APPENDIX B.0 ENTRAINMENT

B.0 EXECUTIVE SUMMARY OF ENTRAINMENT CONCLUSIONS

Entrainment occurs when fish are removed from a water body with water being diverted. In the Delta, entrainment occurs at several locations, including the south Delta Central Valley Project/State Water Project (CVP/SWP) intake facilities, Mirant power plants, agricultural diversions, and other intake facilities such as those operated by Contra Costa Water District (CCWD) and Freeport Regional Water Authority (FRWA). Entrainment has been a major issue of concern related to the aquatic species covered in the Bay Delta Conservation Plan (BDCP), and as such must be evaluated carefully in the Effects Analysis. A cornerstone of the BDCP is the proposed new intake facilities in the north Delta, which allow for more effective screening of fish and less reliance on the south Delta facilities. This component of the BDCP has the potential to reduce entrainment through changes in Sacramento–San Joaquin River Delta (Delta) water management. This appendix provides a description of the potential mechanisms for entrainment; an overview of the historical and current significance of entrainment on each fish species population; a description of the methods used to predict the potential entrainment under the BDCP; results of the application of these methods; and based on these results, a comprehensive description of the expected entrainment of each life stage of each covered fish species. (Population-level effects on each species are presented in a separate appendix.)

The methods used to assess entrainment risk are based on historical salvage data, CALSIM outputs, assumed and measured locations of fish, previous studies in the Delta, Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) analyses, and/or professional judgment. The methods used reflect the best available tools and data regarding fish abundance, movement, and behavior. These methods were applied to a comparison of the Preliminary Proposal (PP)[1] with two baseline conditions (EBC1 and EBC2) at two time periods in the permit term (Early Long-Term [ELT] and Late Long-Term [LLT]). Table B-1 provides a description of each of these conditions. For some methods, five water-year types were modeled based on the historical CALSIM record to determine the variation in entrainment under different flow conditions.

[1] This appendix evaluates entrainment under the preliminary proposal (PP) for operation of the BDCP conveyance facilities, as defined by the BDCP Steering Committee (released February 11, 2010, and evaluated in the November 2010 BDCP Working Draft). This evaluation is based on the preliminary proposal because, at this time, modeling estimates of project operations are available only for this set of operations. Additional modeling is underway of an additional operation called Scenario 6, proposed for evaluation by the fishery agencies. When those results are available, this appendix will be revised to include entrainment estimates based on Scenario 6. Evaluation of both operational scenarios will inform selection of the Proposed Project upon completion of the Effects Analysis.

Table B-1. Definition of Analytical Conditions

Condition	Description
Existing Biological Condition (EBC) 1	This condition assumes current operations based on the 2008 USFWS and 2009 NMFS BOs, excluding the fall X2 actions. Ultimately, this would be similar to how the CVP/SWP has been operated since 2009..
EBC2	This condition assumes current operations based on the 2008 USFWS and 2009 NMFS BOs, including the fall X2 actions called for in the USFWS BO.
EBC1_ELT	This condition assumes that EBC1 continues into the future and includes conditions expected in years 11–15.
EBC1_LLT	This condition assumes that EBC1 continues into the future and includes conditions expected in years 15–50.
EBC2_ELT	This condition assumes that EBC2 continues into the future and includes conditions expected in years 11–15.
EBC2_LLT	This condition assumes that EBC2 continues into the future and includes conditions expected in years 15–50.
Preliminary Proposal (PP)	This condition is based on the set of operations modeling estimates that are available at this time. Additional modeling is underway of an additional operation called Scenario 6, proposed for evaluation by the fishery agencies. When those results are available, this appendix will be revised to include entrainment estimates based on Scenario 6. Evaluation of both operational scenarios will inform selection of the Proposed Project upon completion of the Effects Analysis.
PP_ELT	This condition reflects the preliminary proposal in years 11–15 (prior to the implementation of the new intake facility and the full implementation of the restoration activities).
PP-LLT	This condition assumes full implementation of the BDCP preliminary proposal, and reflects years 15–50.
USFWS = U.S. Fish and Wildlife Service. NMFS = National Marine Fisheries Service. BO = biological opinion. CVP/SWP = Central Valley Project/State Water Project.	

The methods used to evaluate entrainment include:

- **Salvage density**: uses historical salvage data and CALSIM outputs to estimate entrainment under various flow conditions.
- **Old and Middle River (OMR) flow proportional entrainment regressions**: uses linear regression (based on Kimmerer data) and CALSIM data to estimate the proportion of delta smelt population that would be entrained.
- **Manly salvage estimation equation**: builds upon the OMR regressions to include other upstream factors such as turbidity.
- **DSM2 particle-tracking model**: Uses both hypothetical release sites and data from trawls to estimate the movement of larval delta smelt that are assumed to be influenced primarily by flows.
- **Delta passage model proportional salvage estimates**: uses coded wire tag (CWT) salvage data to estimate the proportion of Chinook salmon runs that would be entrained.

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- **Effectiveness of non-physical barriers**: uses results of recent studies at Georgiana Slough and Old River to determine potential effectiveness of barriers in other Delta locations that would exclude fish from diversions.
- **North Delta intakes screening effectiveness analysis**: estimates direct loss and impingement at screens for different sizes of fish based on literature and professional judgment.
- **DRERIP analysis of non-Project diversions**: assumes removal of non-Project diversions would result in a proportional reduction in entrainment.

No single one of these methods could be used for all life stages of all species. As a result, it was necessary to employ these methods in combination to complete the assessment of entrainment. For example, the OMR regression is applicable only to delta smelt, while the Delta Passage Model is applicable only to Chinook salmon. Similarly, the assessment of the north Delta screening efficiency was specific to that facility and focused primarily on larvae life stages.

These methods were applied to each species and life stage as appropriate, and the results of the assessment are presented in Section B.6. The conclusions presented in Section B.7 synthesize multiple results because multiple methods were applied to some species and life stages. The conclusions therefore provide a final determination of the effect of entrainment on each species and life stage. Where information is available, the proportion of a population affected is provided. The following summary table shows the percentage change in entrainment for each species and life stage when compared to the baseline conditions (EBC1 and EBC2).

B.0.1 Summary and Conclusions for Effects on Entrainment

Table B-254 summarizes the results of the numerous analyses of the effects of BDCP on entrainment in the Plan Area by species and life stage. Effects are summarized for each of the five major sources of entrainment. Effects of the SWP/CVP are separated by each of five water-year types when possible (wet, above normal, below normal, dry, and critical). Estimated effects of entrainment at most of the other four sources are not differentiated by water-year type. For analyses based on limited water years (e.g., analyses using DSM2 modeled flows), summaries were calculated only for all water years. The table is based on consideration of the percentage change between baseline (EBC1, EBC2, EBC2_ELT, EBC2_LLT) and the preliminary proposal (PP_ELT and PP_LLT).

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Table B-2. Summary of Effects of BDCP on Entrainment of Covered Fish Species

Species	Life Stage	SWP/CVP South Delta Export Facilities by Water-Year Type						SWP/CVP North Delta Intakes	SWP North Bay Aqueduct Barker Slough Pumping Plant and Alternative Intake	Agricultural Diversions
		All	Wet	Above Normal	Below Normal	Dry	Critical			
Steelhead	Egg/Alevin	Occur upstream of Plan Area								
	Fry	Occur upstream of Plan Area								
	Juvenile	---	----	---	---	-/~	-/~/+	100% screened	100% screened	-/~
	Adult	Large body size/strong swimming ability make entrainment very unlikely								
Winter-run Chinook salmon	Egg/Alevin	Occur upstream of Plan Area								
	Fry	Occur upstream or otherwise included under analysis of juveniles								
	Juvenile	---/--/-/~/+	----	----/---	--	-/~	-/~	100% screened	100% screened	-/~
	Adult	Large body size/strong swimming ability make entrainment very unlikely								
Spring-run Chinook salmon	Egg/Alevin	Occur upstream of Plan Area								
	Fry	Occur upstream or otherwise included under analysis of juveniles								
	Juvenile	---/--/-/~	---	~/+	+++/++++	++/+++/++++	~/+	100% screened	100% screened	-/~
	Adult	Large body size/strong swimming ability make entrainment very unlikely								
Fall-/late fall–run Chinook salmon	Egg/Alevin	Occur upstream of Plan Area								
	Fry	Occur upstream or otherwise included under analysis of juveniles								
	Juvenile	--/-/~/+/++	---	--/-	--/-/~/+/++	-/~/+/++/+++	--/-/~/+/++	100% screened	100% screened	-/~
	Adult	Large body size/strong swimming ability make entrainment very unlikely								
Delta smelt	Egg/Embryo	Adhere to substrates and therefore minimally subject to entrainment								
	Larva[1]	--/-/~/+	----/---/--/-/~/+	--/-/~/+/++	--/-/~/+/++	---/--/-/~/+	---/--/-/~/+	Average PTM entrainment 0.2-1.6% but assumes larvae are passive particles	----/---/--/-	-/~
	Juvenile	--/-/~/+	----/---/--/-/~/+	--/-/~/+/++	--/-/~/+/++	---/--/-/~/+	---/--/-/~/+	100% screened	100% screened at >25 mm; vulnerable at < 25 mm	-/~
	Adult	----/---/--	----/---	---/--/-	--/-	-/~	-/~/+	100% screened	100% screened	-/~
Longfin smelt	Egg/Embryo	Adhere to substrates and therefore minimally subject to entrainment								
	Larva[2]	--/-	NA	---/--	-	-/~/+	-/~	No entrainment based on typical larval distribution	----/---/--/-/~/+/++/+++/++++	-/~
	Juvenile	~/+	--	++	+++/++++	+/++	-	100% screened	100% screened at >25 mm; vulnerable at < 25 mm	-/~
	Adult	---	----	---	--/-	--/-	--/-/~/+	100% screened	100% screened	-/~
Sacramento splittail	Egg/Embryo	Adhere to substrates and therefore minimally subject to entrainment								
	Larva	NA	NA	NA	NA	NA	NA	100% screened at >15 mm; vulnerable at < 15 mm	100% screened at >25 mm; vulnerable at < 25 mm	-/~
	Juvenile	----/---/--/-/~/+/++/+++/++++	----/---/--/-/~/+/++/+++/++++	-/~/+/++/+++/++++	--/-/~/+/++/+++/++++	---/--/-/~/+/++/+++/++++	---/--/-/~/+	100% screened	100% screened	-/~
	Adult	---	----	----	---/--	-/~	-/~/+	100% screened	100% screened	-/~
White sturgeon	Egg/Embryo	Adhere to substrates and therefore minimally subject to entrainment								
	Larva	Uncertain as to what extent entrainment occurs because most of the larval population is upstream of the south Delta export facilities						100% screened at >15 mm; vulnerable at < 15 mm	100% screened at >25 mm; vulnerable at < 25 mm	-/~
	Juvenile	NA	---/--		--/-			100% screened	100% screened	-/~
	Adult	Rarely entrained, presumably because of large size						100% screened	100% screened	-/~
Green sturgeon	Egg/Embryo	Occur upstream of Plan Area								
	Larva	Occur upstream of Plan Area								
	Juvenile	NA	---		-			100% screened	100% screened	-/~

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		SWP/CVP South Delta Export Facilities by Water-Year Type						SWP/CVP North Delta Intakes	SWP North Bay Aqueduct Barker Slough Pumping Plant and Alternative Intake	Agricultural Diversions
Species	**Life Stage**	**All**	**Wet**	**Above Normal**	**Below Normal**	**Dry**	**Critical**			
	Adult	Rarely entrained, presumably because of large size						100% screened	100% screened	-/~
Pacific lamprey	Egg/Embryo	Occur upstream of Plan Area								
	Ammocoete	Generally buried in the substrate upstream of the Plan Area but may be subject to entrainment if washed out of natal streams into the Plan Area (before burying into Plan Area substrates)								
	Macropthalmia	---/--	NA	NA	NA	NA	NA	100% screened	100% screened	-/~
	Adult	---/--	NA	NA	NA	NA	NA	100% screened	100% screened	-/~
River lamprey	Egg/Embryo	Occur upstream of Plan Area								
	Ammocoete	Generally buried in the substrate upstream of the Plan Area but may be subject to entrainment if washed out of natal streams into the Plan Area (before burying into Plan Area substrates)								
	Macropthalmia	---/--	NA	NA	NA	NA	NA	100% screened	100% screened	-/~
	Adult	---/--	NA	NA	NA	NA	NA	100% screened	100% screened	-/~

Note: Quantitative results generally are presented as effects because of preliminary proposal relative to baseline (existing biological conditions), with little change indicated as ~ (± ≤ 5%); reductions in entrainment indicated as - (5–25% reduction), -- (25–50% reduction), --- (50–75% reduction), and ---- (>75% reduction); and increases in entrainment indicated as + (5–25% increase), ++ (25–50% increase), +++ (50–75% increase), and ++++ (>75% increase). Results that span several categories are indicated by multiple values separated by forward slashes (/). For example different analysis techniques sometimes yielded different results. In other cases, different preliminary proposal vs. existing biological conditions comparisons gave differing estimates of entrainment.

CVP = Central Valley Project.

SWP = State Water Project.

NA = Not Analyzed.

[1]Summary for south Delta export facilities is based on proportional entrainment regressions (Kimmerer and Miller approaches; Section B.6.1.5.2) and OMR-particle entrainment regression derived from particle-tracking modeling (Section B.6.1.5.1).

[2]Summary for south Delta export facilities is based on OMR-particle entrainment regression derived from particle-tracking modeling (Section B.6.1.6.1).

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BDCP WILL SUBSTANTIALLY CHANGE THE AMOUNT AND PATTERN OF WATER EXPORTS FROM SWP/CVP FACILITIES, WHICH IS EXPECTED TO REDUCE THE NUMBER OF FISH OF ALL SPECIES ENTRAINED RELATIVE TO EXISTING BIOLOGICAL CONDITIONS

Across the five water-year types, exports from the south Delta decrease from 100% of total exports under the existing biological conditions to an average of about 58% under BDCP. The proportion of total exports that comes from the south Delta facilities under BDCP is lowest in wet water years (about 35%) and is highest in critical water years (about 84%). BDCP increases total exports over baselines during April, May, and June but does so largely by taking water from the north Delta intakes. Exports from the south Delta facilities during the spring months are generally similar or reduced relative to the existing biological conditions. With BDCP, total exports from combined north and south Delta intakes increase in the early and late long-term relative to the existing biological conditions in wet, above normal, and below normal water years. Under dry and critical water years, total exports decrease under BDCP relative to existing biological conditions. Nonetheless, overall BDCP will substantially reduce exports from the south Delta facilities in most months relative to the existing biological conditions. Entrainment is expected to be reduced most in wetter years because a greater percentage of flow will be diverted from the north Delta in wet years than in dry years.

Consistent with the general pattern of decreased south Delta exports under the preliminary proposal reducing entrainment relative to existing biological conditions, entrainment of juvenile salmonids at the south Delta export facilities also generally would be lower under BDCP compared to existing biological conditions, with differences according to species and water-year type.

Juvenile steelhead entrainment would decrease substantially overall (greater than 50% decrease across all water years), with decreases occurring mostly in wet (greater than 80%), above normal (around 60%), and below normal years (greater than 50%); entrainment of juvenile steelhead in dry and critical years generally would be similar under the preliminary proposal to existing biological conditions.

The relative decrease in juvenile winter-run Chinook salmon entrainment under the preliminary proposal compared to existing biological conditions was very similar to that for juvenile steelhead, with overall decreases of around 60% based on the salvage-density method. This reduction was attributable to considerable decreases in entrainment in wet, above normal, and below normal years but little change in dry and critical years. The Delta Passage Model suggested that there may be increases in entrainment (salvage) in some years when comparing the preliminary proposal with existing biological conditions in the late long term, but the estimated increased percentage of winter-run Chinook salmon juveniles to be salvaged under the preliminary proposal was quite low (0.01% of all individuals on average, a 12% increase relative to existing biological conditions). Estimates of the percentage of winter-run Chinook salmon salvaged at the south Delta export facilities from the Delta Passage Model were an order of magnitude lower than estimates of entrainment loss from the salvage-density method, even if a

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multiplier of 3 or 4 is applied to the Delta Passage Model results to account for entrainment losses during salvage. The results of the salvage-density method suggested entrainment losses of winter-run Chinook salmon are well below 1% in all water-year types under the preliminary proposal, albeit under a simplified assumption of a fixed number of individuals reaching the Delta each year.

Entrainment of juvenile spring-run Chinook salmon was estimated to be similar or somewhat lower under the preliminary proposal than under existing biological conditions across all water years (considering the all-year salvage-density results and the average results from the Delta Passage Model). The salvage-density results suggested that substantial decreases in entrainment in wet years under the preliminary proposal (around 60%, but with large numbers of fish) contrasted with appreciable increases in below normal (50–90%) and dry years (50–80%), albeit with lower numbers of fish estimated to be entrained in the latter year types. The estimates of the percentage of spring-run Chinook salmon juveniles entrained at the south Delta export facilities from the salvage-density method was up to 5% for the preliminary proposal and over 10% for existing biological conditions, but these percentages are probably an overestimate because the length-based classification method may classify fall-run Chinook salmon as spring-run. As with winter-run Chinook salmon, the estimates of salvage from the Delta Passage Model were considerably less than the entrainment loss estimates from the salvage-density method, even accounting for losses not included in the Delta Passage Model estimates.

The general similarity in emigration timing of juvenile fall-run Chinook salmon to spring-run Chinook salmon resulted in similar salvage-density results: overall modestly reduced entrainment losses (less than 30%) under the preliminary proposal compared to existing biological conditions that was driven largely by substantial decreases in entrainment in wet years when more export pumping shifts to the north Delta intakes. The results for late fall–run Chinook salmon suggested decreased entrainment under the preliminary proposal by 30–40% across all water years relative to existing biological conditions, with this pattern again being driven largely by considerable decreases in wet years, but the differing seasonality of emigration meant that increases in entrainment under the preliminary proposal were not generally evident in any of the water-year types. The results of the Delta Passage Model for fall-run Chinook salmon generally suggested modest differences (typically less than 30%) in entrainment between the preliminary proposal and existing biological conditions for fish originating in the Sacramento and San Joaquin watersheds. As with winter-run Chinook salmon, salvage under the preliminary proposal would be greater than under existing biological conditions (by 40%), but the overall percentage of fish lost to entrainment (0.01–0.02%) was very low. The percentage of fall-run and late fall–run Chinook salmon estimated to be lost to entrainment from the salvage density method was well below 1% for all scenarios, and the estimated salvage from the Delta Passage Model for Sacramento River–origin fish was also very low (below 0.1%). The estimated salvage of San Joaquin–origin fall-run Chinook salmon was above 1% for existing biological conditions and preliminary proposal scenarios, reflecting the greater likelihood of fish from the San Joaquin watershed reaching the south Delta export facilities than the Sacramento River–origin fish.

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ENTRAINMENT OF DELTA SMELT AT THE SOUTH DELTA EXPORT FACILITIES MAY GENERALLY DECREASE UNDER BDCP RELATIVE TO EXISTING BIOLOGICAL CONDITIONS, ALTHOUGH INSTANCES OF INCREASED ENTRAINMENT ARE ALSO POSSIBLE

In general, entrainment of delta smelt was reduced under the preliminary proposal relative to existing biological conditions, reflecting the reduced south Delta exports. Therefore the project generally maintains or enhances the low entrainment from south Delta pumping regulations assumed under the existing biological conditions. For adults, a number of different methods (salvage density, OMR regressions based on unadjusted and adjusted Kimmerer estimates of proportional entrainment, and the Manly salvage estimation technique) generally gave the same basic results: across all water years entrainment would be substantially reduced (25% to almost100%), with the magnitude of decrease being greatest in wet years (greater than 50%) ranging to little change from existing biological conditions in dry and critical years.

In addition to decreases in entrainment, results for larvae and juveniles suggested possible increases in entrainment. For juveniles, average decreases in entrainment under the preliminary proposal relative to existing biological conditions averaged around 25–40% across all water years using the salvage-density method. However, increased south Delta exports during the juvenile period in above normal years gave increased entrainment by 20–30%, for example. Application of the analyses based on Miller (2011) meant that in addition to OMR flows, the position of X2 also became important. Because X2 is positively related to proportional entrainment and can be greater (further upstream) under the preliminary proposal than existing biological conditions because of the north Delta diversions, estimates of proportional entrainment were occasionally relatively higher (e.g., by 10–30%) under the preliminary proposal than under the existing biological conditions. The estimated absolute differences were small, however, and constituted less than 0.01 (1% of the population) in most cases.

Adjustment of Kimmerer's estimates to account for potential biases described by Miller (2011) reduces the proportion of the population estimated to be entrained, in particular for adults. Thus unadjusted estimates of adult entrainment averaged up to 0.10 (10% of the population) in some water year types whereas adjusted estimates never averaged more than around 0.06 (6% of the population). The actual proportion of the population entrained may be within the range bounded by the adjusted and unadjusted estimates. Application of a different adjustment factor would change the absolute estimates of entrainment but would maintain the relative differences in entrainment between preliminary proposal and existing biological conditions.

ENTRAINMENT OF LARVAL AND ADULT LONGFIN SMELT AT THE SOUTH DELTA EXPORT FACILITIES MAY DECREASE UNDER BDCP RELATIVE TO EXISTING BIOLOGICAL CONDITIONS, WHEREAS JUVENILE ENTRAINMENT COULD REMAIN SIMILAR TO EXISTING BIOLOGICAL CONDITIONS OR SLIGHTLY INCREASE

Overall, entrainment of larval and adult longfin smelt at the south Delta export facilities may decrease under the preliminary proposal relative to existing biological conditions. Entrainment for these life stages follows a familiar pattern evident in a number of the covered species: decreases in entrainment under the preliminary proposal relative to existing biological conditions

in higher-flow years coupled with modest changes (increases or decreases) in lower-flow years. For juvenile longfin smelt, salvage has historically been higher in lower-flow years and the salvage-density approach for March–June entrainment suggested that overall entrainment loss would be similar or slightly increase (by up to 25%) under the preliminary proposal relative to existing biological conditions. Although there were considerable relative increases in entrainment (over 100% in some cases) under the preliminary proposal in below normal years, the actual numbers of fish involved were very low (single individuals). Higher numbers of entrained fish were estimated in dry water years and it was in these years that entrainment under the preliminary proposal was 14–44% higher than existing biological conditions. In critical years, there were modest decreases of 5–20% in entrainment under the preliminary proposal relative to existing biological conditions.

ENTRAINMENT OF SACRAMENTO SPLITTAIL AT THE SOUTH DELTA EXPORT FACILITIES MAY INCREASE BECAUSE IMPROVED REPRODUCTION FROM INCREASED ACCESSIBILITY TO FLOODPLAIN HABITAT WOULD INCREASE POPULATION SIZE

The two different modeling techniques for entrainment (represented by salvage) of Sacramento splittail gave opposite results. The Delta inflow method estimated substantially less salvage under the preliminary proposal compared to existing biological conditions because of reduced pumping in the south Delta under the preliminary proposal. In contrast, the Yolo Bypass days of inundation method estimated that there would be substantial increases (severalfold to an order of magnitude or more) in the number of Sacramento splittail entrained in most water-year types; this would occur because of increased accessibility to floodplain habitat for spawning and early rearing, leading to more juvenile splittail occupying the Plan Area. However, the general decrease in export pumping from the south Delta during the main May–July entrainment period for juvenile splittail would result in a lower overall proportion of the splittail population being entrained.

ENTRAINMENT OF WHITE STURGEON AND GREEN STURGEON AT THE SOUTH DELTA EXPORT FACILITIES MAY DECREASE BECAUSE OF REDUCED EXPORT PUMPING

Under the assumption that reduced export pumping in the south Delta is directly proportional to entrainment of juvenile white and green sturgeon, entrainment of these two species should decrease under the preliminary proposal relative to existing biological conditions. The decrease would be greater in wet and above normal years (40–60%) than in below normal, dry, and critical years (10–30% or less).

ENTRAINMENT OF PACIFIC LAMPREY AND RIVER LAMPREY AT THE SOUTH DELTA EXPORT FACILITIES MAY DECREASE BECAUSE OF REDUCED EXPORT PUMPING

As with white and green sturgeon, reductions in south Delta export pumping would be expected to decrease entrainment of Pacific and river lamprey macropthalmia and adults under the preliminary proposal relative to existing biological conditions. The estimated level of reduction (approximately 50%) is based solely on the assumption that proportional changes in flow lead to similar proportional changes in entrainment.

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NONPHYSICAL BARRIERS HAVE THE POTENTIAL TO REDUCE ENTRAINMENT OF SOME COVERED FISH SPECIES AT THE SWP/CVP SOUTH DELTA EXPORT FACILITIES, BUT THERE IS UNCERTAINTY BECAUSE OF HYDRODYNAMICS AND PREDATION

Nonphysical barriers at the entrances to Clifton Count Forebay (CCF) and the Delta-Mendota Canal (DMC) have the best potential to reduce entrainment of juvenile Chinook salmon and steelhead and juvenile and adult delta smelt, longfin smelt, and Sacramento splittail. There is little potential to reduce entrainment of white and green sturgeon or Pacific and river lamprey because these species have little sensitivity to the acoustic deterrence of the nonphysical barriers. The effectiveness of nonphysical barriers will depend on the water velocity characteristics in the vicinity of the barrier and on the extent to which predatory fish occur along the barrier.

SCREENING OF THE SWP/CVP NORTH DELTA INTAKES SHOULD PREVENT ENTRAINMENT AND IMPINGEMENT OF ALL BUT THE SMALLEST LIFE STAGES OF COVERED FISH SPECIES

The north Delta intakes will be screened to exclude juvenile delta smelt and are expected to be effective at excluding fish less than 15 mm long. Because this life stage of delta smelt is smaller than most life stages of all the covered fish, the screens are expected to be protective of nearly all life stages of all covered fish species. Exceptions could be smaller larvae of delta smelt, Sacramento splittail, and white sturgeon that may occur in the intake vicinity. Very little is known of the densities of these species in this area, so entrainment and impingement monitoring will determine the extent to which they occur there. The considerable along-bank length of each of the intakes necessitates monitoring (see below) that fish are indeed being excluded from entrainment and impingement in the manner that the design specifications suggest they should be.

IMPLEMENTATION OF A DUAL CONVEYANCE FOR THE SWP NORTH BAY AQUEDUCT SHOULD REDUCE ENTRAINMENT OF DELTA SMELT AND LONGFIN SMELT LARVAE

Construction of an alternative intake on the Sacramento River for the North Bay Aqueduct (NBA) will provide flexibility in operations and facilitate reduced pumping from the Barker Slough Pumping Plant in the Cache Slough Subregion, a particularly important portion of the delta smelt range. This should reduce entrainment of delta smelt larvae because delta smelt are not commonly found in the vicinity of the alternative intake. Particle-tracking modeling also showed that tidal restoration and changes in hydrodynamics could reduce larval delta smelt entrainment at the Barker Slough Pumping Plant even without implementation of a dual conveyance, as there were very few model runs with greater entrainment under preliminary proposal scenarios compared to existing biological conditions. In contrast to delta smelt, it was estimated that increased entrainment of longfin smelt larvae at the Barker Slough Pumping Plant under the preliminary proposal relative to existing biological conditions would occur as often as decreased entrainment under the preliminary proposal; however, the percentage of entrained particles was very low and would become even lower with the implementation of a dual conveyance.

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DECOMMISSIONING OF AGRICULTURAL DIVERSIONS IN BDCP RESTORATION OPPORTUNITY AREAS WILL REDUCE ENTRAINMENT OF COVERED SPECIES TO SOME SMALL DEGREE

There is no evidence of substantial entrainment of covered fish species at agricultural diversions in the Plan Area, but some entrainment likely is occurring. Whatever entrainment is occurring would be reduced by decommissioning agricultural diversions in the BDCP Restoration Opportunity Areas (ROAs). Particle-tracking modeling and extrapolations to a hypothetical number of diversions to be removed from the ROAs (i.e., around 4–12% of diversions) gave estimates of up to a 1% reduction in overall loss of delta smelt larvae because of such decommissioning. This reduction is uncertain because particle tracking is not necessarily an accurate representation of smelt larval behavior in relation to agricultural intakes. Greater benefits to smelt and other covered species associated with removing water diversion structures may occur from the reduction of predator holding habitat (see Appendix F) than from reductions in entrainment.

ESTIMATES OF ENTRAINMENT CHANGES UNDER BDCP ARE UNCERTAIN, BUT ENTRAINMENT IS READILY MONITORED

There is uncertainty when estimating the effects of pumping changes that may result under the preliminary proposal, beyond the general observation that entrainment should decrease as pumping decreases. An example is the uncertainty of whether the relationship between pumping and entrainment is linear or non-linear. However, fish losses at water diversions are readily monitored. Entrainment (and impingement) sampling programs already exist, and others will be developed as part of the BDCP implementation in order to allow monitoring of the preliminary proposal, with particular emphasis on:

- Continued salvage and entrainment monitoring at the SWP/CVP south Delta export facilities.
- Entrainment and impingement monitoring at the new SWP/CVP north Delta intakes.
- Entrainment and impingement monitoring at the SWP NBA Barker Slough Pumping Plant and Alternative Intake on the Sacramento River.

Continued entrainment monitoring into the future will be of particular importance, given the likely changes in species distribution caused by large-scale habitat changes. For example, species such as longfin smelt may spawn farther upstream as sea level rises.

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B.1 ORGANIZATION OF THE APPENDIX

This appendix provides details of technical analyses of entrainment of covered fish species in water diversions under the BDCP preliminary proposal. The appendix is organized as follows.

- **Section B.2 (Introduction)** provides background on the issue of entrainment in the Plan Area, a conceptual model for the factors affecting entrainment, the potential importance of entrainment as assessed in the DRERIP species conceptual models, the ways in which entrainment has been reduced by the 2008 and 2009 Biological Opinions (BOs), the means by which the BDCP may affect entrainment, and the objectives of the appendix.
- **Section B.3 (Sources of Entrainment—Water Diversion Facility Descriptions)** provides descriptions of the main water diversion facilities that would be constructed or would have changed operations under BDCP (i.e., the State Water Project/Central Valley Project [SWP/CVP] south Delta export facilities, the SWP/CVP north Delta intake, the NBA Barker Slough Pumping Plant and Alternative Intake, and agricultural diversions).
- **Section B.4 (Schedules of Water Diversions)** summarizes the changes in diversion flows and schedules under the preliminary proposal for the SWP/CVP south Delta export facilities, the SWP/CVP north Delta intake, and the NBA Barker Slough Pumping Plant.
- **Section B.5 (Methods of Biological Analysis)** outlines the procedures used to assess the exposure of each species to entrainment and describes in detail the technical methods used to analyze the effects of entrainment on covered fish species.
- **Section B.6 (Results of Biological Analysis)** describes in detail the results of the entrainment analyses for all covered fish species.
- **Section B.7 (Summary and Conclusions for Effects on Entrainment)** summarizes the overall results of the entrainment analyses by describing percentage change from baseline that is attributable to BDCP and provides narrative conclusions regarding the results.

B.2 INTRODUCTION

This appendix describes changes in operations of water diversions in the Delta as a result of BDCP and provides estimates of entrainment of covered fish species under BDCP. The main objective of the appendix is to use these estimates of entrainment to estimate the relative difference in entrainment between preliminary proposal (PP) and baseline condition referred to as the *existing biological condition* or EBC. The results from this appendix will be rolled up into Chapter 5, allowing the relative change to be placed in the context of the overall importance of the stressor to the populations of covered fish species.

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Entrainment is the removal of fish and other aquatic organisms from water bodies by water diversions[2]. In the San Francisco Bay/Sacramento–San Joaquin River Delta (Bay-Delta), there are many water diversions with varying potential to cause entrainment, including:

- SWP and CVP south Delta export facilities (South Delta Subregion; see Appendix A, Figure 5 for subregions).
- SWP NBA Barker Slough Pumping Plant (Cache Slough Subregion).
- Other larger diversions (e.g., FRWA intake, CCWD intakes at Rock Slough, Old River, and other locations).
- Agricultural[3] diversions and other diversions (all subregions).
- Cooling intakes for energy generating facilities (e.g., Mirant power plant)

Fish entering a water diversion facility are considered to be entrained (Kimmerer 2008). For most diversions, entrained fish are regarded as mortalities and removed from the system. However, the CVP and SWP south Delta pumping facilities have louver systems designed to support fish salvage by diverting a portion of entrained fish into facilities where fish can be sampled, counted, and ultimately transferred to refrigerated trucks to be moved downstream of the pumping stations. Sampling of fish in the salvage facilities is the primary numeric measure of the impacts of entrainment on Delta fish species and provides the basis for most estimates of entrainment. These salvage facilities were designed primarily to protect juvenile salmonids. More fragile species such as delta smelt do not generally survive salvage, and all delta smelt entering salvage are considered mortalities (U.S. Fish and Wildlife Service 2008). The mechanisms for salvage are described in Section 2.4 and summarized below.

The BDCP is intended minimize entrainment levels, while also increasing water supply and water supply reliability. This is accomplished through the use of the proposed north Delta intake facilities in addition to the existing south Delta facilities. The north Delta intakes will have state-of-the-art screening and operational criteria intended to eliminate entrainment from these intakes.

The definition of change in either water-diverted or fish entrained is made by comparing the preliminary proposal (PP) for BDCP operations to base conditions termed existing biological conditions (EBC). The choice of base conditions is an important consideration that affects the depiction of changes under BDCP. As discussed in the Analytical Framework, different legal requirements dictate different base cases. EBC1 is appropriate for consideration of change relative to the needs of the California Environmental Quality Act (CEQA). It includes operations in the 2008 U.S. Fish and Wildlife Service (USFWS) and 2009 National Marine Fisheries Service (NMFS) BOs except for provisions relating to management of the position of X2 in the

[2] This definition of entrainment is consistent with the general usage in California. With respect to removal of fish at cooling water intakes, the term *entrainment* generally is applied only to organisms such as fish eggs or larvae that are too small to be screened (Langford 1983).

[3] The term *agricultural diversions* includes the great majority of diversions, not part of the SWP and CVP.

fall which have not yet been implemented. EBC2 is appropriate for consideration of change relative to the requirement of ESA and includes all provision of the 2008 and 2009 BOs including the fall X2 provisions.

This appendix evaluates the initial project operations as defined by the BDCP steering committee released on February 11, 2010, and evaluated in the November 2010 Working Draft of the BDCP (designated Alternative 1 for the BDCP EIR/EIS). This is defined as the preliminary proposal for the purposes of this appendix because it reflects the modeling results available at this time. When additional modeling results become available, the appendix will be revised, including an assessment of fall X2 and water operations under Scenario 6 (Alternative 1A for the BDCP EIR/EIS). This may modify the analysis and require modification of this appendix and should assist in development of a proposed project for the BDCP.

B.2.1 Conceptual Model of Entrainment

Susceptibility of covered fish species to entrainment is a function of a number of factors, represented conceptually in Figure B-1. These can be summarized as follows:

- Individuals of a species must occur in the vicinity of an intake to be susceptible to entrainment
  - Seasonal migrations may cause species to pass close to intakes
  - Habitat preferences affect proximity (e.g., littoral species may be more susceptible than pelagic species [Nobriga et al. 2004]; species may occur in the vicinity of an intake if preferred physicochemical conditions such as salinity or turbidity are found there [Grimaldo et al. 2009])
  - Bidirectional flows in tidal areas may increase the number of times fish encounter intakes
- The size of an intake relative to the water body that it is in affects entrainment susceptibility
  - The size of the hydraulic zone of influence (HZI)[4] (Richardson and Dixon 2004) increases as water diversion rate increases and as water body size decreases
- The ability of a fish to avoid entrainment is a function of the ability to detect, orient away from, and escape the intake
  - Detection and orientation are most affected by visibility, which may differ depending on turbidity and darkness (Langford 1983) but may be enhanced by other stimuli such as light and sound (Maes et al. 2004),
  - Escape is a function of swimming ability, which is dependent on species (e.g., juvenile Chinook salmon are relatively good swimmers, delta smelt are relatively

[4] The HZI is the region in a water body where the probability of entrainment is high (Richardson and Dixon 2004).

poor swimmers), body size (smaller fish generally swim at slower rates than larger fish), water temperature, body condition (Sprengel and Luchtenberg 1991), and other factors,

- Increases in water velocity entering an intake (approach velocity) increase the risk of entrainment, with the speed past the intake (sweeping velocity, for which increases generally reduce the risk of being entrained) also being important and changing as a function of prevailing river,
- Screening reduces the risk of entrainment by preventing fish from passing into an intake, although the risk of impingement increases as approach velocity increases and sweeping velocity decreases—the effects of impingement on survival are affected by factors such as water temperature (Swanson et al. 2005).

Fish that are entrained may be salvaged if specialized collection facilities exist, such as those at the SWP/CVP south Delta export facilities (Brown et al. 1996). Survival of collection, handling, transport, and release back to the Delta depends on species sensitivity and the physical conditions during transport (e.g., temperature). Predation, which will be analyzed in more detail in Appendix F, is a factor that also can greatly decrease survival of entrained fish at the south Delta export facilities and may affect fish approaching the north Delta intakes.

The conceptual model presented in Figure B-1 introduces the idea that the HZI increases with the size of the diversion. Moyle and Israel (2005) noted that there are few data for entrainment in the Central Valley at locations other than the SWP/CVP south Delta export facilities, but that those that do exist suggest a nonlinear increase in entrainment as diversions increase at least for salmon. This reflects the increase in volume of the HZI. A nonlinear relationship between intake flow and entrainment is also characteristic of the SWP/CVP south Delta export facilities (Kimmerer 2008). Small intakes, such as agricultural diversions, have considerably smaller HZI that are restricted to the nearshore area. Many small diversions cumulatively may divert as much water as a single very large intake, but the entrainment rate of the agricultural diversions expressed as density of fish per unit volume diverted may be considerably less than that diverted by the single large intake. However, as noted above, predation at these many small diversions may be substantial.

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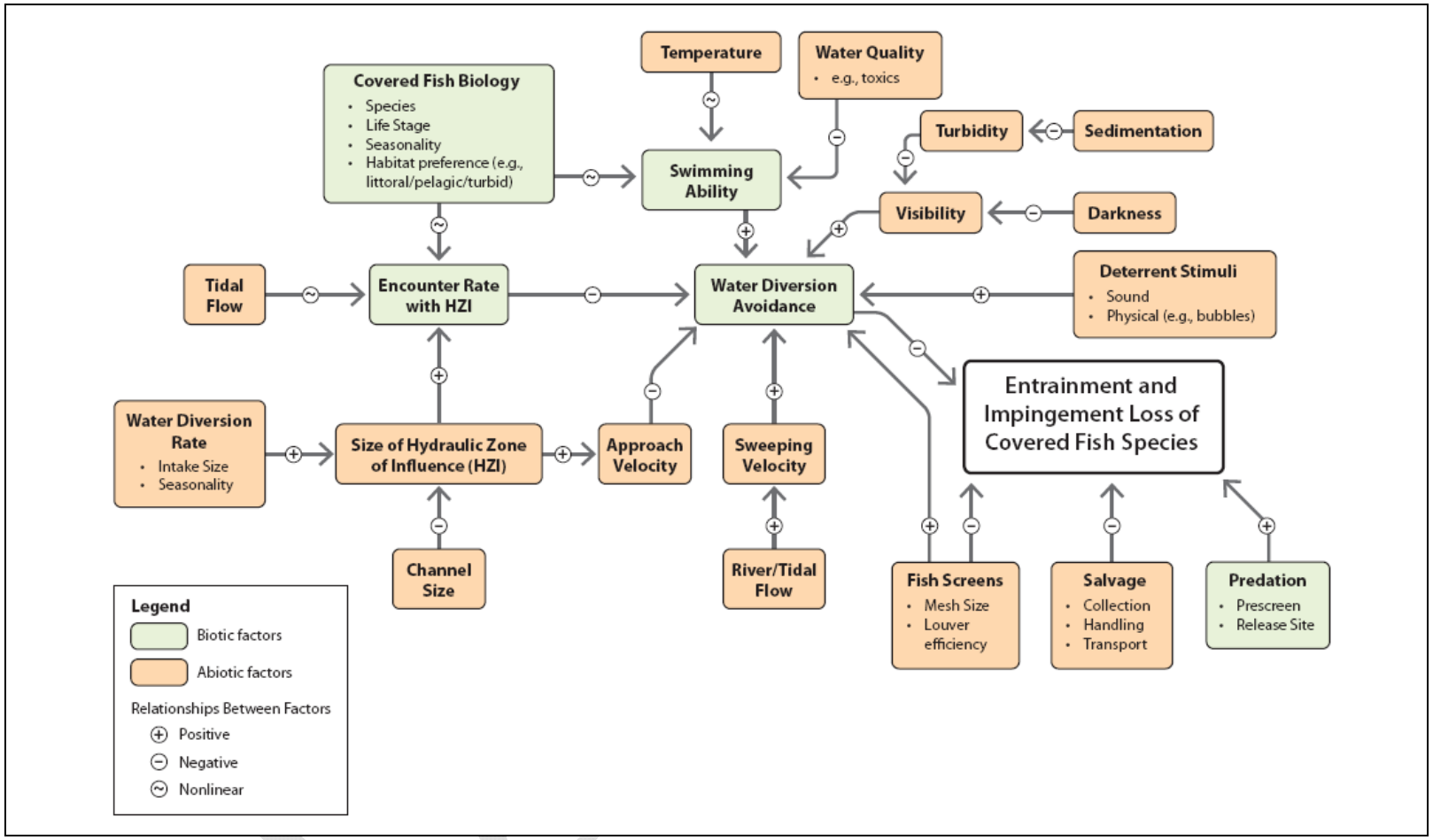

Figure B-1. Conceptual Model of Biotic and Abiotic Factors Influencing Entrainment and Impingement Loss of Covered Fish Species

B.1.1 Potential Importance of Entrainment

The overall importance of entrainment relative to specific species populations, and how the BDCP may affect populations, will be discussed under the topic of population-level effects of BDCP in Chapter 5. This section will review information related to the historical pattern and numbers of fish entrained in the SWP and CVP south Delta facilities and the impact of recent regulatory changes on the estimated numbers of fish entrained.

The importance of different environmental factors such as entrainment on the control and recovery of covered fish species reflects their life histories and physiological requirements. Exposure of fish to environmental stressors reflects the spatial and temporal movement of life stages through the study area and differences in habitat requirements for life stages (Appendix A, Figure A-10). Life stages of covered fish species reside in or pass through the Bay-Delta and may be at risk of entrainment (e.g., delta smelt, juvenile salmonids), whereas others (e.g., eggs of green sturgeon) do not occur in the Bay-Delta but may be entrained at agricultural diversions in natal rivers. Life stages of various species enter and use the Delta and become susceptible to entrainment at different times, resulting in differences in entrainment impacts (Grimaldo et al. 2009).

Entrainment of Delta fish in water diversions has been an important focus for scientific investigation in the Delta and a key consideration for management of water operations and fish conservation. Because the south Delta SWP and CVP facilities are the largest water diversions in the Delta, they have been the subject of most scientific investigation and management actions relating to entrainment. In the past, these facilities have entrained large numbers of Delta fish species. For example, between 1979 and 1993 up to 435,000 juvenile Chinook salmon and 56,000 delta smelt were salvaged annually at the SWP south Delta fish facility; because of predation and the relatively low diversion efficiency of the louver screens (the percentage of fish that are successfully directed to holding tanks and counted) actual loss of fish to entrainment at the CVP/SWP facilities during this period are believed to have been several times these estimates (Brown et al. 1996). Entrainment by agricultural diversions also occurs (Cook and Buffaloe 1998; Nobriga et al. 2004) but is not believed to be as substantial because of the small size of these intakes, although predation levels in the vicinity of the structures may be high (Vogel 2011).

