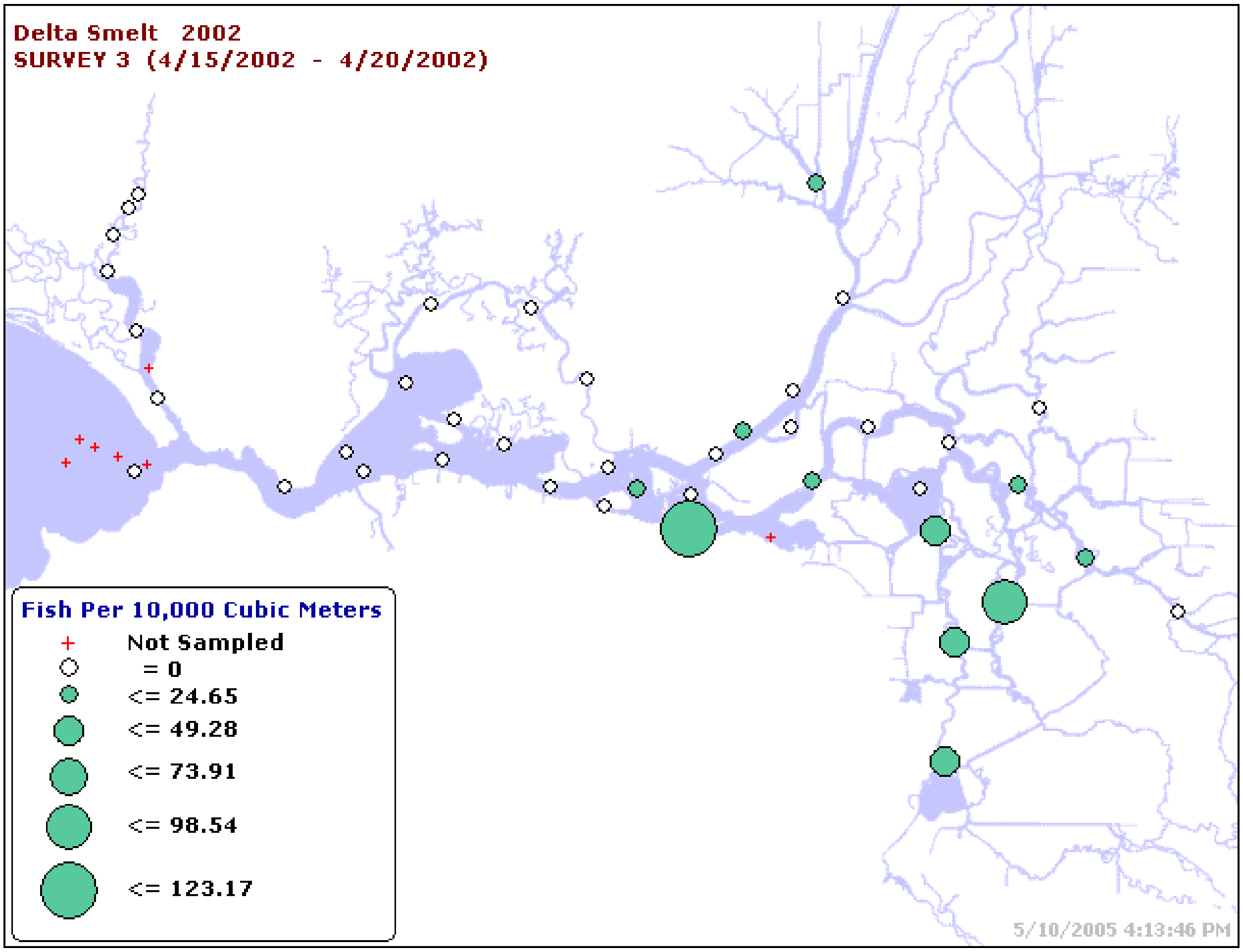

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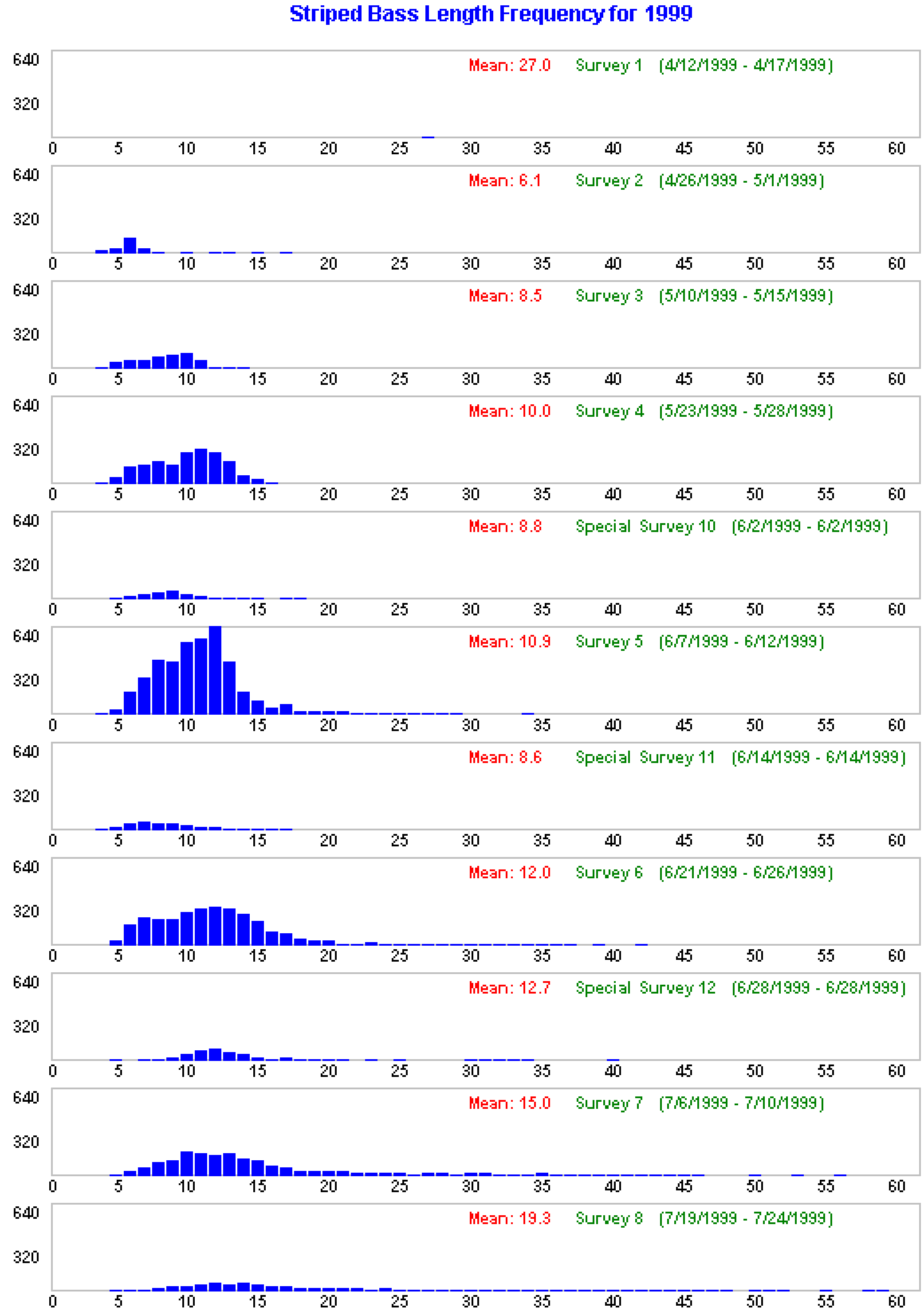
Figure J-13

Example of 20-mm Survey Distribution and Abundance "Bubble" Map for April 2002



Source: <http://www.delta.dfg.ca.gov/data/20mm/Length_frequency.asp>.

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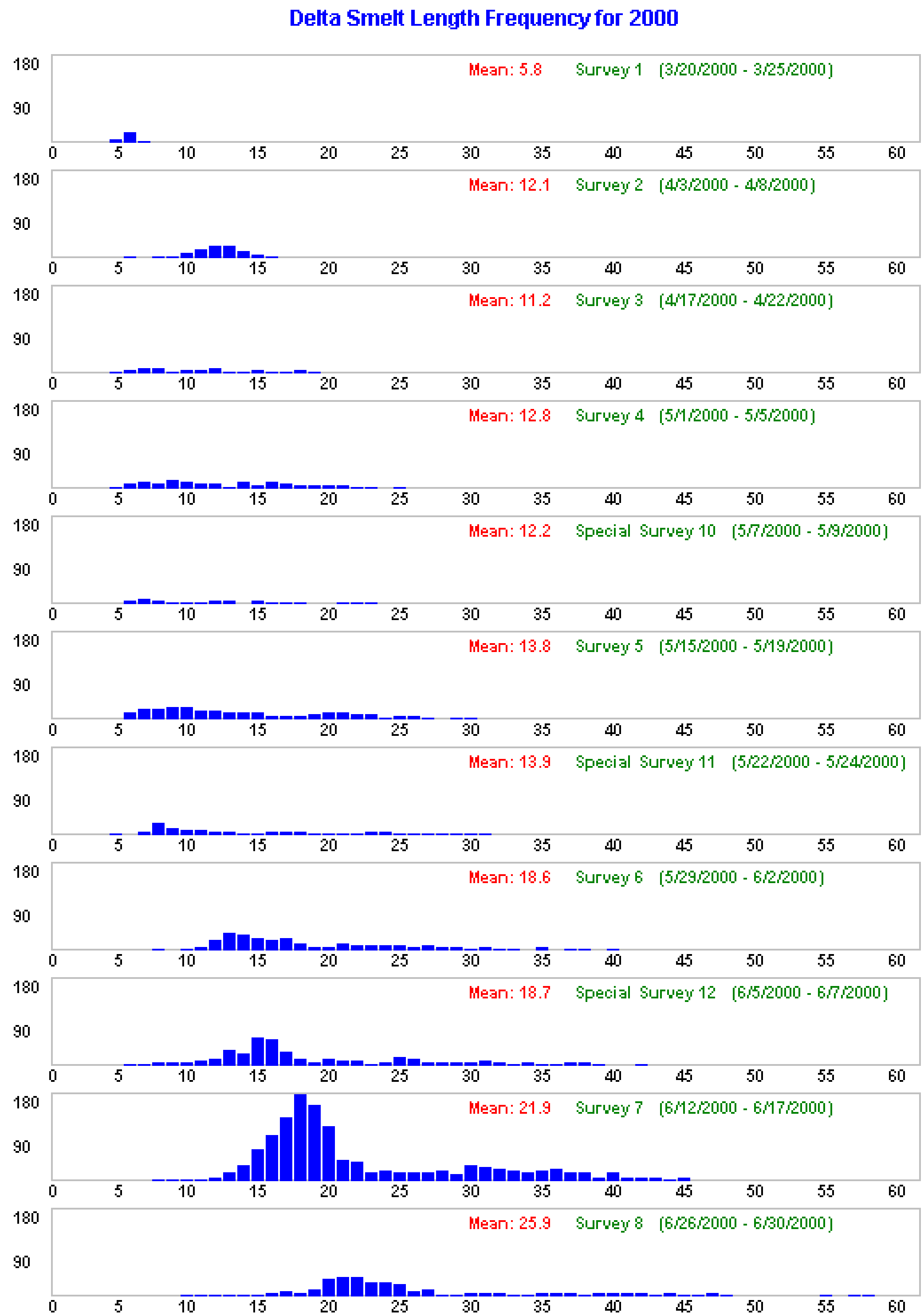
Figure J-14

Striped Bass Length-Frequency from 20-mm Surveys during 1999



Source: <http://www.delta.dfg.ca.gov/data/20mm/Length_frequency.asp>.