In recent years, entrainment of pelagic species (e.g., delta smelt and longfin smelt) and other Delta fish from the south Delta facilities has been substantially reduced due to changes in export operations but also because of declining abundance of some fish such as delta smelt (Kimmerer 2011).

Figure B-2 compares total monthly and annual CVP and SWP salvage for several covered fish species (delta smelt, longfin smelt, Chinook salmon and splittail) from 1991 through 2010. Salvage is a proportion of total entrainment reflecting the efficiency of louvers to divert fish into the salvage facilities but is assumed to index total entrainment. Actual entrainment is always

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appreciably larger than salvage. Chinook salmon and delta smelt have a clear pattern of entrainment with peak numbers entering salvage in 1999 and 2000 but a sharp decline in more recent years. Splittail and longfin smelt have shown high levels of salvage in some years. Salvage has a seasonal pattern as well with salvage of all four species concentrated in March through May. The monthly and annual salvage varies from year to year because of changes in pumping and changes in the density of fish (number of fish per unit volume of water) in the vicinity of the diversions. These graphs show that, as noted above, the number of fish salvaged at CVP and SWP in recent years is greatly reduced from previous levels. This presumably reflects reduced abundance of fish, various pumping restrictions, and the use of new management techniques for avoiding entrainment through the management of turbidity events into the Central Delta. Nonetheless, entrainment remains a focus of regulatory concern due to the requirement to estimate and regulate species take, as well as the fact that it is essentially the only source of mortality that is catalogued and reported every single day. Thus, a key part of the BDCP Effects Analysis must evaluate effects on entrainment.

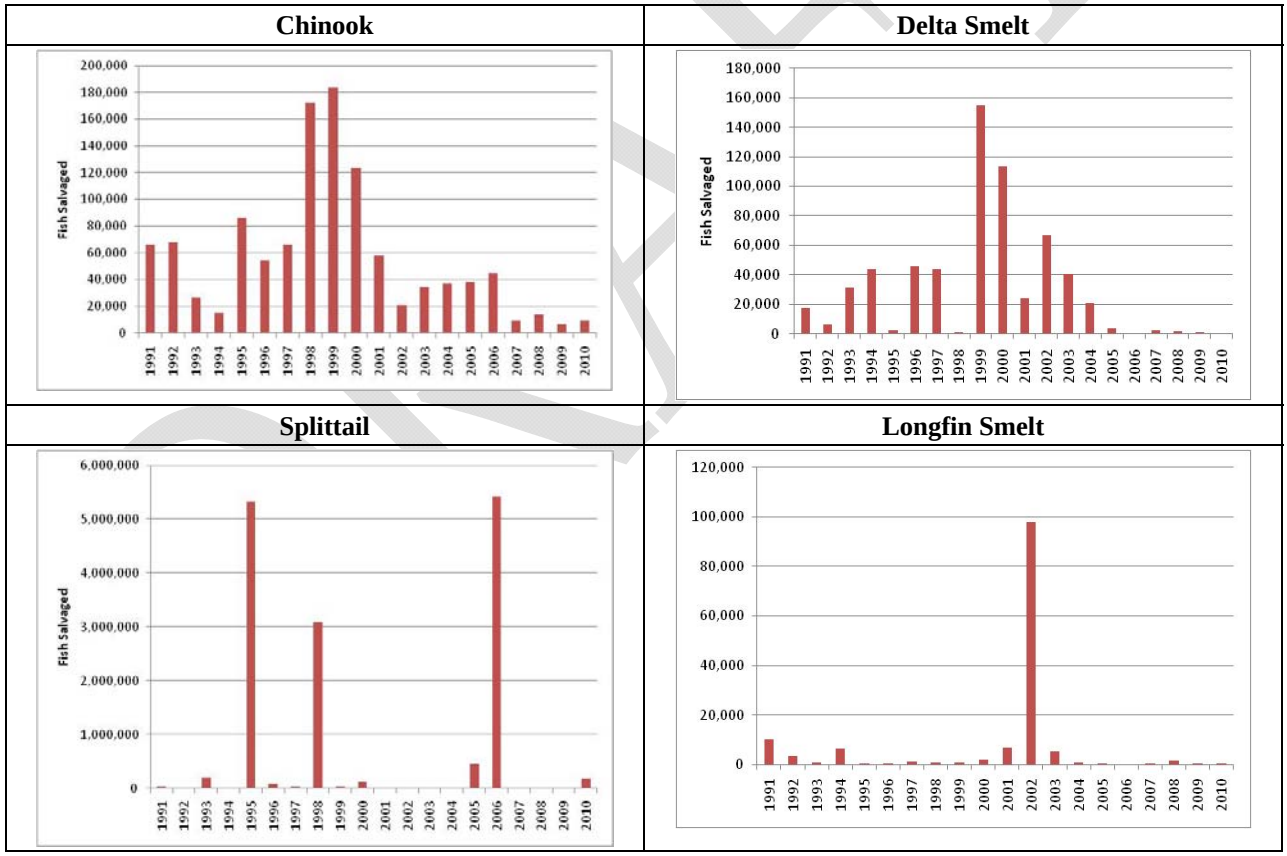

Figure B-2. Combined Salvage of Fish at CVP and SWP Pumping Facilities

As noted above, entrainment of fish does not necessarily mean they are killed. The fish salvage systems at the CVP Tracy Fish Facility and the SWP Skinner Fish Facility divert a portion of fish into a salvage system and to be returned to the Delta. These systems were designed primarily

to salvage juvenile salmon and other fairly robust fish. However, delta smelt are more fragile and are assumed not to survive the salvage process. For the remainder of listed fish species, the proportion of fish killed by entrainment depends on factors such as predation and louver screening efficiency. Louver efficiency is low, < 20% at SWP and <40% at CVP (NMFS 2009).

Because of the difficulty associated with estimating total population size of the Delta fish species, most analysts have estimated fish entrainment as a proportion of population indices assuming that this proportionality applies to the population as well. Kimmerer (2008) estimated the loss of larval and juveniles for the years 1995 to 2006 at between 0 and 26% of the larval and juvenile population and from 1 to 22% of the adult delta smelt population. Miller (2011) reanalyzed and updated Kimmerer's analysis and concluded that no more than 13% of delta smelt was entrained by the south Delta pumps. Kimmerer (2011) concurred with some points of Miller's reanalysis but also noted that the reduced proportions in recent years may reflect reduced abundance of delta smelt in the south Delta. Both analyses indicate that appreciable proportions of the overall populations of some species may have been entrained in some years.

The numbers and proportions of delta smelt entrained in the south Delta pumps has been a consistent management concern and has resulted in significant modification of regional water operations (U.S. Fish and Wildlife Service 2008). However, analyses to date have not found correlation between entrainment and population level responses of delta smelt (e.g., Kimmerer 2008, Baxter et al. 2010). In fact, analyses have generally failed to find strong signals from any single environmental attribute that explains the recent population declines in delta smelt and other pelagic fish species (Baxter et al. 2010). This indicates that the changes in the Delta fish community are the result of many converging factors and argues for a holistic, ecosystem approach to restoration.

The relative importance of entrainment and other attributes was evaluated by a group of regional scientists through a series of conceptual models published by the Delta Regional Ecosystem Implementation Program (DRERIP)[5]. The DRERIP models provide a conceptual view of the life history and habitat requirements of the species and a subjective ranking of stressors for the species. I t is important to note that the DRERIP conceptual models generally were written prior to the OCAP BOs (USFWS 2008; NMFS 2009) and do not reflect the pumping restrictions intended to reduce the effects of entrainment at the south Delta export facilities. The DRERIP model for delta smelt developed by Nobriga and Herbold (2009) ranked water exports (entrainment) and water transparency as the most important stressors on delta smelt at that time; food, competition and ecosystem effects also received high rankings. These rankings have not been updated to reflect the operational changes in pumping at the south Delta facilities.

The DRERIP rankings as well as the quantitative analyses such as those of Kimmerer (2008, 2011) and Miller (2011), while reflecting different assumptions and approaches, converge on a conclusion that entrainment of large numbers of covered fish species has occurred in the past

[5] http://www.dfg.ca.gov/ERP/conceptual_models.asp

during periods of high water exports from the CVP and SWP facilities. It is also clear that the numbers of fish entrained has declined in recent years and that the importance of entrainment to short- and long-term population dynamics of delta smelt is not clear. Regardless, as pointed out by Grimaldo et al. (2009) because entrainment is a function of water exports and is a highly visible source of human-caused mortality to Delta fish species, it will continue to receive close scrutiny and a focus of efforts to reduce impacts of water operations on fish.

The protection of delta smelt and other species by curtailing water exports has resulted in significant water supply and economic costs and may not be effective in recovering delta smelt (Miller 2011; Maunder and Deriso 2011). Therefore, BDCP includes new diversion facilities and operational rules to control and manage entrainment that work in conjunction with habitat restoration and other measures to recover the Delta ecosystem. The entrainment analyses presented in the sections below focus on how entrainment of covered fish species may change in the future as a result of implementation of BDCP CM1, which consists of new conveyance facilities and operational rules designed to minimize entrainment.

B.1.2 How the Bay Delta Conservation Plan May Affect Entrainment

As described in Chapter 3, BDCP proposes a number of alterations to water diversion facilities in the Plan Area that may change the effects of entrainment on covered fish species. These include:

- Reduction of exports at the SWP/CVP south Delta export facilities through construction and use of a new north Delta intake that would operate in tandem with south Delta export facilities as a dual conveyance facility.
- Installation of nonphysical barriers at the entrance to CCF and the DMC.
- Reduction of exports at the SWP NBA Barker Slough Pumping Plant through construction of a new alternative intake on the Sacramento River that would operate in tandem with the Barker Slough Pumping Plant.
- Elimination of agricultural diversions onto lands restored by BDCP (and taken out of agricultural production) within the BDCP restoration opportunity areas (ROAs).

B.2 SOURCES OF ENTRAINMENT—WATER DIVERSION FACILITY DESCRIPTIONS

B.2.1 BDCP Conservation Measure 1: Dual Conveyance System

BDCP CM1 calls for the application of a new system for SWP and CVP water exports in the Delta. This system consists of a new pumping facility on the Sacramento River (north Delta diversion) that would be connected to the existing south Delta facilities. This will increase flexibility of water operations and affect the amount of water exported from the existing south Delta pumps with expected changes in the number of fish entrained in south Delta export facilities.

B.2.2 SWP South Delta Export Facilities

The SWP south Delta export facility consists of three major components: (1) CCF, (2) the Banks pumping facility, and (3) the Skinner fish protection facility.

B.2.2.1 *Clifton Court Forebay*

Water for the SWP south Delta export facilities is diverted into CCF and pumped at Harvey O. Banks Pumping Plant (Banks). CCF is a 2.6-mile-by-2.1-mile, 31,000-acre-foot regulatory reservoir located in the southwestern edge of the Delta in the South Delta Subregion, about 10 miles northwest of the city of Tracy. Inflows from surrounding channels are controlled by five 22-foot-wide radial gates in the southeast of the forebay, which generally are operated based on the tidal cycle to reduce approach velocities, prevent scour in adjacent channels, and minimize water-level fluctuation in the south Delta by taking water in through the gates at times other than low tide. When a large head differential (difference in water surface elevation) exists between the outside and the inside of the gates, theoretical inflow can be as high as 15,000 cubic feet per second (cfs) for a short time and exceed 10 feet per second (ft/sec) (Kano 1990). Water is withdrawn from the forebay through a 0.8-mile-long rock-lined outlet channel paralleling the western edge, which originally connected Italian Slough to the California Aqueduct. The John E. Skinner Delta Fish Protective Facility fish screens at the southern end of the outlet channel separate the CCF from the channel leading to Banks and thence to the California Aqueduct. The CCF is notable for the large population of predatory fish such as striped bass, which once were estimated to number around 200,000 fish (Brown et al. 1996) (although the movement of fish into and out of the CCF probably resulted in an overestimate of abundance [Kano 1990]). These predators apparently consume approximately 75% or more of the prey fish that are entrained into the CCF, based on mark-recapture studies (Gingras 1997; Clark 2009).

B.2.2.2 *Harvey O. Banks Pumping Plant*

Banks is in the South Delta Subregion about 8 miles northwest of Tracy and marks the beginning of the California Aqueduct. Banks provides the initial lift of water 244 feet into the aqueduct by means of 11 pumps, including two rated at 375-cfs capacity, five at 1,130-cfs capacity, and four at 1,067-cfs capacity. The nominal capacity of Banks is 10,300 cfs. The pumps can be operated at full capacity to enable diversions to use power in off-peak periods, typically 2200–0800 hours (Kano 1990).

B.2.2.3 *John E. Skinner Delta Fish Protective Facility*

The John E. Skinner Delta Fish Protective Facility is located at the head of the intake channel that connects CCF to Banks and screens fish away from the pumps. Debris is directed away from the pumps by a 388-foot-long trash boom. Fish are diverted from the intake channel into bypasses by a series of metal louvers, 1 inch apart and set at 15° to the water flow, while the main flow of water continues through the louvers and toward the pumps. Fish pass through a secondary system of louvers and pipes into seven holding tanks, where a subsample (fish

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collected approximately 10–30 minutes out of every 2 hours) later is counted and recorded. Primary and secondary louver efficiency is a function of fish species, size, and approach velocity, with typical efficiencies of 70–95% for the primary and secondary louvers (Brown et al. 1996:1523). The salvaged fish then are driven in oxygenated tank trucks to several release sites in the West Delta Subregion: Horseshoe Bend (Sacramento River), Sherman Island (San Joaquin River), and Antioch (a site shared with the Tracy Fish Collection Facility) (NMFS 2009:351).

B.2.3 CVP South Delta Export Facilities

The CVP (south Delta export facility consists of two components: (1) Jones Pumping Plant and (2) the Tracy Fish Facility.

B.2.3.1 *C.W. "Bill" Jones Pumping Plant*

The Jones Pumping Plant is located at the end of an earth-lined intake channel about 2.5 miles long (NMFS 2009: Appendix A). Jones Pumping Plant has a permitted diversion capacity of 4,600 cfs with maximum pumping rates typically ranging from 4,500 to 4,300 cfs during the peak of the irrigation season and approximately 4,200 cfs during the winter non-irrigation season until construction and full operation of the Delta-Mendota Canal (DMC)/California Aqueduct Intertie. The winter-time constraints at the Jones Pumping Plant are the result of a DMC freeboard constriction near O'Neill Forebay, O'Neill Pumping Plant capacity, and the current water demand in the upper sections of the DMC.

B.2.3.2 *Tracy Fish Collection Facility*

Off Old River (South Delta Subregion), at the head of the intake channel to the Jones Pumping Plant, the Tracy Fish Collection Facility's louver screens intercept fish, which, in a salvage process similar to the John E. Skinner Delta Fish Protective Facility (described above), then are collected, held, and transported by tanker truck to release sites in the West Delta Subregion: Horseshoe Bend (Sacramento River) and adjacent to the State Route 160 bridge in Antioch (NMFS 2009:351). As with the John E. Skinner Delta Fish Protective Facility, the salvage of fish is less than 100% efficient: prescreen losses to predation are estimated at 15%; louver efficiency is around 50%; and collection, handling, and transport are 98% efficient (NMFS 2009:352).

B.2.4 SWP/CVP North Delta Intake

The SWP/CVP north Delta intake does not presently exist but is proposed as part of the BDCP Dual Conveyance facility. Conceptual designs for the SWP/CVP north Delta intake have not been finalized, but it is generally thought that five 1,200-foot-long, 3,000-cfs, on-bank intakes with positive barrier screens (Figure B-3) would be constructed in the Hood area of the Sacramento River (North Delta Subregion).

The north Delta intake is being designed to minimize entrainment effects on covered fish species. The facility on the Sacramento River above the range of major concentrations of delta smelt and along the side of the river (rather than intercepting the entire channel as is the case for

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the south Delta facilities) which should increase sweeping flow. The proposed positive barrier intake screens will be designed in accordance with the California Department of Fish and Game (DFG) (2011) and National Marine Fisheries Service (NMFS) (2008) fish screen criteria. These criteria include, for fish screens in areas where delta smelt are known to occur, a screen mesh with opening (assuming a wedge-wire screen surface) of 1.75 mm and a maximum approach velocity of 0.33 ft/sec; however, the screens would be operated at 0.2 ft/sec to meet delta smelt screening requirements. In addition, the sweeping velocity of water passing the intakes will be at least two times the approach velocity, or greater than 0.4 ft/sec. Unused sections of the fish screens would be covered to provide operational flexibility as necessary.

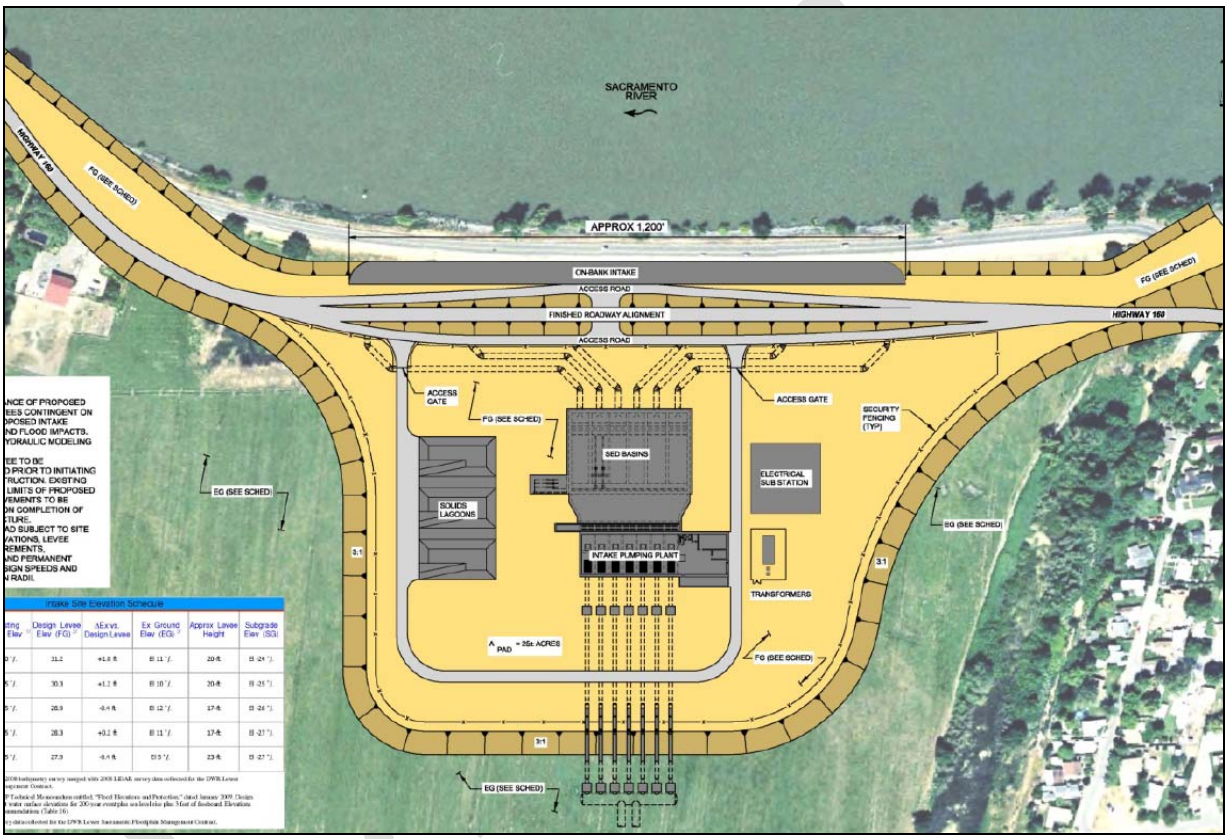

Figure B-3. Schematic of Hypothetical On-Bank Intake

B.2.5 SWP North Bay Aqueduct Barker Slough Pumping Plant and Alternative Intake

The Barker Slough Pumping Plant is part of the SWP and diverts water from Barker Slough (Cache Slough Subregion) into the North Bay Aqueduct (NBA) for delivery to municipal and industrial uses in Napa and Solano Counties. The NBA intake is located approximately 10 miles from the mainstem Sacramento River at the end of Barker Slough, just upstream. The maximum pumping capacity is 175 cfs (pipeline capacity). During the last few years, daily pumping rates have ranged between 0 and 140 cfs because of thick bio-film growth on the interior of the NBA

pipeline that has resulted in reducing the effective diameter of the pipe (ESA 2009). Each of the 10 NBA pump bays is fitted individually with a positive-barrier fish screen consisting of a series of flat, stainless steel, wedge-wire panels with a slot width of 3/32 inch. This configuration is designed to exclude fish 25 millimeters (mm) or larger from being entrained. The bays tied to the two smaller units have an approach velocity of about 0.2 ft/sec. The larger units were designed for a 0.5-ft/sec approach velocity, but actual approach velocity is about 0.44 ft/sec. The screens routinely are cleaned to prevent excessive head loss, thereby minimizing increased localized approach velocities.

The NBA Alternative Intake is a new facility to be located on the Sacramento River upstream of the Sacramento Regional Wastewater Treatment Plant that will address some of the main concerns with the existing Barker Slough Pumping Plant (ESA 2009). Barker Slough provides habitat to both state- and federally listed species (including delta smelt and longfin smelt). In 2000, the CALFED Record of Decision (ROD) concluded that relocation of the NBA intake out of Barker Slough was part of a comprehensive solution to improve the Delta because it would alleviate negative effects on critical habitat, including that of the delta smelt in the Cache Slough Subregion (CALFED 2000). Water quality in Barker Slough becomes degraded during and after rainfall events. The NBA pipeline section from the Barker Slough Pumping Plant to the North Bay Regional Treatment Plant has a design capacity of 175 cfs but, as noted above, the system can deliver a maximum of only about 140 cfs because of thick bio-film growth on the interior of the NBA pipeline. The Alternative Intake would be operated in conjunction with the existing NBA intake at Barker Slough. The Barker Slough Pumping Plant would be operated to divert and deliver water through the NBA up to its current pumping capacity of approximately 140 cfs, when acceptable water quality is available at Barker Slough and environmental concerns are not in effect. During the periods when the Barker Slough Pumping Plant cannot meet the water demand and/or the water quality in Barker Slough is not acceptable, or when there are concerns about listed fish, the Alternative Intake would be operated to help meet water demands. The Alternative Intake would be fitted with state-of-the-art, positive-barrier fish screens to minimize the risk of entrainment and impingement of listed fish species.

B.2.6 Agricultural Diversions

There are a large number of agricultural diversions in the BDCP Plan Area; Herren and Kawasaki (2001) documented more than 2,200 diversions (including nonagricultural diversions) in the Delta (Cache Slough, West Delta, East Delta, and South Delta Subregions) and nearly 370 in Suisun Marsh (Suisun Marsh Subregion). Nobriga and Herbold (2009, delta smelt conceptual model) noted that the actual number may be notably smaller because of the difficulty in differentiating between intake pipes used to divert water and outfall pipes used to drain water off Delta islands. Diversions in the Delta consist mostly of siphons (45% by number) (Herren and Kawasaki 2001) with diversion flows that, after priming, are controlled by both valves in the pipes and differences in water elevations on the water and land sides of the levee (Nobriga et al. 2004). The other most common diversion types are vertical and centrifugal pumps, which contribute 19% and 17% of the total number (Herren and Kawasaki 2001). The great majority of

diversions in Suisun Marsh (79% by number) are floodgates. Ninety percent of the diversion intake sizes in the Delta measured between 12 and 24 inches, whereas 90% of Suisun Marsh floodgates had intake sizes between 36 and 48 inches. Fish screens on diversions in the Delta are very uncommon, with Herren and Kawasaki (2001) estimating that only 0.7% of diversions were screened to DFG criteria.

B.3 SCHEDULES OF WATER DIVERSIONS

Central to the analysis of entrainment is the question of how BDCP is expected to modify the environment by changing water diversions within the BDCP study area. These changes in water diversions are reviewed in this section. Sections 2.5 and 2.6 review analyses that evaluate these changes to the environment in terms of fish entrained.

As described above, changes in water diversions are made by comparing the amount of water diverted in a base case (EBC) to the amount diverted under the preliminary proposal (PP). As discussed in the Analytical Framework, environmental and biological changes are evaluated for each of five water-year types at three points in time: current (base case), early long-term (ELT) and late long-term (LLT). ELT and LLT scenarios incorporate changes to climate expected in the study area over the 50-year BDCP period. In addition, there are two base conditions that reflect different regulatory standards as discussed in the Analytical Framework.

The modeled scenarios included:

- EBC1: Existing biological conditions incorporating the 2008 and 2009 USFWS and NMFS BOs, omitting the fall X2 requirement of the 2008 USFWS BO.
- EBC2: Existing biological conditions fully incorporating the 2008 and 2009 USFWS and NMFS BOs.
- EBC2_ELT: EBC2 in the early long-term, i.e., 11–15 years after the commencement of project implementation incorporating climate change assumptions.
- EBC2_LLT: EBC2 in the late long-term, i.e., 15–50 years after the commencement of project implementation incorporating climate change assumptions.
- PP_ELT: Preliminary proposal including new north Delta intakes and reduced south Delta pumping (dual conveyance structure) in the early long-term, as defined above.
- PP_LLT: Preliminary proposal in the late long-term, as defined above.

The five water-year types are those in the 40-30-30 Sacramento River Basin Index (California Department of Water Resources 2009). Water-year types are not equally distributed within the 1922–2003 hydrologic sequence simulated with CALSIM. Water years and accounting within the 82-year base period are as follows:

- Wet: 26 years (31%)
- Above normal: 12 years (15%)

- Below normal: 14 years (17%)
- Dry: 18 years (22%)
- Critical: 12 years (15%)

B.3.1 Relative Contribution of North and South Delta Intakes under BDCP

The dual conveyance system is intended to provide increased flexibility in management of the SWP/CVP water export system in the Delta. Total pumping would proportionately shift between the north and the south Delta facilities in response to environmental requirements and water demands.

The distribution of pumping between the north and south Delta facilities is shown in Figure B-4, which provides the results of CALSIM analysis of the preliminary proposal and the two base cases. Under existing biological conditions (EBC) exports decline sharply in April and May in response to fish protection measures. The comparison of EBC1 and EBC2 illustrates the reduction in exports in the fall under EBC2 in response to the fall X2 guidelines in the 2008 USFWS BO. Under the preliminary proposal (PP), in the wetter water years (wet and wet conditions, 46% of the water years), most of the combined total exports would come from the new north Delta facility and exports from the south Delta facility would be reduced relative to the base condition (Figure B-4).The reliance on the north Delta pumps declines in the dryer years with almost all pumping coming from the south Delta pumps in dry and critical water years (37% of the years). The declining use of the north Delta pumps in dryer water years reflects requirements to maintain minimum flow and water quality in the lower Sacramento River.

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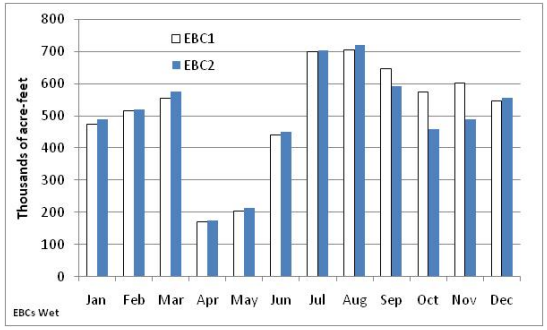
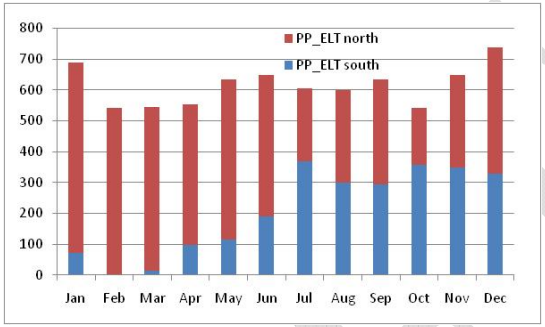
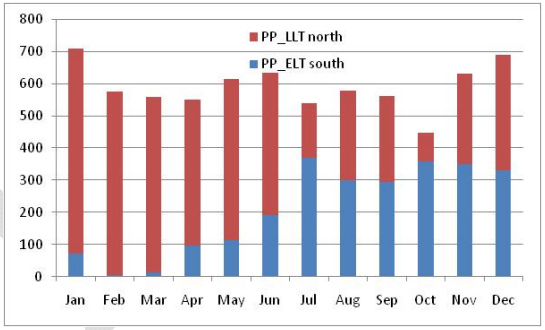
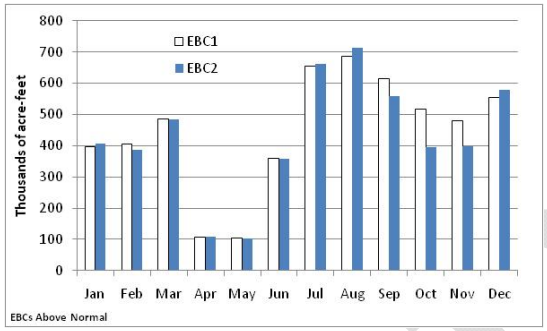
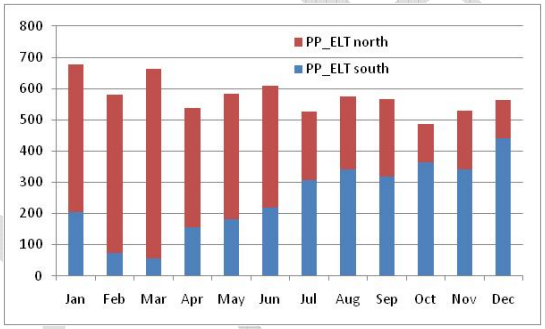
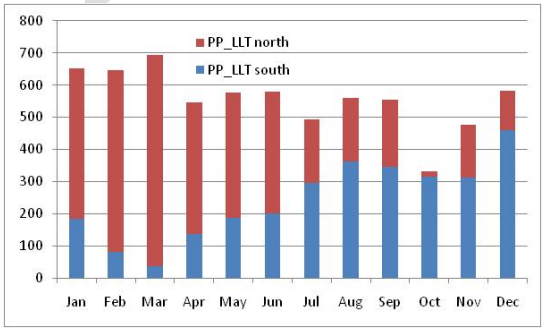
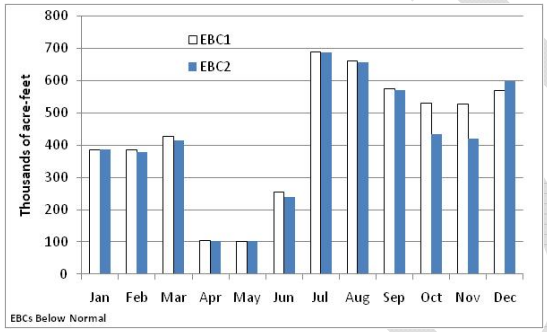
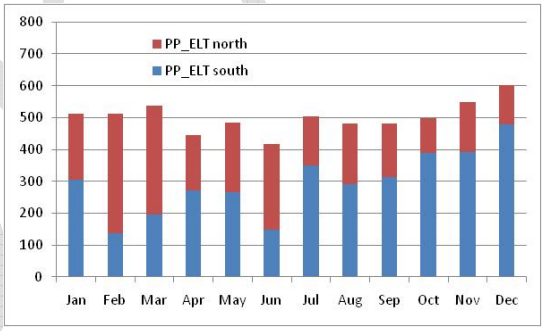
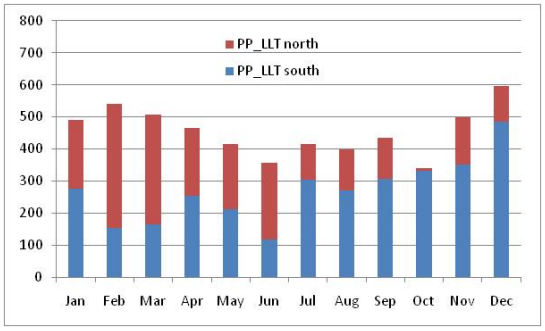
	Existing Biological Condition (Current)	Preliminary Proposal Early Long-Term (PP_ELT)	Preliminary Proposal Late Long-Term (PP_LLT)
Wet (26 years)			
Above Normal (12 years)			
Below Normal (14 years)			

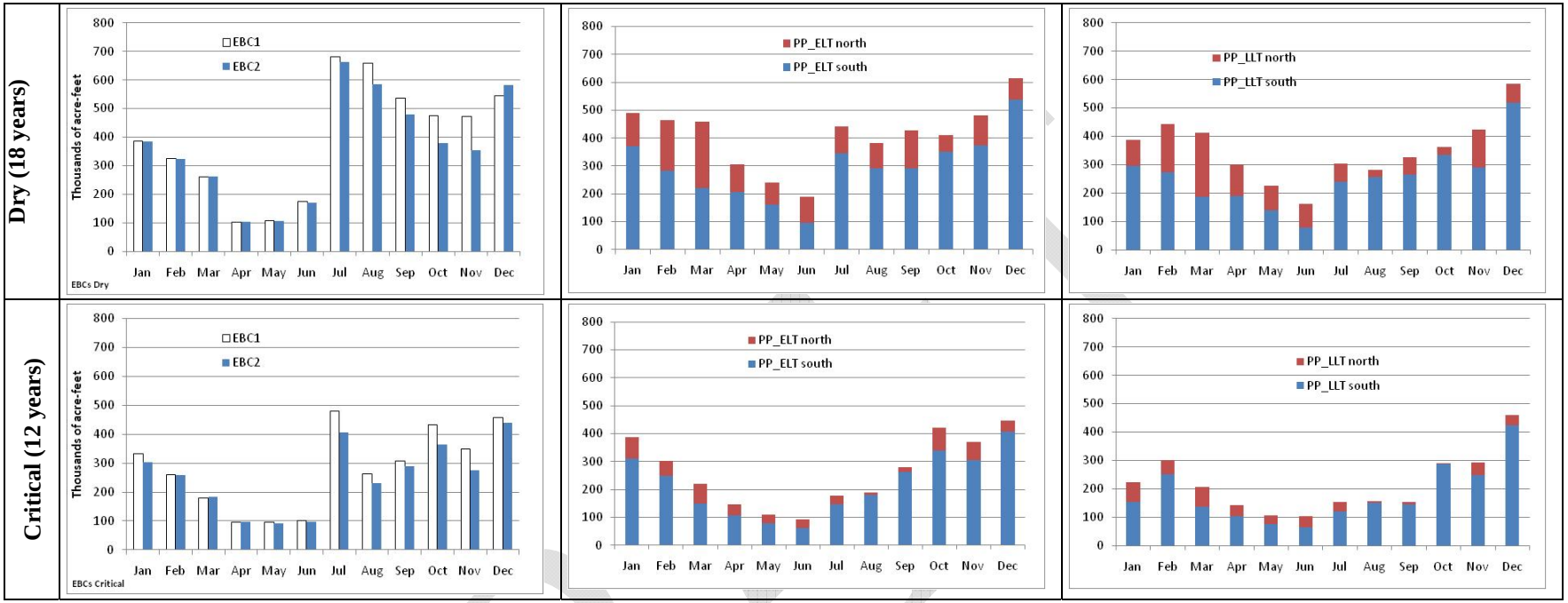


Figure B-4. Water Exports (Thousands of Acre-Feet) from the BDCP Dual Conveyance System Allocated between the Planned North Delta Facility and Existing South Delta Facility under Different Water-Year Types

B.2.2 Change in Exports from the South Delta Pumps under BDCP

BDCP changes the amount and pattern of exports from the south Delta pumps compared to exports under current conditions. Figure B-5 compares CALSIM results for just the south Delta pumps to highlight the impacts of BDCP on the existing pattern of exports in the Delta. Under BDCP total exports from the south Delta pumps are substantially reduced in all water years because of the contribution of the north Delta pumps to total CVP/SWP exports.

Under the Preliminary Project, exports under BDCP from the south Delta pumps are reduced in the wet water years in all months because of the use of the north Delta pumps compared to either of the base conditions (Figure B-5). Pumping is especially reduced in the winter and spring months when delta smelt entrainment typically peaks. Compared to EBC1 or EBC2, exports from the south Delta decrease with the preliminary proposal in most months in all water conditions except during the spring period (Figure B-5). Relative to EBC1, the preliminary proposal increases spring exports from the south Delta in Below Normal water years; in other water years spring exports decrease or show little change relative to EBC1. However, compared to EBC2, exports from the south Delta pumps increase under the preliminary proposal in the spring (April and May) in all other water-year conditions. The largest increase occurs during the Below Normal and Dry water-year conditions.

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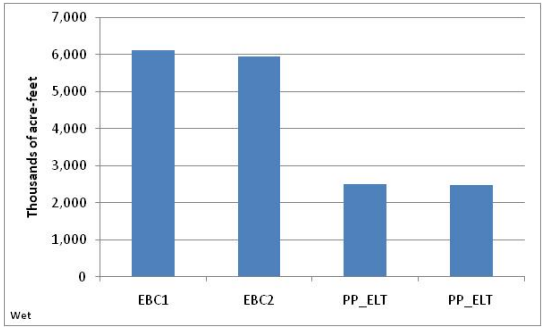
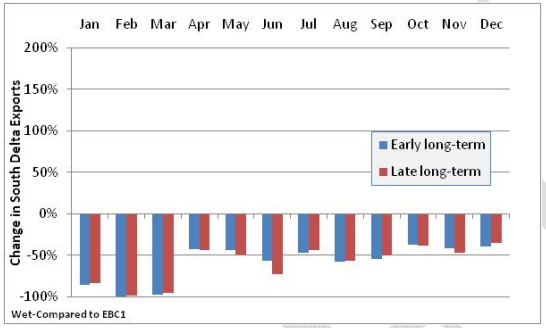
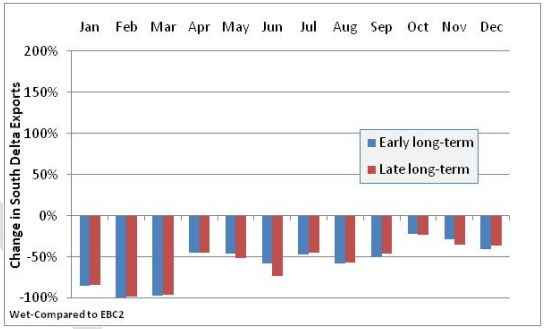
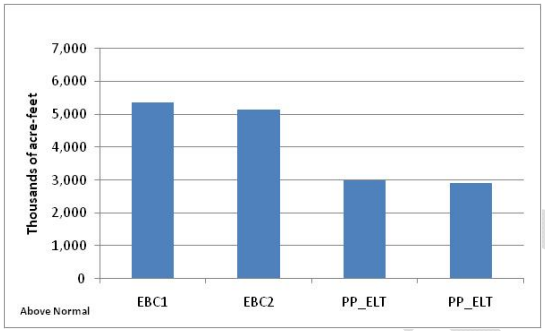
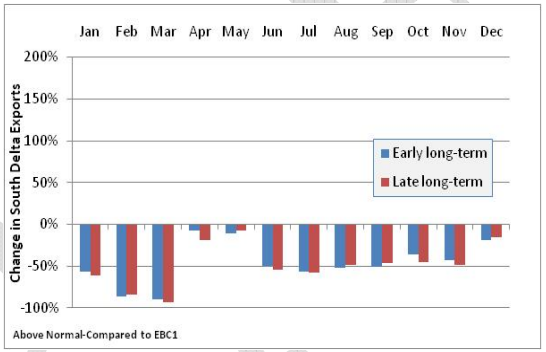
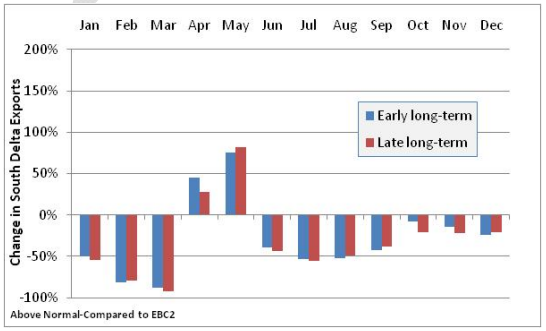
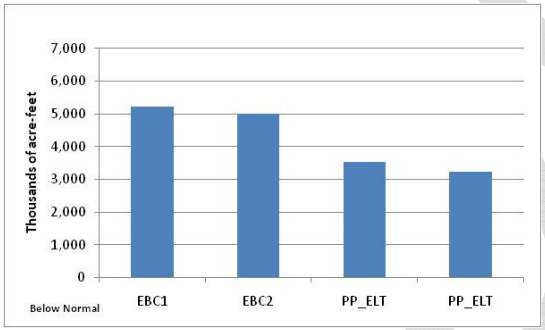
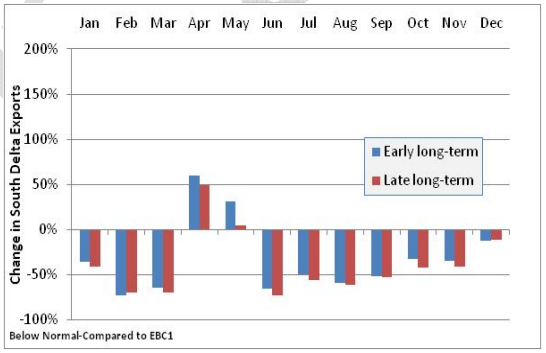
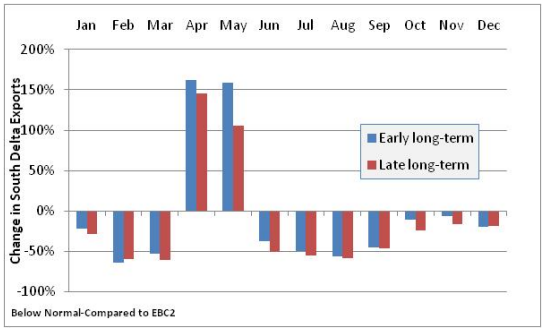
	Total South Delta Exports	Preliminary Proposal compared to EBC1 (Current)	Preliminary Proposal compared to EBC2 (Current)
Wet			
Above Normal			
Below Normal			

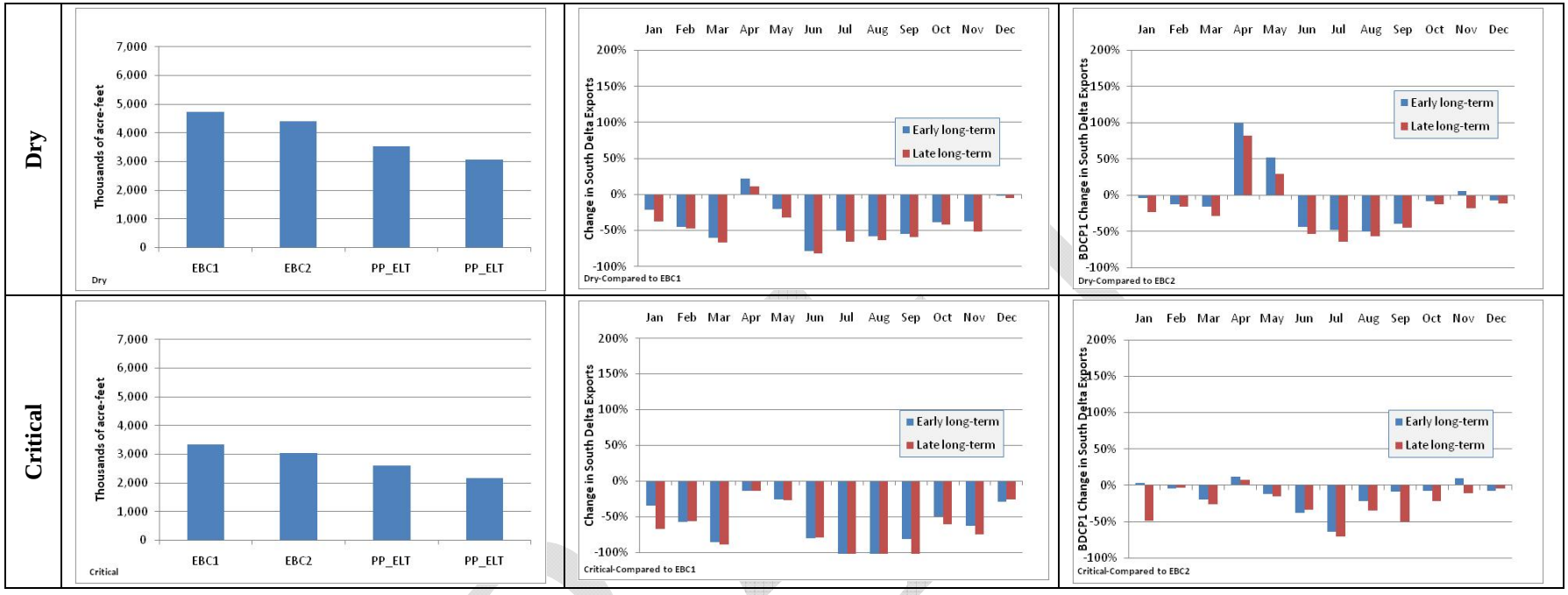


Figure B-5. Impact of BDCP on Water Export from the South Delta CVP/SWP Pumps

B.2.3 Old and Middle River Flows

Changes to flow in OMR under BDCP reflect changes in water export from the south Delta pumps discussed above. Pumping from the CVP and SWP facilities can reverse the normative northerly flow in OMR and create a generally southward flow toward the pumps. By convention, a positive OMR flow is the normative northern flow while a negative OMR flow is reversed toward the pumping facilities. The amount and direction OMR flow is important because of its relationship to entrainment of fish in the SWP and CVP facilities (Kimmerer 2008; Baxter et al. 2010). Under some conditions such as high levels of turbidity, fish can be drawn toward the pumps by negative OMR flow.