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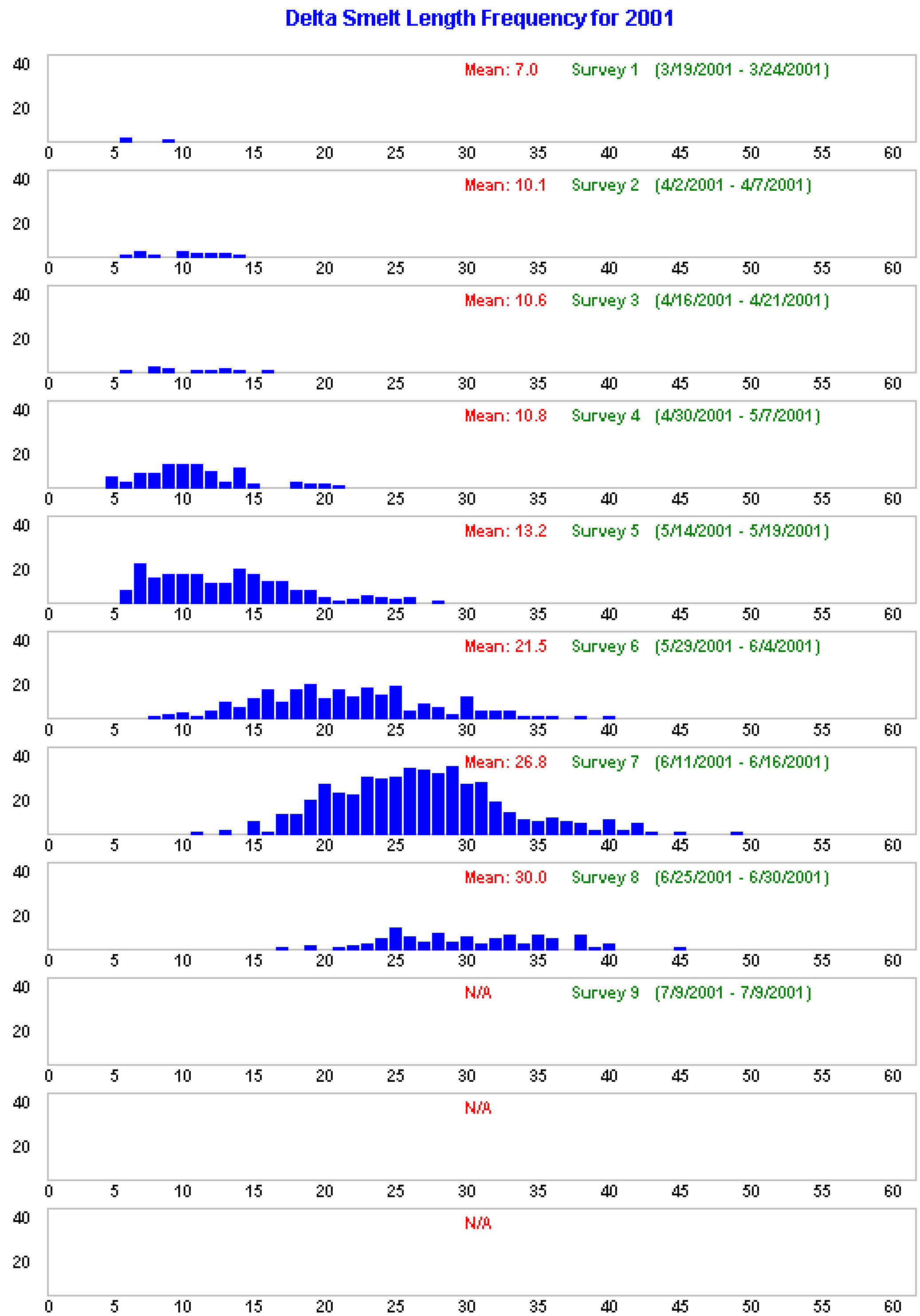
Figure J-15a
Delta Smelt Length-Frequency from 20-mm Surveys during 2000



Source: <http://www.delta.dfg.ca.gov/data/20mm/Length_frequency.asp>.

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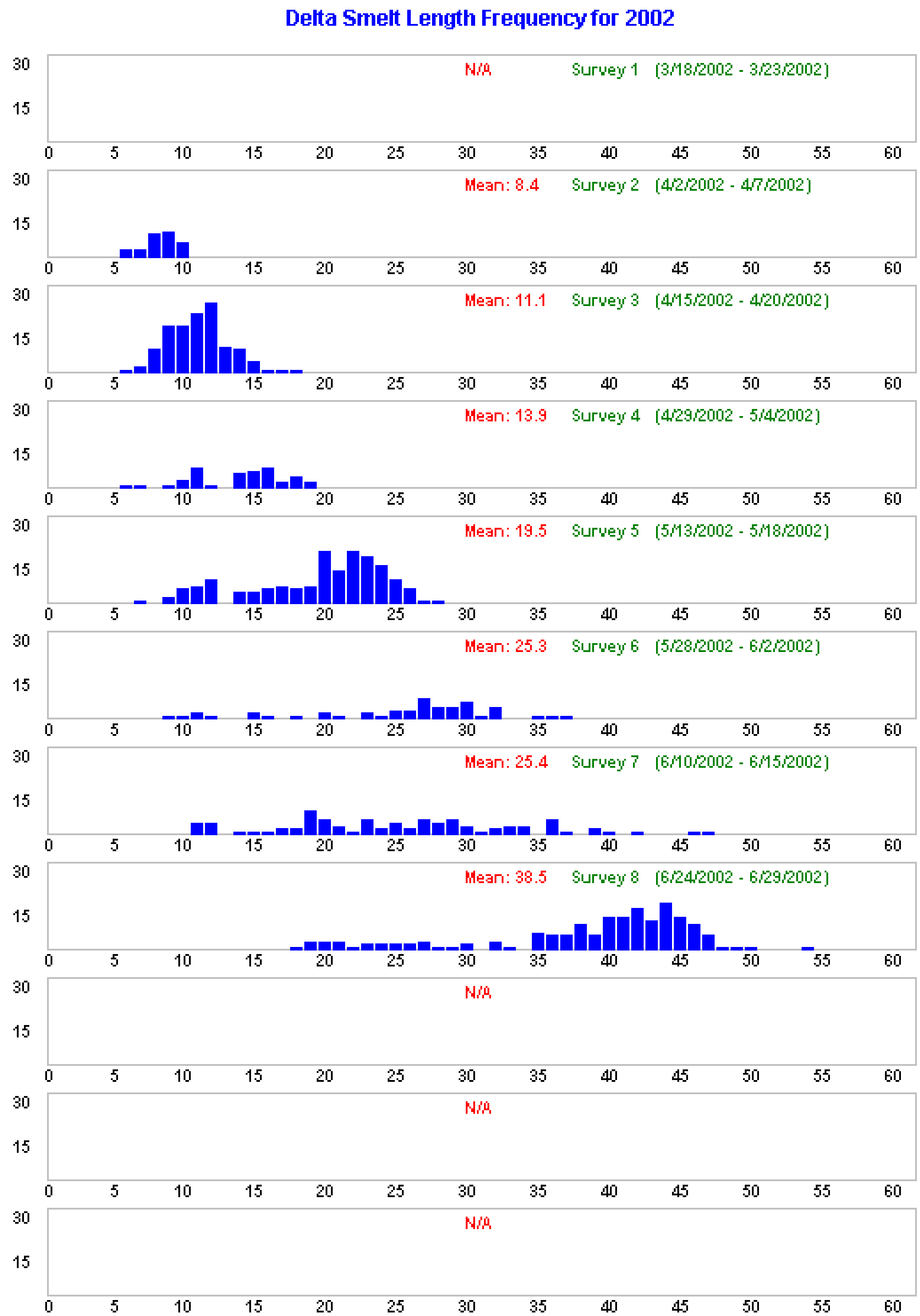
Figure J-15b

Delta Smelt Length-Frequency from 20-mm Surveys during 2001



Source: <http://www.delta.dfg.ca.gov/data/20mm/Length_frequency.asp>.

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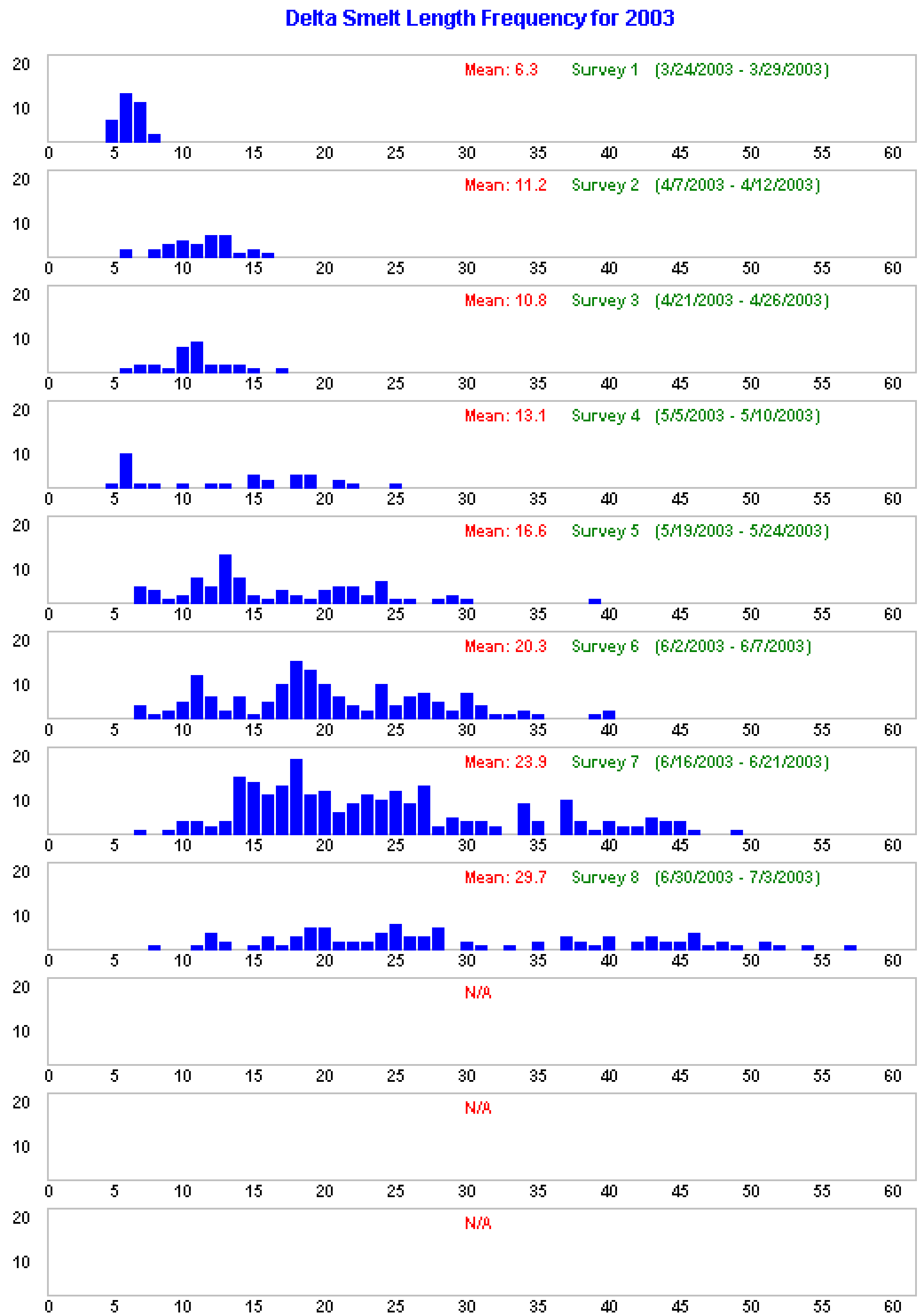
Figure J-15c

Delta Smelt Length-Frequency from 20-mm Surveys during 2002



Source: <http://www.delta.dfg.ca.gov/data/20mm/Length_frequency.asp>.

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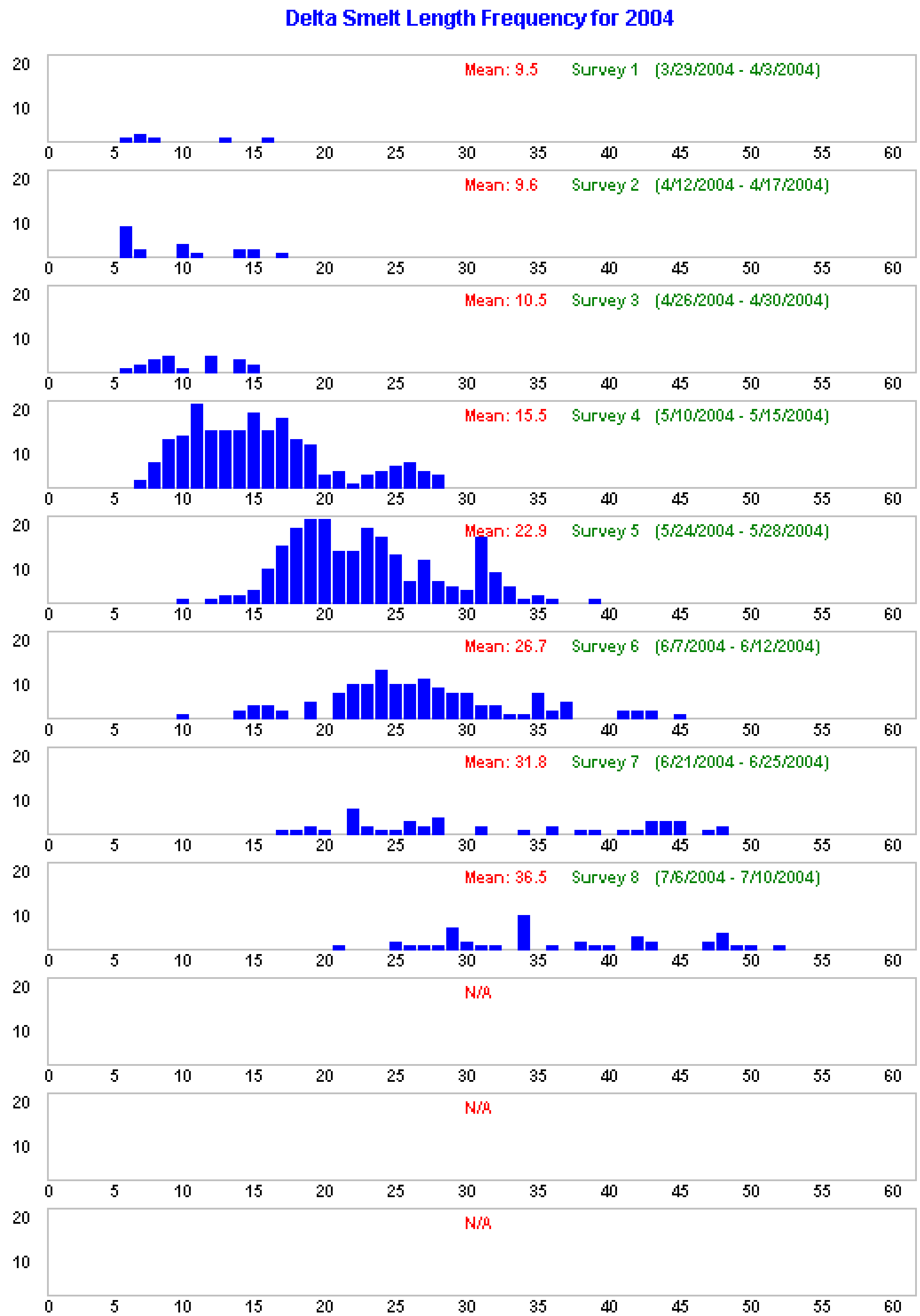
Figure J-15d

Delta Smelt Length-Frequency from 20-mm Surveys during 2003



Source: <http://www.delta.dfg.ca.gov/data/20mm/Length_frequency.asp>.