OMR flows can be approximated as about half of the San Joaquin River flows (fraction diverted into Old River near Mossdale) minus the SWP/CVP south Delta exports. In the base condition (EBC) OMR flows reflect limits imposed in the 2008 USFWS BO and the 2009 NMFS BO that are applied under an adaptive management framework during the January to June period. Generally, OMR flow cannot be below (i.e. more negative) -5,000 cfs toward the south Delta export facilities during these months. Under other cases, the OMR flows can be restricted to greater than -2,000 cfs. There are no OMR restrictions in the July–December period. As a result of these restrictions, OMR flow in EBC1 and EBC2 base conditions from January through June period is less negative (less movement toward the pumps) compared to the summer and fall periods when OMR becomes strongly negative in all water-year conditions (but many covered fish species are not in the vicinity of the south Delta facilities during these months). OMR flow is more strongly negative in the winter months under EBC1 compared to EBC2 because of flow restrictions during winter under the BOs related to the position of X2.

Under the BDCP preliminary proposal OMR flows become more positive in most months under all water-year conditions compared to either of the base conditions (Figure B-6). This difference between the preliminary proposal and the existing condition decreases in the dryer water-year conditions as the system relies more heavily on the south Delta pumps. Under the wet water-year condition, the Preliminary Proposal appreciably increased positive OMR flow relative to the base case and resulted in strongly positive flow during the winter and spring period. However, in all but the wet water-year condition, the preliminary proposal decreases (makes more negative) OMR flow during the spring period (April and May). This is the result of increased exports from the south Delta facilities during April and May under the preliminary proposal in all but the wet water-year conditions (Figure B-6).

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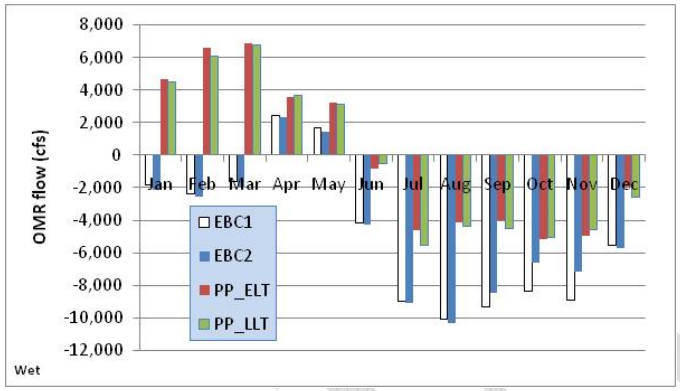
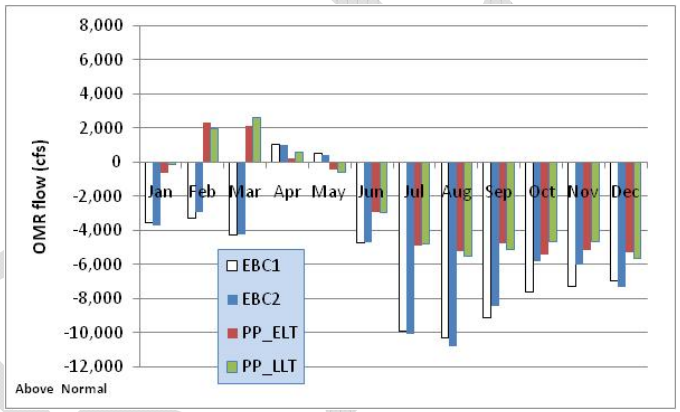
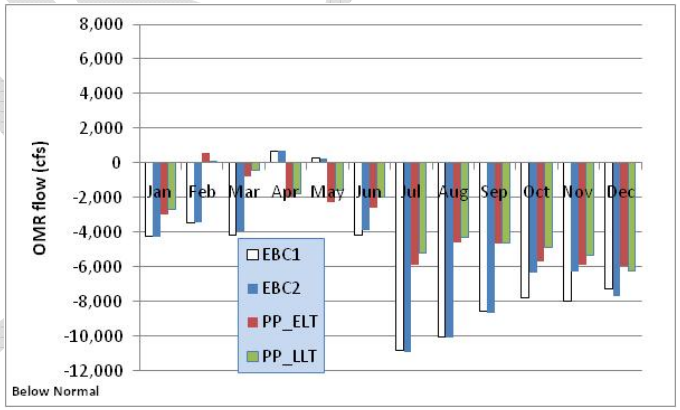
Wet	
Above Normal	
Below Normal	

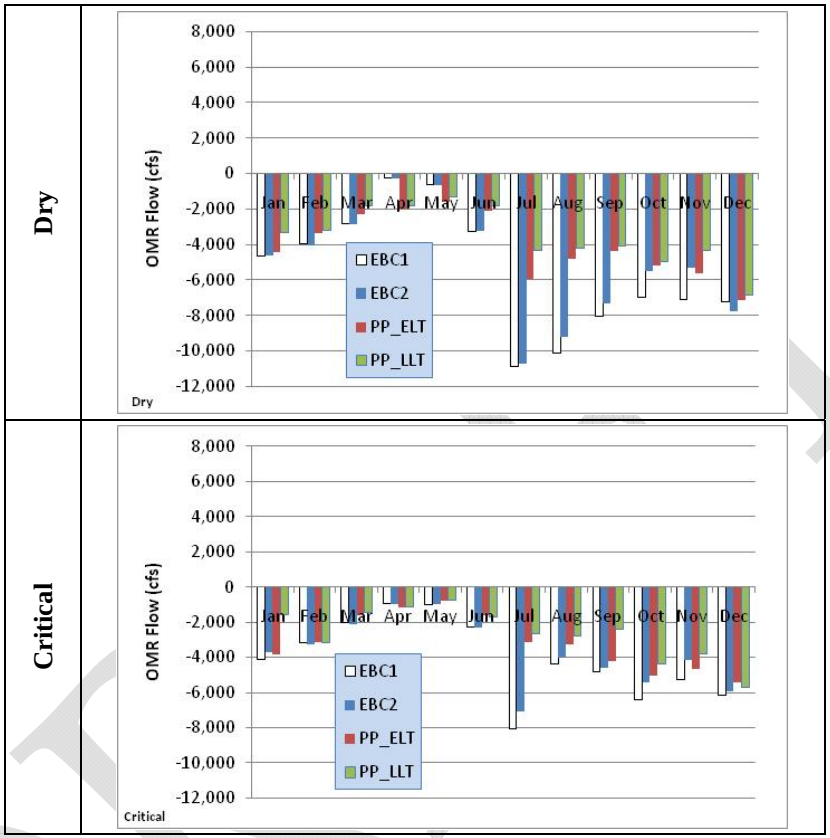


Figure B-6. Flow (cfs) in Old and Middle Rivers (OMR) under the Base Condition (EBC2) and Preliminary Proposal (PP) in the Early Long-Term (ELT) and Late Long-Term (LLT) Periods

Overall Change in SWP/CVP Exports under BDCP

Based on CALSIM analysis, the BDCP preliminary proposal will appreciably change the total amount of water exported from the Delta by the SWP and CVP projects (Figure B-7). These changes varying across water-year types. On average, as well as for wet, above normal and below normal water-year conditions (77% of the water years), BDCP is expected to increase the total amount of water exported from the SWP and CVP dual conveyance system relative to either of the existing biological conditions which only use the south Delta pumps. In dry water years, BDCP actions increased exports in the first 15 years of the license period (ELT) but decreased exports for the remainder of the license period (LLT). In critical water years, BDCP decreased total exports relative to the existing base conditions.

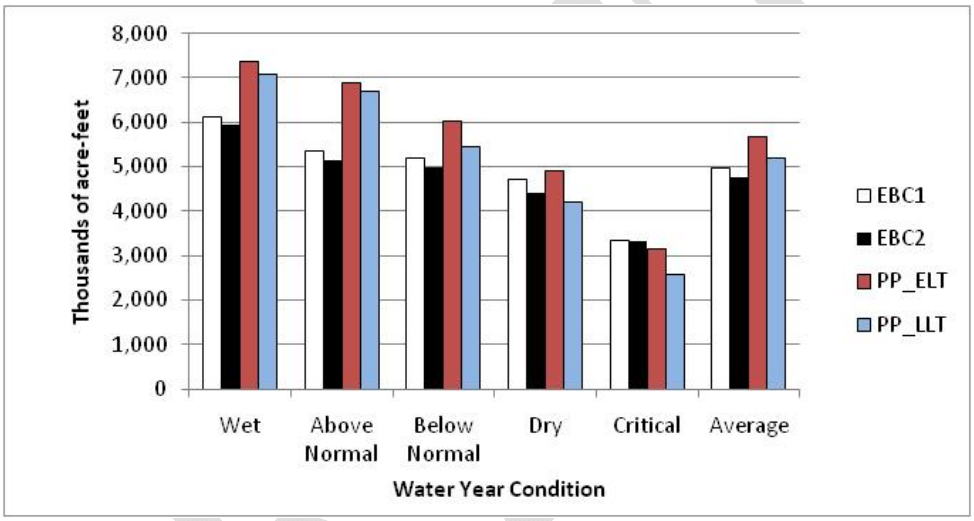


Figure B-7. Total Exports from Combined North Delta and South Delta Pumping Facilities under BDCP Preliminary Proposal (PP) Compared to the Existing Biological Condition (EBC) Baselines (Current)

SWP North Bay Aqueduct (Barker Slough Pumping Plant and New Sacramento River Facility)

Monthly average diversions at the NBA Barker Slough Pumping Plant tend to be greatest in wetter years at around 130 cfs and least in dry and critical years (70–90 cfs), although variable by month (Table B-3). Modeling was not conducted to simulate the proportion of diversions that would be relocated to the new Alternative Intake on the Sacramento River.

Table B-3. Average Monthly North Bay Aqueduct Barker Slough Pumping Plant (Cubic Feet per Second) from DSM2 Modeling, Reported by Water-Year Type

Month	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
Wet (5 Years)						
Jan	-156	-106	-90	-90	-101	-92
Feb	-155	-105	-110	-100	-122	-103
Mar	-90	-124	-124	-113	-132	-123
Apr	-103	-141	-141	-132	-141	-131
May	-94	-143	-142	-136	-143	-125
Jun	-119	-148	-139	-132	-151	-146
Jul	-86	-138	-140	-149	-148	-152
Aug	-120	-131	-134	-131	-148	-116
Sep	-125	-124	-126	-122	-141	-141
Oct	-107	-125	-121	-118	-142	-142
Nov	-107	-112	-113	-112	-129	-129
Dec	-101	-143	-137	-135	-139	-133
Above Normal (2 Years)						
Jan	-109	-61	-51	-48	-67	-51
Feb	-89	-86	-90	-89	-85	-101
Mar	-41	-104	-84	-101	-91	-91
Apr	-74	-136	-136	-125	-141	-130
May	-80	-140	-141	-136	-142	-142
Jun	-109	-157	-158	-121	-140	-138
Jul	-66	-116	-118	-118	-75	-133
Aug	-91	-115	-118	-118	-149	-126
Sep	-83	-115	-117	-117	-141	-141
Oct	-51	-71	-71	-71	-71	-72
Nov	-65	-80	-58	-74	-71	-105
Dec	-49	-77	-84	-75	-114	-108
Below Normal (1 Year)						
Jan	-158	-84	-81	-79	-81	-80
Feb	-157	-96	-93	-88	-92	-88
Mar	-127	-136	-125	-91	-113	-90
Apr	-105	-141	-141	-129	-141	-105
May	-109	-142	-142	-139	-142	-118
Jun	-61	-117	-115	-110	-132	-103
Jul	-61	-112	-111	-119	-1	-1
Aug	-71	-112	-143	-156	-1	-1
Sep	-131	-141	-141	-141	-140	-140
Oct	-55	-102	-104	-102	-142	-142
Nov	-116	-70	-72	-69	-137	-103
Dec	-63	-127	-128	-125	-147	-152

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Month	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
Dry (4 Years)						
Jan	-142	-94	-85	-84	-97	-94
Feb	-122	-91	-71	-90	-99	-108
Mar	-128	-87	-85	-84	-113	-110
Apr	-124	-95	-96	-68	-127	-92
May	-57	-80	-72	-70	-130	-115
Jun	-58	-77	-79	-75	-154	-132
Jul	-49	-50	-50	-50	-51	-51
Aug	-84	-84	-87	-87	-87	-87
Sep	-24	-26	-25	-20	-123	-124
Oct	-92	-96	-87	-95	-134	-118
Nov	-72	-75	-76	-74	-104	-108
Dec	-100	-127	-130	-127	-126	-127
Critical (5 Years)						
Jan	-124	-72	-72	-71	-72	-79
Feb	-113	-39	-54	-74	-46	-45
Mar	-82	-51	-51	-50	-59	-49
Apr	-62	-53	-52	-36	-63	-35
May	-53	-55	-53	-44	-65	-53
Jun	-59	-62	-61	-76	-49	-83
Jul	-53	-44	-54	-54	-31	-42
Aug	-56	-57	-57	-56	-22	-36
Sep	-29	-39	-30	-30	-94	-113
Oct	-55	-132	-85	-102	-111	-103
Nov	-90	-60	-52	-30	-108	-56
Dec	-91	-132	-118	-125	-144	-133

Agricultural Diversions

A typical pattern of assumed agricultural diversions for irrigation in Delta islands is shown in Figure B-8. This highlights that diversions are minimal during the late fall and winter, with increases in spring up to maxima in early summer when irrigation of agricultural land is at its peak. The summer peaks average around 5,000 cfs in June and July (Figure B-8).

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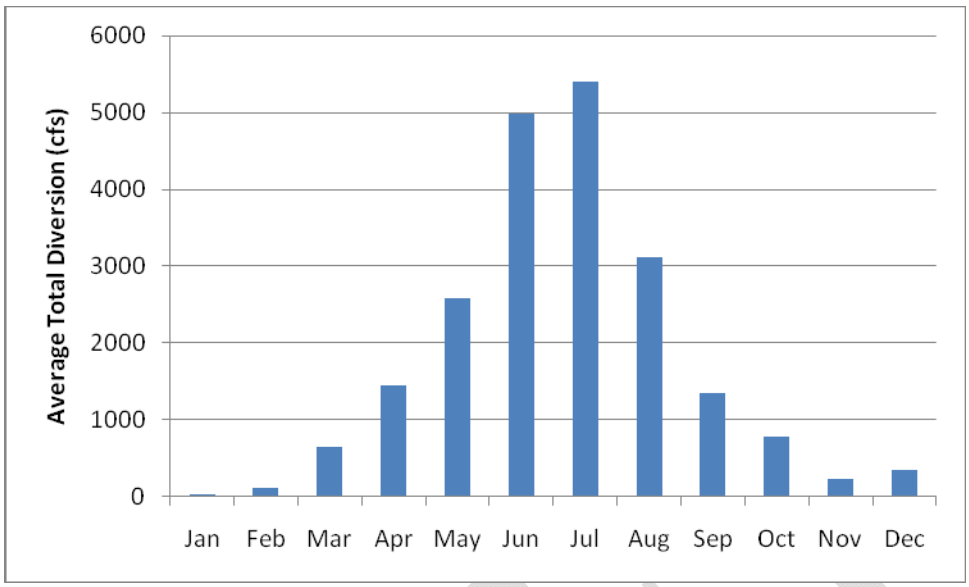

Source: Based on Delta Island Consumptive Use values modeled in DSM2 for the Water Years 1975–1991 (Anderson 2003).

Figure B-8. Monthly Average Total Delta Island Agricultural Diversions

Based on a hypothetical restoration scenario wherein diversions to agricultural islands are decommissioned under BDCP, it is estimated that more than 100 diversions in the Plan Area would be removed within the first 15 years (ELT) and nearly 240 would be removed by 50 years (LLT). There is little information on the actual flows typically diverted by these intakes, but under the assumption that all intakes are of similar size, the habitat restoration would decrease diversions in the Plan Area by approximately 4.2% in the ELT and 12.4% in the LLT. This topic is discussed further in Section B.6.4.1, Particle-Tracking Modeling results for delta smelt larvae.

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B.3 METHODS

B.3.1 Assess Species Exposure

To understand the rationale for selection of particular methods for each species and life stage, it is necessary to also understand the potential exposure to entrainment for each species and life stage. Table B-4 shows whether or not each species and life stage is subject to entrainment at each of the potential intakes in the Plan Area.

Table B-4. Potential Exposure of Covered Fish Species to Entrainment Locations in the BDCP Plan Area

Species	Life Stage	SWP/CVP South Delta Pumps	SWP/CVP North Delta Intake	SWP North Bay Aqueduct Barker Slough Pumping Plant and Alternative Intake	Agricultural Diversions
Steelhead	Egg/alevin	Occur upstream of the Plan Area			
	Fry	Occur upstream of the Plan Area			
	Juvenile	X	X	X	X
	Adult	Large body size/strong swimming ability make entrainment very unlikely			
Winter-run Chinook salmon	Egg/alevin	Occur upstream of the Plan Area			
	Fry	Occur upstream or otherwise included under analysis of juveniles			
	Juvenile	X	X	X	X
	Adult	Large body size/strong swimming ability make entrainment very unlikely			
Spring-run Chinook salmon	Egg/alevin	Occur upstream of the Plan Area			
	Fry	Occur upstream or otherwise included under analysis of juveniles			
	Juvenile	X	X	X	X
	Adult	Large body size/strong swimming ability make entrainment very unlikely			
Fall-/late fall–run Chinook salmon	Egg/alevin	Occur upstream of the Plan Area			
	Fry	Occur upstream or otherwise included under analysis of juveniles			
	Juvenile	X	X	X	X
	Adult	Large body size/strong swimming ability make entrainment very unlikely			
Delta smelt	Egg/embryo	Adhere to substrates and therefore minimally subject to entrainment			
	Larva	X	X	X	X
	Juvenile	X	X	X	X
	Adult	X	X	X	X
Longfin smelt	Egg/embryo	Adhere to substrates and therefore minimally subject to entrainment			
	Larva	X	X	X	X
	Juvenile	X	X	X	X
	Adult	X	X	X	X
Sacramento splittail	Egg/embryo	Adhere to substrates and therefore minimally subject to entrainment			
	Larva	X	X	X	X
	Juvenile	X	X	X	X
	Adult	X	X	X	X

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Species	Life Stage	SWP/CVP South Delta Pumps	SWP/CVP North Delta Intake	SWP North Bay Aqueduct Barker Slough Pumping Plant and Alternative Intake	Agricultural Diversions
White sturgeon	Egg/embryo	Adhere to substrates and therefore minimally subject to entrainment			
	Larva	X	X	X	X
	Juvenile	X	X	X	X
	Adult	X	X	X	X
Green sturgeon	Egg/embryo	Occur upstream of the Plan Area			
	Larva	Occur upstream of the Plan Area			
	Juvenile	X	X	X	X
	Adult	X	X	X	X
Pacific lamprey	Egg/embryo	Occur upstream of the Plan Area			
	Ammocoete	Buried in the substrate but may be subject to entrainment when entering the Plan Area			
	Macropthalmia	X	X	X	X
	Adult	X	X	X	X
River lamprey	Egg/embryo	Occur upstream of the Plan Area			
	Ammocoete	Buried in the substrate but may be subject to entrainment when entering the Plan Area			
	Macropthalmia	X	X	X	X
	Adult	X	X	X	X

B.3.2 Overview of Assessment Methods

The assessment of entrainment effects for each species and life stage is based on a comparison between each of the baseline conditions (EBC1 and EBC2) and the BDCP. There are two primary data sources used (particle tracking and salvage data), but multiple methods were used to analyze entrainment based on the available data. Multiple methods are necessary to generate estimates of entrainment because no one method and/or model is applicable to all species and life stages. The methods used are summarized by species and life stage in Table B-5. Delta smelt, in particular, has a number of different methods applied as a result of its importance from a regulatory perspective and subsequent considerable study. Each method has particular benefits and limitations, which are summarized later in Section B.3.11.

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Table B-5. Methods Used to Analyze Entrainment Effects, by Entrainment Location, Species, and Life Stage

Entrainment Location or Species	Geographic Subregion or Life Stage	Salvage-Density Method	Old and Middle River Flow Proportional Entrainment Regressions	DSM2 Particle-Tracking Model (PTM)	Manly (2011) Salvage Estimation Equation	Delta Passage Model Proportional Salvage Estimates	Effectiveness of Nonphysical Barriers	North Delta Intakes Screening Effectiveness Analysis	DRERIP Evaluation of Nonproject Diversions
SWP/CVP south Delta export facilities	South Delta Subregion	X	X	X		X	X		
SWP/CVP north Delta intake	North Delta Subregion			X				X	
SWP North Bay Aqueduct Barker Slough Pumping Plant and Alternative Intake				X					
Agricultural diversions				X					X
Mirant power plants									
Steelhead	Juvenile	X				X	X	X	X
Winter-run Chinook salmon	Juvenile	X				X	X	X	X
Spring-run Chinook salmon	Juvenile	X				X	X	X	X
Fall-/late fall–run Chinook salmon	Juvenile	X				X	X	X	X
Delta smelt	Larva			X			X	X	X
	Juvenile	X	X				X	X	X
	Adult	X	X		X		X	X	X
Longfin smelt	Larva			X			X	X	X
	Juvenile	X					X	X	X
	Adult	X					X	X	X
Sacramento splittail	Juvenile	X					X	X	X
	Adult	X					X	X	X
White sturgeon	Egg/embryo							X	X
	Larva						X	X	X
	Juvenile						X	X	X
Green sturgeon	Juvenile	X					X	X	X

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Entrainment Location or Species	Geographic Subregion or Life Stage	Salvage-Density Method	Old and Middle River Flow Proportional Entrainment Regressions	DSM2 Particle-Tracking Model (PTM)	Manly (2011) Salvage Estimation Equation	Delta Passage Model Proportional Salvage Estimates	Effectiveness of Nonphysical Barriers	North Delta Intakes Screening Effectiveness Analysis	DRERIP Evaluation of Nonproject Diversions
Pacific lamprey	Macropthalmia	X					X	X	
	Adult	X					X	X	
River lamprey	Macropthalmia	X					X	X	
	Adult	X					X	X	

B.3.3 Summary of Methods Used

The various methods used to analyze entrainment have benefits and limitations, as summarized in Table B-6.

Table B-6. Main Benefits and Limitations of Methods Used to Analyze Entrainment

Method	Description of Method	Benefits	Limitations
Salvage-Density Method	Uses historical salvage and flow data to predict entrainment	Numerous data exist for all species. Method has been used before to analyze effects of other projects.	Assumes a linear relationship between flow and entrainment, which may not be justified. Estimates of numbers of fish entrained should be viewed as highly uncertain, and focus should be on relative change between scenarios.
Old and Middle River Flow Proportional Entrainment Regressions	Uses linear regression (based on Kimmerer data) and CALSIM data to estimate the proportion of delta smelt population that would be entrained	Provides estimates of the overall proportion of the delta smelt population that is lost to entrainment; Miller's method also introduces other important predictors of entrainment such as turbidity	Regressions are based on relatively few data points and on predictors averaged over several months, which may simplify underlying dynamics. The analysis based on Kimmerer's approach does not include turbidity and assumes that entrainment is solely related to OMR pumping rate.
Manly (2011) Salvage Estimation Equation	Uses multiple regression to estimate salvage of adult delta smelt as a function of OMR flows, turbidity, and population size	Incorporates terms to account for turbidity, delta smelt distribution in relation to flow, and overall population size (from fall midwater trawl index)	Equation is quite complex and may be challenging to interpret. Future estimates assume that current relationship between flow and turbidity will continue into the future. If the Delta becomes substantially clearer and less turbid in the future, this

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Method	Description of Method	Benefits	Limitations
			assumption would result in predictions that overestimate future entrainment.
DSM2 Particle-Tracking Model	Estimates entrainment of larval delta and longfin smelt that originate from various starting spawning locations using modeling of Delta hydrodynamics under the assumption that the larvae are essentially passive particles	Allows assessment of entrainment potential at numerous locations from a variety of starting points.	Assumes smelt larvae are passive particles without behaviors that may alter responses to flows rather than solely being carried by prevailing flows. Estimates of entrained numbers of larvae should be viewed with considerable caution, and focus should be on relative change between scenarios.
Delta Passage Model Salvage Estimates	Uses CWT salvage data to estimate the proportion of Chinook runs that would be entrained	Provides estimates of overall proportions of migrating juvenile Chinook salmon runs that are lost to entrainment, while accounting for movement down different Delta channels ; allows differentiation of fall-run populations by Sacramento or San Joaquin river basin	Many of the model assumptions are based on results from large, hatchery-reared fall-run Chinook salmon that may not be representative of smaller, wild-origin fish. Model is applicable only to migrating fish and not to those rearing in the Delta.
Effectiveness of Nonphysical Barriers	Discusses results of recent studies at Georgiana Slough and Old River as well as literature studies to determine potential effectiveness of barriers in other Delta locations	Based partly on Delta-specific studies	Considerable uncertainty about velocities in barrier vicinity and potential predation. Qualitative discussion only.
Screening Effectiveness Analysis (North Delta Intake)	Estimate of potential for screening based on different sizes of fish approaching the north Delta intakes	Based on published literature for exclusion of fish at screened intakes	Little is known of the occurrence of larval fish in the area and how screenable-sized fish may respond to such large intakes. Qualitative discussion based on likely sizes of fish that would be excluded.
DRERIP Analysis of Nonproject Diversions	Qualitative assessment of the population-level benefits of screening nonproject diversions that was previously proposed as a BDCP conservation measure	Represents the analysis of a panel of experts	Does not directly address solely agricultural diversions within the BDCP ROAs (but is probably sufficiently similar). Qualitative analysis only (however, estimates of number of diversions to be decommissioned as part of BDCP habitat restoration allow some context for the extent of entrainment reduction).

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B.3.4 Salvage-Density Method (SWP/CVP South Delta Export Facilities)

The salvage-density method relies on salvage data and was used to estimate changes in entrainment at the SWP/CVP export facilities. The same basic method has been used in recent effects analyses (e.g., the DMC/California Aqueduct Intertie [Reclamation 2009]). This method applied to all covered species, although there are limitations for each species as described in detail below. For the BDCP effects analysis, a refinement of the method was used, as described below.

B.3.4.1 *Preprocessing of Input Data*

Historical monthly export data (acre-feet) for water years 1995–2009 were obtained from Reclamation's Central Valley Operations Total Tracy Pumping web page (http://www.usbr.gov/mp/cvo/vungvari/tracy_pump.pdf) and DWR's State Water Project Annual Reports of Operations (http://www.water.ca.gov/swp/operationscontrol/annual.cfm). Historical monthly salvage data for the water years 1995–2009 were provided by Sheila Greene (DWR) for all species. (Water year 2009 was excluded for some species because the data were not complete.) These data are expanded salvage data, i.e., the extrapolated estimates of the total number of fish salvaged based on a subsample that actually was identified, counted, and measured. These data provided the basic estimates of fish density (number of fish salvaged per volume of water exported) that were subsequently multiplied by simulated export data for the CALSIM modeling period (1922–2003) to assess differences between PP and EBC scenarios, as described below in Section B.5.4.3. Juvenile Chinook salmon were divided into races based on fork length on the date of salvage, according to the Delta model of length at date (Brown et al. 1996). It should be noted that these divisions are not without considerable overlap between races, especially for juvenile spring-run and fall-run Chinook salmon; extrapolations of numbers of fish salvaged by race should be regarded cautiously, particularly given the relative abundance of the adult stocks from which the juveniles originate (e.g., fall-run are considerably more abundant than spring-run, and therefore the relative proportions salvaged should reflect such differences but may not when based on length criteria). Data for juvenile Chinook salmon salvage were extrapolated into total entrainment losses to reflect prescreen losses to predation (75% at SWP and 15% at CVP), louver efficiency (size-specific equations based on primary water velocity through the intake screens [DWR and DFG 1986:Appendix A]), and losses during transport to the release site (2% for younger fish, 0% for larger fish [DWR and DFG 1986:Appendix A]). In similar fashion, steelhead, delta smelt, and longfin smelt also had various entrainment losses applied: prescreen losses of 75% at SWP and 15% at CVP, louver losses of 50%, and transport losses of 2% (delta and longfin smelt) or 0% (steelhead). Analyses of delta smelt were divided into juveniles (May–July) and adults (December–April) based on seasonal occurrence. Lamprey are not identified to species during salvage, so analyses for Pacific and river lamprey are combined.

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B.3.4.2 *Normalization to Population Size*

Salvage and loss data for analysis were normalized, where possible, by measures of annual population abundance in the year of entrainment. This step aimed to adjust the salvage and loss to account for the abundance of the population (e.g., a relatively high number of fish would be expected to be entrained in a year of relatively high abundance). Normalization was undertaken by multiplying the raw monthly salvage or loss in a given month by a factor to account for the relative size of the population in that year compared to the average population size over the years from which salvage or loss data were available. The factor was the population size in that year divided by the average population size in the years from which salvage data were available (1996–2009 for most species). The following datasets were used to normalize salvage and loss estimates:

- Winter-run Chinook salmon: juvenile production estimate (NMFS 2009).
- Fall-/late fall–run and spring-run Chinook salmon: adult run size estimates from DFG's GrandTab.
- Delta and longfin smelt: fall midwater trawl index (Newman 2008a).

No normalization was undertaken for steelhead, Sacramento splittail, Pacific lamprey, river lamprey, or green sturgeon because there are no suitable indices of annual abundance for these species.

B.3.4.3 *Entrainment Index Calculation*

For each covered species in each month at each facility, density (fish per taf) as entrainment loss or expanded salvage was simply calculated as the total loss or expanded salvage for the facility divided by the total volume of water exported in that month. It is acknowledged that the assumption of a linear relationship between entrainment and flow may be an oversimplification given the evidence for nonlinear relationships (e.g., Kimmerer 2008) and so the method essentially functions as description of changes in flows weighted by seasonal changes in salvage density of covered species. All salvage or loss densities for a given month in a given water-year type from the 1995–2009 salvage data were multiplied by all corresponding export values for the same month and water-year type from the modeled 1922–2003 CALSIM data, except for Pacific lamprey and river lamprey, for which water years were not divided. Water years were based on the Sacramento Valley (40-30-30) classification, except for white and green sturgeon, for which calculations for both the Sacramento Valley and San Joaquin Valley (60-20-20) classifications were undertaken separately because the species occur in both basins and water-year designations for the period of salvage density data differ slightly (Table B-7)[6].

[6] Although there is some similarity between designated water years for the Sacramento and San Joaquin systems, there are sufficient differences to justify independent salvage analyses (Table B-7). From the period of 1995 to 2008 (the period of most appropriate salvage data for the analyses), water year classifications were different in five years (1999, 2003, 2004, 2005, and 2007). However, based on binned water years (W/AN compared to BN/D/C), the only difference occurs in 2003, which was designated as above normal in

For the sturgeons, two sets of water-year types from each classification (Sacramento Valley and San Joaquin Valley) were used: (1) wetter water years (wet and above normal); and (2) drier water years (below normal, dry, and critical). It is thought that wetter years contribute more to sturgeon year class strength (Fish 2010); therefore, more individuals may be exposed to entrainment at the south Delta facilities. During years of low rainfall, the reduction in suitability of other water quality factors (temperature and flow) may contribute to limited spawning, hatching, and survival of juvenile sturgeon; therefore, fewer individuals may be exposed to entrainment at the south Delta facilities. However, because juvenile sturgeon may occur in habitats in the vicinity of the south Delta export facilities for multiple years, a straight correlation of salvage and water-year type may not be sufficient. To account for the potential differences that may occur in both wetter and drier years, historical salvage data were divided into these two categories to estimate salvage under each model scenario.

The mean and 95% confidence interval entrainment index in each month of each water-year type was calculated as follows: the salvage or loss density for a given month in a given water-year type was multiplied by the CALSIM-modeled export volume for the same month for all of the water years of that water-year type. For example, there were five wet years (1996–1999, 2006) in the data used to calculate salvage or loss densities. There were 26 wet years in the CALSIM modeling of 1922–2003. Using the month of January as an example, there were five unique wet January salvage or loss densities calculated. Each of these then was multiplied by each of the 26 wet January export volumes from CALSIM, giving a sample size of 130 from which to calculate means and 95% confidence intervals.

The analysis was repeated for each scenario–time period combination (EBC1, EBC2, EBC2_ELT, EBC2_LLT, PP_ELT, PP_LLT) and for all years combined.

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the Sacramento and below normal in the San Joaquin Valley.

Table B-7. Water-Year Designations for the Sacramento and San Joaquin Watersheds, 1995–2008

Water Year	Sacramento Valley Classification	San Joaquin Valley Classification
1995	W	W
1996	W	W
1997	W	W
1998	W	W
1999	W	AN
2000	AN	AN
2001	D	D
2002	D	D
2003	AN	BN
2004	BN	D
2005	AN	W
2006	W	W
2007	D	C
2008	C	C
Data source: <http://cdec.water.ca.gov/cgi-progs/iodir/wsihist> on June 8, 2010. W = wet, AN = above normal, BN = below normal, D = dry, C = critical.		

B.3.4.4 *Proportional Entrainment (Juvenile Chinook Salmon)*

In addition to estimating relative magnitude of entrainment loss for each run under each model scenario, an index was developed of the relative magnitude of losses in comparison with a general index of juvenile population abundance to help provide a population-level context for assessing south Delta losses. For salmonids other than juvenile winter-run Chinook salmon, there is no annual estimate of juvenile production. For winter-run Chinook salmon, NMFS calculates a juvenile production estimate of juveniles passing Red Bluff Diversion Dam (RBDD); the mean value of this estimate from 1994 to 2009 was around 1 million fish. It is recognized that reproductive success of salmonids varies among years and watersheds in response to a variety of factors such as hydrologic conditions, spawning gravel quality and availability, exposure to elevated water temperatures, and other factors like hatchery management. Variation in these and other factors has not been included in the development of the broad index of juvenile production. Levels of mortality from predation and other sources vary for juvenile salmonids during their downstream migration to the Delta, which for winter-run Chinook salmon NMFS assumes is 50% of the upstream abundance at RBDD. The juvenile abundance estimates used in the present analysis are based on the assumption that overall juvenile production of all Chinook salmon races is proportional to overall adult escapement. The average annual percentage of adult in-river escapement attributable to each run during 1994–2009 is summarized in Table B-8. Extrapolating from the estimate of 1 million winter-run Chinook salmon juveniles to the other Chinook salmon runs in direct proportion to adult abundance gives an annual estimate of 50 million juvenile Chinook salmon, which becomes 25 million when the 50% mortality from

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upstream of the Delta is factored in (Table B-8). Annual adult steelhead abundance estimates are not available, and hence no index of juvenile abundance was developed for Central Valley steelhead. Losses of juvenile Chinook salmon as estimated from the salvage-density method were expressed as percentages of the total juvenile abundance index for each run.

Table B-8. Summary of Information Used in Developing a General Index of Juvenile Chinook Salmon Abundance Estimates

Species	Winter-Run Chinook Salmon	Spring-Run Chinook Salmon	Fall-Run Chinook Salmon	Late Fall–Run Chinook Salmon
Percentage of adult escapement to Central Valley[1]	2	3	92	4
Upstream juvenile abundance index	1 million	1.5 million	46 million	2 million
Assumed juvenile abundance reaching Delta after 50% mortality	0.5 million	0.75 million	23 million	1 million

Source: DFG Grand Tab.
[1] Percentages do not equal 100% as a result of rounding.

B.3.4.5 *Flow-Based Salvage Estimate (Sacramento Splittail)*

B.3.4.5.1 Method Based on Delta Inflow

Juvenile splittail are vulnerable to entrainment at the south Delta export facilities primarily from May through July, during their downstream emigration from floodplain rearing and spawning habitats (Figure B-9). The level of entrainment is strongly influenced by their abundance, which varies greatly from year to year (Sommer et al. 1997). An unknown percentage of the splittail entrained at the export facilities are salvaged and returned to the Delta, where less than about 10% are lost to predation at release sites (see Section E1.4.2.2.6). High losses to predation and other factors also occur before the juveniles reach the export pumps, particularly in CCF of the SWP facilities. Total export losses, including prescreen losses and losses during salvage operations, are thought to be four to five times the number of fish salvaged at the SWP facilities and 15 to 20% greater than the salvage losses at the CVP facilities, based on studies conducted on juvenile Chinook salmon (Gingras 1997; NMFS 2009). However, because of the high uncertainty in these estimates, they were not included in the effects analysis.

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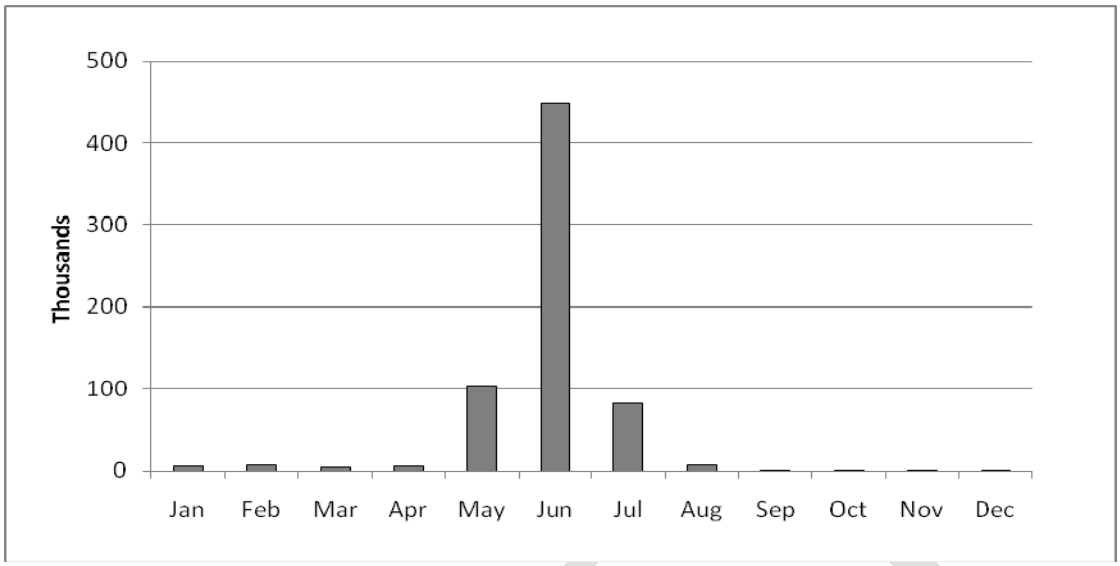

Figure B-9. Average Expanded Splittail Salvage by Month (1980–2008)

The relationship between flow and splittail salvage density was analyzed by regressing average May to July salvage density on average February to June total Delta inflow for 1996–2009. A log-linear regression (log of salvage density vs. inflow) was highly significant ($p << 0.01$) for both the SWP and CVP export facilities, indicating that salvage density increased exponentially with increases in Delta inflow (Figure B-10 and Figure B-11).

Using the regression equations with CALSIM modeling estimates of average February–June Delta inflow and May–July total export volumes at the SWP and CVP facilities, salvage was estimated with 95% confidence intervals for each year of the CALSIM record under each of the existing conditions and preliminary proposal operating scenarios. The confidence intervals were computed using the 95% confidence levels of the slope estimates of the regression.

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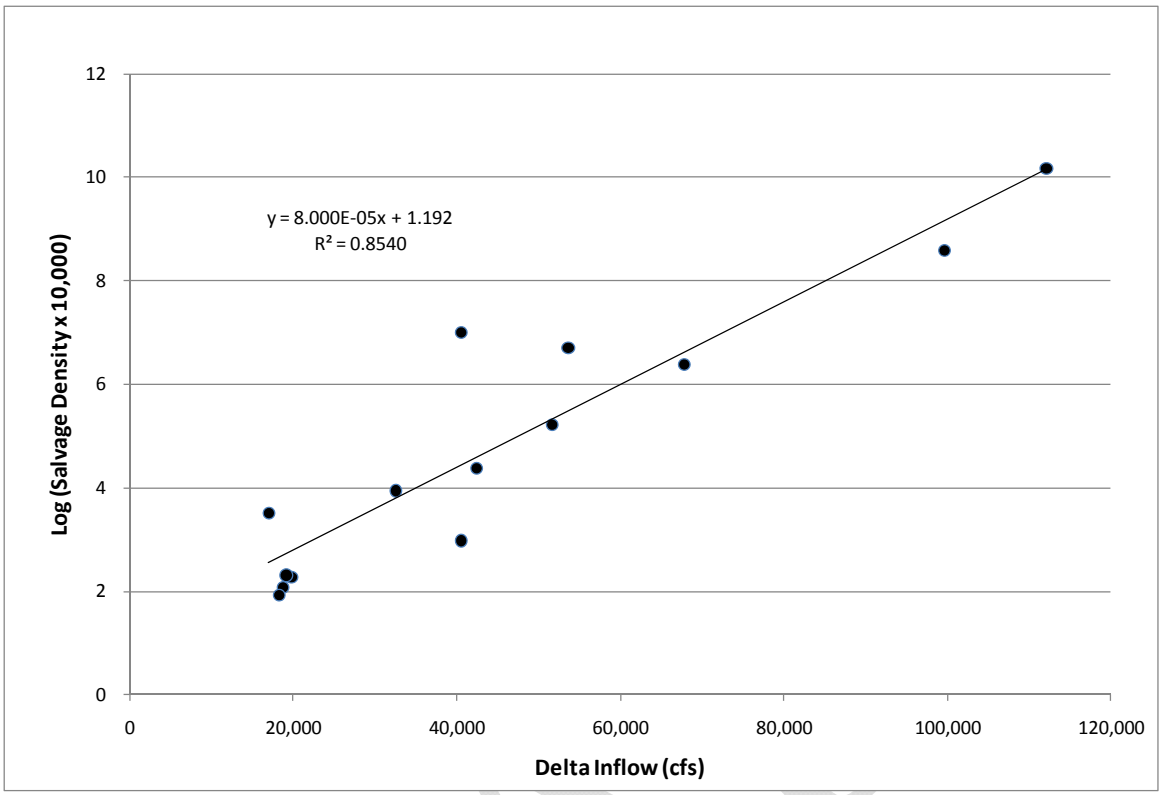

Figure B-10. Mean Splittail Salvage Density at SWP vs. Delta Inflow, 1996–2009

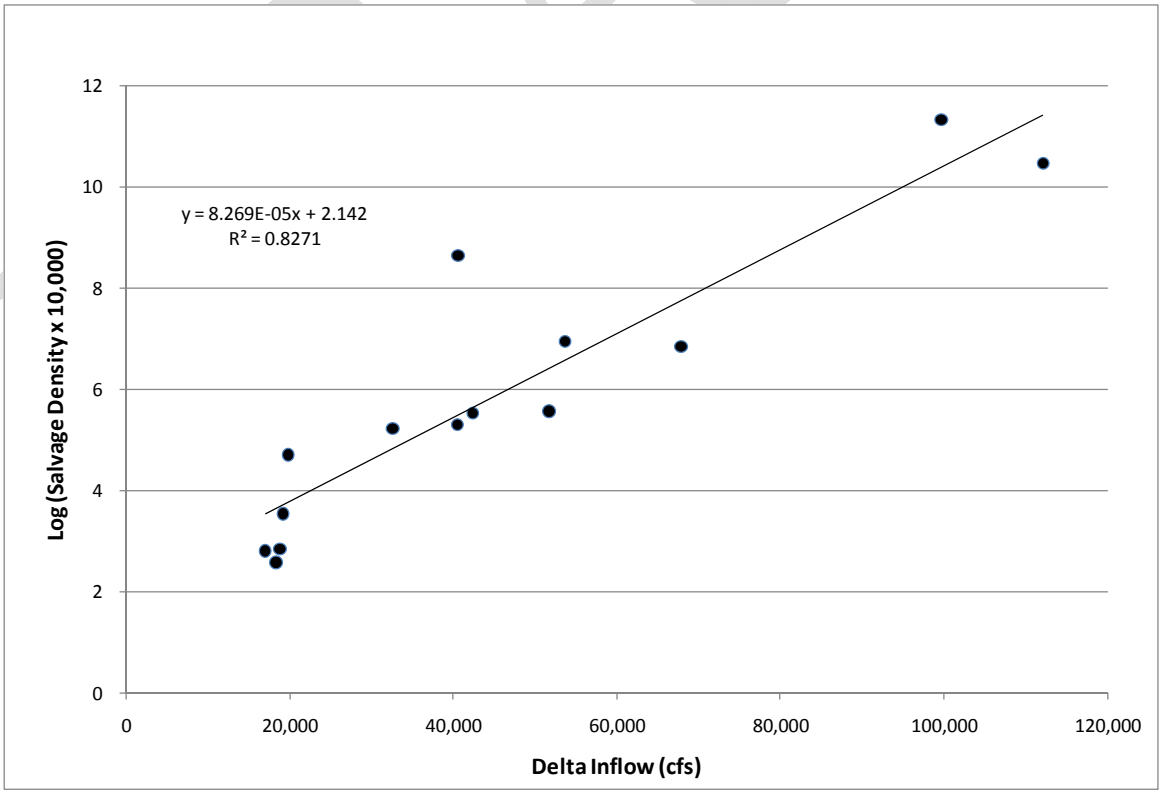

Figure B-11. Mean Splittail Salvage Density at CVP vs. Delta Inflow, 1996–2009

Salvage of adult splittail at CVP and SWP facilities in the south Delta often increases abruptly following the first flush during December through March. Numbers salvaged are relatively high during years of high outflow and when exports are high. Numbers are also likely to be high 1–3 years after years that produced strong year classes of splittail (DWR and Reclamation 1994). Thus actual numbers of adult splittail entrained appear to be a complex function of (1) adult population size, (2) amount of pumping during winter months, (3) timing of pumping in relation to the hydrograph, and (4) total outflow (Moyle et al. 2004).

Following the method described above for juvenile splittail, average salvage densities of adult splittail were computed from numbers of splittail salvaged and volumes of water exported. Unlike juvenile splittail, adult splittail had no consistently significant relationship between salvage density and Delta inflow, so Delta inflow was not included in the effects analysis for adult splittail. Rather, an average salvage density for December–March over the entire 1996–2010 period, with 95% confidence intervals, was computed for each of the export facilities. The confidence intervals were computed from the among-year variances. For the effects analysis, the average 1996–2010 SWP and CVP salvage densities were multiplied by CALSIM modeling estimates of exports at each of the export facilities to estimate the salvage levels. CALSIM modeling results for 1922–2003 were used to compute salvage for each model run. Mean salvage for each export facility was estimated with 95% confidence intervals for each model run. Normalizing adult splittail salvage by population size was not possible in this analysis because there are no reliable estimates of adult splittail population size.

B.3.4.5.2 Method Based on Yolo Bypass Inundation

As noted above in Section 5.3.5.1, juvenile Sacramento splittail salvage density at the SWP/CVP south Delta fish facilities is correlated with Delta inflow. Years with higher inflow have higher recruitment of splittail because increased inundation of floodplain habitat results in greater habitat for spawning and early rearing (Sommer et al. 1997; Feyrer et al. 2006). In addition to estimating salvage density from Delta inflow, as described in Section B.5.3.5.1 above, a second analysis was conducted wherein salvage density was estimated from the number of days that the Yolo Bypass was inundated during spawning and early rearing. Because of the large size of the Yolo Bypass relative to other floodplain habitats in the Central Valley, it was assumed that the inundation of the Yolo Bypass provides a good index of total splittail recruitment and, therefore, of splittail salvage at the south Delta fish facilities. Historic data on the number of days during which stage at Fremont Weir reached or exceeded 33.55 feet NAVD were compiled; at this stage flow over the weir is 3,000 cfs and significant out-of-channel inundation begins (Bay Delta Conservation Plan Integration Team 2009). Regression analysis was used to develop equations relating the number of days during February–June with flow over Fremont Weir >= 3,000 cfs to the May–July salvage density of YOY splittail (Figure B-12 and Figure B-13). The equations were used with CALSIM estimates of Fremont Weir flow to compare EBC and PP scenarios for estimated salvage of juvenile splittail in a similar manner to the analysis based on salvage estimated from Delta inflow. This method is preliminary and requires additional review and

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refinement, for example to incorporate measures of population size in order to set the changes in entrainment in proper context.

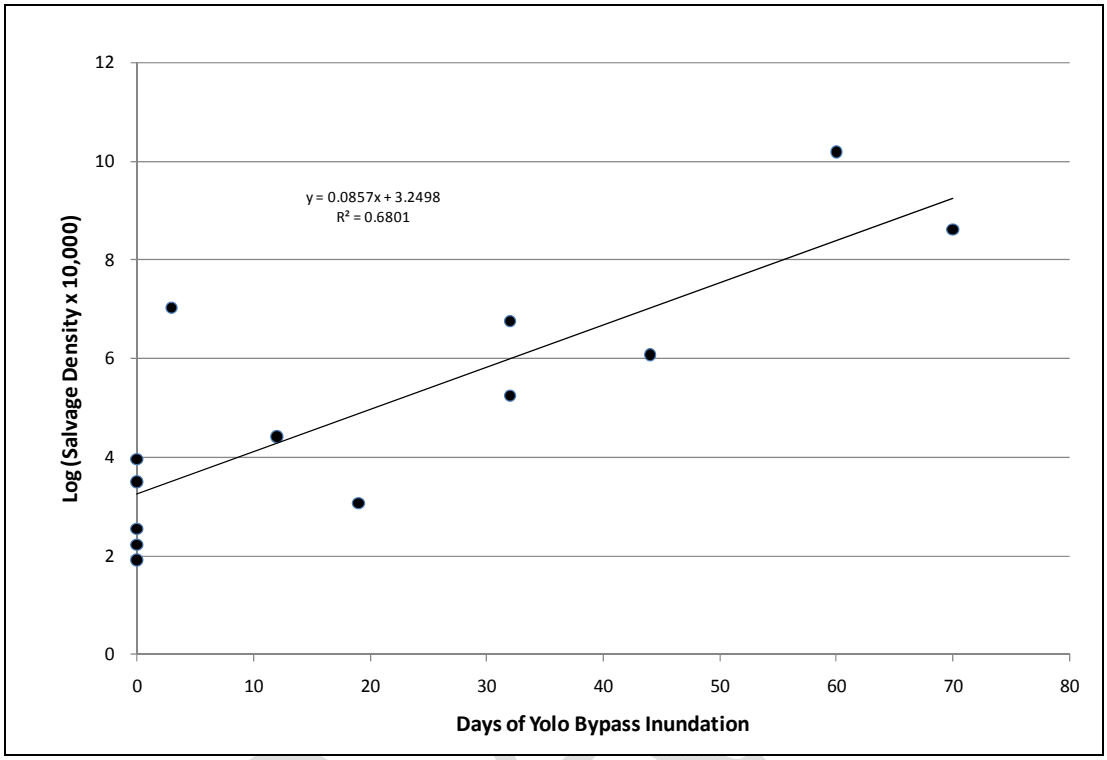

Figure B-12. Mean Splittail Salvage Density at SWP vs. Number of Days of Yolo Bypass Inundation, 1996–2009

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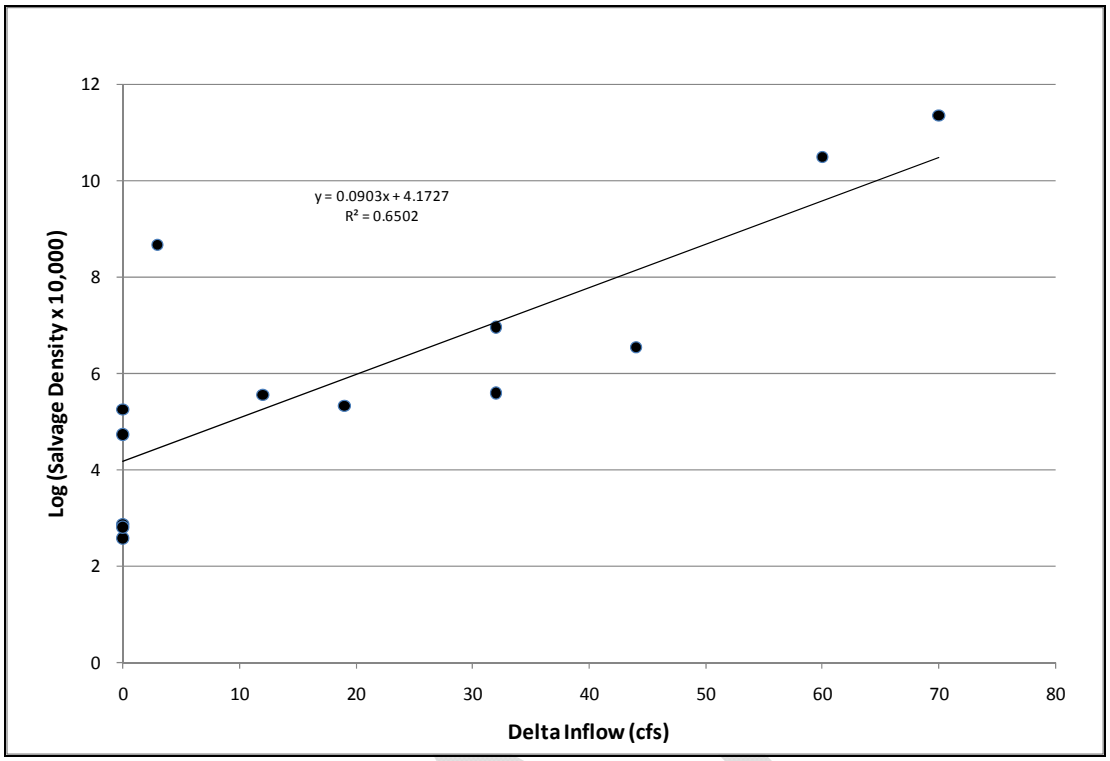

Figure B-13. Mean Splittail Salvage Density at CVP vs. Number of Days of Yolo Bypass Inundation, 1996–2009

B.3.5 Old and Middle River Flow Proportional Entrainment Regressions (SWP/CVP South Delta Export Facilities)

This method includes using flow data for OMR to estimate the proportion of a population that would be entrained. It has been applied to delta smelt in the 2008 USFWS BO and was used for analysis of the BDCP as described below. It was not used for Chinook salmon as no statistically significant relationship was found between OMR flows and entrainment of these species.

B.3.5.1 *Proportional Entrainment Loss Regressions: Delta Smelt*

B.3.5.1.1 Estimates of Proportional Loss Based on Kimmerer (2008)

The proportion of the delta smelt population entrained at the south Delta export facilities was estimated for each existing condition and project scenario from predicted OMR flows. Recent (1996–2006) estimates of the proportions of the total populations of delta smelt adults and juveniles plus larvae entrained were obtained from the work of Kimmerer (2008) as reported in Miller (2011). The effects of OMR flows on Kimmerer's estimate of the proportions entrained were determined by linear regression of the proportions on log-transformed OMR flows. For adults, the proportion for each year was regressed on average December–April OMR flow. A constant of 10,000 was added to the averages to eliminate negative numbers prior to computing the log. The regression was statistically significant ($p<0.01$, Figure B-14). A regression for the juveniles-larvae was similarly computed using May–July OMR flow averages, and again the

regression was statistically significant ($p<0.01$, Figure B-14). The equations from the regression analyses then were used with CALSIM modeling estimates of average December–April and May–July OMR flow for existing biological conditions in the near-term (EBC), early long-term (EBC_ELT), and late long-term (EBC_LLT), and the preliminary proposal in the early long-term (PP_ELT) and late long-term (PP_LLT) to estimate the average proportion of the population lost for each scenario for all water years and for each water-year type separately. Negative calculated values for proportional loss were changed to zero before calculating summary statistics. The main disadvantage of the estimates of proportional loss based solely on OMR flows is that factors other than OMR flows (e.g., turbidity and Delta outflow) also explain delta smelt south Delta entrainment (Manly 2011) and these are not accounted for. Estimates of proportional entrainment based on Miller (2011) described below in Section B.5.5.1.2 and estimates of salvage from the Manly (2011) Salvage Estimation Equation described in Section B.5.5.2 attempt to account for both of these important factors.

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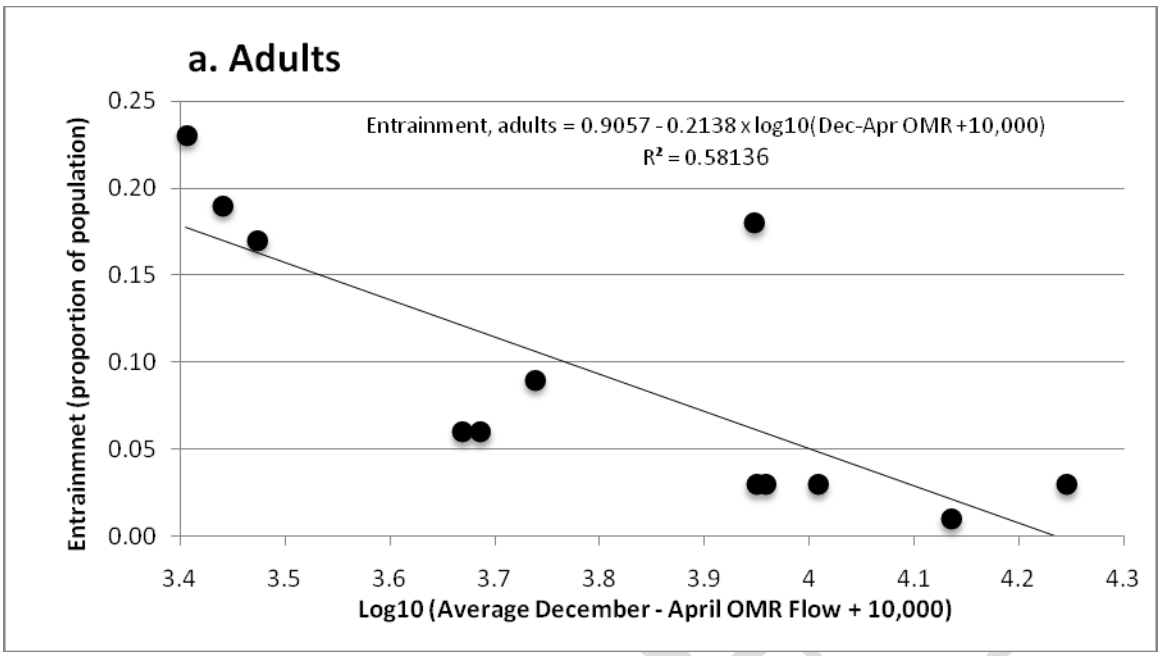

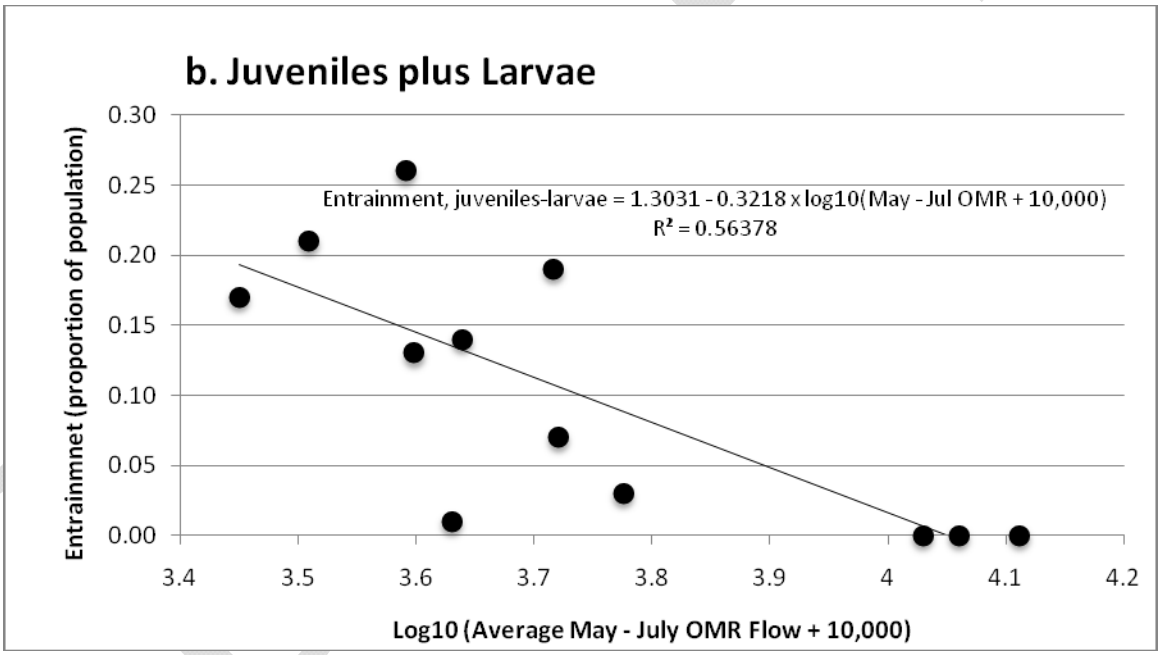

Figure B-14. Annual (1996–2006) Entrainment (Proportion of Population Entrained) vs. Old and Middle River Flow for Delta Smelt (a) Adults and (b) Larvae and Juveniles

B.3.5.1.2 Estimates Based on Miller (2011) Adjustment of Proportional Loss

Miller (2011) proposed that Kimmerer's (2008) estimates of proportional entrainment may have been biased high for a variety of reasons, including that overall population size may have been underestimated because trawl sampling in the Bay-Delta did not include the full range of delta smelt. Kimmerer (2011) acknowledged that better analytical techniques could be applied and

estimated that proportional entrainment of adults could be revised downward by approximately 25%.

Estimates of proportional entrainment for the "adjusted Kimmerer approach" for the six BDCP scenarios (EBC1, EBC2, EBC2_ELT, EBC2_LLT, PP_ELT, and PP_LLT) were developed for adult entrainment using monthly average OMR flows (December–March), and minimum monthly Secchi depth (December–February) in the southeast Delta for the years 1995 through 2006. The regression variables for larval-juvenile entrainment were estimates of proportional entrainment, monthly average X2 (March–June), and monthly average OMR flows (March–June) for the years 1995 through 2006.using estimates of proportional entrainment and the following regression equations for adult and larval-juvenile entrainment:

% adult entrainment = 0.224 – 1.34x10-5*Dec–Mar OMR – 0.00291*Min Monthly Secchi, Dec–Feb

$R^2 = 0.84$, p(OMR) = 0.0001, p(Secchi) = 0.0009

% larval-juvenile entrainment = -0.572 + 0.00972*Mar–Jun X2 – 2.157x10-5*Mar–Jun OMR

$R^2 = 0.90$, p(X2) = 0.007, p(OMR) = 0.04

Adult proportional entrainment was set equal to zero whenever the OMR term in equation (1) was positive, because adults would not be drawn to the export pumps then, or when the minimum Secchi depth term was greater than 55 cm because very few adults are found in water with Secchi depth greater than 55 cm. Secchi depths were estimated using a regression equation relating minimum monthly Secchi depth in the southeast Delta (December–February) to water year (Sacramento Valley Index) and maximum monthly Delta inflow from the Sacramento River and Yolo Bypass (December–February):

LOG min. monthly Secchi depth Dec–Feb = -152 + 46.87*LOG water year – 0.2336*LOG maximum monthly Sac basin inflow Dec–Feb

$R^2 = 0.55$, p(Log water year) = $1x10^{-5}$, p(Log inflow) = 0.0002

The increasing trend in Secchi depth in the southeast is a source of bias in estimating proportional larval-juvenile entrainment (Miller 2011). Feeding success by larval delta smelt is adversely affected when turbidity is low, specifically when water clarity is above 55 cm Secchi depth (Baskerville-Bridges et al. 2004 as cited by Miller 2011). Because of expected lower survival associated with reduced feeding success, simulations of future larval-juvenile proportional entrainment based on X2 and OMR alone would likely overestimate entrainment mortality. The effect of Secchi depth on feeding success of larval-juvenile entrainment mortality was addressed by reducing the proportional entrainment estimates by an adjustment factor derived from the relationship shown in Figure B-15. Note that the maximum survival is only about 70%. Survival at any Secchi depth can be used to adjust downward the estimates of larval-juvenile proportional entrainment developed without regard for Secchi depth. The adjustment factor would be the survival developed from the Figure B-16 relationship divided by 0.70, the maximum survival, to normalize the adjustment and not over-correct for Secchi depth.

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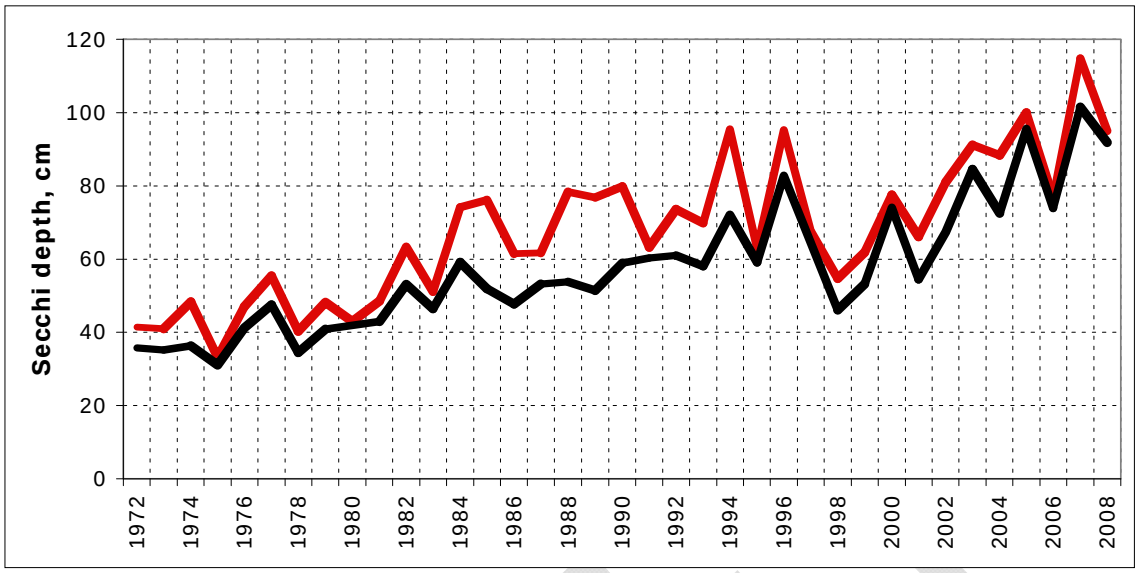
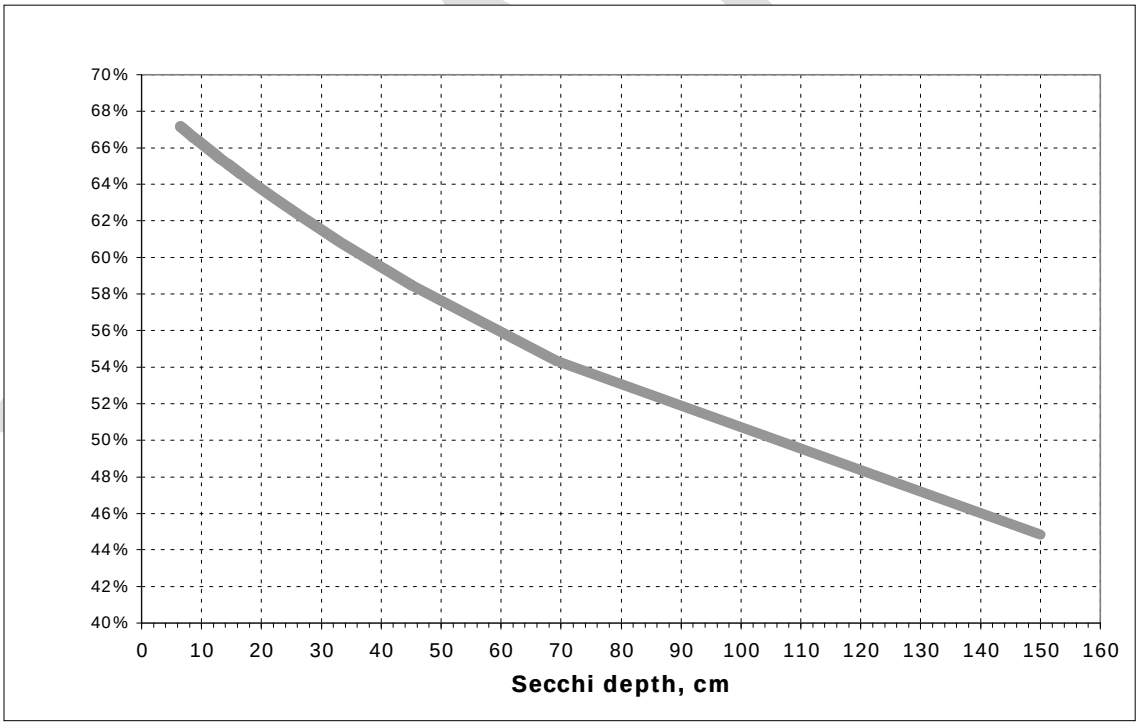


Black line is the average of monthly averages, April–June. Red line is the maximum of monthly averages, April–June. Data is the monthly average of Secchi depth measurements from eight routine surveys (see Miller et al. in press).

Figure B-15. Secchi Depth in the Southeast Delta



Data from Baskerville-Bridges et al. (2003).

Figure B-16. 30-Day Survival (%) of Delta Smelt Larvae and Small Juveniles in the Presence of Adequate Prey at Different Secchi Depths

For each of the BDCP study scenarios, regression estimates of adult and larval-juvenile proportional entrainment were adjusted downward by a factor of 0.36 and 0.6, respectively, to

account for biases described by Miller (2011). Recent data indicate that between 20% and 80% of delta smelt (adults and larvae-juveniles) are found in areas not sampled by the surveys Kimmerer (2008) used in his analysis. 60% is the midrange of those percentages and gives the 0.6 adjustment used for larvae and juveniles. For adults, an additional adjustment of 0.6 was applied to account for potential overestimation of the ratio of entrainment to salvage by Kimmerer (2008); this gives an overall adjustment of 0.36 for adults (0.6 × 0.6). In addition, estimates of future proportional entrainment under each scenario were calculated based on three assumptions regarding future trends in Secchi depth:

1. The historical trend in Secchi depth will continue in the future, increasing logarithmically with year
2. Secchi depth will remain at existing conditions (2010 levels)
3. Secchi depths will remain at 1990 levels when Secchi depths were below levels associated with avoidance by adults and reduced feeding success of larvae-juveniles (<55 cm)

Application of the first assumption to those alternatives whose year of development was 2050 resulted in Secchi depth estimates exceeding 150 cm. Data from Old River and the Sacramento River at Rio Vista for recent years indicated that a practical upper limit to Secchi depth is about 150 cm (5 feet). Therefore, Secchi depth estimates were capped at that value.

B.3.5.2 *Manly (2011) Salvage Estimation Equation: Adult Delta Smelt*

The proportional loss estimation equation for adult delta smelt described above in Section B.5.5.1.1 explains entrainment loss (originally derived from salvage) solely as a function of OMR flows. The approach based on Miller (2011) accounts for the positive correlations between delta smelt occurrence and increased turbidity. As noted by USFWS (2008:212), much of the variation in the estimates is not captured because adult salvage and entrainment are not explained solely by OMR flows and there is wide, apparently random, variation in the use of the central and south Delta by spawning delta smelt. Upstream migrations to spawn by delta smelt appear to be cued by storms that increase Sacramento River flow and turbidity (Grimaldo et al. 2009).

In an effort to model entrainment in response to OMR flows and turbidity, Manly (2011) developed equations that estimate the total salvage (SWP/CVP south Delta export facilities combined) of adult delta smelt in December and January of each water year. The equations were derived from flow data spanning December 1993 to January 2009 and estimated biweekly salvage beginning December 1, December 15, December 29, and January 12, as a function of OMR flows (representing the hydrodynamic ‘pull’ of the export facilities [Grimaldo et al. 2009]), Sacramento River at Freeport flows (representing turbidity during storm events), other flow locations (e.g., San Joaquin River at Vernalis), and the same water year’s fall midwater trawl index (representing overall population size). A variety of different equations was explored consisting of one, two, or three flow terms, and two-flow-term equations proved to be the best

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compromise in terms of number of parameters and variation explained (which was >80% variation explained for 64 observations used to develop the regression, i.e., four biweekly periods over 16 years from 1993 to 2009).

The present analysis used the best-fit two-flow-term equation that includes terms readily available from the BDCP DSM2 modeling: combined OMR flows and Sacramento River at Freeport flows. DSM2 data were used because the analysis requires biweekly averaging, and CALSIM outputs, the preferred option for flow-related analysis, are given at the monthly time scale. The equation used was:

$$\text{Estimated salvage} = \text{EXP}[1.01+(-5.04*\text{sOMR})+(3.42*\text{sSAC})+(-2.94*(\text{sOMR}^2))+(-0.77*(\text{sSAC}^2))+(0.57*\text{sOMR}*\text{sSAC})+0.44*(\text{LN}(\text{FMWT}))]$$

$$R^2 = 0.837 \text{ (n = 64 observations)}$$

where EXP = exponent; sOMR = 14-day average of daily OMR flow standardized[7] to the mean (-4,447 cfs) and standard deviation (5,016 cfs) of the dataset used to develop the equation, beginning 2 days before the associated salvage period to be estimated; sOMR = 14-day average of daily Sacramento River at Freeport flow standardized to the mean (22,934 cfs) and standard deviation (18,377 cfs) of the dataset used to develop the equation, beginning 2 days before the associated salvage period to be estimated; and FMWT = 133, the median fall midwater trawl index during 1993–2009, the period over which the equation was developed.

Figure B-17 illustrates the important features of the Manly (2011) equation for a series of Sacramento River at Freeport flows from 5,000 cfs to 100,000 cfs, OMR flows from -2,000 cfs to -8,000 cfs, and a fall midwater trawl index of 133 (the median value for 1993–2009). At low Sacramento River at Freeport flows (< 20,000 cfs), salvage is low regardless of how negative OMR flows are, probably reflecting the lack of a turbidity signal for delta smelt to migrate upstream into areas that may make them susceptible to entrainment at the SWP/CVP south Delta export facilities. At Sacramento River flows above 20,000 cfs, there is an increase in salvage, presumably triggered by increased upstream migration cued by turbidity; the extent of the increase in salvage is very much dependent on OMR flows, with very little increase at -2,000 cfs and a considerable increase between -4,000 and -6,000 cfs. In the example given, salvage peaks at 60,000 cfs Sacramento River flow and -8,000 cfs; as Sacramento River flows increase beyond 60,000 cfs, salvage decreases, presumably reflecting the physical effect of substantial flow increasingly limiting the upstream movement of delta smelt into areas susceptible to entrainment at the SWP/CVP south Delta export facilities.

The effects analysis involved calculating salvage for 68 14-day periods in December and January for the 1975–1991 water years included in the DSM2 simulation for each of the six model scenarios. Total December–January salvage in each water year then was calculated by summing the four 2-week periods for each water year. This allowed comparison of total December–January salvage between EBC and PP scenarios.

[7] Standardization refers here to subtraction of the mean and division by the standard deviation.

B.3.5.3 *Juvenile Winter-Run and Spring-Run Chinook Salmon Incidental Take Rate*

For possible use in the effects analysis, relationships were investigated between juvenile Chinook salmon incidental take rate (entrainment loss divided by escapement size) at the SWP/CVP south Delta export facilities and OMR flows (Deriso 2010). The intention was to use any statistically significant regressions to estimate future juvenile losses. Results of the regression analyses did not reveal any statistically significant relationships (Figure B-18), so the method was not used. Entrainment estimates for salmonids instead were based on the salvage-density method (described above) and proportional salvage as calculated in the Delta Passage Model (described below).

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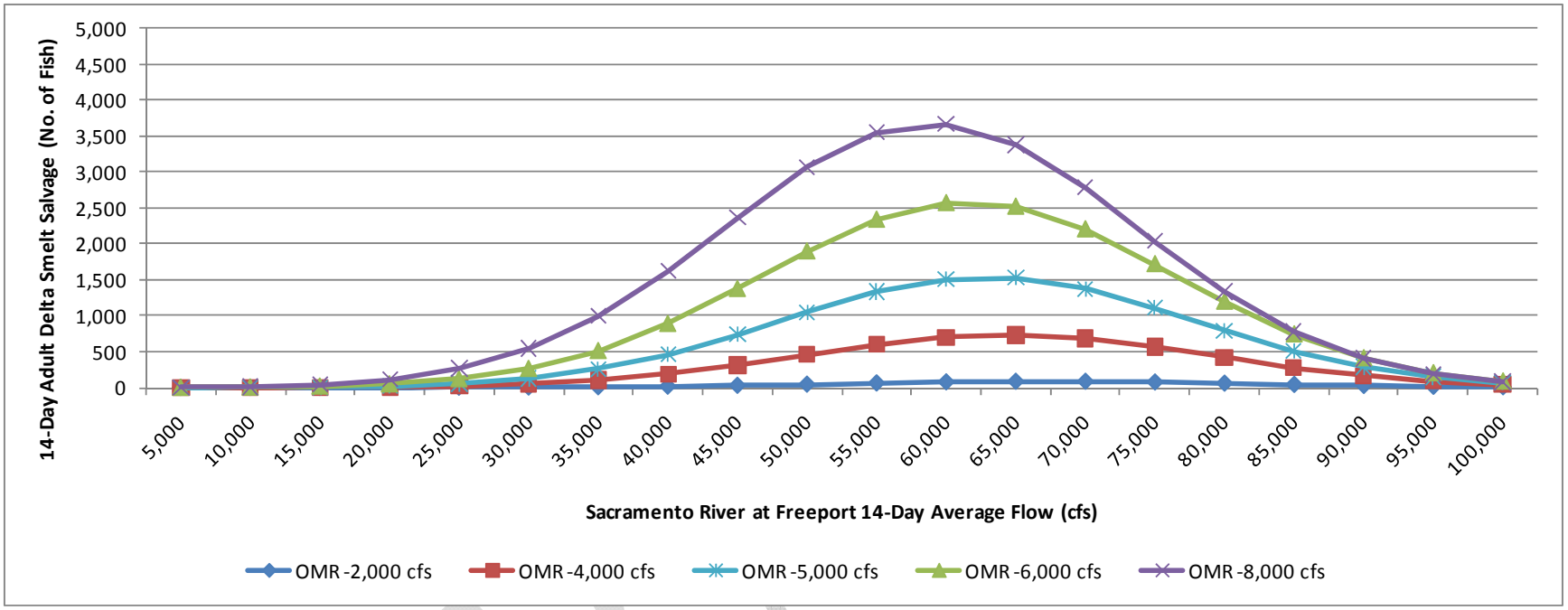
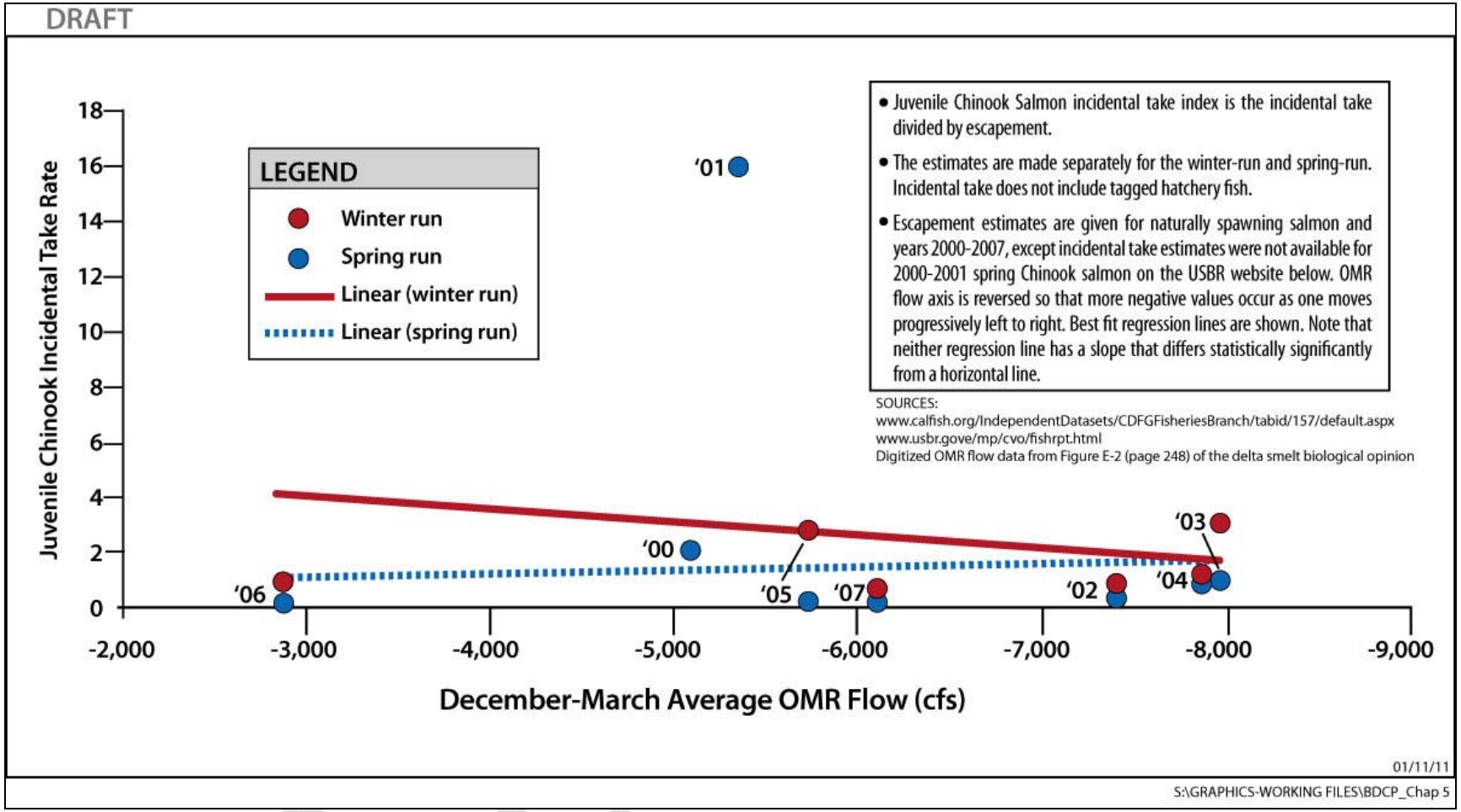


OMR = Old and Middle River Flows.

Figure B-17. Estimated 14-Day Adult Delta Smelt Salvage in December and January, As Derived from the Equation of Manly (2011)



Source: Adapted from Deriso 2010.

Figure B-18. Relationship between Average Monthly OMR Reverse Flows and a Normalized Juvenile Incidental Take Index for Winter-Run Chinook Salmon in December–March of 2000–2007

B.3.6 Particle-Tracking Modeling: Larval Smelt Entrainment (SWP/CVP South Delta Export Facilities; SWP/CVP North Delta Intake; North Bay Aqueduct Barker Slough Pumping Plant; Agricultural Diversions)

B.3.6.1 *Delta Smelt*

The DSM2-PTM was used to generate a weighted average entrainment (% of particles entrained) of larval delta smelt from stations throughout the Delta based on an assumed starting distribution of smelt in the Delta and PTM results. The tool was used to examine both the March–June and April–May periods. Results from each model scenario were compared to determine the relative differences in entrainment risk between the project and existing conditions for this life stage. Results of the simulation model do not represent the actual entrainment of larval delta smelt that may have occurred in the past or would occur in the future, but rather should be viewed as a comparative indicator of the relative risk of larval entrainment under existing biological conditions and BDCP operations. PTM results generally assume that delta smelt larvae act as passive particles which is likely to be a more reasonable assumption for the weaker swimming younger individuals but is less likely to be true following growth in the Delta. This again emphasizes the importance of considering the relative change in proportional entrainment of particles between scenarios rather than a focus on estimated entrainment numbers from the analysis. For purposes of this effects analysis, those particles that were estimated to have entered the SWP or CVP export facility (final fate) are characterized as having been entrained. The weighting of entrainment risk was performed through post-processing of the PTM results to represent the proportion of fish that would occur in different parts of the Delta or starting distributions. The PTM inserts particles into the Delta at 29 points (see below). The PTM runs were used to describe the total proportion of all particles injected into the Delta at the start of a particular run that reach specific endpoints. These endpoints were:

- To Martinez—particles moving out of the Delta and into Suisun Bay.
- To North Delta Diversions—particles entrained at the intakes of the proposed north Delta diversion facilities on the Sacramento River.
- To North Bay Aqueduct—particles entrained at the intakes in Barker Slough in the Cache Slough Region.
- To Delta Ag—particles entrained at agricultural intakes distributed throughout the Delta.
- To South Delta Pumps—particles entrained at the intakes at the CVP and SWP facilities in the south Delta.