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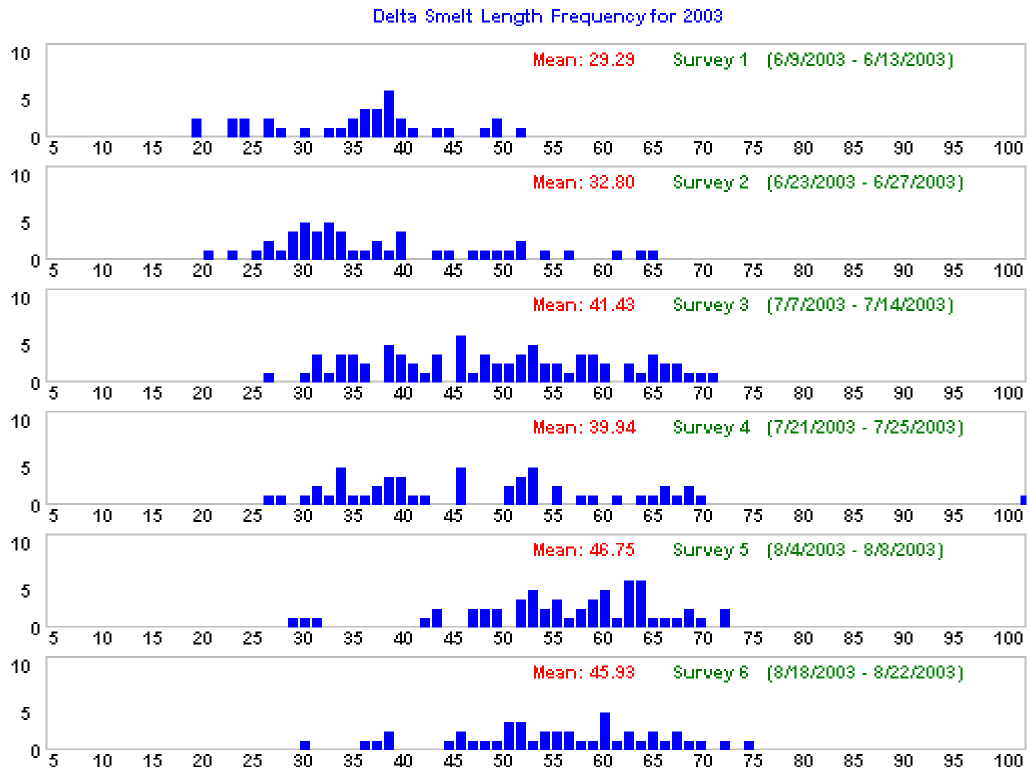
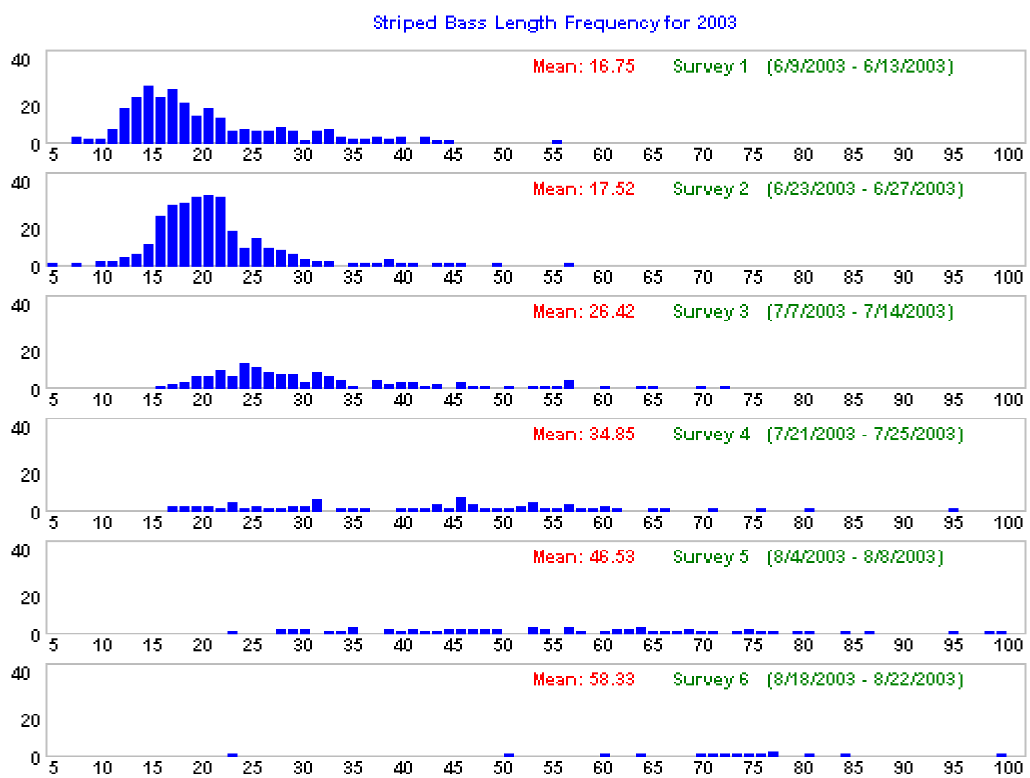
Figure J-15e

Delta Smelt Length-Frequency from 20-mm Surveys during 2004





Source: <http://www.delta.dfg.ca.gov/data/20mm/Length_frequency.asp>.

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Figure J-16

Example of Summer Tow-Net Survey Length-Frequency Diagrams for Delta Smelt and Striped Bass for 2003

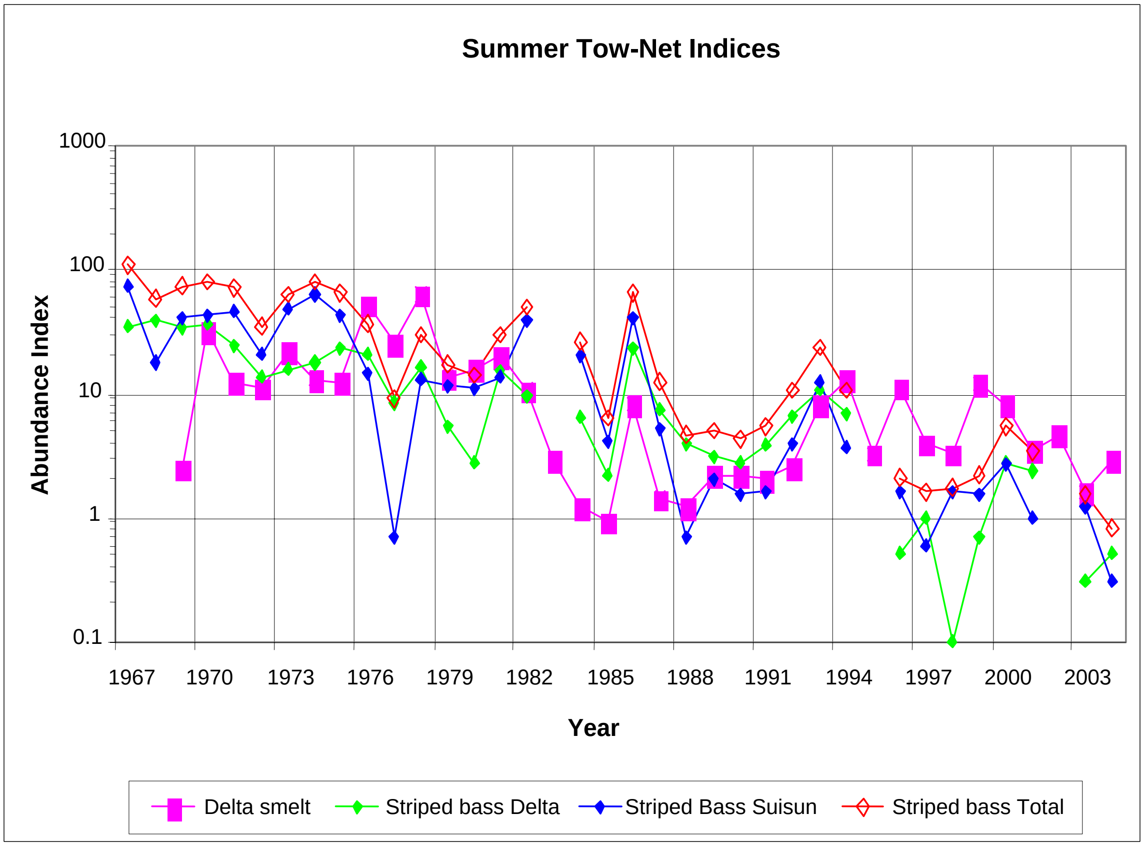

Figure J-17. Summer Tow-Net Indices for Striped Bass and Delta Smelt for 1967–2004