The analysis focused on the total percent of the population that would move to the different endpoints after 30 or 60 days under the project relative to existing conditions. The specific starting distributions used are described in the fry entrainment sections of the species-specific methods for delta and longfin smelt. The PTM was run for numerous scenarios representing a wide range of hydrologic conditions in the Delta.

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Two approaches were employed to evaluate the effects of the preliminary proposal on larval delta smelt entrainment: (1) PTM modeling and evaluation of particle fate, as described in Section 2.1.15; and (2) development of a relationship between loss of particles to all Delta diversions and OMR flows from the PTM, and application to 82 years of OMR flow data from CALSIM II.

For the first of these approaches (PTM modeling and evaluation of particle fate), two methods were used to establish starting distributions for the evaluation of larval delta smelt entrainment. The first method assumed a uniform starting distribution. To obtain a uniform distribution of delta smelt throughout the Delta, the PTM results were weighted by proportion of the total area of the Delta area within each of five regions in the Delta. This weighting was necessary because these regions vary in size and the number of insertion points they contain. This starting distribution was intended to provide perspective regarding the potential effects of the BDCP under an assumption that their starting distribution may change substantially in the future as a result of changes in hydrology and water quality conditions associated with both climate change and the project.

The second method based the starting distributions of delta smelt on the DFG spring kodiak trawl (SKT) data collected during February through May, 2002 through 2010. These surveys identify the distribution of female delta smelt and assess the reproductive stage of these fish. In addition to the distribution of all females, the distribution of ripe and spent females was used to determine the areas where eggs were likely to be laid, and the presence of spent females was used to determine the onset of spawning. The total number of fish caught in a single survey was assumed to be an index of the total population of the species, and the proportion of females caught at stations in regions of the Delta, weighted by the area associated with that station, was assumed to represent the proportion of larvae that would be produced in that area. The regions of the Delta and the sampling stations used to represent those regions are presented in Table B-9 and shown in Figure B-19.

Table B-9. Regions and Spring Kodiak Trawl Sampling

Region	Sampling Stations
Suisun Bay	340, 405, 411, 418, 501, 504, 519
Suisun Marsh	602, 606, 609, 610
Confluence	508, 513, 520, 801
Sacramento River	704, 706, 707
Cache Slough Area	711, 712, 713, 715, 716, 719
San Joaquin River	804, 809, 812, 815
South Delta	902–915
Eastern Delta	724, 919–923

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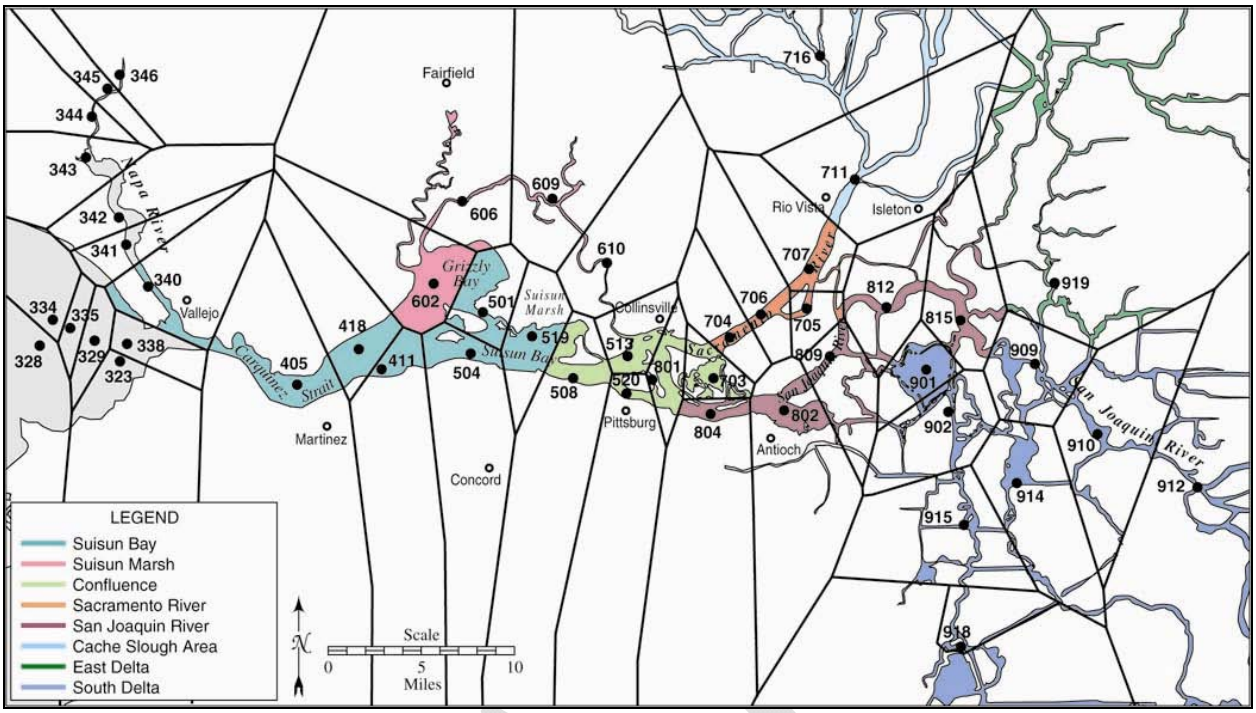

Figure B-19. Regions Used in Calculating Starting Distributions

The average percentage of all female delta smelt found in each region in each month was calculated for drier years (2002, 2004, 2007, 2008, and 2009) and wetter years (2003, 2005, 2006, and 2010) and is shown in Table B-10. An additional analysis was run for ripe female delta smelt for the same set of months and years. A subset of these distributions was selected to represent a suite of different smelt starting distributions for PTM runs. Results from the additional analysis run for ripe female delta smelt for the same set of months and years are shown in Table B-11. The subset of these distributions selected to represent a suite of different starting smelt distributions for PTM runs is indicated with shaded rows in Table B-10 and Table B-11. These starting distributions were selected to represent a broad range of smelt starting distributions, so that the known variability in starting distributions was incorporated into the modeling. The composition of the seven starting distributions used for the delta smelt PTM analysis is shown in Figure B-20.

The hydrologic conditions at the start of each PTM period selected for the analysis are shown in Figure B-20[8]. In discussing results of the PTM modeling in this and subsequent sections, the text refers to the total proportion or percent of the population that moves to the different end points after 30 or 60 days. When comparing between model scenarios, the values discussed are the absolute differences, not the percentage change from the existing biological conditions (EBC1 and EBC2) scenarios.

[8] This figure also includes the hydrologic conditions for January periods. These periods are used in the larval longfin smelt analysis (Section 5.4.6.2.1), but not used for delta smelt.

Table B-10. Calculated Average Distributions of All Female Delta Smelt for Drier and Wetter Water Years (Percent of Total Population)

Hydrologic Condition	Month	Region							
		Suisun Bay	Suisun Marsh	Con-fluence	Sacramento River	Cache Slough Area	San Joaquin River	South Delta	East Delta
Uniform		25.89	13.07	11.30	4.59	11.09	11.31	19.99	2.76
Drier Water Years	Feb	0.76	56.01	0.47	15.91	24.29	2.55	0.00	0.00
	Mar	1.58	52.26	0.87	7.88	29.09	7.42	0.64	0.27
	Apr	2.16	3.15	6.74	29.87	47.90	9.67	0.51	0.00
	May	0.00	14.77	11.37	16.54	50.24	7.08	0.00	0.00
Wetter Water Years	Feb	10.62	60.40	0.92	1.68	22.07	2.69	0.71	0.28
	Mar	15.14	20.74	1.65	8.05	53.41	0.72	0.00	0.29
	Apr	2.53	6.81	3.57	28.60	45.68	11.85	0.96	0.00
	May	36.98	0.00	3.22	3.47	28.37	18.98	0.00	8.97
Shaded rows indicate starting distributions selected for this analysis.									

Table B-11. Calculated Average Distributions of Ripe Female Delta Smelt for Drier and Wetter Water Years (Percent of Total Population)

Hydrologic Condition	Month	Region							
		Suisun Bay	Suisun Marsh	Con-fluence	Sacramento River	Cache Slough Area	San Joaquin River	South Delta	East Delta
Drier Water Years	Feb	0.00	56.21	0.00	0.00	33.65	4.41	5.74	0.00
	Mar	0.24	39.03	0.36	5.68	49.03	4.54	1.03	0.09
	Apr	1.45	3.56	1.44	28.50	58.76	5.85	0.43	0.00
	May	0.00	19.06	0.60	16.39	61.98	1.98	0.00	0.00
Wetter Water Years	Feb	9.00	51.22	0.65	1.18	36.72	0.58	0.00	0.66
	Mar	20.18	20.71	0.47	3.49	55.09	0.00	0.00	0.06
	Apr	0.87	5.38	3.20	9.29	78.83	1.31	1.12	0.00
	May	3.00	0.00	1.30	3.23	42.48	31.83	0.00	18.17
Shaded rows indicate starting distributions selected for this analysis.									

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Figure B-20. Distribution of Smelt in Different Regions of the Delta

The seven starting distributions were used to post-weight PTM results to determine how each model scenario would change entrainment and emigration of delta smelt. The proportion of the population moving to different end points resulting from these starting distributions was evaluated at 30 and 60 days after the start of PTM runs. The 30-day period reflects a complete tidal cycle (28 days) and reduces the error propagated when the PTM is run for a longer time period. In addition, delta smelt have a growth rate of approximately 0.5 mm/day; thus, they increase in fork length from approximately 5 millimeters (mm) at hatching to 20 mm in 30 days. At 20 mm, they have greater swimming mobility and are less likely to behave as neutrally buoyant, passive particles. The 60-day period provides an assessment of varying hydrodynamic conditions over a longer time period but is less likely to reflect swimming behavior of larval delta smelt as they grow larger and become juveniles.

Thirteen PTM scenarios were used to represent different hydrologic conditions during the months of February through June, when delta smelt larvae would be in the Delta. These PTM periods were selected to represent lower to higher outflows on the Sacramento River and, within these groups, lower to higher outflows on the San Joaquin River. The PTM hydrologic scenarios were selected to represent a range of flows on the Sacramento River ranging from about 10,000 to 26,000 cfs and flows on the San Joaquin River ranging from 1,000 to 12,200. A final scenario (Feb 1940) represents Sacramento River flows of 52,300 cfs on the Sacramento River and 3,900 cfs on the San Joaquin River. The range of flows above on the Sacramento River was subdivided into five parts, and the range of San Joaquin River flows was modeled within each of those subdivisions. In the following sections, each PTM run is referred to by the month and year representing the start of that set of hydrologic conditions in the sections that follow. However, these runs are taken to represent a specific set of hydrologic conditions, which may occur during different months or years. These are not intended to represent the specific month and year indicated.

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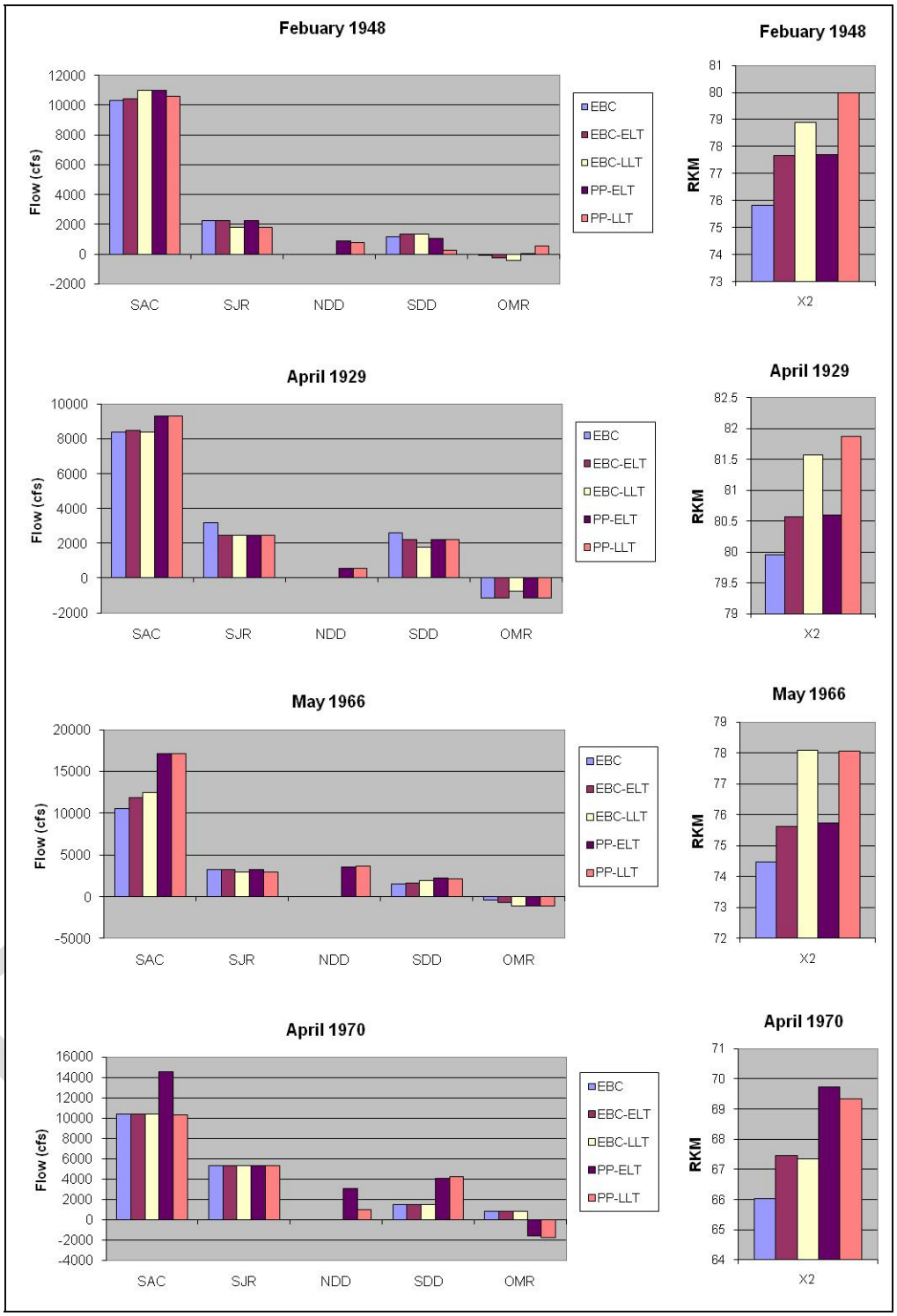

(SAC = Sacramento River flows; SJR = San Joaquin River, NDD = north Delta diversion export rate, SDD = south Delta diversion export rate; OMR = Old and Middle River reverse flows, EBC = Existing biological conditions, ELT = early long-term; LLT = late long-term.

Note: January periods were not used for delta smelt analysis described in this section.)

Figure B-21. Hydrologic Conditions at the Start of PTM Runs

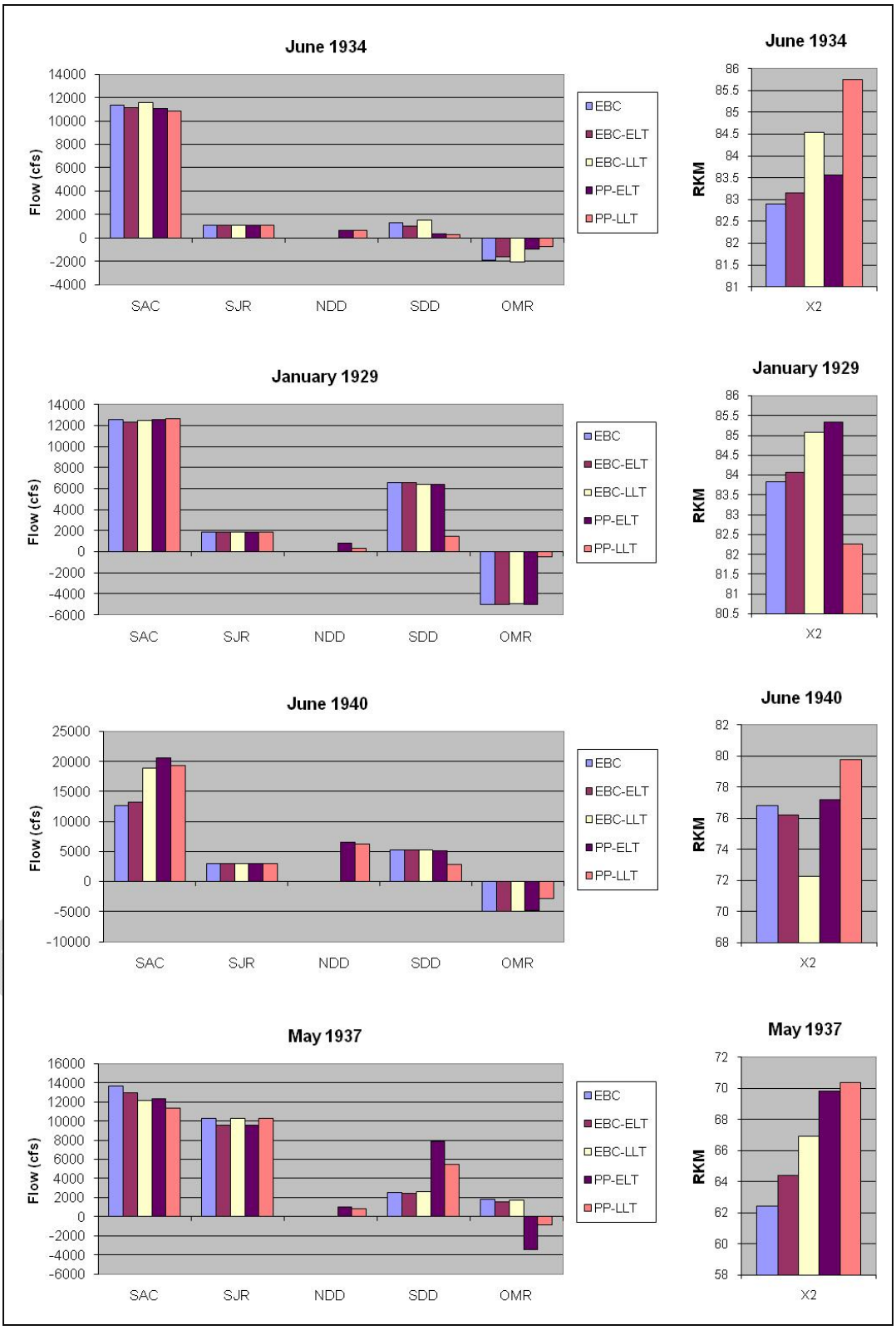

Figure B-21. Hydrologic Conditions at the Start of PTM Runs (continued)

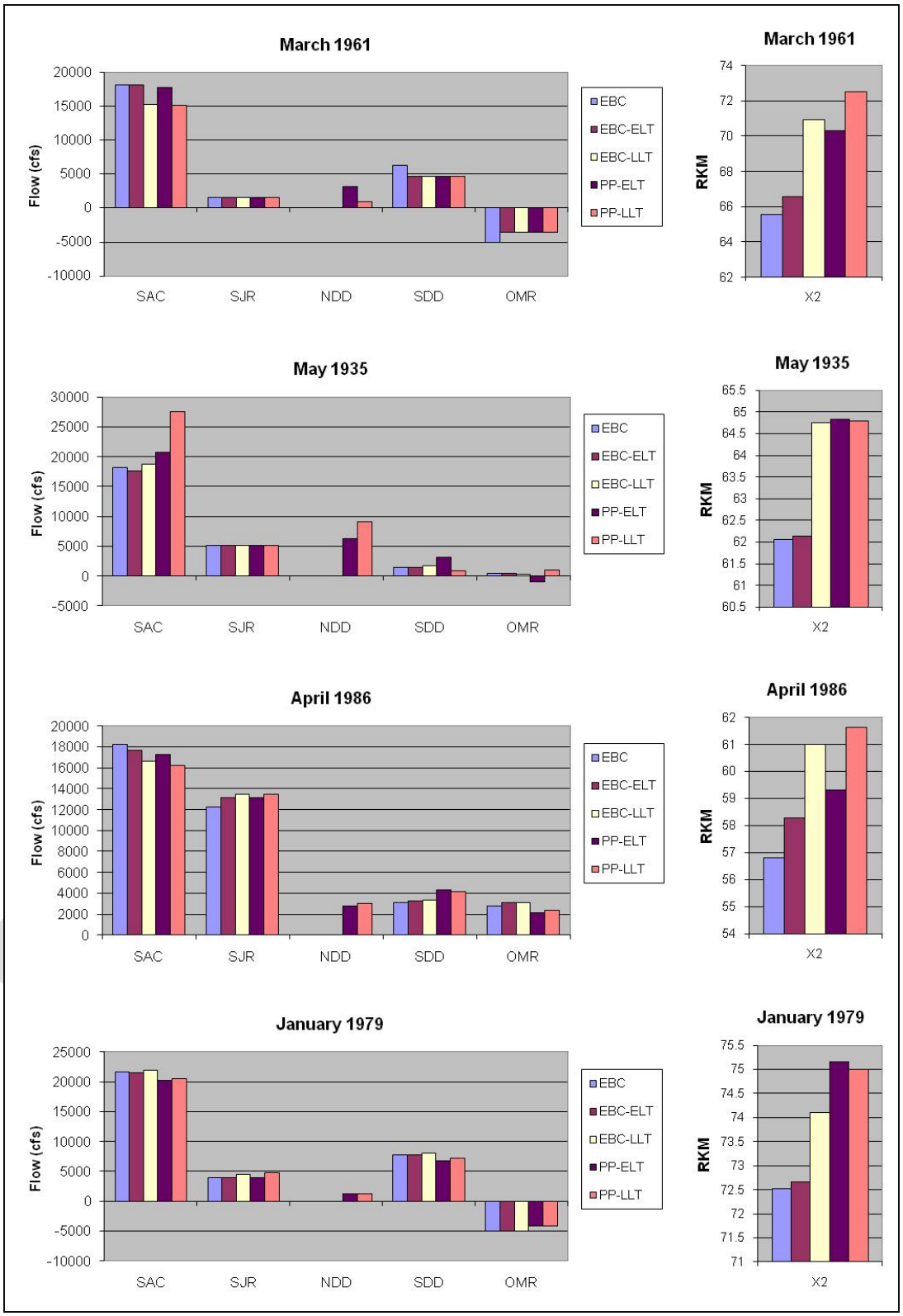

Figure B-21. Hydrologic Conditions at the Start of PTM Runs (continued)

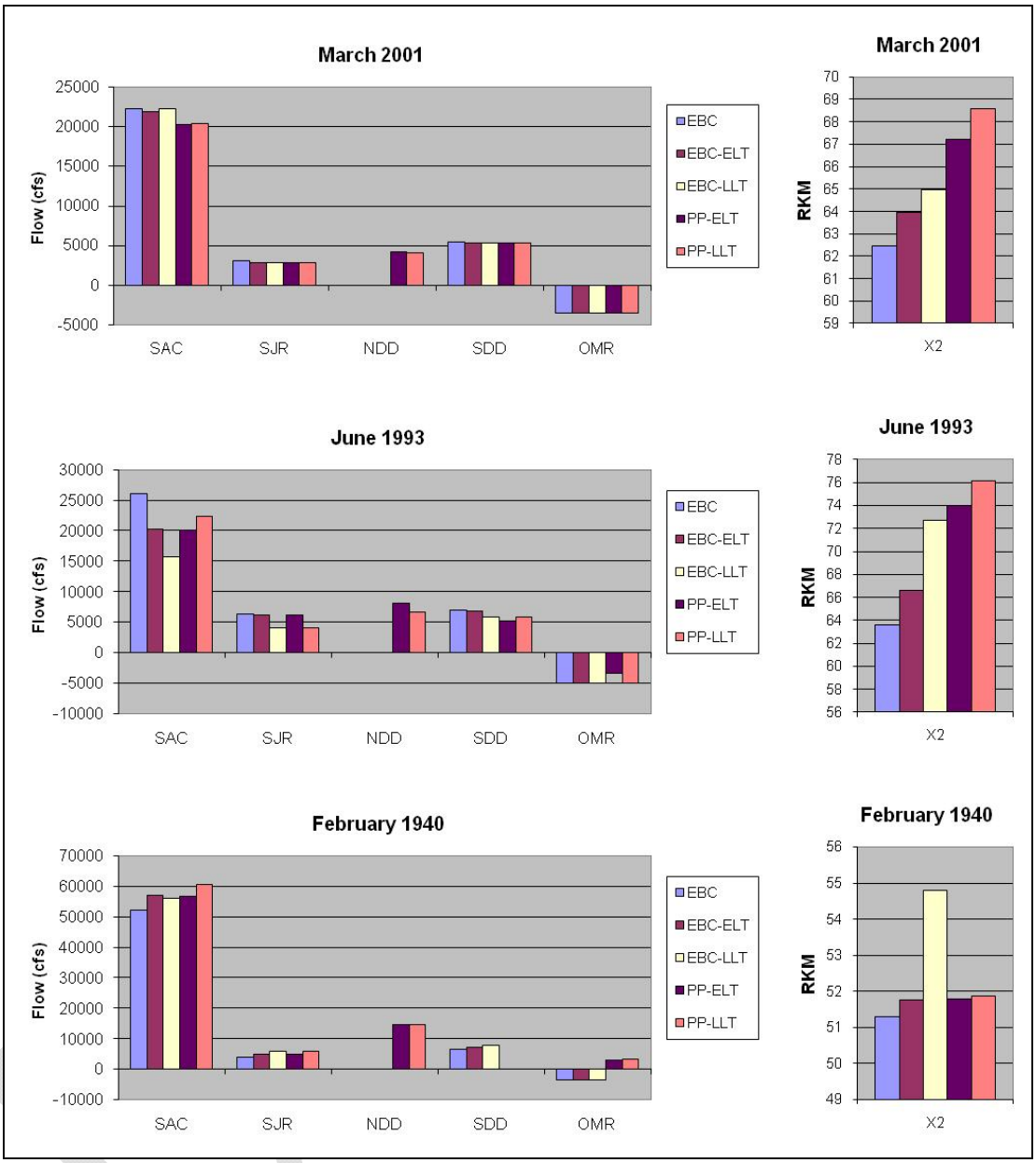

Figure B-21. Hydrologic Conditions at the Start of PTM Runs (continued)

For the second approach (development of a relationship between loss of particles to all Delta diversions and OMR flows, and application to 82 years of OMR flow data from CALSIM II), a third order function was applied to the relationship between loss of particles to all Delta diversions and OMR flows from the PTM for the uniform distribution:

$$\text{Percent loss of particles} = 9.01 - (3.04 \times 10^{-3}\, OMR) + (1.11 \times 10^{-7}\, OMR^2) + (3.07 \times 10^{-11}\, OMR^3),\ R^2 = 0.92$$

This relationship was developed to provide an equation with which to predict entrainment based on OMR flow from the CALSIM II 82-year record. Because the equation generated was based

on the uniform distribution, which assumes a relatively large proportion of the delta smelt population to be present in the south Delta, an attempt was made to determine under which hydrologic conditions a large proportion of the population would occur in the south Delta and identify when this equation should be applied. Specifically, relationships between salvage and SKT data and indicators of hydrologic conditions (OMR and X2) were used to identify years in which a larger proportion of delta smelt would be expected to occur in the south Delta. The results of this analysis were inconclusive, precluding a formal analysis of entrainment in this manner.

B.3.6.2 *Longfin Smelt*

Longfin smelt are thought to be influenced by tidal and net currents while migrating downstream. The two approaches outlined under larval delta smelt entrainment (Section B.5.6.1) were used to evaluate the effects of the preliminary proposal on larval longfin smelt entrainment. For the first of these two approaches, the PTM was used to assess larval (and young juvenile) longfin smelt entrainment during the larval/young juvenile period (January–March). The index was separated by water-year type because entrainment of longfin smelt larvae/young juveniles is greatest during dry and critical water years. Starting distributions for PTM runs for longfin smelt included the geographic distributions used in the DFG 2081 permit for the long-term operations of the CVP and SWP (DFG 2009b; Figure B-22). The temporal distributions contained in that document were not used, as the PTMs applied for BDCP analysis were not consistent with that approach. In this modeling, only the insertion points used in the 2081 permit were given weight in the analysis. The other insertion points included in the model were given weights of zero. The insertion points used were located in the following regions: Sacramento River (706), Cache Slough Area (711, 716), San Joaquin River (809, 812, 815), and the south Delta (906). Because of the relatively limited availability of data describing larval longfin smelt distributions, a sensitivity analysis was conducted for the starting distributions described here. This analysis provided a range of potential values for larval entrainment based on various assumptions regarding the distribution of longfin smelt.

The analysis is based on a comparative assessment of simulated particles whose fate was determined in the PTM to be transported to the south Delta export facilities. Results of the simulation model do not represent the actual entrainment of larval longfin smelt that may have occurred in the past or would occur in the future, but rather should be viewed as a comparative indicator of the relative risk of larval entrainment under existing biological conditions and BDCP operations. For purposes of this effects analysis, those particles that were estimated to have entered the SWP or CVP export facilities (final fate) are characterized as having been entrained.

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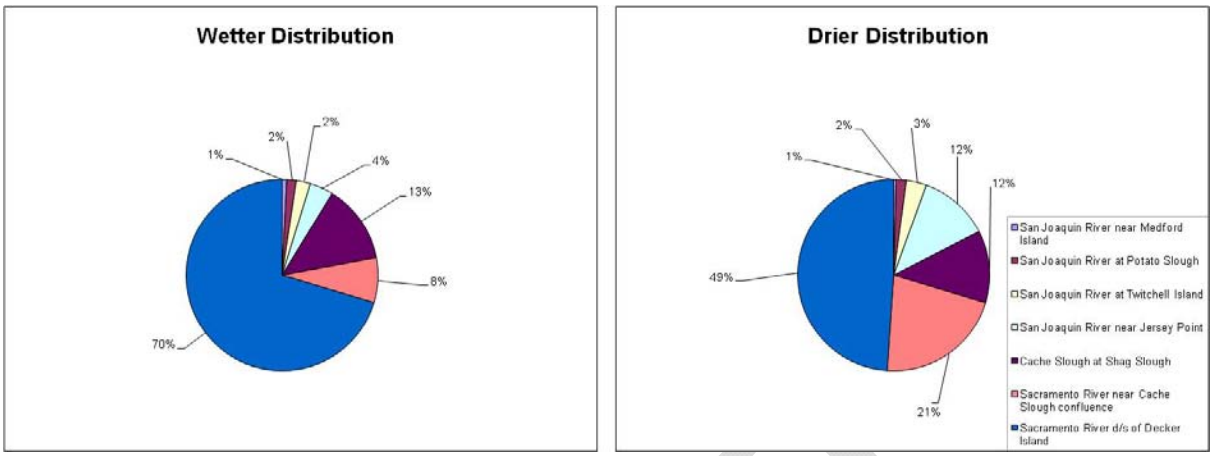

Figure B-22. Distribution of Larval Longfin Smelt in Different Regions of the Delta

Historical salvage data indicate that juvenile and adult longfin smelt generally are salvaged in greater numbers at the SWP and CVP facilities in drier years. The larval longfin smelt PTM analysis included all months between December and May that were available for PTM runs. Runs from drier periods may be more reflective of entrainment risk. Given the uncertainty regarding larval longfin smelt distributions historically and in the future, the evaluation treats all PTM run periods equally. The wetter and drier distributions place 0.43% and 0.79% of particles in the south Delta. Sensitivity analyses were used to address the potential for greater proportions of larval longfin smelt to be in the south Delta: particle tracking runs with 2%, 10% and 15% of particles starting in the south Delta were also undertaken. Sensitivity analyses were undertaken only for 30-day tracking periods and did not include the EBC1 scenario.

For the second approach, CALSIM OMR flow data for the longfin smelt larval period (January–May) were evaluated in light of the relationship developed between percent loss of particles and OMR flow, using an approach similar to that described above for delta smelt larvae (see Section B.5.5.1).

$$\text{Percent loss of particles} = 8.68 - (2.64 \times 10^{-3} \cdot OMR) + (1.08 \times 10^{-7} \cdot OMR^2),\ R^2 = 0.95$$

As with the delta smelt analysis, the OMR-particle loss regression was applied to the uniform distribution (note that the uniform distribution was not analyzed for the different hydrologic scenarios described above). The analysis of particle entrainment in relation to OMR flows for longfin smelt was an updated version of the analysis previously conducted for the February 10 effects analysis that had relied on the equation developed for delta smelt.

B.3.7 Delta Passage Model Salvage Estimates: Juvenile Chinook Salmon (SWP/CVP South Delta Export Facilities)

The Delta Passage Model (DPM), described in more detail in Appendix C, provides estimates of the proportion of migrating Chinook salmon smolts salvaged at the SWP/CVP south Delta export facilities. Fish are divided by run and by river basin of origin (Sacramento or San Joaquin). The daily proportion of Chinook salmon smolts lost at the SWP/CVP south Delta export facilities

was estimated by conducting an analysis of factors affecting the proportion of coded-wire-tagged (CWT) salmon recovered at the export salvage facilities. CWT recoveries used for analysis were expanded to account for subsampling that occurs at the export salvage facilities. For example, three CWT fish recovered in 6 hours of sampling would yield a salvage rate of 0.5 fish per hour. The expanded estimate of CWT fish for the corresponding 24-hour period would be 12 (0.5 fish per hour × 24 hours). However, expanded salvage loss estimates used for analysis here do not include prescreen predation mortality, for which a multiplier of several times may be necessary (see Salvage-Density Method section above). For fish entering the Delta from the Sacramento River (winter-run, spring-run, and fall-run), the daily proportion of fish salvaged was modeled using releases of CWT salmon into Georgiana Slough as part of the Delta Action 8 (DA8) experiments from Newman and Brandes (2010). A generalized linear model with a log-link function for the relationship between daily proportional salvage and total Delta exports was calculated:

$$\ln(\text{daily proportional salvage}) = -7.216+0.000266*\text{total exports}$$

$$R^2 = 0.30 \text{ (n = 15 observations)}$$

This relationship was applied within the DPM to those fish entering the interior Delta through Georgiana Slough and the Delta Cross Channel. In contrast to the analysis conducted for San Joaquin River–origin fish (see below), no attempt was made to account for other factors (e.g., Sacramento River flow or proportion of flow entering Georgiana Slough) because DA8 CWT releases were made directly into Georgiana Slough. Given the location of these releases and the experimental design of the DA8 experiments, there would be little opportunity for factors other than export volume to influence salvage rate.

Similar to the analysis for Sacramento River–origin fish, a relationship was developed for San Joaquin–origin Chinook salmon smolts (fall-run). As with the Sacramento River–origin smolts, a generalized linear model was used to examine factors explaining the proportion of CWT release groups recaptured at the pumping facilities. However, because these releases occurred upstream of the Delta, catch of those same CWT release groups in trawling at Chipps Island was included in the model, as well as factors such as Sacramento and San Joaquin flow, export levels, and proportion of flow entering Old River. For smolts entering the Delta from the San Joaquin River (San Joaquin fall-run), the daily proportional fish salvaged was estimated using data from CWT smolts from Newman (2008b). Generalized linear models with a logit-link function for predicting proportional salvage resulted in a best-fit model that included the variables release location (location), number of CWT smolts recaptured in Chipps Island trawl surveys (chipps), mean 8-day flow (cfs) at Stockton following release (flow), total exports (exports), river temperature (Celsius) at release site (temp), and proportion of San Joaquin River flow in Old River (old):

$$\ln(\text{proportional salvage}) = B0+B1*\text{location}+B2*\text{chipps}+B3*\text{flow}+B4*\text{exports}+B5*\text{temp}+B6*\text{old}$$

Release location was held constant at Mossdale while Chipps catch and temperature were held at mean values in the model.

Therefore, daily proportional salvage changed as a function of daily San Joaquin River flow, total exports, and proportional Old River flow:

$$\ln(\text{daily proportional salvage}) = -5.46+0.862*(\text{location} = 3)+0.021*(\text{chipps} = 17.85)-0.000096*(\text{flow})+0.00019*\text{exports}-0.17*(\text{temp} = 17.12)+0.025*(\text{old})$$

$$R^2 = 0.46 \text{ (n = 82 observations)}$$

For both Sacramento watershed– and San Joaquin watershed–origin fish, the daily proportional loss was accumulated into a total annual loss, which then was compared between the various scenarios for existing baseline conditions and preliminary proposal. Proportional salvage was expressed as a percentage of salmon smolts entering the Delta.

B.3.8 Effectiveness of Nonphysical Fish Barriers (SWP/CVP South Delta Export Facilities)

BDCP Conservation Measure (CM) 16 proposes installation and testing of nonphysical fish barriers at a number of locations in the Delta. Among these locations are the entrances to CCF (SWP south Delta export facilities) and the DMC (CVP south Delta export facilities). Nonphysical fish barriers consisting of combinations of bubble curtains, acoustic deterrence, and strobe lights have been tested since 2009 at various important channel divergences in the Delta (San Joaquin River–Old River and Sacramento River–Georgiana Slough) with the primary goal of assessing effectiveness of the barriers in deterring downstream migrating Chinook salmon smolts from entering the interior Delta, where survival is relatively low. The nonphysical barriers function by enclosing unpleasant sound stimuli within a well-defined area enclosed by the bubble curtain. The main deterrent for the fish is the acoustic stimuli, with the bubble barrier and strobe lights enabling the fish to perceive where the sound is coming from in order to orient away from the stimuli (Bowen et al. 2009). Results from the head of Old River studies in 2009 suggest that deterrence (movement away from the barrier in response to the barrier's unpleasant stimuli, leading to avoidance of the less desirable migration pathway) may be high (~80%, although less at higher flows) but that the effectiveness of the barriers in improving fish survival is dependent on other factors such as predation in the vicinity of the barrier (Bowen et al. 2009; Bowen and Bark 2010).

The potential effectiveness of nonphysical barriers at the entrances to CCF and the DMC was assessed qualitatively based on several important factors:

- Water column position:
  - Depending on water depth, the bubble-generating apparatus may be close to the bottom (e.g., within 12 inches at the head of Old River) or in the midpoint of the water column (Sacramento River–Georgiana Slough) in order to preserve the integrity of the bubble barrier and the intensity of the acoustic stimuli.

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  - This may influence the likelihood of fish encountering barriers or swimming beneath them.
  - Water depth at the entrances to the CCF and DMC are shallow enough to assume that the bubble-generating apparatus would be close to the bottom, as at head of Old River.
- Hearing ability:
  - Different fish species have different hearing abilities or sensitivities and so may be deterred to varying degrees.
- Escape ability:
  - Species and life stage of fish influence swimming ability and hence the ability to effectively orient away from and escape the unpleasant stimuli generated by the barrier.
  - Velocity through and parallel to the barrier interacts with swimming ability to determine escape ability.
- Predation:
  - Installation of nonphysical barriers introduces new in-water structures to river channels that may serve as velocity refuges and ambush habitat for predatory fish.

B.3.9 Screening Effectiveness Analysis (SWP/CVP North Delta Intakes)

The north Delta intakes will be equipped with state-of-the-art positive-barrier fish screens. The fish screens will be designed and operated to comply with current approach velocity and screen mesh size criteria. Results of monitoring conducted at other fish screens with similar approach velocities and screen mesh were assembled and used as the basis for assessing the potential for covered fish entrainment and impingement at the new north Delta diversion locations. The assessment of the risk of direct losses from entrainment and impingement on the north Delta fish screens was based on best professional judgment after the evaluation of other similar facilities, screen design criteria, and the probable sizes of covered fish species that may be exposed to the intakes.

The size of larval and juvenile fish vulnerable to fish screen entrainment is a function of the slot opening of the screen mesh and the size (length and depth) of the fish (Tomljanovich et al. 1978; Schneeberger and Jude 1981; Zeitoun et al. 1981; Weisberg et al. 1987; C. Hanson unpublished data). Several investigations and analyses have been performed to establish the relationship between fish length (for different species) and the effectiveness of various screen mesh openings in physically excluding fish entrainment. Because the relationship differs for fish species having different general body shapes, the data developed by Weisberg et al. (1987) for larval bay anchovy were selected for use in this analysis because of the general similarity of anchovy body shape to larval delta and longfin smelt, which are representative small-bodied covered fish

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species in the effects analysis. Weisberg et al. (1987) estimated that a wedge-wire screen having a 1-mm slot opening would exclude 99.9% of the larvae greater than 15 mm in length and a 2-mm-slot screen would exclude 99.5% of the larvae greater than 15 mm in length (compared to the receiving water densities). Larvae smaller than 15 mm were excluded in lower percentages. The analysis of the effectiveness of the north Delta intake screens was based on a qualitative evaluation of entrainment and impingement risk based on an assumed 1.75-mm smooth screen mesh.

B.3.10 Agricultural Diversions (Cache Slough, North Delta, West Delta, East Delta, South Delta, and Suisun Marsh Subregions)

B.3.10.1 *Particle-Tracking Modeling and Proportional Reduction in Number of Intakes (Larval Smelt Entrainment)*

As described above, PTM was used to estimate entrainment of larval delta smelt and longfin smelt by agricultural diversions in the Delta. The potential reduction in entrainment caused by decommissioning of agricultural diversions in ROAs under the preliminary proposal was estimated by enumerating the number of diversions in the ROAs that would be eliminated in the ELT and LLT and relating this to the total number of intakes in the Delta. Data on intake locations were obtained from the DFG Passage Assessment Database. As the information about agricultural intake size and operations is generally lacking, it was assumed that the intakes were all of similar size and that the reduction in diversions and hence entrainment would be proportional to the percentage reduction in the number of intakes.

B.3.10.2 *Delta Regional Ecosystem Restoration Implementation Plan Analysis of Nonproject Diversions*

The 2009 DRERIP analysis of the formerly proposed BDCP Other Stressors Conservation Measure (OSCM) 21, Nonproject Diversions (Cavallo et al. 2009b), was used to qualitatively assess the magnitude and certainty of positive effects of removing agricultural diversions during habitat restoration in the ROAs. OSCM 21, which is no longer a conservation measure proposed under BDCP, proposed to screen or alter priority (>50 cfs) unscreened nonproject (i.e., non–SWP/CVP) diversions in the Plan Area, presumably including prominent agricultural diversions. The analysis is still relevant because in effect it is similar to the decommissioning of agricultural diversions in the ROAs and is used for most covered species in this appendix.

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B.4 RESULTS

B.4.1 SWP/CVP South Delta Export Facilities (South Delta Subregion)

The results of the entrainment analyses for the SWP/CVP south Delta export facilities are presented generally by species and life stage and analysis method. However, the analysis of effectiveness of nonphysical barriers is presented at the end of the species-specific sections as all species are discussed together.

B.4.1.1 *Steelhead (Juvenile)*

B.4.1.1.1 Salvage-Density Method

The basic seasonal pattern of salvage of steelhead upon which the salvage-density method is based is presented in Figure B-23, although note that this is an average of all years combined and does not account for water-year differences. Entrainment peaks in February at both SWP and CVP facilities and is also relatively high in January and March.

Estimated losses for juvenile steelhead were approximately four times greater at the SWP export facility compared to the CVP export facilities (Table B-12 through

Table B-17), with losses at both facilities generally from 1,000 to 10,000 fish per year. Losses were greatest in above normal and below normal years and least in critical water years.

Over all years, there was a decrease in entrainment loss of juvenile steelhead under PP scenarios compared to EBC scenarios that was quite consistent regardless of the comparison made and ranged from 6,100 to 6,400 fish (55–59% reduction at both facilities combined; Table B-18). Decreases under PP scenarios were greatest in wet (~5,200–5,500 fish; 84–85% reduction), above normal (~8,400–9,200 fish; 65–69% reduction), and below normal years (~5,600–6,700 fish; 51–56% reduction). In dry and critical years it was estimated that there would be little change (<10%) in entrainment loss, with increases under PP relative to EBC (27–470 fish; 0–6% increase) in some comparisons and slight reductions (~210–680 fish; 9% reduction) in others.

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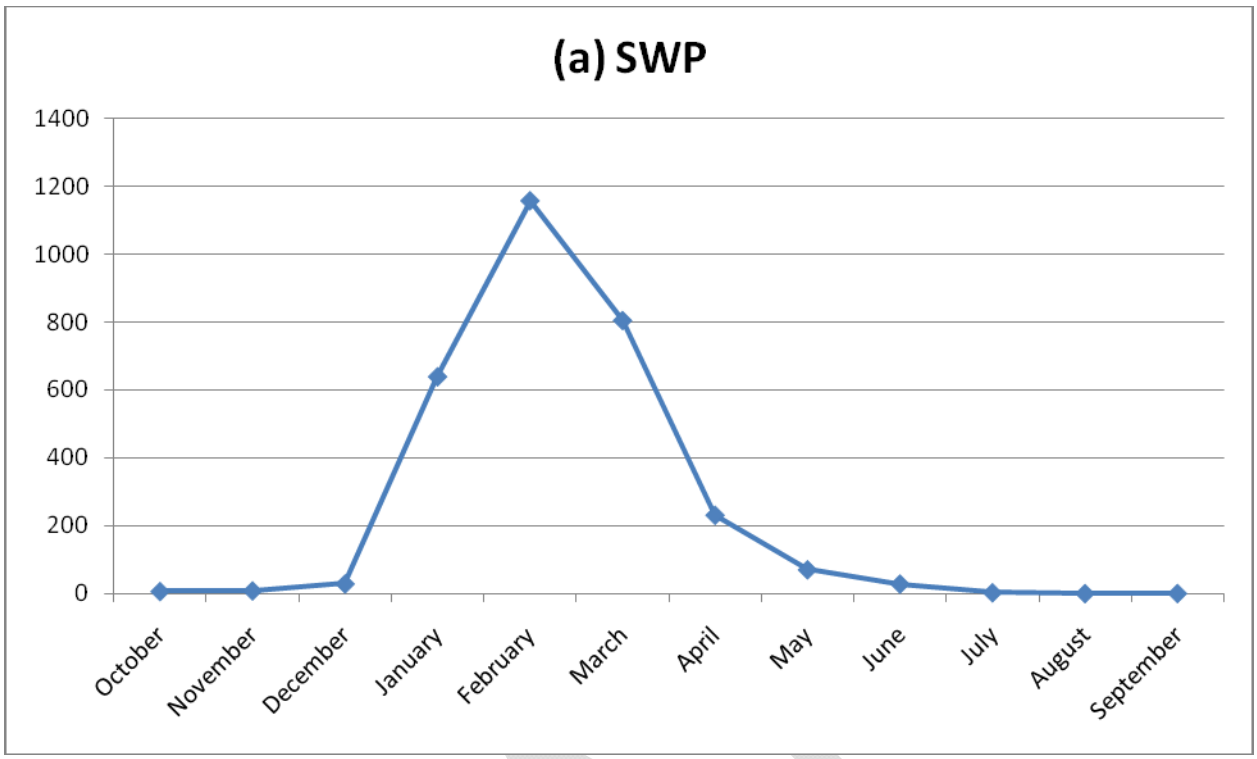

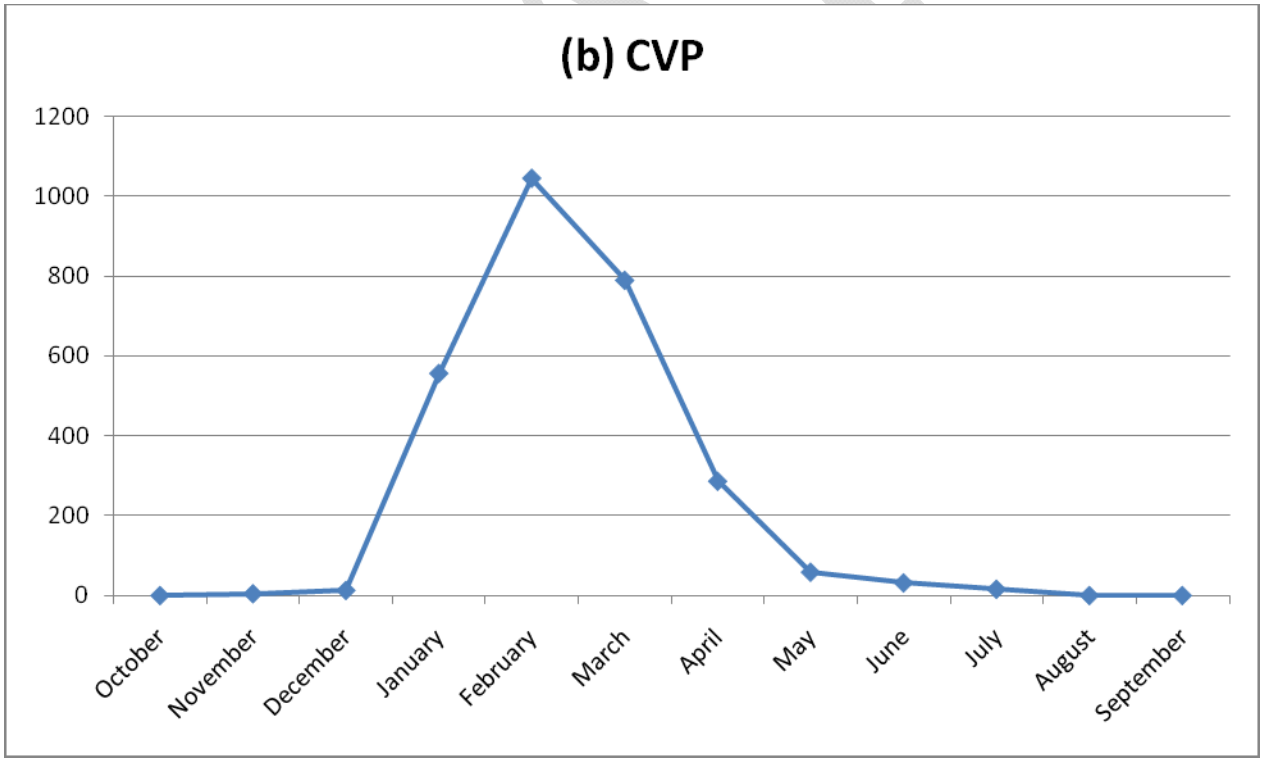

Figure B-23. Mean Monthly Salvage of Juvenile Steelhead Calculated from Observed Salvage Monitoring at the (a) SWP and (b) CVP South Delta Export Facilities, Water Years 1996–2009

Table B-12. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Steelhead for Six Model Scenarios at the SWP and CVP Salvage Facilities for All Water Years

Month	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
	Avg	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*
(a) SWP																		
October	25	±	3	18	±	2	16	±	2	12	±	2	17	±	2	13	±	2
November	28	±	4	20	±	3	19	±	3	18	±	3	18	±	3	18	±	3
December	121	±	13	122	±	13	119	±	13	117	±	13	98	±	12	104	±	13
January	1,459	±	152	1,485	±	158	1,507	±	163	1,487	±	159	847	±	111	669	±	94
February	3,628	±	246	3,689	±	253	3,748	±	261	3,491	±	245	1,255	±	134	1,290	±	136
March	2,654	±	189	2,711	±	197	2,713	±	201	2,632	±	198	838	±	88	652	±	75
April	389	±	24	404	±	26	414	±	27	429	±	27	582	±	39	538	±	37
May	230	±	16	238	±	19	252	±	19	254	±	19	286	±	21	242	±	18
June	100	±	10	100	±	11	95	±	10	83	±	9	50	±	6	38	±	5
July	18	±	2	17	±	2	17	±	2	15	±	2	8	±	1	7	±	1
August	1	±	0	1	±	0	1	±	0	1	±	0	0	±	0	0	±	0
September	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
Annual Average	8,654	±	440	8,805	±	458	8,902	±	473	8,541	±	454	4,000	±	257	3,572	±	230
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	5	±	1	5	±	1	5	±	1	5	±	1	4	±	0	3	±	0
December	16	±	2	17	±	2	16	±	2	15	±	2	12	±	2	12	±	2
January	478	±	60	472	±	60	474	±	60	457	±	59	265	±	43	220	±	37
February	938	±	58	902	±	57	911	±	58	922	±	59	302	±	32	313	±	35
March	789	±	50	788	±	50	772	±	50	754	±	50	197	±	24	207	±	23
April	153	±	9	151	±	9	158	±	10	161	±	10	170	±	13	160	±	13
May	52	±	3	52	±	3	53	±	3	52	±	3	55	±	3	52	±	3
June	25	±	3	25	±	3	22	±	3	20	±	3	13	±	2	10	±	2
July	17	±	3	16	±	3	14	±	3	12	±	2	9	±	2	8	±	2
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	2,473	±	109	2,428	±	110	2,426	±	110	2,398	±	111	1,028	±	71	986	±	65

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Table B-13. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Steelhead for Six Model Scenarios at the SWP and CVP Salvage Facilities for Wet Water Years

Month	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
	Avg	±	95% CI	Avg	±	95% CI	Avg	±	95% CI	Avg	±	95% CI	Avg	±	95% CI	Avg	±	95% CI
(a) SWP																		
October	64	±	13	47	±	10	40	±	9	33	±	7	37	±	8	32	±	7
November	14	±	5	10	±	4	10	±	4	9	±	4	7	±	3	7	±	3
December	37	±	9	38	±	9	39	±	9	39	±	9	21	±	6	23	±	7
January	1,209	±	398	1,240	±	415	1,287	±	427	1,242	±	414	150	±	113	173	±	109
February	1,496	±	265	1,511	±	271	1,568	±	281	1,490	±	270	16	±	19	31	±	34
March	1,409	±	236	1,483	±	251	1,514	±	255	1,461	±	250	58	±	34	43	±	29
April	440	±	90	463	±	98	467	±	98	478	±	99	267	±	86	265	±	83
May	315	±	77	345	±	87	354	±	88	342	±	87	192	±	57	153	±	46
June	240	±	53	249	±	55	224	±	50	204	±	45	103	±	31	63	±	22
July	5	±	2	5	±	2	5	±	2	4	±	2	2	±	1	2	±	1
August	3	±	1	3	±	1	3	±	1	3	±	1	1	±	0	1	±	0
September	4	±	1	4	±	1	4	±	1	3	±	1	2	±	1	2	±	1
Annual Average	5,235	±	663	5,397	±	698	5,514	±	714	5,309	±	697	854	±	193	794	±	163
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	3	±	1	3	±	1	3	±	1	3	±	1	2	±	1	2	±	1
December	5	±	1	5	±	1	5	±	1	5	±	1	3	±	1	3	±	1
January	161	±	35	168	±	38	170	±	38	167	±	37	31	±	16	33	±	15
February	219	±	34	220	±	35	225	±	35	230	±	36	0	±	0	3	±	4
March	379	±	88	383	±	91	388	±	92	393	±	93	0	±	0	23	±	21
April	105	±	20	105	±	20	106	±	20	108	±	20	55	±	19	54	±	19
May	51	±	9	50	±	9	52	±	9	50	±	9	26	±	6	27	±	6
June	45	±	12	45	±	12	42	±	11	37	±	10	20	±	7	13	±	5
July	29	±	9	29	±	9	25	±	8	21	±	7	20	±	7	19	±	7
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	996	±	96	1,008	±	99	1,016	±	100	1,014	±	101	158	±	26	178	±	34

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Table B-14. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Steelhead for Six Model Scenarios at the SWP and CVP Salvage Facilities for Above Normal Water Years

Month	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
	Avg	±	95% CI	Avg	±	95% CI	Avg	±	95% CI	Avg	±	95% CI	Avg	±	95% CI	Avg	±	95% CI
(a) SWP																		
October	7	±	3	5	±	2	4	±	2	3	±	1	4	±	2	3	±	2
November	37	±	20	26	±	16	26	±	15	27	±	17	26	±	14	27	±	14
December	312	±	110	319	±	113	318	±	112	319	±	112	257	±	97	295	±	117
January	3,161	±	1,183	3,417	±	1,364	3,585	±	1,471	3,477	±	1,403	1,479	±	776	1,328	±	710
February	4,889	±	1,415	4,908	±	1,453	5,007	±	1,529	4,909	±	1,467	818	±	554	790	±	425
March	2,107	±	266	2,058	±	252	2,107	±	280	2,154	±	346	367	±	226	110	±	121
April	292	±	31	290	±	31	309	±	33	343	±	34	491	±	140	437	±	143
May	155	±	29	155	±	29	174	±	36	182	±	36	328	±	108	308	±	112
June	91	±	18	87	±	18	89	±	17	74	±	12	58	±	15	47	±	10
July	9	±	4	9	±	4	8	±	4	7	±	4	5	±	3	4	±	3
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	11,059	±	1,780	11,274	±	1,932	11,625	±	2,157	11,493	±	2,055	3,832	±	1,163	3,350	±	827
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	7	±	2	7	±	2	7	±	2	7	±	2	5	±	2	4	±	1
December	29	±	9	31	±	10	32	±	10	29	±	10	22	±	8	19	±	8
January	853	±	337	817	±	319	718	±	295	801	±	322	484	±	264	441	±	249
February	597	±	107	522	±	118	572	±	121	584	±	113	114	±	76	151	±	83
March	361	±	36	366	±	39	343	±	41	328	±	45	15	±	17	35	±	34
April	57	±	8	57	±	8	59	±	9	64	±	9	70	±	21	60	±	20
May	35	±	5	35	±	5	37	±	6	38	±	6	50	±	15	58	±	17
June	6	±	3	6	±	3	5	±	3	5	±	2	3	±	2	3	±	2
July	2	±	1	3	±	1	2	±	1	1	±	1	1	±	1	1	±	1
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	1,947	±	382	1,843	±	369	1,774	±	367	1,857	±	378	763	±	310	773	±	298

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Table B-15. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Steelhead for Six Model Scenarios at the SWP and CVP Salvage Facilities for Below Normal Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg**	**±**	**95% CI**	**Avg**	**±**	**95% CI**	**Avg**	**±**	**95% CI**	**Avg**	**±**	**95% CI**	**Avg**	**±**	**95% CI**	**Avg**	**±**	**95% CI**
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	103	±	19	108	±	17	99	±	18	99	±	20	92	±	27	92	±	33
January	406	±	49	423	±	65	431	±	72	396	±	93	389	±	128	333	±	113
February	5,688	±	1,662	5,812	±	1,729	6,233	±	1,939	5,258	±	1,451	1,830	±	852	2,638	±	1,374
March	2,990	±	602	3,034	±	674	3,052	±	709	2,827	±	701	1,475	±	641	1,163	±	507
April	40	±	4	40	±	4	44	±	6	53	±	9	132	±	29	122	±	25
May	69	±	7	69	±	8	74	±	11	87	±	14	218	±	70	169	±	58
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	9,296	±	2,180	9,485	±	2,380	9,933	±	2,620	8,720	±	2,068	4,136	±	1,294	4,518	±	1,551
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	8	±	0	8	±	1	8	±	1	8	±	1	6	±	1	6	±	1
January	53	±	6	51	±	7	51	±	7	45	±	9	32	±	10	32	±	10
February	1,816	±	370	1,692	±	334	1,398	±	352	1,728	±	373	725	±	348	577	±	344
March	647	±	112	588	±	106	572	±	106	583	±	135	265	±	154	247	±	116
April	30	±	2	30	±	2	32	±	4	34	±	5	59	±	11	56	±	12
May	29	±	2	29	±	3	30	±	2	32	±	4	60	±	10	50	±	13
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	2,583	±	457	2,398	±	405	2,091	±	441	2,429	±	439	1,148	±	416	969	±	370

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Table B-16. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Steelhead for Six Model Scenarios at the SWP and CVP Salvage Facilities for Dry Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg**	**±**	**95% CI**	**Avg**	**±**	**95% CI**	**Avg**	**±**	**95% CI**	**Avg**	**±**	**95% CI**	**Avg**	**±**	**95% CI**	**Avg**	**±**	**95% CI**
(a) SWP																		
October	2	±	1	2	±	1	1	±	1	1	±	0	2	±	1	1	±	1
November	39	±	18	26	±	12	25	±	12	22	±	12	27	±	12	25	±	12
December	83	±	32	85	±	33	83	±	33	79	±	32	88	±	35	88	±	36
January	578	±	115	568	±	113	562	±	113	590	±	118	595	±	121	477	±	118
February	2,387	±	610	2,382	±	626	2,251	±	585	2,035	±	548	2,381	±	663	2,236	±	664
March	2,613	±	530	2,591	±	520	2,440	±	485	2,413	±	471	2,495	±	477	2,016	±	468
April	374	±	57	398	±	60	424	±	75	404	±	76	880	±	133	784	±	129
May	165	±	23	161	±	22	181	±	27	186	±	27	227	±	42	199	±	40
June	10	±	5	11	±	5	10	±	5	8	±	4	5	±	2	5	±	2
July	18	±	5	18	±	5	17	±	5	16	±	5	10	±	4	7	±	3
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	6,270	±	1,237	6,242	±	1,236	5,995	±	1,164	5,755	±	1,113	6,709	±	1,281	5,838	±	1,234
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	2	±	1	2	±	1	2	±	1	2	±	1	2	±	1	1	±	1
December	2	±	1	2	±	1	2	±	1	2	±	1	2	±	1	2	±	1
January	46	±	11	46	±	11	48	±	12	45	±	11	41	±	11	32	±	10
February	504	±	116	507	±	113	513	±	117	475	±	114	374	±	96	372	±	102
March	569	±	102	579	±	101	586	±	100	517	±	92	414	±	86	374	±	82
April	117	±	21	114	±	21	133	±	26	126	±	24	203	±	38	191	±	40
May	13	±	3	13	±	3	12	±	3	12	±	3	20	±	5	17	±	5
June	6	±	1	6	±	1	5	±	1	4	±	0	4	±	1	3	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	1,259	±	217	1,269	±	218	1,301	±	219	1,183	±	205	1,059	±	189	992	±	174

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Table B-17. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Steelhead for Six Model Scenarios at the SWP and CVP Salvage Facilities for Critical Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg**	**±**	**95% CI**	**Avg**	**±**	**95% CI**	**Avg**	**±**	**95% CI**	**Avg**	**±**	**95% CI**	**Avg**	**±**	**95% CI**	**Avg**	**±**	**95% CI**
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	185	±	40	173	±	45	159	±	50	175	±	35	192	±	41	89	±	44
February	3,501	±	904	3,840	±	1,019	3,583	±	734	3,499	±	889	4,110	±	1,144	3,806	±	746
March	731	±	210	727	±	246	642	±	212	616	±	228	659	±	282	632	±	299
April	208	±	73	216	±	69	191	±	58	170	±	47	264	±	67	249	±	79
May	170	±	26	158	±	31	164	±	31	148	±	48	127	±	46	133	±	51
June	57	±	15	55	±	16	52	±	14	45	±	14	31	±	8	35	±	12
July	79	±	15	69	±	19	62	±	19	46	±	20	21	±	14	13	±	8
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	4,932	±	1,050	5,238	±	1,123	4,854	±	935	4,699	±	1,076	5,405	±	1,327	4,958	±	872
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	200	±	33	177	±	36	185	±	37	173	±	42	168	±	45	89	±	36
February	572	±	134	517	±	150	585	±	126	501	±	135	422	±	95	486	±	152
March	113	±	37	122	±	44	105	±	35	96	±	34	85	±	26	74	±	28
April	44	±	5	43	±	4	41	±	5	41	±	5	44	±	8	43	±	9
May	8	±	1	8	±	0	7	±	1	7	±	0	7	±	2	6	±	1
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	937	±	169	866	±	200	924	±	163	819	±	179	726	±	145	698	±	142

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Table B-18. Estimated Absolute and Percent Differences between Model Scenarios in Juvenile Steelhead Entrainment Index (Number of Fish Lost, Based on Nonnormalized Data) at the SWP and CVP Salvage Facilities during All Water Years

Water-Year Type	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
CVP						
Wet	-838 (-84%)	-818 (-82%)	-850 (-84%)	-830 (-82%)	-858 (-84%)	-837 (-82%)
Above Normal	-1183 (-61%)	-1174 (-60%)	-1080 (-59%)	-1070 (-58%)	-1011 (-57%)	-1084 (-58%)
Below Normal	-1435 (-56%)	-1614 (-62%)	-1250 (-52%)	-1429 (-60%)	-943 (-45%)	-1460 (-60%)
Dry	-200 (-16%)	-267 (-21%)	-210 (-17%)	-277 (-22%)	-243 (-19%)	-191 (-16%)
Critical	-211 (-23%)	-239 (-25%)	-140 (-16%)	-168 (-19%)	-198 (-21%)	-120 (-15%)
All Years	-1445 (-58%)	-1486 (-60%)	-1401 (-58%)	-1442 (-59%)	-1399 (-58%)	-1412 (-59%)
SWP						
Wet	-4380 (-84%)	-4441 (-85%)	-4543 (-84%)	-4604 (-85%)	-4660 (-85%)	-4515 (-85%)
Above Normal	-7227 (-65%)	-7710 (-70%)	-7442 (-66%)	-7924 (-70%)	-7793 (-67%)	-8143 (-71%)
Below Normal	-5160 (-56%)	-4778 (-51%)	-5349 (-56%)	-4967 (-52%)	-5798 (-58%)	-4202 (-48%)
Dry	438 (7%)	-432 (-7%)	467 (7%)	-403 (-6%)	714 (12%)	83 (1%)
Critical	473 (10%)	26 (1%)	167 (3%)	-280 (-5%)	551 (11%)	259 (6%)
All Years	-4655 (-54%)	-5082 (-59%)	-4806 (-55%)	-5234 (-59%)	-4902 (-55%)	-4969 (-58%)
Combined Losses						
Wet	-5219 (-84%)	-5259 (-84%)	-5393 (-84%)	-5434 (-85%)	-5518 (-85%)	-5352 (-85%)
Above Normal	-8410 (-65%)	-8883 (-68%)	-8522 (-65%)	-8995 (-69%)	-8804 (-66%)	-9227 (-69%)
Below Normal	-6596 (-56%)	-6393 (-54%)	-6599 (-56%)	-6396 (-54%)	-6741 (-56%)	-5662 (-51%)
Dry	239 (3%)	-699 (-9%)	258 (3%)	-680 (-9%)	472 (6%)	-108 (-2%)
Critical	262 (4%)	-212 (-4%)	27 (0%)	-448 (-7%)	352 (6%)	139 (3%)
All Years	-6100 (-55%)	-6569 (-59%)	-6207 (-55%)	-6676 (-59%)	-6301 (-56%)	-6381 (-58%)

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B.4.1.2 *Winter-Run Chinook Salmon (Juvenile)*

B.4.1.2.1 Salvage-Density Method

The basic seasonal pattern of entrainment loss of juvenile winter-run Chinook salmon upon which the salvage-density method is based is presented in Figure B-24, although note that this is an average of all years combined and does not account for water-year differences. Losses began to occur in December and climbed to peaks in March at both facilities, before sharply declining in April.

In general, estimated losses of winter-run Chinook salmon in the SWP facility were approximately five to ten times greater than those estimated for the CVP export facility (Table B-19 through Table B-30). Normalization of the data to adult population size increased the estimated entrainment loss relative to nonnormalized data for wet, above normal, and below normal years; decreased entrainment loss for dry years; and resulted in little change to entrainment loss in critical years. This summary of the main results focuses only on normalized data. Estimated annual losses at SWP across all water years averaged around 6,000 fish under EBC scenarios and 2,400–2,700 fish under PP scenarios; for the CVP, the annual average loss was around 830–860 fish under EBC and 320–330 fish under PP (Table B-19). Losses were greatest in wet years (>10,000 fish at SWP, >1,300 fish at CVP) and decreased with reduced flows (e.g., <1,000 fish at SWP in critical years) (Table B-20 through Table B-24).

As with steelhead, differences in entrainment loss of juvenile winter-run Chinook salmon between EBC and PP scenarios were greatest in wet and above normal years, with reductions at both facilities under PP scenarios compared to EBC scenarios of ~5,000–10,000 fish (73–88% reduction) (Table B-31). Across all water years, reductions under PP scenarios compared to EBC scenarios were estimated to be on the order of 3,700–4,200 fish (55–60% reduction). This reflected estimates of entrainment loss under PP scenarios in dry and critical water years that were relatively small changes under PP relative to EBC (all <20% change).

Under the assumption that the annual number of winter-run Chinook salmon juveniles approaching the Delta was 500,000 fish, the percentage of the population lost to entrainment across all years averaged around 1.4% under EBC scenarios and decreased to 0.5–0.6% under PP scenarios (Table B-33). In wet years, EBC entrainment losses of 2.3–2.4% were reduced to 0.3% under PP scenarios (Table B-34). Proportional losses in above normal years (EBC: 1.3%; PP: 0.3%) and below normal years (EBC: 1.4–1.5%; PP: 0.7%) also suggested significant decreases under PP scenarios relative to EBC scenarios (Table B-35 and Table B-36). There was little difference between EBC and PP proportional entrainment loss of winter-run Chinook salmon juveniles in dry (EBC: 0.7–0.75%; PP: 0.6–0.7%) and critical years (Table B-37 and Table B-38). Nonnormalized estimates were generally lower, as noted above (Table B-39 through Table B-44).

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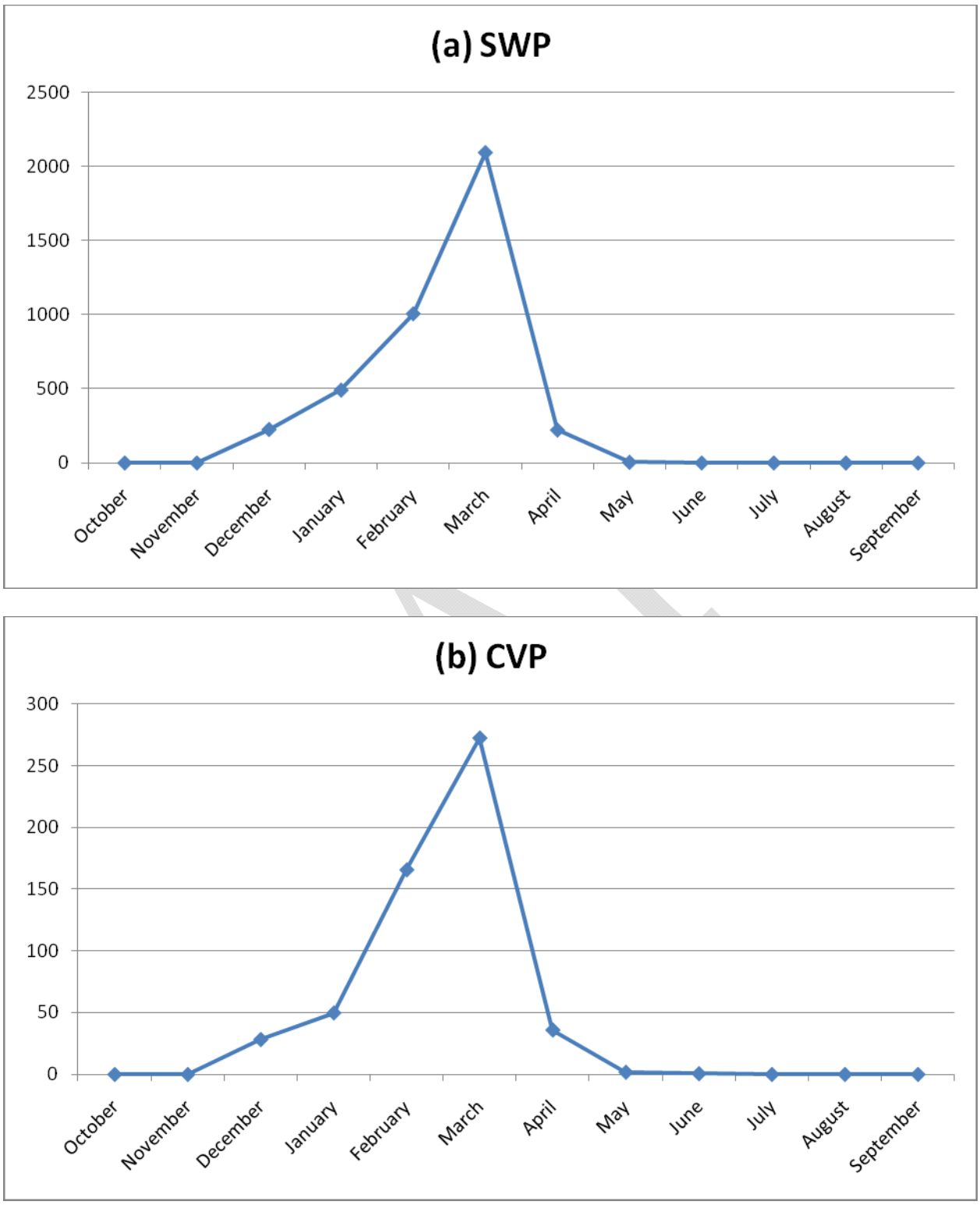

Figure B-24. Mean Monthly Loss of Juvenile Winter-Run Chinook Salmon Calculated from Observed Salvage Monitoring at the (a) SWP and (b) CVP South Delta Export Facilities, Water Years 1996–2008

Table B-19. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Normalized Salvage Data) of Juvenile Winter-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for All Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	303	±	37	306	±	37	298	±	37	293	±	36	246	±	33	260	±	36
January	1,175	±	148	1,196	±	154	1,215	±	159	1,199	±	155	682	±	107	539	±	90
February	1,284	±	135	1,306	±	139	1,327	±	143	1,236	±	134	444	±	68	456	±	69
March	2,909	±	209	2,971	±	217	2,974	±	222	2,885	±	219	918	±	98	715	±	83
April	274	±	45	285	±	47	292	±	48	302	±	50	410	±	70	379	±	66
May	6	±	2	6	±	2	6	±	2	6	±	2	7	±	2	6	±	2
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	5,951	±	357	6,070	±	372	6,112	±	382	5,920	±	372	2,708	±	218	2,355	±	189
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	53	±	4	56	±	4	55	±	4	50	±	4	41	±	4	40	±	4
January	88	±	7	87	±	8	87	±	8	84	±	7	49	±	6	40	±	5
February	201	±	12	193	±	12	195	±	12	198	±	12	65	±	7	67	±	7
March	462	±	29	462	±	30	453	±	29	442	±	30	116	±	14	121	±	14
April	51	±	6	50	±	5	53	±	6	53	±	6	56	±	7	53	±	7
May	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	857	±	37	850	±	38	844	±	38	828	±	39	328	±	23	324	±	22

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Table B-20. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Normalized Salvage Data) of Juvenile Winter-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Wet Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	402	±	142	413	±	147	425	±	151	430	±	153	229	±	100	246	±	116
January	2,548	±	797	2,614	±	833	2,712	±	857	2,618	±	829	315	±	229	364	±	221
February	695	±	218	702	±	222	729	±	230	692	±	221	7	±	13	15	±	23
March	5,542	±	946	5,833	±	1,006	5,958	±	1,024	5,748	±	1,003	227	±	136	169	±	116
April	862	±	284	907	±	307	913	±	309	935	±	312	523	±	250	519	±	244
May	2	±	1	2	±	1	2	±	1	2	±	1	1	±	1	1	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	10,050	±	1,436	10,471	±	1,519	10,739	±	1,542	10,426	±	1,513	1,302	±	376	1,314	±	346
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	99	±	16	100	±	17	100	±	17	95	±	16	64	±	15	69	±	15
January	138	±	34	144	±	37	145	±	37	143	±	36	27	±	15	28	±	15
February	178	±	34	179	±	35	183	±	35	187	±	36	0	±	0	3	±	3
March	811	±	127	820	±	132	830	±	133	841	±	135	0	±	0	50	±	36
April	102	±	29	102	±	29	103	±	29	105	±	29	54	±	25	53	±	25
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	1,328	±	129	1,344	±	134	1,362	±	136	1,373	±	138	145	±	34	202	±	51

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Table B-21. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Normalized Salvage Data) of Juvenile Winter-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Above Normal Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	369	±	183	377	±	187	376	±	185	377	±	185	304	±	158	349	±	189
January	771	±	258	833	±	299	874	±	323	848	±	308	361	±	174	324	±	159
February	2,708	±	1,222	2,718	±	1,245	2,773	±	1,297	2,719	±	1,253	453	±	408	437	±	321
March	2,067	±	717	2,019	±	696	2,067	±	727	2,113	±	787	360	±	320	108	±	164
April	75	±	24	75	±	24	80	±	26	89	±	28	127	±	60	113	±	59
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	5,990	±	2,099	6,022	±	2,123	6,169	±	2,244	6,145	±	2,229	1,604	±	842	1,331	±	467
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	19	±	9	21	±	10	21	±	10	19	±	9	14	±	8	13	±	7
January	55	±	15	53	±	14	47	±	13	52	±	14	31	±	13	29	±	12
February	186	±	73	163	±	71	178	±	76	182	±	74	35	±	34	47	±	38
March	320	±	118	324	±	121	304	±	116	291	±	115	14	±	22	31	±	45
April	50	±	23	50	±	23	52	±	25	56	±	26	61	±	38	53	±	36
May	3	±	2	3	±	2	4	±	2	4	±	2	5	±	3	6	±	4
June	1	±	1	1	±	1	1	±	1	1	±	1	1	±	0	1	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	635	±	219	615	±	218	606	±	219	604	±	219	161	±	82	179	±	94

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Table B-22. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Normalized Salvage Data) of Juvenile Winter-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Below Normal Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	100	±	19	105	±	16	96	±	17	96	±	19	89	±	26	90	±	32
January	403	±	48	419	±	64	427	±	72	393	±	92	386	±	127	330	±	112
February	2,206	±	645	2,254	±	671	2,418	±	752	2,039	±	563	710	±	331	1,023	±	533
March	3,530	±	710	3,582	±	796	3,604	±	838	3,338	±	828	1,742	±	757	1,373	±	598
April	18	±	2	18	±	2	20	±	3	23	±	4	58	±	13	54	±	11
May	52	±	6	52	±	6	56	±	8	65	±	11	164	±	53	127	±	44
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	6,309	±	1,294	6,430	±	1,454	6,620	±	1,567	5,955	±	1,327	3,149	±	957	2,998	±	846
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	49	±	1	51	±	3	49	±	4	46	±	6	37	±	9	39	±	8
January	84	±	10	81	±	11	82	±	11	72	±	14	52	±	16	52	±	15
February	344	±	70	321	±	63	265	±	67	328	±	71	137	±	66	109	±	65
March	387	±	67	351	±	63	342	±	63	348	±	81	158	±	92	148	±	69
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	864	±	130	804	±	120	738	±	127	793	±	128	385	±	135	347	±	102

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Table B-23. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Normalized Salvage Data) of Juvenile Winter-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Dry Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	267	±	82	277	±	85	269	±	85	257	±	84	285	±	89	286	±	92
January	147	±	18	145	±	18	143	±	18	150	±	19	151	±	19	121	±	23
February	872	±	250	871	±	257	823	±	240	744	±	225	870	±	273	817	±	274
March	1,743	±	471	1,728	±	463	1,628	±	433	1,610	±	422	1,664	±	428	1,345	±	409
April	67	±	9	71	±	9	76	±	12	72	±	13	158	±	21	140	±	21
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	3,097	±	679	3,092	±	676	2,939	±	631	2,833	±	605	3,129	±	659	2,710	±	639
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	38	±	5	42	±	6	41	±	6	37	±	6	34	±	5	30	±	6
January	65	±	10	65	±	10	68	±	11	64	±	10	58	±	10	46	±	10
February	247	±	51	248	±	49	251	±	51	233	±	51	183	±	44	182	±	47
March	317	±	62	323	±	62	326	±	61	288	±	56	230	±	53	209	±	51
April	27	±	3	26	±	3	30	±	4	29	±	4	46	±	6	44	±	7
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	693	±	109	704	±	110	716	±	109	650	±	104	551	±	96	510	±	87

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Table B-24. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Normalized Salvage Data) of Juvenile Winter-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Critical Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	137	±	30	128	±	33	118	±	37	129	±	26	142	±	30	66	±	32
February	264	±	68	290	±	77	271	±	55	264	±	67	310	±	86	287	±	56
March	507	±	145	504	±	171	445	±	147	427	±	158	457	±	196	438	±	208
April	25	±	9	26	±	8	23	±	7	20	±	6	32	±	8	30	±	10
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	933	±	199	948	±	218	857	±	198	841	±	212	941	±	253	822	±	221
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	39	±	6	34	±	7	36	±	7	34	±	8	33	±	9	17	±	7
February	106	±	25	96	±	28	108	±	23	93	±	25	78	±	18	90	±	28
March	184	±	59	197	±	72	170	±	56	155	±	55	137	±	41	119	±	46
April	4	±	0	4	±	0	4	±	0	4	±	0	4	±	1	4	±	1
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	332	±	77	331	±	93	318	±	74	285	±	71	251	±	55	230	±	49

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Table B-25. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Winter-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for All Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*	*Avg*	±	*95% CI*
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	230	±	28	232	±	28	226	±	28	222	±	28	187	±	25	197	±	27
January	332	±	21	338	±	22	344	±	23	339	±	22	193	±	17	152	±	14
February	778	±	72	791	±	74	803	±	76	748	±	71	269	±	37	276	±	38
March	1,685	±	154	1,721	±	160	1,722	±	162	1,671	±	160	532	±	69	414	±	58
April	87	±	9	90	±	10	92	±	10	95	±	10	129	±	15	120	±	14
May	5	±	1	5	±	1	5	±	1	5	±	1	6	±	1	5	±	1
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	3,116	±	221	3,177	±	230	3,193	±	235	3,080	±	228	1,316	±	108	1,164	±	96
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	28	±	2	30	±	2	29	±	2	26	±	2	22	±	2	21	±	2
January	42	±	2	41	±	2	42	±	2	40	±	2	23	±	2	19	±	2
February	132	±	10	127	±	10	128	±	10	130	±	10	42	±	5	44	±	6
March	235	±	13	234	±	13	230	±	13	224	±	13	59	±	6	62	±	6
April	18	±	1	18	±	1	18	±	1	19	±	1	20	±	2	19	±	2
May	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	456	±	23	452	±	23	449	±	23	441	±	23	167	±	12	166	±	12

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Table B-26. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Winter-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Wet Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	63	±	15	65	±	16	67	±	16	68	±	16	36	±	11	39	±	13
January	399	±	93	409	±	98	424	±	100	410	±	97	49	±	29	57	±	27
February	220	±	51	222	±	53	231	±	54	219	±	52	2	±	3	5	±	6
March	1,400	±	207	1,473	±	221	1,505	±	224	1,452	±	220	57	±	32	43	±	27
April	183	±	59	192	±	64	194	±	64	199	±	64	111	±	52	110	±	51
May	5	±	2	5	±	3	5	±	3	5	±	3	3	±	2	2	±	1
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	2,269	±	244	2,367	±	261	2,426	±	264	2,352	±	261	259	±	67	256	±	59
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	25	±	5	26	±	5	26	±	5	24	±	5	16	±	4	18	±	4
January	25	±	4	26	±	5	26	±	5	26	±	5	5	±	2	5	±	2
February	52	±	7	53	±	7	54	±	8	55	±	8	0	±	0	1	±	1
March	188	±	22	190	±	23	192	±	24	195	±	24	0	±	0	12	±	8
April	19	±	6	19	±	6	19	±	6	19	±	6	10	±	5	10	±	5
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	309	±	25	313	±	26	317	±	26	320	±	27	31	±	7	45	±	11

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Table B-27. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Winter-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Above Normal Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	509	±	252	519	±	257	517	±	255	519	±	255	419	±	218	481	±	261
January	479	±	134	518	±	157	543	±	171	527	±	162	224	±	95	201	±	87
February	1,045	±	279	1,049	±	288	1,070	±	303	1,049	±	291	175	±	114	169	±	87
March	1,120	±	160	1,094	±	153	1,120	±	167	1,145	±	201	195	±	123	59	±	66
April	47	±	6	47	±	6	50	±	6	55	±	6	79	±	23	71	±	24
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	3,200	±	604	3,227	±	625	3,300	±	660	3,295	±	652	1,092	±	393	980	±	335
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	26	±	13	28	±	14	29	±	14	26	±	13	20	±	11	17	±	10
January	40	±	6	38	±	5	33	±	6	37	±	6	22	±	7	20	±	7
February	84	±	18	73	±	19	80	±	20	82	±	19	16	±	11	21	±	13
March	156	±	24	158	±	25	148	±	25	142	±	26	7	±	8	15	±	16
April	15	±	6	15	±	6	16	±	6	17	±	7	18	±	10	16	±	9
May	5	±	2	5	±	2	5	±	2	5	±	3	7	±	4	8	±	5
June	2	±	1	2	±	1	2	±	1	1	±	1	1	±	1	1	±	1
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	327	±	53	319	±	55	312	±	57	310	±	56	91	±	30	99	±	33

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Table B-28. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Winter-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Below Normal Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*
(a) SWP																		
October	0	±	N/A	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	N/A	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	64	±	12	67	±	10	61	±	11	62	±	12	57	±	17	57	±	20
January	258	±	31	269	±	41	274	±	46	252	±	59	247	±	82	211	±	71
February	1,413	±	413	1,444	±	430	1,548	±	482	1,306	±	360	455	±	212	655	±	341
March	2,261	±	455	2,294	±	510	2,308	±	536	2,138	±	530	1,115	±	485	880	±	383
April	11	±	1	11	±	1	12	±	2	15	±	2	37	±	8	35	±	7
May	33	±	4	33	±	4	36	±	5	42	±	7	105	±	34	82	±	28
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	4,040	±	829	4,118	±	931	4,240	±	1,004	3,814	±	850	2,017	±	613	1,920	±	542
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	31	±	1	33	±	2	32	±	3	29	±	4	24	±	6	25	±	5
January	54	±	6	52	±	7	52	±	7	46	±	9	33	±	10	33	±	10
February	221	±	45	205	±	40	170	±	43	210	±	45	88	±	42	70	±	42
March	248	±	43	225	±	40	219	±	40	223	±	52	102	±	59	95	±	44
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	553	±	83	515	±	77	473	±	81	508	±	82	246	±	86	222	±	65