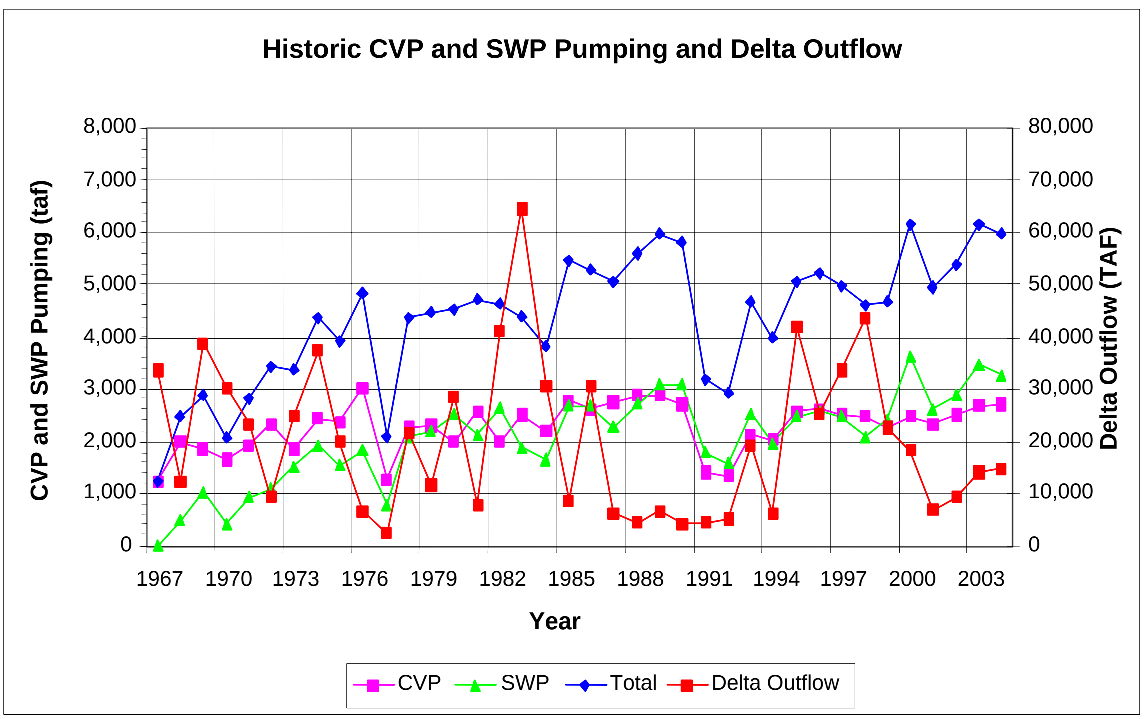

Figure J-18. Annual CVP and SWP Pumping and Delta Outflow for 1967–2004

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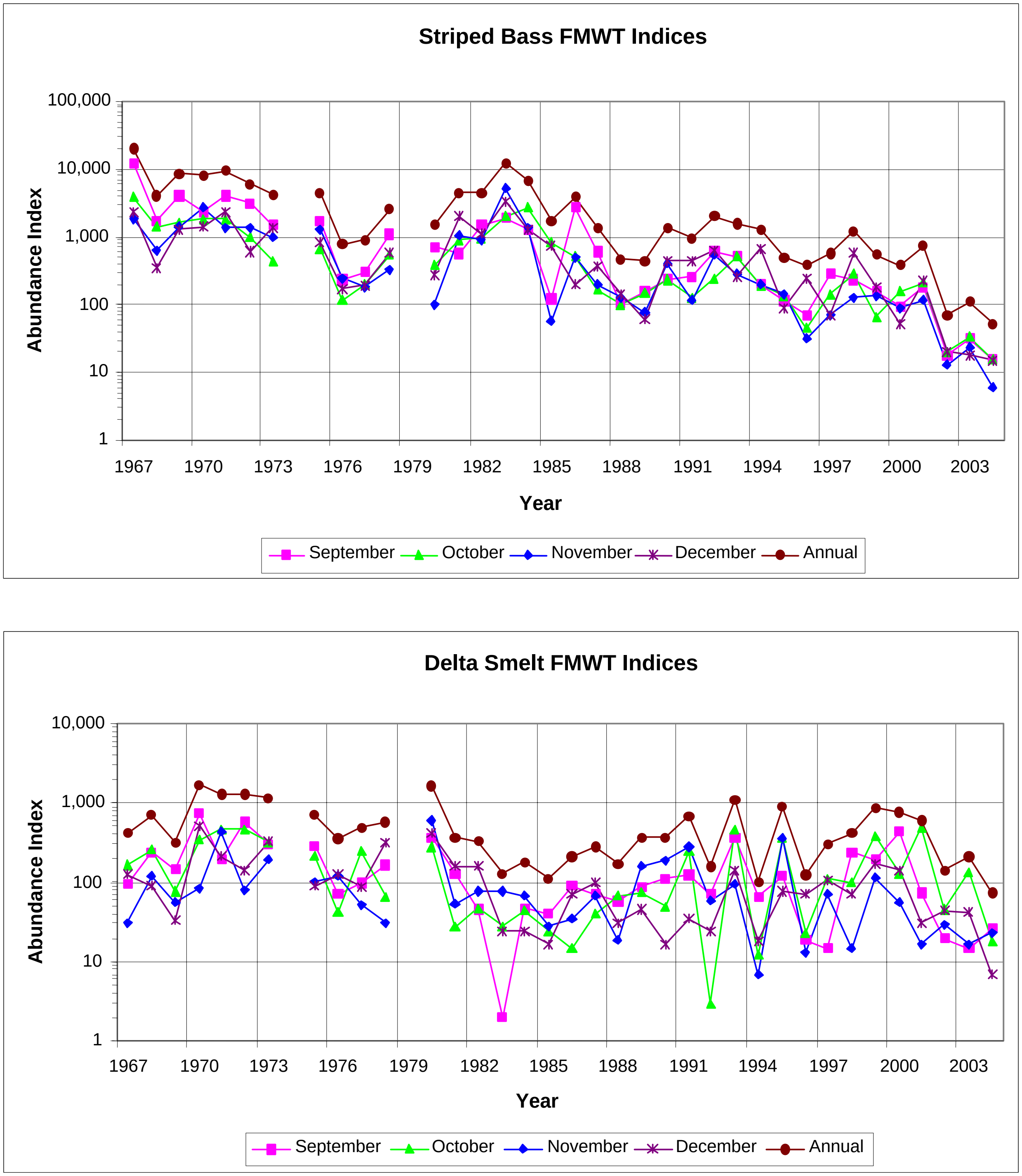

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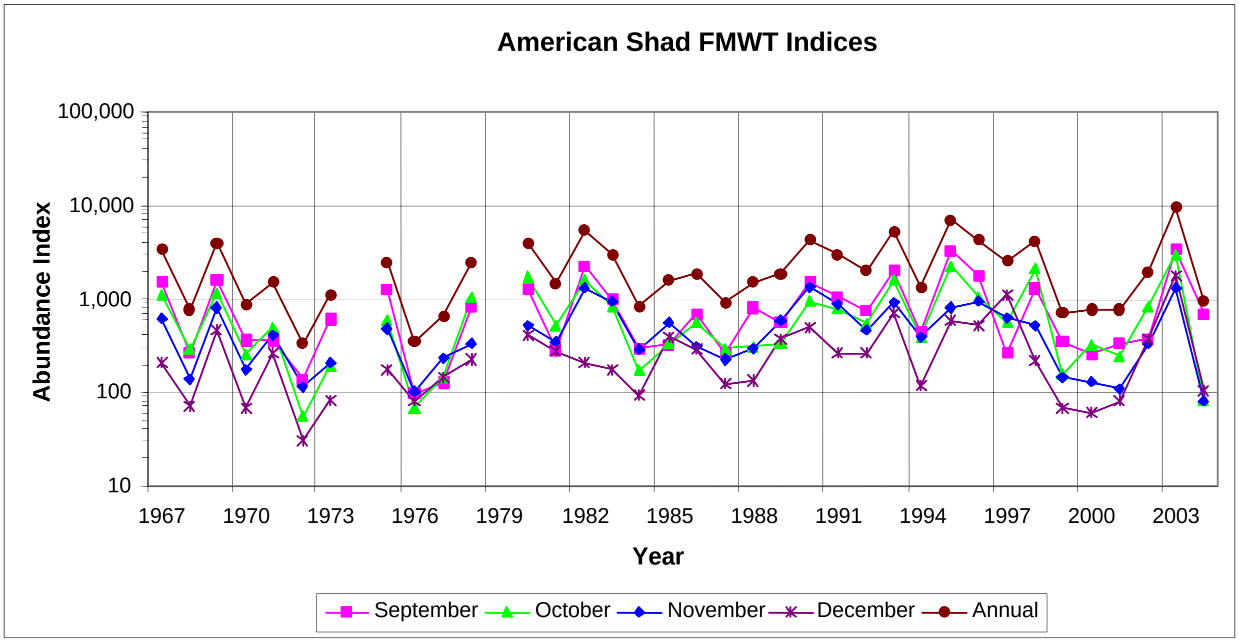
Figure J-19

Fall Mid-Water Trawl Annual Indices for Striped Bass and Delta Smelt for 1967–2004