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Table B-29. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Winter-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Dry Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	403	±	129	417	±	133	405	±	134	387	±	131	429	±	141	431	±	145
January	195	±	29	191	±	29	189	±	28	199	±	30	200	±	31	161	±	34
February	1,096	±	349	1,094	±	357	1,034	±	334	934	±	312	1,094	±	378	1,027	±	377
March	2,179	±	657	2,160	±	646	2,035	±	604	2,012	±	589	2,080	±	599	1,681	±	564
April	75	±	6	80	±	6	85	±	10	81	±	11	176	±	14	157	±	17
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	3,948	±	958	3,942	±	954	3,748	±	892	3,613	±	856	3,980	±	933	3,457	±	894
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	44	±	7	49	±	7	47	±	7	44	±	7	39	±	7	35	±	7
January	72	±	11	72	±	11	76	±	12	71	±	11	64	±	11	51	±	11
February	272	±	62	273	±	60	276	±	62	256	±	62	201	±	52	200	±	56
March	333	±	49	340	±	48	343	±	46	303	±	44	243	±	45	220	±	43
April	30	±	1	29	±	1	34	±	2	32	±	2	52	±	3	48	±	5
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	751	±	99	763	±	98	776	±	97	705	±	95	599	±	89	555	±	80

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Table B-30. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Winter-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Critical Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*	*Avg.*	±	*95% CI*
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	114	±	25	107	±	28	98	±	31	108	±	22	119	±	25	55	±	27
February	221	±	57	243	±	64	226	±	46	221	±	56	260	±	72	241	±	47
March	424	±	122	422	±	143	373	±	123	357	±	132	382	±	164	367	±	174
April	21	±	7	22	±	7	19	±	6	17	±	5	27	±	7	25	±	8
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	781	±	166	793	±	183	717	±	166	704	±	178	787	±	212	688	±	185
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	32	±	5	29	±	6	30	±	6	28	±	7	27	±	7	15	±	6
February	88	±	21	80	±	23	91	±	19	78	±	21	65	±	15	75	±	23
March	154	±	50	165	±	60	143	±	47	130	±	46	114	±	35	100	±	38
April	3	±	0	3	±	0	3	±	0	3	±	0	3	±	1	3	±	1
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	278	±	64	277	±	78	266	±	62	238	±	60	210	±	46	193	±	41

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Table B-31. Estimated Absolute and Percent Differences between Model Scenarios in Juvenile Winter-Run Chinook Salmon Entrainment Index (Number of Fish Lost, Based on Normalized Data) at the SWP and CVP Salvage Facilities during All Water Years

Water-Year Type	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
CVP						
Wet	-1183 (-89%)	-1126 (-85%)	-1200 (-89%)	-1142 (-85%)	-1217 (-89%)	-1170 (-85%)
Above Normal	-473 (-75%)	-456 (-72%)	-453 (-74%)	-436 (-71%)	-445 (-73%)	-426 (-70%)
Below Normal	-479 (-55%)	-516 (-60%)	-419 (-52%)	-457 (-57%)	-353 (-48%)	-446 (-56%)
Dry	-142 (-20%)	-183 (-26%)	-153 (-22%)	-194 (-28%)	-165 (-23%)	-140 (-22%)
Critical	-81 (-24%)	-102 (-31%)	-79 (-24%)	-100 (-30%)	-67 (-21%)	-55 (-19%)
All Years	-529 (-62%)	-533 (-62%)	-522 (-61%)	-526 (-62%)	-516 (-61%)	-504 (-61%)
SWP						
Wet	-8748 (-87%)	-8736 (-87%)	-9169 (-88%)	-9157 (-87%)	-9437 (-88%)	-9112 (-87%)
Above Normal	-4386 (-73%)	-4659 (-78%)	-4418 (-73%)	-4691 (-78%)	-4565 (-74%)	-4814 (-78%)
Below Normal	-3160 (-50%)	-3311 (-52%)	-3281 (-51%)	-3432 (-53%)	-3472 (-52%)	-2957 (-50%)
Dry	32 (1%)	-387 (-12%)	37 (1%)	-381 (-12%)	190 (6%)	-122 (-4%)
Critical	8 (1%)	-111 (-12%)	-7 (-1%)	-126 (-13%)	84 (10%)	-19 (-2%)
All Years	-3243 (-54%)	-3596 (-60%)	-3362 (-55%)	-3715 (-61%)	-3404 (-56%)	-3565 (-60%)
Combined Losses						
Wet	-9931 (-87%)	-9862 (-87%)	-10369 (-88%)	-10299 (-87%)	-10654 (-88%)	-10282 (-87%)
Above Normal	-4859 (-73%)	-5115 (-77%)	-4871 (-73%)	-5127 (-77%)	-5009 (-74%)	-5239 (-78%)
Below Normal	-3639 (-51%)	-3827 (-53%)	-3700 (-51%)	-3889 (-54%)	-3825 (-52%)	-3403 (-50%)
Dry	-110 (-3%)	-569 (-15%)	-116 (-3%)	-575 (-15%)	25 (1%)	-262 (-8%)
Critical	-73 (-6%)	-213 (-17%)	-86 (-7%)	-226 (-18%)	17 (1%)	-74 (-7%)
All Years	-3772 (-55%)	-4129 (-61%)	-3884 (-56%)	-4241 (-61%)	-3920 (-56%)	-4069 (-60%)

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Table B-32. Estimated Absolute and Percent Differences between Model Scenarios in Juvenile Winter-Run Chinook Salmon Entrainment Index (Number of Fish Lost, Based on Nonnormalized Data) at the SWP and CVP Salvage Facilities during All Water Years

Water-Year Type	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
CVP						
Wet	-278 (-90%)	-264 (-86%)	-281 (-90%)	-268 (-86%)	-286 (-90%)	-275 (-86%)
Above Normal	-236 (-72%)	-228 (-70%)	-228 (-72%)	-220 (-69%)	-222 (-71%)	-211 (-68%)
Below Normal	-307 (-55%)	-331 (-60%)	-268 (-52%)	-292 (-57%)	-226 (-48%)	-286 (-56%)
Dry	-152 (-20%)	-196 (-26%)	-165 (-22%)	-209 (-27%)	-178 (-23%)	-151 (-21%)
Critical	-67 (-24%)	-85 (-31%)	-66 (-24%)	-84 (-30%)	-56 (-21%)	-46 (-19%)
All Years	-289 (-63%)	-290 (-64%)	-284 (-63%)	-285 (-63%)	-281 (-63%)	-274 (-62%)
SWP						
Wet	-2011 (-89%)	-2014 (-89%)	-2108 (-89%)	-2112 (-89%)	-2167 (-89%)	-2097 (-89%)
Above Normal	-2108 (-66%)	-2220 (-69%)	-2135 (-66%)	-2247 (-70%)	-2208 (-67%)	-2315 (-70%)
Below Normal	-2024 (-50%)	-2121 (-52%)	-2101 (-51%)	-2198 (-53%)	-2223 (-52%)	-1894 (-50%)
Dry	32 (1%)	-491 (-12%)	38 (1%)	-486 (-12%)	232 (6%)	-156 (-4%)
Critical	6 (1%)	-93 (-12%)	-6 (-1%)	-105 (-13%)	70 (10%)	-16 (-2%)
All Years	-1800 (-58%)	-1951 (-63%)	-1861 (-59%)	-2012 (-63%)	-1877 (-59%)	-1916 (-62%)
Combined Losses						
Wet	-2288 (-89%)	-2278 (-88%)	-2390 (-89%)	-2380 (-89%)	-2453 (-89%)	-2371 (-89%)
Above Normal	-2344 (-66%)	-2448 (-69%)	-2363 (-67%)	-2467 (-70%)	-2430 (-67%)	-2527 (-70%)
Below Normal	-2331 (-51%)	-2451 (-53%)	-2370 (-51%)	-2490 (-54%)	-2449 (-52%)	-2180 (-50%)
Dry	-120 (-3%)	-687 (-15%)	-127 (-3%)	-694 (-15%)	54 (1%)	-307 (-7%)
Critical	-61 (-6%)	-178 (-17%)	-72 (-7%)	-189 (-18%)	15 (1%)	-62 (-7%)
All Years	-2089 (-58%)	-2241 (-63%)	-2145 (-59%)	-2298 (-63%)	-2158 (-59%)	-2191 (-62%)

Table B-33. Average Annual Juvenile Winter-Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	5,951	6,070	6,112	5,920	2,708	2,355
CVP Jones	857	850	844	828	328	324
Combined	6,808	6,920	6,956	6,748	3,036	2,679
Percentage of winter-run juvenile index of abundance	1.36%	1.38%	1.39%	1.35%	0.61%	0.54%

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Table B-34. Wet Year Juvenile Winter-Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	10,050	10,471	10,739	10,426	1,302	1,314
CVP Jones	1,328	1,344	1,362	1,373	145	202
Combined	11,378	11,816	12,101	11,799	1,447	1,516
Percentage of winter-run juvenile index of abundance	2.28%	2.36%	2.42%	2.36%	0.29%	0.30%

Table B-35. Above Normal Year Juvenile Winter-Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	5,990	6,022	6,169	6,145	1,604	1,331
CVP Jones	635	615	606	604	161	179
Combined	6,625	6,637	6,775	6,749	1,765	1,510
Percentage of winter-run juvenile index of abundance	1.32%	1.33%	1.35%	1.35%	0.35%	0.30%

Table B-36. Below Normal Year Juvenile Winter-Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	6,309	6,430	6,620	5,955	3,149	2,998
CVP Jones	864	804	738	793	385	347
Combined	7,172	7,234	7,358	6,748	3,534	3,345
Percentage of winter-run juvenile index of abundance	1.43%	1.45%	1.47%	1.35%	0.71%	0.67%

Table B-37. Dry Year Juvenile Winter-Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	3,097	3,092	2,939	2,833	3,129	2,710
CVP Jones	693	704	716	650	551	510
Combined	3,790	3,796	3,655	3,483	3,680	3,221
Percentage of winter-run juvenile index of abundance	0.76%	0.76%	0.73%	0.70%	0.74%	0.64%

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Table B-38. Critical Year Juvenile Winter-Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	933	948	857	841	941	822
CVP Jones	332	331	318	285	251	230
Combined	1,265	1,278	1,175	1,126	1,192	1,052
Percentage of winter-run juvenile index of abundance	0.25%	0.26%	0.23%	0.23%	0.24%	0.21%

Table B-39. Average Annual Juvenile Winter-Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	2,269	2,367	2,426	2,352	259	256
CVP Jones	309	313	317	320	31	45
Combined	2,578	2,680	2,743	2,672	290	300
Percentage of winter-run juvenile index of abundance	0.52%	0.54%	0.55%	0.53%	0.06%	0.06%

Table B-40. Wet Year Juvenile Winter-Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	2,269	2,367	2,426	2,352	259	256
CVP Jones	309	313	317	320	31	45
Combined	2,578	2,680	2,743	2,672	290	300
Percentage of winter-run juvenile index of abundance	0.52%	0.54%	0.55%	0.53%	0.06%	0.06%

Table B-41. Above Normal Year Juvenile Winter-Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	3,200	3,227	3,300	3,295	1,092	980
CVP Jones	327	319	312	310	91	99
Combined	3,527	3,546	3,613	3,605	1,183	1,079
Percentage of winter-run juvenile index of abundance	0.71%	0.71%	0.72%	0.72%	0.24%	0.22%

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Table B-42. Below Normal Year Juvenile Winter-Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	4,040	4,118	4,240	3,814	2,017	1,920
CVP Jones	553	515	473	508	246	222
Combined	4,594	4,633	4,712	4,322	2,263	2,142
Percentage of winter-run juvenile index of abundance	0.92%	0.93%	0.94%	0.86%	0.45%	0.43%

Table B-43. Dry Year Juvenile Winter-Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	3,948	3,942	3,748	3,613	3,980	3,457
CVP Jones	751	763	776	705	599	555
Combined	4,698	4,706	4,524	4,318	4,578	4,011
Percentage of winter-run juvenile index of abundance	0.94%	0.94%	0.90%	0.86%	0.92%	0.80%

Table B-44. Critical Year Juvenile Winter-Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	781	793	717	704	787	688
CVP Jones	278	277	266	238	210	193
Combined	1,058	1,070	983	942	998	880
Percentage of winter-run juvenile index of abundance	0.21%	0.21%	0.20%	0.19%	0.20%	0.18%

B.4.1.2.2 Delta Passage Model Salvage Estimates

The estimated percentage of juvenile winter-run Chinook salmon salvaged at the SWP/CVP south Delta export facilities averaged around 0.14–0.15% for EBC1, EBC2, and EBC2_ELT scenarios, and around 0.09% for EBC2_LLT, PP_ELT, and PP_LLT scenarios (Table B-45). Percentages in individual years ranged from around 0.01 (PP scenarios in 1983, a wet year) to 0.26–0.27 (PP scenarios in 1985, a dry year). On average, there was an approximate 30–40% decrease (0.05–0.06% in absolute terms) in percentage salvage in most comparisons from EBC to PP scenarios, except for an average increase of 0.01% (relative increase of 12%) from EBC2_LLT to PP_LLT (Table B-46).

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Table B-45. Estimated Percentage of Juvenile Winter-Run Chinook Salmon Entering the Delta Salvaged at the SWP/CVP South Delta Export Facilities from Delta Passage Model Runs of DSM2-Simulated Water Years 1975–1991 for the Six Model Scenarios

Water-Year (Type)	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1975 (W)	0.2363	0.2136	0.2259	0.0740	0.1346	0.1486
1976 (C)	0.2417	0.2159	0.1956	0.0840	0.1201	0.1491
1977 (C)	0.0793	0.0493	0.0479	0.0426	0.0646	0.0396
1978 (AN)	0.0717	0.0837	0.0778	0.0616	0.0509	0.0252
1979 (BN)	0.1459	0.1994	0.2046	0.1433	0.1180	0.1620
1980 (AN)	0.1842	0.2410	0.1827	0.1293	0.0693	0.1485
1981 (D)	0.1176	0.2105	0.2159	0.0805	0.1205	0.1363
1982 (W)	0.1434	0.1443	0.1408	0.0901	0.0573	0.0194
1983 (W)	0.1141	0.2229	0.2416	0.2110	0.0105	0.0103
1984 (W)	0.1581	0.1538	0.1449	0.1307	0.0136	0.0125
1985 (D)	0.2422	0.2541	0.2475	0.0762	0.2611	0.2750
1986 (W)	0.1303	0.1623	0.1516	0.0977	0.1257	0.1839
1987 (D)	0.1503	0.1594	0.1676	0.0340	0.0928	0.1025
1988 (C)	0.0736	0.0817	0.0844	0.0334	0.0817	0.0692
1989 (D)	0.0826	0.1002	0.0880	0.0529	0.0754	0.0455
1990 (C)	0.1145	0.0938	0.0935	0.0661	0.0918	0.0645
1991 (C)	0.0505	0.0446	0.0404	0.0364	0.0414	0.0265
Average	0.1374	0.1547	0.1500	0.0849	0.0900	0.0952

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Table B-46. Change in Estimated Percentage of Juvenile Winter-Run Chinook Salmon Salvaged at the SWP/CVP South Delta Export Facilities from Delta Passage Model Runs of DSM2-Simulated Water Years 1975–1991 for the Six Model Scenarios

Water-Year (Type)	PP_ELT vs. EBC1	PP_LLT vs. EBC1	PP_ELT vs. EBC2	PP_LLT vs. EBC2	PP_ELT vs. EBC2_ELT	PP_LLT vs. EBC2_LLT
1975 (W)	-0.1017 (-43%)	-0.0877 (-37%)	-0.079 (-37%)	-0.065 (-30%)	-0.0913 (-40%)	0.0746 (101%)
1976 (C)	-0.1216 (-50%)	-0.0927 (-38%)	-0.0958 (-44%)	-0.0669 (-31%)	-0.0755 (-39%)	0.0651 (77%)
1977 (C)	-0.0147 (-19%)	-0.0397 (-50%)	0.0153 (31%)	-0.0096 (-20%)	0.0168 (35%)	-0.0029 (-7%)
1978 (AN)	-0.0208 (-29%)	-0.0465 (-65%)	-0.0328 (-39%)	-0.0586 (-70%)	-0.0269 (-35%)	-0.0365 (-59%)
1979 (BN)	-0.0279 (-19%)	0.0161 (11%)	-0.0814 (-41%)	-0.0374 (-19%)	-0.0866 (-42%)	0.0187 (13%)
1980 (AN)	-0.1149 (-62%)	-0.0357 (-19%)	-0.1717 (-71%)	-0.0925 (-38%)	-0.1134 (-62%)	0.0192 (15%)
1981 (D)	0.0029 (2%)	0.0187 (16%)	-0.09 (-43%)	-0.0742 (-35%)	-0.0954 (-44%)	0.0558 (69%)
1982 (W)	-0.0862 (-60%)	-0.124 (-86%)	-0.087 (-60%)	-0.1248 (-87%)	-0.0836 (-59%)	-0.0706 (-78%)
1983 (W)	-0.1036 (-91%)	-0.1038 (-91%)	-0.2124 (-95%)	-0.2126 (-95%)	-0.2311 (-96%)	-0.2007 (-95%)
1984 (W)	-0.1445 (-91%)	-0.1456 (-92%)	-0.1401 (-91%)	-0.1412 (-92%)	-0.1312 (-91%)	-0.1182 (-90%)
1985 (D)	0.0188 (8%)	0.0327 (14%)	0.007 (3%)	0.0209 (8%)	0.0136 (5%)	0.1987 (261%)
1986 (W)	-0.0046 (-4%)	0.0535 (41%)	-0.0366 (-23%)	0.0215 (13%)	-0.0259 (-17%)	0.0862 (88%)
1987 (D)	-0.0575 (-38%)	-0.0478 (-32%)	-0.0666 (-42%)	-0.0569 (-36%)	-0.0748 (-45%)	0.0685 (201%)
1988 (C)	0.008 (11%)	-0.0045 (-6%)	-0.0001 (0%)	-0.0126 (-15%)	-0.0027 (-3%)	0.0357 (107%)
1989 (D)	-0.0071 (-9%)	-0.0371 (-45%)	-0.0248 (-25%)	-0.0547 (-55%)	-0.0126 (-14%)	-0.0074 (-14%)
1990 (C)	-0.0227 (-20%)	-0.05 (-44%)	-0.002 (-2%)	-0.0293 (-31%)	-0.0016 (-2%)	-0.0016 (-2%)
1991 (C)	-0.0091 (-18%)	-0.0239 (-47%)	-0.0032 (-7%)	-0.0181 (-41%)	0.001 (3%)	-0.0099 (-27%)
Average	-0.0475 (-35%)	-0.0422 (-31%)	-0.0648 (-42%)	-0.0595 (-38%)	-0.0601 (-40%)	0.0103 (12%)

B.4.1.3 *Spring-Run Chinook Salmon (Juvenile)*

B.4.1.3.1 Salvage-Density Method

The basic seasonal pattern of entrainment of juvenile spring-run Chinook salmon upon which the salvage-density method is based is presented in Figure B-25, although note that this is an average of all years combined and does not account for water-year differences. Note also that there is considerable overlap in the entrainment of juvenile spring-run and fall-run Chinook salmon and there is difficulty discerning race based solely on length-at-date criteria, the same criteria used to generate Figure B-25. Logic dictates that loss of juvenile spring-run Chinook salmon should be substantially numerically lower than that of juvenile fall-run Chinook salmon because the spawning population of spring-run Chinook salmon is considerably lower than that of fall-run Chinook salmon. This is not the case (compare Figure B-25 and Figure B-26) and suggests that the length-at-date criteria do not allow perfect classification of race by length. Therefore the seasonal entrainment pattern is the best index of entrainment, as opposed to the actual numbers of fish. At both SWP and CVP facilities, entrainment loss peaks in April and is also relatively high in March and May.

In general, estimated losses of spring-run Chinook salmon at the SWP facility were approximately two to three times greater than those estimated for the CVP export facility (Table B-47 through Table B-58). Normalization of the data to adult population size increased the estimated entrainment loss relative to nonnormalized data for wet, dry, and critical water years and resulted in little change to entrainment loss in above normal and below normal years. This summary of the main results focuses only on normalized data. Estimated annual losses at SWP across all water years averaged around 22,000–24,000 fish under EBC and PP scenarios; for the CVP, the annual average loss was around 15,000 fish under EBC and 11,000–12,000 fish under PP (Table 13). Losses were greatest in wet years (at each facility: >40,000 fish under EBC and 14,000–19,000 under PP) and were lowest in below normal years (1,000–5,000 fish at both facilities in EBC and PP scenarios) (Table B-48 and Table B-50).

Differences in entrainment loss of juvenile spring-run Chinook salmon between EBC and PP scenarios were greatest in wet years, with reductions at both facilities under PP scenarios compared to EBC scenarios of ~55,000–60,000 fish (63–65% reduction) (Table B-59). This major reduction, coupled with the high abundance of juvenile spring-run Chinook salmon in wet years and relatively large number of wet years (24 of 82 total years modeled), combined with the general increases in entrainment loss that were evident in the other water-year types (e.g., 4–90+% increases) to give relatively little change in all water years combined. In all water years combined, reductions under PP scenarios compared to EBC scenarios were estimated to be on the order of 500–5,000 fish (3–14% reduction), which was driven largely by the reductions in wet years.

Under the assumption that the annual number of juvenile spring-run Chinook salmon juveniles approaching the Delta was 750,000 fish, the percentage of the population lost to entrainment

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across all years averaged around 5.0–5.3% under EBC scenarios and decreased to 4.5–5.0% under PP scenarios (Table B-60). In wet years, EBC entrainment losses of ~12% were reduced to just over 4% under PP scenarios (Table B-61). Proportional losses in the above normal, below normal, and dry water-year types generally were increased under PP scenarios relative to EBC scenarios and were similar in critical years (Table B-62 through Table B-65). Nonnormalized estimates were generally lower, as noted above (Table B-66 through Table B-72).

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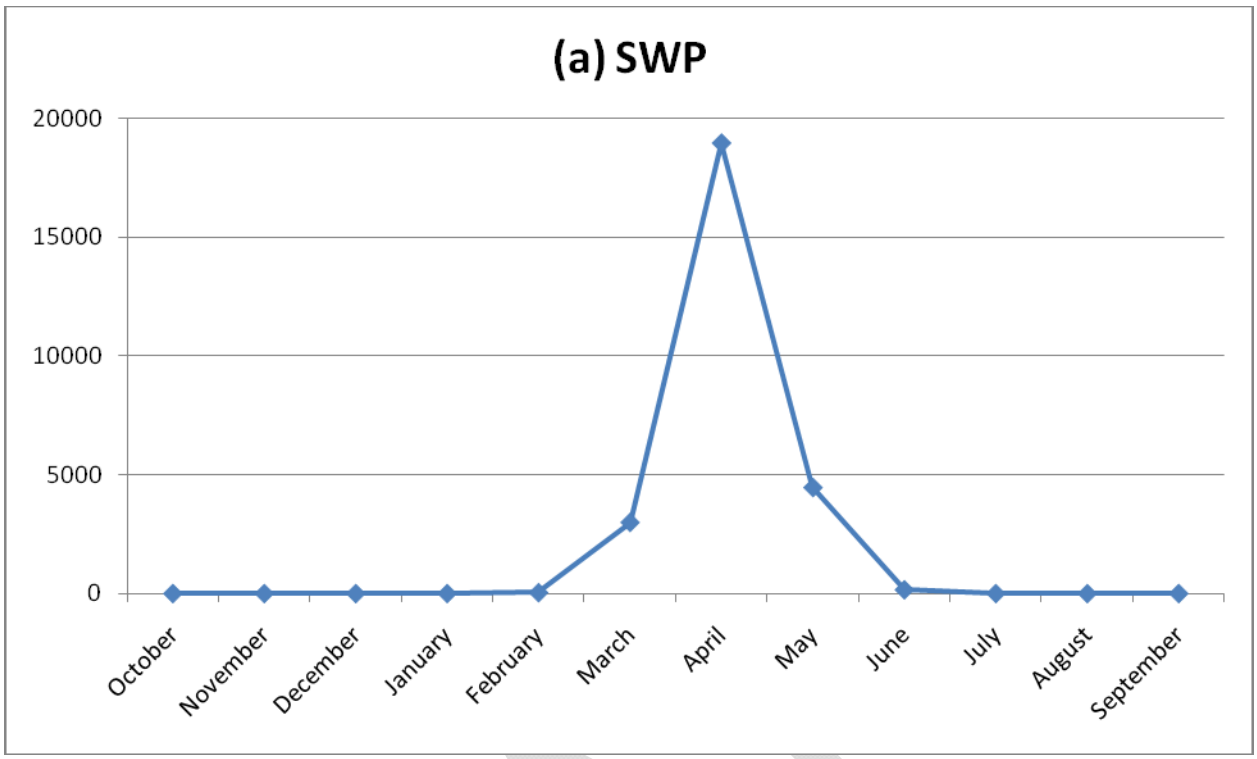

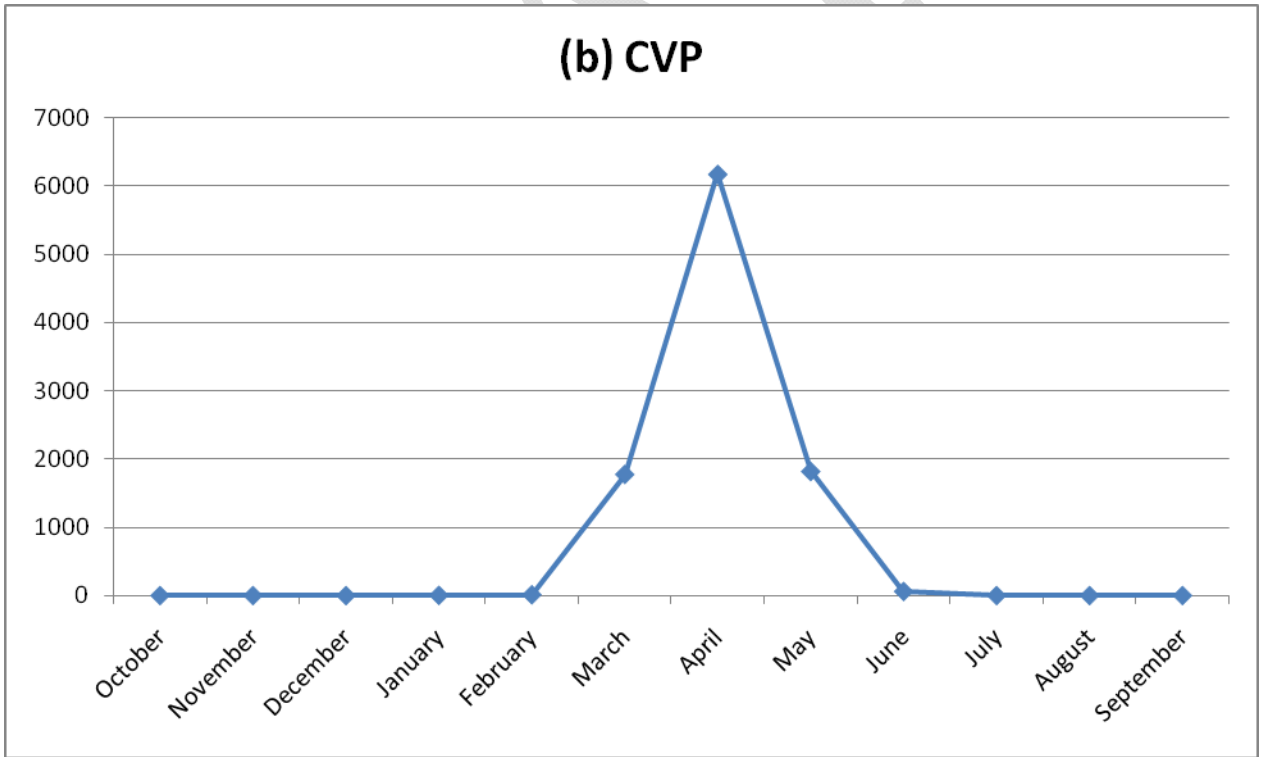

Figure B-25. Mean Monthly Loss of Juvenile Spring-Run Chinook Salmon Calculated from Observed Salvage Monitoring at the (a) SWP and (b) CVP South Delta Export Facilities, Water Years 1996–2008

Table B-47. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Normalized Salvage Data) of Juvenile Spring-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for All Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	24	±	5	17	±	4	15	±	3	12	±	3	16	±	4	12	±	3
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	2	±	0	2	±	0	2	±	0	2	±	0	1	±	0	1	±	0
February	109	±	17	111	±	17	113	±	18	105	±	16	38	±	8	39	±	8
March	5,588	±	793	5,708	±	821	5,713	±	833	5,542	±	818	1,764	±	340	1,373	±	284
April	11,403	±	1,218	11,838	±	1,295	12,135	±	1,325	12,547	±	1,359	17,028	±	1,922	15,757	±	1,804
May	5,126	±	474	5,308	±	529	5,623	±	542	5,663	±	541	6,389	±	612	5,410	±	524
June	467	±	96	466	±	98	441	±	91	389	±	80	234	±	56	178	±	43
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	2	±	1	2	±	1	2	±	0	2	±	0	1	±	0	1	±	0
Annual Average	22,721	±	2,042	23,452	±	2,164	24,043	±	2,204	24,262	±	2,221	25,471	±	2,379	22,770	±	2,152
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	2	±	0	2	±	0	2	±	0	2	±	0	1	±	0	1	±	0
February	24	±	3	23	±	3	23	±	3	23	±	3	8	±	1	8	±	1
March	5,462	±	782	5,453	±	788	5,346	±	776	5,216	±	775	1,366	±	319	1,434	±	319
April	6,291	±	609	6,232	±	604	6,529	±	631	6,629	±	641	6,994	±	788	6,609	±	775
May	3,190	±	619	3,171	±	615	3,234	±	635	3,197	±	622	3,391	±	663	3,174	±	638
June	144	±	29	143	±	29	126	±	26	114	±	23	76	±	17	59	±	14
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	15,112	±	1,874	15,024	±	1,864	15,260	±	1,895	15,182	±	1,894	11,835	±	1,552	11,284	±	1,490

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Table B-48. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Normalized Salvage Data) of Juvenile Spring-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Wet Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	71	±	26	52	±	20	45	±	17	37	±	14	41	±	15	35	±	14
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	316	±	91	319	±	93	331	±	96	315	±	92	3	±	5	7	±	10
March	13,998	±	4,556	14,734	±	4,828	15,049	±	4,918	14,519	±	4,793	573	±	532	427	±	452
April	19,859	±	6,601	20,894	±	7,133	21,050	±	7,172	21,562	±	7,241	12,057	±	5,796	11,965	±	5,660
May	9,480	±	2,202	10,390	±	2,505	10,652	±	2,526	10,293	±	2,508	5,773	±	1,653	4,599	±	1,334
June	1,699	±	587	1,762	±	610	1,587	±	554	1,442	±	494	731	±	321	443	±	229
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	45,423	±	10,815	48,151	±	11,629	48,715	±	11,742	48,168	±	11,708	19,178	±	6,408	17,476	±	5,999
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	58	±	12	58	±	12	60	±	12	61	±	12	0	±	N/A	1	±	1
March	16,340	±	3,772	16,521	±	3,899	16,737	±	3,938	16,957	±	3,991	0	±	N/A	1,011	±	916
April	15,272	±	3,281	15,229	±	3,271	15,409	±	3,305	15,744	±	3,359	8,056	±	2,995	7,881	±	3,029
May	10,941	±	4,045	10,900	±	4,027	11,307	±	4,182	10,830	±	4,036	5,682	±	2,666	5,891	±	2,704
June	541	±	165	543	±	166	509	±	157	443	±	138	236	±	92	155	±	66
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	43,152	±	10,203	43,251	±	10,146	44,021	±	10,396	44,036	±	10,428	13,975	±	5,063	14,939	±	5,345

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Table B-49. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Normalized Salvage Data) of Juvenile Spring-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Above Normal Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	4	±	2	4	±	2	4	±	2	4	±	2	2	±	1	2	±	1
February	82	±	35	83	±	35	84	±	37	83	±	35	14	±	12	13	±	9
March	5,434	±	1,249	5,309	±	1,206	5,435	±	1,276	5,558	±	1,424	946	±	686	285	±	359
April	12,425	±	4,101	12,357	±	4,074	13,137	±	4,338	14,591	±	4,742	20,888	±	10,117	18,601	±	9,861
May	2,341	±	330	2,338	±	328	2,617	±	433	2,737	±	417	4,951	±	1,445	4,643	±	1,513
June	104	±	36	100	±	36	102	±	34	85	±	27	67	±	27	55	±	20
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	12	±	6	12	±	6	12	±	6	12	±	6	6	±	3	7	±	4
Annual Average	20,403	±	5,463	20,204	±	5,399	21,392	±	5,769	23,070	±	6,237	26,873	±	11,020	23,604	±	10,664
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	4	±	2	4	±	2	3	±	2	3	±	2	2	±	1	2	±	1
February	20	±	9	17	±	9	19	±	9	19	±	9	4	±	4	5	±	4
March	1,597	±	213	1,620	±	226	1,517	±	227	1,454	±	240	68	±	79	156	±	157
April	4,104	±	1,308	4,082	±	1,300	4,276	±	1,369	4,599	±	1,473	5,018	±	2,325	4,323	±	2,192
May	560	±	155	560	±	155	600	±	177	613	±	177	794	±	343	934	±	392
June	12	±	6	12	±	6	10	±	5	10	±	5	7	±	4	7	±	4
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	6,297	±	1,403	6,295	±	1,401	6,425	±	1,473	6,698	±	1,580	5,893	±	2,361	5,427	±	2,220

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Table B-50. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Normalized Salvage Data) of Juvenile Spring-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Below Normal Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	12	±	1	13	±	2	13	±	2	12	±	3	12	±	4	10	±	3
February	32	±	9	32	±	10	35	±	11	29	±	8	10	±	5	15	±	8
March	2,269	±	457	2,302	±	511	2,316	±	538	2,145	±	532	1,119	±	487	883	±	385
April	2,219	±	237	2,214	±	248	2,447	±	336	2,916	±	476	7,302	±	1,626	6,766	±	1,386
May	834	±	91	833	±	99	901	±	130	1,053	±	174	2,635	±	852	2,049	±	701
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	5,365	±	664	5,394	±	723	5,712	±	713	6,155	±	684	11,079	±	2,106	9,722	±	1,678
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	517	±	90	470	±	84	457	±	85	466	±	108	212	±	123	197	±	93
April	372	±	29	371	±	31	396	±	48	419	±	62	733	±	138	700	±	147
May	118	±	9	118	±	10	119	±	8	127	±	16	243	±	42	199	±	53
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	1,007	±	79	959	±	80	972	±	82	1,012	±	111	1,188	±	209	1,097	±	225

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Table B-51. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Normalized Salvage Data) of Juvenile Spring-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Dry Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	1,535	±	571	1,522	±	562	1,433	±	527	1,417	±	515	1,466	±	525	1,184	±	484
April	7,301	±	2,484	7,771	±	2,618	8,278	±	3,030	7,873	±	2,997	17,162	±	5,790	15,295	±	5,397
May	4,973	±	1,618	4,842	±	1,576	5,431	±	1,842	5,605	±	1,856	6,813	±	2,595	5,993	±	2,372
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	13,809	±	4,512	14,135	±	4,628	15,142	±	5,224	14,896	±	5,158	25,441	±	8,392	22,473	±	7,741
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	4	±	1	4	±	1	4	±	2	4	±	1	3	±	1	3	±	1
February	1	±	1	1	±	1	1	±	1	1	±	1	1	±	0	1	±	0
March	536	±	180	546	±	181	552	±	180	487	±	163	390	±	145	353	±	136
April	2,006	±	453	1,953	±	439	2,284	±	537	2,165	±	505	3,472	±	804	3,268	±	835
May	90	±	12	89	±	12	87	±	12	88	±	12	144	±	22	120	±	20
June	3	±	1	2	±	1	2	±	1	2	±	1	2	±	1	1	±	1
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	2,639	±	623	2,596	±	616	2,931	±	704	2,747	±	648	4,012	±	929	3,746	±	934

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Table B-52. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Normalized Salvage Data) of Juvenile Spring-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Critical Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	210	±	60	209	±	71	184	±	61	177	±	65	189	±	81	182	±	86
April	4,076	±	1,441	4,243	±	1,344	3,746	±	1,146	3,327	±	930	5,178	±	1,312	4,887	±	1,556
May	4,581	±	698	4,246	±	829	4,410	±	837	3,996	±	1,288	3,432	±	1,240	3,577	±	1,363
June	129	±	33	125	±	35	118	±	33	101	±	31	71	±	18	78	±	27
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	8,996	±	1,627	8,822	±	1,616	8,459	±	1,787	7,600	±	1,885	8,870	±	2,091	8,724	±	2,041
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	102	±	33	109	±	40	95	±	31	86	±	31	76	±	23	66	±	25
April	1,698	±	189	1,667	±	169	1,603	±	187	1,588	±	193	1,705	±	291	1,671	±	336
May	1,076	±	74	1,047	±	64	1,010	±	92	976	±	64	973	±	207	885	±	177
June	5	±	0	4	±	0	4	±	0	5	±	1	3	±	1	3	±	1
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	2,880	±	248	2,828	±	218	2,711	±	271	2,655	±	250	2,757	±	467	2,625	±	470

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Table B-53. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Spring-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for All Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	4	±	1	3	±	1	2	±	1	2	±	0	3	±	1	2	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	2	±	0	2	±	0	2	±	0	2	±	0	1	±	0	1	±	0
February	71	±	8	72	±	8	73	±	8	68	±	8	24	±	4	25	±	4
March	2,875	±	238	2,937	±	248	2,939	±	252	2,851	±	249	908	±	109	706	±	92
April	7,930	±	626	8,233	±	668	8,439	±	683	8,726	±	700	11,841	±	997	10,958	±	938
May	3,836	±	367	3,972	±	409	4,208	±	419	4,238	±	418	4,781	±	473	4,048	±	405
June	135	±	16	135	±	17	128	±	15	112	±	14	68	±	10	51	±	7
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	2	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
Annual Average	14,854	±	983	15,354	±	1,064	15,792	±	1,089	16,001	±	1,101	17,627	±	1,341	15,792	±	1,208
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	2	±	0	2	±	0	2	±	0	2	±	0	1	±	0	1	±	0
February	12	±	1	12	±	1	12	±	1	12	±	1	4	±	0	4	±	1
March	1,528	±	142	1,526	±	144	1,496	±	141	1,459	±	142	382	±	62	401	±	61
April	3,235	±	188	3,204	±	187	3,357	±	195	3,409	±	198	3,596	±	259	3,398	±	257
May	1,113	±	108	1,107	±	107	1,129	±	111	1,116	±	108	1,183	±	116	1,108	±	112
June	44	±	5	43	±	5	38	±	5	35	±	4	23	±	3	18	±	3
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	5,934	±	343	5,894	±	341	6,033	±	349	6,032	±	352	5,190	±	347	4,930	±	339

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Table B-54. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Spring-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Wet Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	11	±	4	8	±	3	7	±	3	6	±	2	6	±	2	6	±	2
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	197	±	38	199	±	39	206	±	41	196	±	39	2	±	3	4	±	5
March	5,071	±	1,176	5,338	±	1,248	5,452	±	1,270	5,260	±	1,240	208	±	149	155	±	127
April	12,796	±	2,886	13,462	±	3,139	13,563	±	3,155	13,893	±	3,174	7,768	±	2,693	7,709	±	2,626
May	7,152	±	2,125	7,839	±	2,405	8,036	±	2,430	7,765	±	2,405	4,355	±	1,557	3,469	±	1,255
June	391	±	90	405	±	93	365	±	85	332	±	75	168	±	51	102	±	37
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	25,618	±	4,738	27,251	±	5,249	27,630	±	5,297	27,452	±	5,292	12,508	±	3,806	11,445	±	3,386
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	26	±	3	26	±	3	27	±	3	27	±	3	0	±	0	0	±	0
March	3,608	±	661	3,648	±	687	3,696	±	693	3,745	±	703	0	±	0	223	±	176
April	6,302	±	859	6,285	±	856	6,359	±	864	6,497	±	876	3,324	±	924	3,252	±	938
May	3,209	±	627	3,197	±	624	3,316	±	648	3,177	±	628	1,667	±	448	1,728	±	452
June	153	±	27	153	±	27	144	±	25	125	±	23	67	±	16	44	±	12
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	13,298	±	1,529	13,309	±	1,512	13,541	±	1,552	13,570	±	1,570	5,058	±	1,165	5,248	±	1,202

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Table B-55. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Spring-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Above Normal Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	5	±	3	5	±	3	6	±	3	5	±	3	2	±	2	2	±	1
February	59	±	21	59	±	22	60	±	23	59	±	22	10	±	8	10	±	6
March	4,910	±	934	4,797	±	899	4,910	±	960	5,022	±	1,097	855	±	580	257	±	306
April	9,852	±	2,432	9,798	±	2,415	10,416	±	2,573	11,569	±	2,795	16,561	±	6,605	14,748	±	6,517
May	2,124	±	183	2,122	±	182	2,375	±	283	2,483	±	255	4,492	±	1,159	4,212	±	1,232
June	94	±	36	90	±	36	92	±	35	76	±	27	60	±	27	49	±	20
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	8	±	4	8	±	4	8	±	4	8	±	4	4	±	2	4	±	2
Annual Average	17,051	±	3,124	16,879	±	3,079	17,867	±	3,310	19,223	±	3,575	21,984	±	7,102	19,283	±	6,996
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	5	±	2	5	±	2	4	±	2	5	±	2	3	±	2	3	±	2
February	14	±	6	12	±	6	13	±	6	14	±	6	3	±	3	4	±	3
March	1,500	±	188	1,520	±	201	1,424	±	203	1,365	±	217	64	±	74	146	±	146
April	3,154	±	752	3,138	±	747	3,286	±	788	3,534	±	848	3,857	±	1,474	3,322	±	1,407
May	525	±	158	525	±	158	562	±	180	575	±	180	744	±	340	876	±	389
June	12	±	6	12	±	6	10	±	5	10	±	5	7	±	4	7	±	4
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	5,210	±	732	5,212	±	734	5,300	±	788	5,502	±	854	4,677	±	1,501	4,357	±	1,427

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Table B-56. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Spring-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Below Normal Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	11	±	1	12	±	2	12	±	2	11	±	3	11	±	4	9	±	3
February	29	±	9	30	±	9	32	±	10	27	±	7	9	±	4	14	±	7
March	2,096	±	422	2,127	±	472	2,139	±	497	1,981	±	492	1,034	±	449	815	±	355
April	2,050	±	219	2,045	±	229	2,260	±	311	2,693	±	440	6,745	±	1,502	6,249	±	1,281
May	770	±	84	769	±	92	833	±	120	973	±	160	2,434	±	787	1,892	±	648
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	4,956	±	613	4,982	±	668	5,276	±	658	5,685	±	632	10,233	±	1,946	8,980	±	1,549
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	477	±	83	434	±	78	422	±	78	430	±	99	196	±	113	182	±	86
April	344	±	27	343	±	29	366	±	44	387	±	57	677	±	128	647	±	136
May	109	±	8	109	±	9	110	±	8	118	±	15	225	±	39	184	±	49
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	930	±	73	886	±	74	898	±	75	935	±	102	1,097	±	193	1,013	±	208