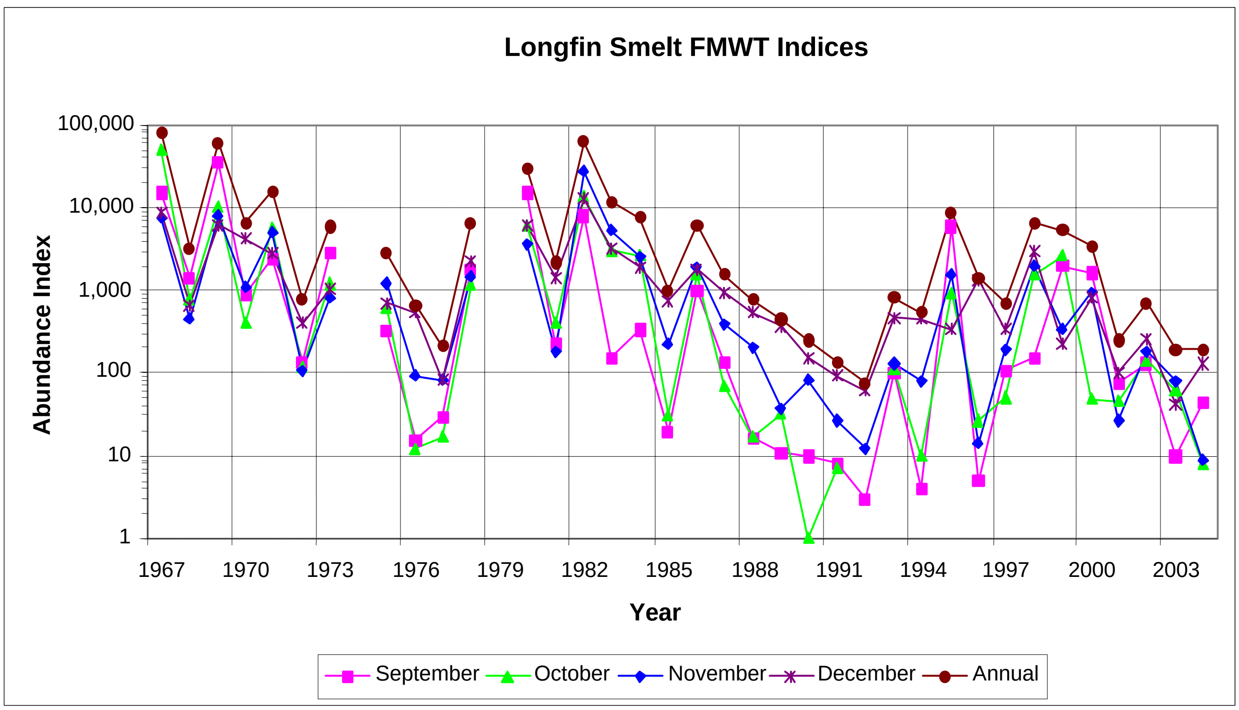


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Figure J-20

Fall Mid-Water Trawl Annual Indices for American Shad and Longfin Smelt for 1967–2004

Delta Pelagic Species Conceptual Model

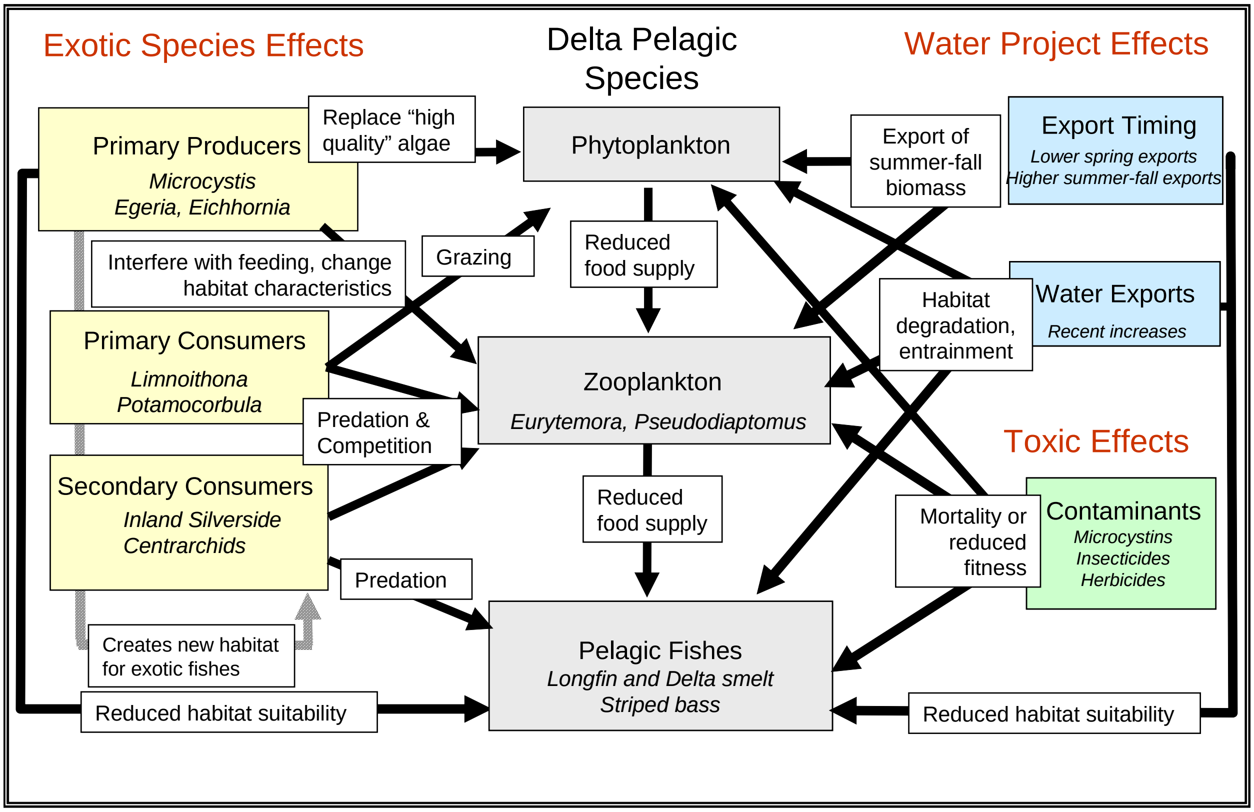

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Figure J-21

Delta Pelagic Species Conceptual Ecosystem Model

Photograph J-1. Aerial View of the CVP Tracy Fish Facility on Old River at the Entrance to the Delta-Mendota Canal Intake Channel Leading to the CVP Tracy Pumping Plant
(Source: Bureau of Reclamation.)

Photograph J-2. View of the Primary Louvers at the CVP Tracy Fish Facility
(Source: Bureau of Reclamation.)

02053.02 101

Photograph J-3. Aerial View of the John E. Skinner Fish Facility in Byron, California
Located between Clifton Court Forebay and the SWP Banks Pumping Plant.
(Source: California Department of Water Resources.)

Photograph J-4. View of the Entrance to the Skinner Fish Facility
Primary Louver Channels
(Source: California Department of Water Resources;
Photograph by Steve Foss, California Department of Fish and Game.)

Photograph J-5. Close-Up View of the Skinner Fish Facility Primary Louver Channels
Diversion bays direct fish toward secondary channels. (Source: California Department of Water Resources; Photograph by Steve Foss, California Department of Fish and Game.)

Photograph J-6. Close-Up View of the Skinner Fish Facility Secondary Louver Channels
Channels divert fish on their way to the sampling area. (Source: California Department of Water Resources; Photograph by Steve Foss, California Department of Fish and Game.)

02053.02 101

Photograph J-7. View of the Skinner Fish Facility Holding Tanks and Bucket
A bucket is lowered into a holding tank to capture fish for counting.
(Source: California Department of Water Resources.)

Photograph J-8. View of the Skinner Fish Facility Bucket and Counting Station
The bucker is positioned at the counting station.
(Source: California Department of Water Resources.)

Photograph J-9. Close-Up View of the Skinner Fish Facility Counting Station
(Source: California Department of Water Resources.)

Photograph J-10. Skinner Fish Facility Salvage Truck
Trucks are used to return the fish to safer Delta waters. (Source: California Department of Water Resources; Photograph by Steve Foss, California Department of Fish and Game.)