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Table B-57. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Spring-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Dry Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	957	±	318	949	±	312	894	±	293	884	±	286	914	±	291	739	±	271
April	4,655	±	1,353	4,955	±	1,424	5,278	±	1,666	5,020	±	1,655	10,943	±	3,149	9,752	±	2,954
May	3,219	±	871	3,134	±	849	3,515	±	999	3,628	±	1,003	4,410	±	1,431	3,879	±	1,315
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	8,831	±	2,440	9,038	±	2,503	9,687	±	2,848	9,532	±	2,813	16,267	±	4,544	14,370	±	4,219
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	5	±	2	5	±	2	6	±	2	5	±	2	5	±	2	4	±	2
February	2	±	1	2	±	1	2	±	1	2	±	1	1	±	1	1	±	1
March	364	±	98	371	±	98	375	±	98	331	±	89	265	±	80	240	±	76
April	1,533	±	229	1,493	±	222	1,746	±	280	1,655	±	261	2,653	±	414	2,497	±	456
May	79	±	10	79	±	10	78	±	10	78	±	10	128	±	19	107	±	17
June	4	±	1	3	±	1	3	±	1	2	±	1	2	±	1	2	±	1
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	1,987	±	316	1,953	±	312	2,208	±	362	2,073	±	330	3,054	±	475	2,851	±	502

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Table B-58. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Spring-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Critical Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	157	±	45	156	±	53	138	±	46	132	±	49	141	±	61	136	±	64
April	3,044	±	1,076	3,168	±	1,004	2,797	±	856	2,484	±	694	3,867	±	979	3,650	±	1,162
May	3,421	±	521	3,171	±	619	3,293	±	625	2,984	±	962	2,563	±	926	2,671	±	1,018
June	97	±	25	93	±	26	88	±	24	75	±	23	53	±	13	59	±	20
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	6,718	±	1,215	6,588	±	1,207	6,317	±	1,334	5,675	±	1,408	6,624	±	1,561	6,515	±	1,524
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	76	±	25	82	±	30	71	±	23	64	±	23	57	±	17	50	±	19
April	1,268	±	141	1,245	±	126	1,197	±	140	1,186	±	144	1,273	±	217	1,248	±	251
May	803	±	55	782	±	48	754	±	69	729	±	48	727	±	154	661	±	132
June	3	±	0	3	±	0	3	±	0	3	±	1	2	±	1	2	±	1
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	2,151	±	185	2,112	±	162	2,025	±	203	1,983	±	187	2,059	±	348	1,960	±	351

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Table B-59. Average Annual Juvenile Spring-Run Chinook Salmon Losses in Each Water-Year Type Calculated Using Normalized Salvage Densities for Facilities Model Scenarios at the CVP, SWP, and Combined CVP/SWP South Delta Export Facilities

Water-Year Type	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
CVP						
Wet	-29178 (-68%)	-28213 (-65%)	-29276 (-68%)	-28312 (-65%)	-30047 (-68%)	-29096 (-66%)
Above Normal	-404 (-6%)	-871 (-14%)	-403 (-6%)	-869 (-14%)	-532 (-8%)	-1272 (-19%)
Below Normal	181 (18%)	90 (9%)	228 (24%)	137 (14%)	216 (22%)	85 (8%)
Dry	1373 (52%)	1107 (42%)	1416 (55%)	1150 (44%)	1081 (37%)	999 (36%)
Critical	-123 (-4%)	-255 (-9%)	-72 (-3%)	-203 (-7%)	45 (2%)	-30 (-1%)
All Years	-3277 (-22%)	-3827 (-25%)	-3189 (-21%)	-3739 (-25%)	-3425 (-22%)	-3897 (-26%)
SWP						
Wet	-26245 (-58%)	-27947 (-62%)	-28974 (-60%)	-30676 (-64%)	-29538 (-61%)	-30692 (-64%)
Above Normal	6470 (32%)	3201 (16%)	6669 (33%)	3400 (17%)	5480 (26%)	535 (2%)
Below Normal	5713 (106%)	4356 (81%)	5685 (105%)	4328 (80%)	5367 (94%)	3567 (58%)
Dry	11632 (84%)	8663 (63%)	11306 (80%)	8338 (59%)	10299 (68%)	7577 (51%)
Critical	-126 (-1%)	-272 (-3%)	48 (1%)	-98 (-1%)	411 (5%)	1124 (15%)
All Years	2749 (12%)	49 (0%)	2019 (9%)	-682 (-3%)	1427 (6%)	-1492 (-6%)
Combined Losses						
Wet	-55423 (-63%)	-56160 (-63%)	-58250 (-64%)	-58987 (-65%)	-59584 (-64%)	-59788 (-65%)
Above Normal	6066 (23%)	2331 (9%)	6266 (24%)	2532 (10%)	4948 (18%)	-737 (-2%)
Below Normal	5894 (92%)	4446 (70%)	5914 (93%)	4465 (70%)	5583 (84%)	3651 (51%)
Dry	13005 (79%)	9770 (59%)	12723 (76%)	9488 (57%)	11380 (63%)	8576 (49%)
Critical	-249 (-2%)	-527 (-4%)	-24 (0%)	-301 (-3%)	457 (4%)	1094 (11%)
All Years	-528 (-1%)	-3778 (-10%)	-1171 (-3%)	-4421 (-11%)	-1998 (-5%)	-5389 (-14%)

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Table B-60. Average Annual Juvenile Spring-Run Chinook Salmon Losses in Each Water-Year Type Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the CVP, SWP, and Combined CVP/SWP South Delta Export Facilities

Water-Year Type	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
CVP						
Wet	-8240 (-62%)	-8051 (-61%)	-8251 (-62%)	-8061 (-61%)	-8483 (-63%)	-8323 (-61%)
Above Normal	-533 (-10%)	-852 (-16%)	-535 (-10%)	-855 (-16%)	-623 (-12%)	-1145 (-21%)
Below Normal	167 (18%)	83 (9%)	211 (24%)	127 (14%)	199 (22%)	78 (8%)
Dry	1067 (54%)	863 (43%)	1101 (56%)	898 (46%)	846 (38%)	778 (38%)
Critical	-92 (-4%)	-190 (-9%)	-53 (-3%)	-152 (-7%)	34 (2%)	-22 (-1%)
All Years	-744 (-13%)	-1004 (-17%)	-704 (-12%)	-964 (-16%)	-844 (-14%)	-1102 (-18%)
SWP						
Wet	-13110 (-51%)	-14173 (-55%)	-14744 (-54%)	-15806 (-58%)	-15122 (-55%)	-16007 (-58%)
Above Normal	4933 (29%)	2232 (13%)	5105 (30%)	2404 (14%)	4117 (23%)	60 (0%)
Below Normal	5277 (106%)	4024 (81%)	5251 (105%)	3998 (80%)	4958 (94%)	3294 (58%)
Dry	7435 (84%)	5539 (63%)	7229 (80%)	5332 (59%)	6580 (68%)	4838 (51%)
Critical	-94 (-1%)	-203 (-3%)	36 (1%)	-73 (-1%)	307 (5%)	839 (15%)
All Years	2773 (19%)	938 (6%)	2273 (15%)	438 (3%)	1834 (12%)	-208 (-1%)
Combined Losses						
Wet	-21350 (-55%)	-22223 (-57%)	-22995 (-57%)	-23868 (-59%)	-23606 (-57%)	-24329 (-59%)
Above Normal	4401 (20%)	1379 (6%)	4570 (21%)	1549 (7%)	3494 (15%)	-1085 (-4%)
Below Normal	5444 (92%)	4107 (70%)	5462 (93%)	4125 (70%)	5157 (84%)	3373 (51%)
Dry	8502 (79%)	6402 (59%)	8330 (76%)	6230 (57%)	7426 (62%)	5616 (48%)
Critical	-186 (-2%)	-394 (-4%)	-18 (0%)	-225 (-3%)	341 (4%)	817 (11%)
All Years	2028 (10%)	-66 (0%)	1568 (7%)	-526 (-2%)	991 (5%)	-1311 (-6%)

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Table B-61. Average Annual Juvenile Spring-Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	22,721	23,452	24,043	24,262	25,471	22,770
CVP Jones	15,112	15,024	15,260	15,182	11,835	11,284
Combined	37,833	38,476	39,303	39,443	37,305	34,055
Percentage of spring-run juvenile index of abundance	5.04%	5.13%	5.24%	5.26%	4.97%	4.54%

Table B-62. Wet Year Juvenile Spring-Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	45,423	48,151	48,715	48,168	19,178	17,476
CVP Jones	43,152	43,251	44,021	44,036	13,975	14,939
Combined	88,575	91,402	92,736	92,203	33,152	32,415
Percentage of spring-run juvenile index of abundance	11.81%	12.19%	12.36%	12.29%	4.42%	4.32%

Table B-63. Above Normal Year Juvenile Spring-Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	20,403	20,204	21,392	23,070	26,873	23,604
CVP Jones	6,297	6,295	6,425	6,698	5,893	5,427
Combined	26,700	26,499	27,817	29,768	32,765	29,031
Percentage of spring-run juvenile index of abundance	3.56%	3.53%	3.71%	3.97%	4.37%	3.87%

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Table B-64. Below Normal Year Juvenile Spring-Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	5,365	5,394	5,712	6,155	11,079	9,722
CVP Jones	1,007	959	972	1,012	1,188	1,097
Combined	6,372	6,353	6,684	7,167	12,267	10,819
Percentage of spring-run juvenile index of abundance	0.85%	0.85%	0.89%	0.96%	1.64%	1.44%

Table B-65. Dry Year Juvenile Spring-Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	13,809	14,135	15,142	14,896	25,441	22,473
CVP Jones	2,639	2,596	2,931	2,747	4,012	3,746
Combined	16,449	16,731	18,073	17,642	29,453	26,219
Percentage of spring-run juvenile index of abundance	2.19%	2.23%	2.41%	2.35%	3.93%	3.50%

Table B-66. Critical Year Juvenile Spring-Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	8,996	8,822	8,459	7,600	8,870	8,724
CVP Jones	2,880	2,828	2,711	2,655	2,757	2,625
Combined	11,876	11,650	11,170	10,255	11,627	11,349
Percentage of spring-run juvenile index of abundance	1.58%	1.55%	1.49%	1.37%	1.55%	1.51%

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Table B-67. Average Annual Juvenile Spring-Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	14,854	15,354	15,792	16,001	17,627	15,792
CVP Jones	5,934	5,894	6,033	6,032	5,190	4,930
Combined	20,788	21,248	21,826	22,033	22,816	20,723
Percentage of spring-run juvenile index of abundance	2.77%	2.83%	2.91%	2.94%	3.04%	2.76%

Table B-68. Wet Year Juvenile Spring-Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	25,618	27,251	27,630	27,452	12,508	11,445
CVP Jones	13,298	13,309	13,541	13,570	5,058	5,248
Combined	38,916	40,560	41,171	41,022	17,565	16,693
Percentage of spring-run juvenile index of abundance	5.19%	5.41%	5.49%	5.47%	2.34%	2.23%

Table B-69. Above Normal Year Juvenile Spring-Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	17,051	16,879	17,867	19,223	21,984	19,283
CVP Jones	5,210	5,212	5,300	5,502	4,677	4,357
Combined	22,261	22,091	23,168	24,725	26,661	23,640
Percentage of spring-run juvenile index of abundance	2.97%	2.95%	3.09%	3.30%	3.55%	3.15%

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Table B-70. Below Normal Year Juvenile Spring-Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	4,956	4,982	5,276	5,685	10,233	8,980
CVP Jones	930	886	898	935	1,097	1,013
Combined	5,886	5,868	6,174	6,620	11,330	9,993
Percentage of spring-run juvenile index of abundance	0.78%	0.78%	0.82%	0.88%	1.51%	1.33%

Table B-71. Dry Year Juvenile Spring-Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	8,831	9,038	9,687	9,532	16,267	14,370
CVP Jones	1,987	1,953	2,208	2,073	3,054	2,851
Combined	10,819	10,991	11,895	11,604	19,321	17,221
Percentage of spring-run juvenile index of abundance	1.44%	1.47%	1.59%	1.55%	2.58%	2.30%

Table B-72. Critical Year Juvenile Spring-Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	6,718	6,588	6,317	5,675	6,624	6,515
CVP Jones	2,151	2,112	2,025	1,983	2,059	1,960
Combined	8,869	8,700	8,342	7,658	8,683	8,475
Percentage of spring-run juvenile index of abundance	1.18%	1.16%	1.11%	1.02%	1.16%	1.13%

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B.4.1.3.2 Delta Passage Model Salvage Estimates

The estimated percentage of juvenile spring-run Chinook salmon salvaged at the SWP/CVP south Delta export facilities averaged around 0.06–0.10% for EBC scenarios and just over 0.03% for PP scenarios (Table B-73). Percentages in individual years ranged from around 0.01 (PP scenarios in 1983, a wet year) to 0.29 (EBC2_ELT in 1986, a wet year). On average, there was an approximate 62–67% decrease (0.05–0.06% in absolute terms) in percentage salvage in most comparisons from EBC to PP scenarios, except for an average decrease of just over 0.02% (relative decrease of 42%) from EBC2_LLT to PP_LLT (Table B-74).

Table B-73. Estimated Percentage of Juvenile Spring-Run Chinook Salmon Entering the Delta Salvaged at the SWP/CVP South Delta Export Facilities from Delta Passage Model Runs of DSM2-Simulated Water Years 1975–1991 for the Six Model Scenarios

Water-Year (Type)	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1975 (W)	0.1557	0.1364	0.1426	0.0813	0.0244	0.0278
1976 (C)	0.0739	0.0727	0.0751	0.0367	0.0686	0.0603
1977 (C)	0.0264	0.0268	0.0259	0.0148	0.0285	0.0256
1978 (AN)	0.1731	0.1659	0.1706	0.0957	0.0141	0.0135
1979 (BN)	0.1743	0.1634	0.1611	0.0881	0.0383	0.0345
1980 (AN)	0.0993	0.0767	0.0856	0.0496	0.0226	0.0245
1981 (D)	0.0653	0.0594	0.0547	0.0359	0.0441	0.0569
1982 (W)	0.2099	0.1983	0.2032	0.1019	0.0109	0.0110
1983 (W)	0.0544	0.0659	0.0634	0.0481	0.0111	0.0106
1984 (W)	0.1521	0.1648	0.1667	0.0950	0.0321	0.0268
1985 (D)	0.0689	0.0657	0.0673	0.0427	0.0713	0.0686
1986 (W)	0.1561	0.1047	0.2929	0.1599	0.0231	0.0230
1987 (D)	0.0443	0.0551	0.0552	0.0284	0.0535	0.0485
1988 (C)	0.0397	0.0328	0.0348	0.0169	0.0301	0.0249
1989 (D)	0.0278	0.0298	0.0289	0.0170	0.0272	0.0247
1990 (C)	0.0307	0.0326	0.0312	0.0171	0.0315	0.0301
1991 (C)	0.0315	0.0318	0.0312	0.0160	0.0335	0.0330
Average	0.0931	0.0872	0.0994	0.0556	0.0332	0.0320

Table B-74. Change in Estimated Percentage of Juvenile Spring-Run Chinook Salmon Salvaged at the SWP/CVP South Delta Export Facilities from Delta Passage Model Runs of DSM2-Simulated Water Years 1975–1991 for the Six Model Scenarios

Water-Year (Type)	PP_ELT vs. EBC1	PP_LLT vs. EBC1	PP_ELT vs. EBC2	PP_LLT vs. EBC2	PP_ELT vs. EBC2_ELT	PP_LLT vs. EBC2_LLT
1975 (W)	-0.1314 (-84%)	-0.1279 (-82%)	-0.112 (-82%)	-0.1086 (-80%)	-0.1182 (-83%)	-0.0535 (-66%)
1976 (C)	-0.0052 (-7%)	-0.0135 (-18%)	-0.0041 (-6%)	-0.0124 (-17%)	-0.0064 (-9%)	0.0236 (64%)
1977 (C)	0.0022 (8%)	-0.0008 (-3%)	0.0017 (6%)	-0.0012 (-4%)	0.0026 (10%)	0.0108 (73%)
1978 (AN)	-0.159 (-92%)	-0.1596 (-92%)	-0.1519 (-92%)	-0.1525 (-92%)	-0.1565 (-92%)	-0.0822 (-86%)
1979 (BN)	-0.1359 (-78%)	-0.1397 (-80%)	-0.1251 (-77%)	-0.1289 (-79%)	-0.1227 (-76%)	-0.0536 (-61%)
1980 (AN)	-0.0767 (-77%)	-0.0749 (-75%)	-0.054 (-70%)	-0.0522 (-68%)	-0.063 (-74%)	-0.0252 (-51%)
1981 (D)	-0.0213 (-33%)	-0.0085 (-13%)	-0.0154 (-26%)	-0.0026 (-4%)	-0.0107 (-19%)	0.0209 (58%)
1982 (W)	-0.199 (-95%)	-0.199 (-95%)	-0.1874 (-95%)	-0.1874 (-94%)	-0.1923 (-95%)	-0.0909 (-89%)
1983 (W)	-0.0432 (-80%)	-0.0438 (-80%)	-0.0547 (-83%)	-0.0553 (-84%)	-0.0523 (-82%)	-0.0375 (-78%)
1984 (W)	-0.12 (-79%)	-0.1253 (-82%)	-0.1327 (-81%)	-0.138 (-84%)	-0.1346 (-81%)	-0.0682 (-72%)
1985 (D)	0.0024 (3%)	-0.0003 (0%)	0.0056 (8%)	0.0029 (4%)	0.004 (6%)	0.0259 (61%)
1986 (W)	-0.1329 (-85%)	-0.133 (-85%)	-0.0816 (-78%)	-0.0817 (-78%)	-0.2697 (-92%)	-0.1369 (-86%)
1987 (D)	0.0092 (21%)	0.0042 (9%)	-0.0016 (-3%)	-0.0066 (-12%)	-0.0017 (-3%)	0.0201 (71%)
1988 (C)	-0.0096 (-24%)	-0.0148 (-37%)	-0.0027 (-8%)	-0.0079 (-24%)	-0.0047 (-13%)	0.008 (47%)
1989 (D)	-0.0006 (-2%)	-0.0031 (-11%)	-0.0026 (-9%)	-0.0051 (-17%)	-0.0017 (-6%)	0.0077 (45%)
1990 (C)	0.0008 (3%)	-0.0006 (-2%)	-0.0011 (-3%)	-0.0025 (-8%)	0.0003 (1%)	0.013 (76%)
1991 (C)	0.002 (6%)	0.0015 (5%)	0.0017 (5%)	0.0012 (4%)	0.0023 (7%)	0.0169 (106%)
Average	-0.0599 (-64%)	-0.0611 (-66%)	-0.054 (-62%)	-0.0552 (-63%)	-0.0662 (-67%)	-0.0236 (-42%)

B.4.1.4 *Fall-Run/Late Fall–Run Chinook Salmon (Juvenile)*

B.4.1.4.1 Salvage-Density Method

The basic seasonal pattern of entrainment of juvenile fall-run and late fall–run Chinook salmon upon which the salvage-density method is based is presented in Figure B-26 and Figure B-27, although note that this is an average of all years combined and does not account for water-year differences. As noted above for spring-run Chinook salmon juveniles, the seasonal entrainment pattern is the best index of entrainment, as opposed to the actual numbers of fish, because of the overlap between fall-run and spring-run juvenile Chinook salmon and the length-at-date criteria used to characterize race. Entrainment loss of fall-run Chinook salmon peaks in May at both the SWP and CVP facilities, and there is a second, almost as large, peak in February at the CVP facility.

In general, estimated losses of fall-run Chinook salmon were approximately 1.5–3 times greater at the SWP export facilities compared to the CVP export facility (Table B-75 to Table B-86). Estimated losses of late fall–run Chinook salmon varied between the two facilities, with entrainment loss at CVP generally being lower than at SWP but not in all water-year types (Table B-87 to Table B-92). For fall-run Chinook salmon, normalization of the data to adult population size increased the estimated entrainment loss relative to nonnormalized data for wet and critical water years; decreased the estimated entrainment loss in below normal and dry years; and resulted in little change to entrainment loss in above normal years. For late fall–run Chinook salmon, normalization of the data to adult population size increased the estimated entrainment loss relative to nonnormalized data for wet and critical water years; decreased the estimated entrainment loss in above normal years; and resulted in little change to entrainment loss in below normal and dry years. This summary of the main results focuses only on normalized data.

For fall-run Chinook salmon, estimated annual losses at SWP across all water years averaged around 36,000 fish per year under EBC scenarios and 28,000–32,000 fish under PP scenarios; for the CVP, the annual average loss was around 19,000 fish under EBC and 12,000 fish under PP (Table B-75). Losses of fall-run Chinook salmon were greatest in wet years (SWP: 77,000–82,000 fish under EBC and 25,000–32,000 under PP; CVP: 50,000 under EBC and 14,000 under PP) and were lowest in below normal years at SWP (8,000 fish under EBC and 11,000–13,000 fish under PP scenarios; Table B-78) and in dry years at CVP (2,500–2,700 fish under EBC and 3,300–3,700 under PP; Table B-79). For late fall–run Chinook salmon, estimated annual losses at SWP across all water years averaged nearly 900 fish under EBC scenarios and 430–500 under PP scenarios; for the CVP, the annual average loss was around 1,000 fish under EBC and 730–770 fish under PP (Table B-87). Entrainment losses of late fall–run Chinook salmon were greatest in wet years (SWP: 2,600–2,800 fish under EBC and 290–330 fish under PP; CVP: 3,200–3,400 fish under EBC and 1,800 fish under PP (Table B-88). Entrainment loss in other water-year types was one or two orders of magnitude lower than in wet years (Table B-89 to Table B-92).

Differences in entrainment loss of juvenile fall-run Chinook salmon between EBC and PP scenarios were greatest in wet years, with reductions at both facilities under PP scenarios compared to EBC scenarios of ~80,000–94,000 fish (64–71% reduction) (Table B-99). This major reduction, coupled with smaller reductions of 9–21% in above normal and critical years, contrasted with increases in entrainment loss under PP scenarios relative to EBC scenarios of ~950–12,000 fish (7–60%) in below normal and dry years. Across all water years, reductions under PP scenarios compared to EBC scenarios were estimated to be on the order of 9,500–15,500 fish (18–27% reduction). Differences in entrainment loss of juvenile late fall–run Chinook salmon between EBC and PP scenarios were also greatest in wet years, with reductions at both facilities under PP scenarios compared to EBC scenarios of ~3,700–4,000 fish (63–66% reduction) (Table B-101). Decreases in entrainment loss under PP scenarios relative to EBC scenarios were also evident in above normal years (207–225 fish; 37–39% reduction). Changes in entrainment loss in other water-year types generally amounted to only tens or single digit numbers of fish. Across all water years, reductions of entrainment loss of juvenile late fall–run Chinook salmon under PP scenarios compared to EBC scenarios were estimated to be around 660–810 fish (18–27% reduction).

Under the assumption that the annual number of juvenile fall-run Chinook salmon juveniles approaching the Delta was 23 million fish, the percentage of the population lost to entrainment across all years averaged 0.24% under EBC scenarios and decreased to 0.17–0.20% under PP scenarios (Table B-103). In wet years, EBC entrainment losses of just under 0.6% were reduced to just over 0.2% or less under PP scenarios (Table B-104). Proportional losses in the above normal, and below normal water years were quite similar between EBC and PP scenarios (0.06–0.15%), whereas in dry water years proportional losses were increased under PP scenarios relative to EBC scenarios (0.12–0.14% compared to less than 0.1%) and were slightly decreased in critical years under PP (0.14% compared to 0.16–0.18% under EBC) (Table B-105 to Table B-108). Nonnormalized estimates were generally lower, as noted above (Table B-109 to Table B-114). Assuming that 1 million juvenile late fall–run Chinook salmon entered the Delta, the percentage of the juvenile population lost to entrainment at the SWP/CVP south Delta export facilities across all years was around 0.2% under EBC scenarios and 0.12–0.13% under PP scenarios (Table B-115). The percentage of all juveniles lost to entrainment was greatest in wet years: 0.6% under EBC scenarios and just over 0.2% under PP scenarios (Table B-116). The proportions of the population lost to entrainment in all other water-year types was well below 0.1% in EBC and PP scenarios (Table B-117 to Table B-120). Nonnormalized data suggested an even smaller proportion of the population was lost to entrainment (Table B-121 to Table B-126).

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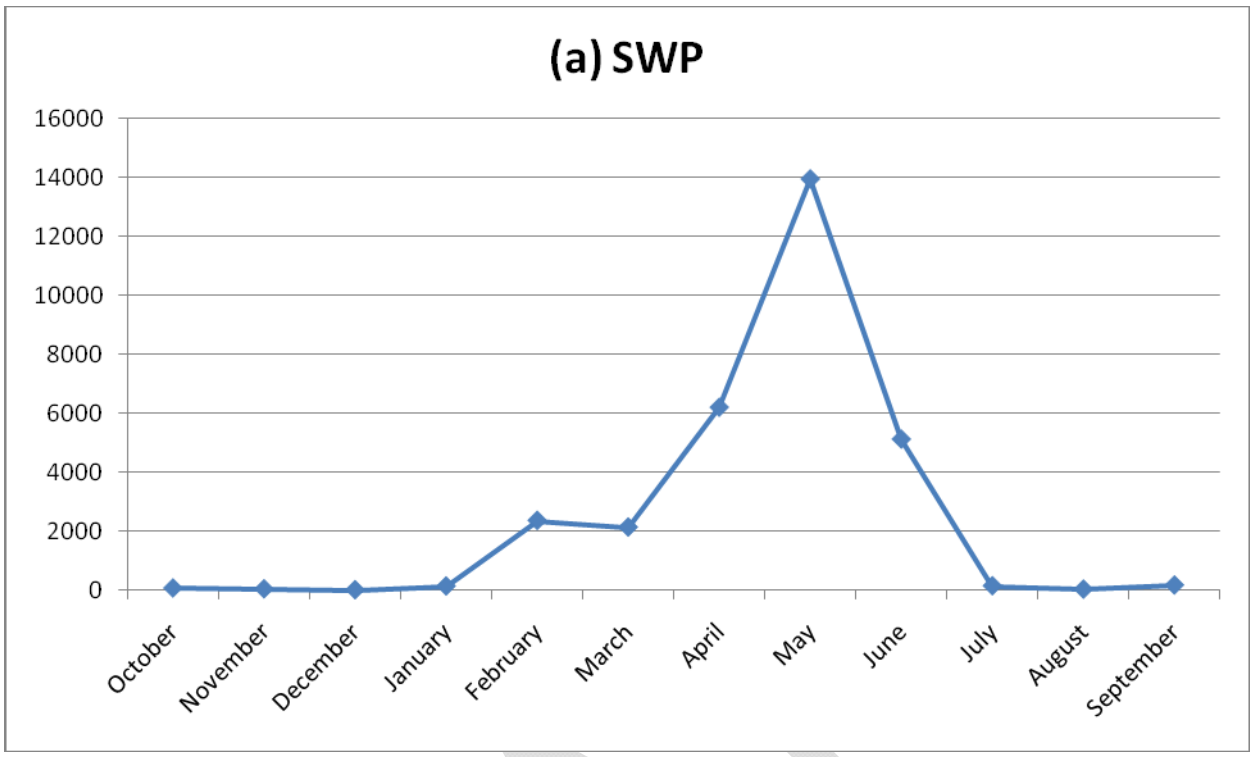

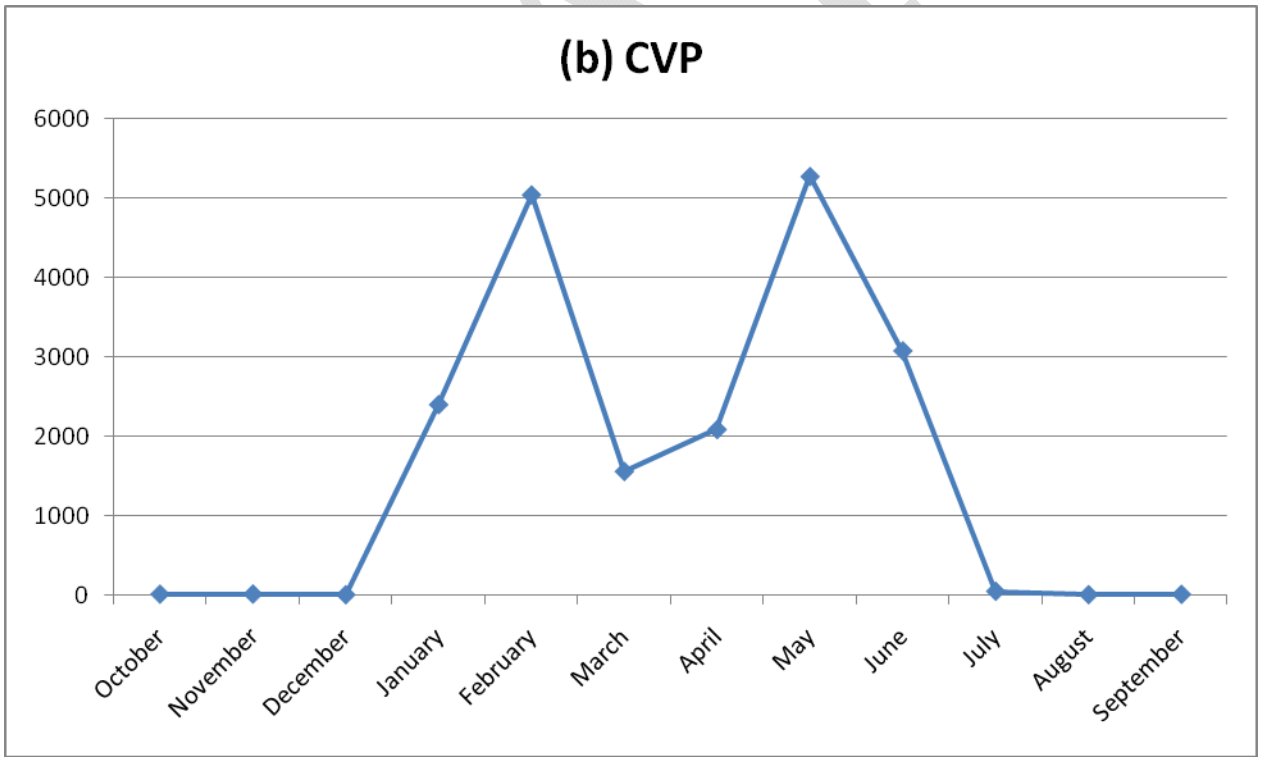

Figure B-26. Mean Monthly Loss of Juvenile Fall-Run Chinook Salmon Calculated from Observed Salvage Monitoring at the (a) SWP and (b) CVP South Delta Export Facilities, Water Years 1996–2008

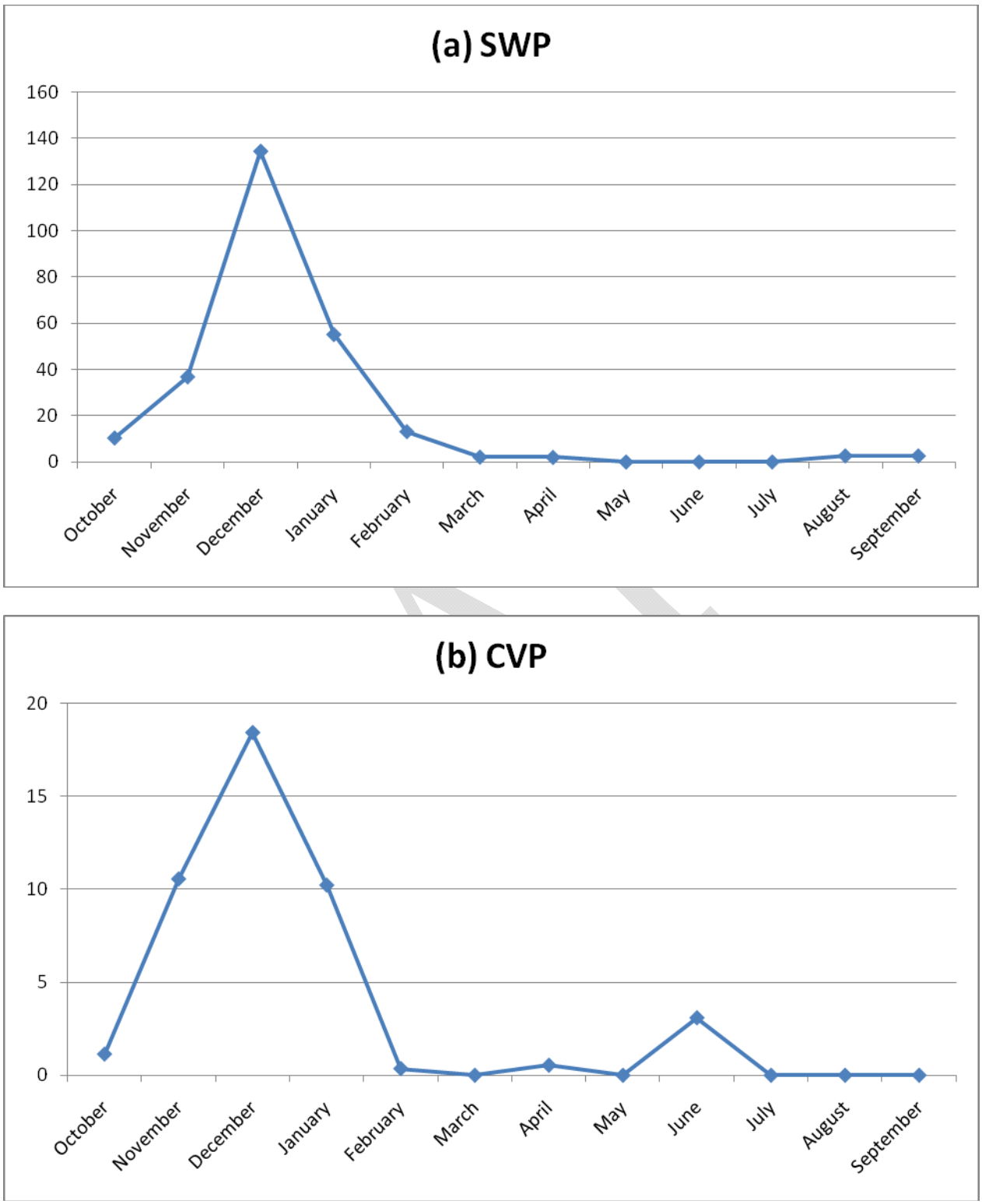

Figure B-27. Mean Monthly Loss of Juvenile Late Fall–Run Chinook Salmon Calculated from Observed Salvage Monitoring at the (a) SWP and (b) CVP South Delta Export Facilities, Water Years 1996–2008

Table B-75. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Normalized Salvage Data) of Juvenile Fall-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for All Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	52	±	10	37	±	7	32	±	6	25	±	5	35	±	7	26	±	5
November	43	±	6	30	±	5	29	±	5	28	±	5	27	±	4	27	±	4
December	5	±	1	6	±	1	5	±	1	5	±	1	4	±	1	5	±	1
January	335	±	37	341	±	39	346	±	40	341	±	39	194	±	27	154	±	23
February	6,008	±	851	6,108	±	871	6,206	±	896	5,781	±	838	2,078	±	416	2,135	±	423
March	2,059	±	246	2,103	±	255	2,105	±	259	2,042	±	255	650	±	107	506	±	90
April	3,130	±	399	3,250	±	424	3,331	±	433	3,445	±	445	4,674	±	627	4,326	±	588
May	17,653	±	2,096	18,279	±	2,321	19,364	±	2,386	19,503	±	2,381	22,003	±	2,696	18,630	±	2,306
June	5,619	±	482	5,605	±	492	5,311	±	455	4,679	±	399	2,812	±	291	2,139	±	224
July	231	±	22	228	±	22	219	±	21	203	±	20	106	±	13	95	±	12
August	31	±	5	30	±	5	30	±	5	28	±	5	11	±	2	10	±	2
September	138	±	24	128	±	22	125	±	22	115	±	20	66	±	12	65	±	13
Annual Average	35,304	±	3,307	36,145	±	3,553	37,103	±	3,631	36,197	±	3,550	32,661	±	3,350	28,117	±	2,922
(b) CVP																		
October	10	±	1	9	±	1	8	±	1	7	±	1	7	±	1	8	±	1
November	16	±	2	15	±	2	15	±	2	14	±	2	13	±	2	9	±	1
December	2	±	0	3	±	0	2	±	0	2	±	0	2	±	0	2	±	0
January	2,163	±	393	2,139	±	393	2,146	±	397	2,071	±	387	1,201	±	275	997	±	239
February	5,660	±	696	5,442	±	682	5,498	±	688	5,566	±	701	1,820	±	343	1,889	±	365
March	1,383	±	118	1,380	±	120	1,353	±	118	1,321	±	118	346	±	52	363	±	52
April	1,439	±	148	1,426	±	147	1,494	±	154	1,517	±	156	1,600	±	191	1,512	±	188
May	5,600	±	588	5,566	±	585	5,677	±	605	5,613	±	592	5,953	±	632	5,571	±	612
June	3,137	±	342	3,113	±	341	2,755	±	312	2,480	±	279	1,646	±	205	1,291	±	168
July	56	±	8	54	±	8	47	±	7	40	±	7	30	±	6	27	±	5
August	4	±	1	4	±	1	4	±	1	4	±	1	3	±	0	3	±	0
September	7	±	1	7	±	1	6	±	1	6	±	1	4	±	1	4	±	1
Annual Average	19,478	±	1,763	19,159	±	1,738	19,006	±	1,746	18,640	±	1,730	12,624	±	1,192	11,676	±	1,120

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Table B-76. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Normalized Salvage Data) of Juvenile Fall-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Wet Water Years

Month	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
	Avg.	±	95% CI	Avg.	±	95% CI	Avg.	±	95% CI	Avg.	±	95% CI	Avg.	±	95% CI	Avg.	±	95% CI
(a) SWP																		
October	18	±	5	13	±	4	11	±	3	9	±	3	10	±	3	9	±	3
November	131	±	30	95	±	24	93	±	24	86	±	23	65	±	20	62	±	20
December	7	±	3	7	±	3	8	±	3	8	±	3	4	±	2	4	±	2
January	645	±	95	661	±	100	686	±	103	662	±	100	80	±	35	92	±	33
February	17,059	±	4,449	17,239	±	4,546	17,882	±	4,707	16,989	±	4,515	181	±	273	359	±	491
March	3,935	±	1,316	4,142	±	1,395	4,231	±	1,421	4,082	±	1,385	161	±	153	120	±	130
April	3,860	±	1,627	4,061	±	1,755	4,091	±	1,765	4,191	±	1,784	2,343	±	1,399	2,325	±	1,367
May	36,643	±	13,102	40,161	±	14,793	41,174	±	14,963	39,786	±	14,779	22,312	±	9,484	17,776	±	7,639
June	14,664	±	2,113	15,209	±	2,197	13,698	±	2,008	12,443	±	1,762	6,308	±	1,346	3,822	±	1,017
July	567	±	72	572	±	72	566	±	72	531	±	69	234	±	42	281	±	47
August	67	±	23	69	±	24	69	±	24	68	±	23	17	±	9	16	±	9
September	95	±	23	90	±	22	89	±	22	80	±	20	38	±	12	43	±	13
Annual Average	77,691	±	19,041	82,318	±	20,964	82,598	±	21,243	78,934	±	20,653	31,754	±	10,669	24,909	±	8,749
(b) CVP																		
October	23	±	5	20	±	4	19	±	4	17	±	4	15	±	4	17	±	4
November	41	±	8	38	±	8	38	±	8	36	±	8	29	±	7	25	±	6
December	6	±	2	6	±	2	6	±	2	6	±	2	4	±	1	4	±	1
January	5,852	±	1,774	6,113	±	1,886	6,166	±	1,903	6,069	±	1,875	1,126	±	734	1,184	±	718
February	14,501	±	3,152	14,544	±	3,208	14,899	±	3,259	15,251	±	3,333	0	±	N/A	213	±	292
March	2,251	±	485	2,276	±	501	2,306	±	506	2,336	±	513	0	±	N/A	139	±	121
April	2,585	±	825	2,577	±	822	2,608	±	831	2,665	±	846	1,363	±	697	1,334	±	703
May	13,837	±	3,500	13,785	±	3,484	14,300	±	3,619	13,697	±	3,498	7,187	±	2,394	7,450	±	2,422
June	11,016	±	1,567	11,052	±	1,580	10,358	±	1,508	9,009	±	1,349	4,813	±	1,012	3,152	±	755
July	151	±	38	151	±	38	132	±	34	112	±	31	106	±	30	98	±	29
August	11	±	3	11	±	3	11	±	3	11	±	3	7	±	2	8	±	2
September	4	±	1	3	±	1	3	±	1	3	±	1	2	±	1	2	±	1
Annual Average	50,277	±	8,457	50,578	±	8,419	50,846	±	8,602	49,211	±	8,601	14,652	±	3,352	13,627	±	3,345

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Table B-77. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Normalized Salvage Data) of Juvenile Fall-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Above Normal Water Years

Month	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
	Avg.	±	95% CI	Avg.	±	95% CI	Avg.	±	95% CI	Avg.	±	95% CI	Avg.	±	95% CI	Avg.	±	95% CI
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	11	±	6	12	±	6	12	±	6	12	±	6	9	±	5	11	±	6
January	16	±	5	18	±	6	18	±	6	18	±	6	8	±	3	7	±	3
February	5,431	±	2,530	5,451	±	2,578	5,561	±	2,685	5,452	±	2,594	908	±	838	877	±	659
March	2,440	±	1,018	2,384	±	989	2,440	±	1,030	2,496	±	1,106	425	±	425	128	±	216
April	1,804	±	645	1,794	±	641	1,907	±	682	2,118	±	747	3,032	±	1,560	2,700	±	1,515
May	7,183	±	1,540	7,175	±	1,536	8,031	±	1,884	8,398	±	1,879	15,190	±	5,361	14,245	±	5,513
June	5,699	±	1,880	5,490	±	1,861	5,595	±	1,792	4,628	±	1,393	3,636	±	1,424	2,981	±	1,032
July	83	±	25	83	±	25	79	±	24	71	±	23	43	±	19	36	±	19
August	25	±	12	26	±	12	26	±	12	26	±	12	11	±	7	10	±	7
September	527	±	250	516	±	247	541	±	256	532	±	254	264	±	147	291	±	154
Annual Average	23,219	±	7,300	22,949	±	7,208	24,210	±	7,651	23,751	±	7,325	23,527	±	7,218	21,286	±	7,067
(b) CVP																		
October	1	±	1	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
November	4	±	2	4	±	2	4	±	2	4	±	2	3	±	2	2	±	1
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	158	±	58	152	±	55	133	±	51	149	±	56	90	±	46	82	±	44
February	4,192	±	1,706	3,669	±	1,653	4,016	±	1,755	4,101	±	1,721	798	±	788	1,063	±	880
March	1,481	±	451	1,502	±	464	1,407	±	445	1,348	±	443	63	±	94	144	±	187
April	860	±	240	855	±	239	896	±	251	963	±	271	1,051	±	444	906	±	421
May	2,220	±	512	2,217	±	511	2,375	±	595	2,429	±	592	3,143	±	1,216	3,699	±	1,388
June	695	±	178	712	±	172	592	±	156	568	±	145	402	±	126	409	±	124
July	17	±	5	18	±	5	13	±	4	10	±	4	6	±	3	8	±	3
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	28	±	13	23	±	11	25	±	12	26	±	13	15	±	9	16	±	9
Annual Average	9,657	±	2,969	9,153	±	2,896	9,463	±	3,019	9,599	±	3,024	5,573	±	1,833	6,331	±	1,844

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Table B-78. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Normalized Salvage Data) of Juvenile Fall-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Below Normal Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	43	±	13	44	±	13	47	±	15	40	±	11	14	±	6	20	±	10
March	3,907	±	786	3,964	±	881	3,988	±	927	3,693	±	916	1,927	±	838	1,520	±	662
April	1,365	±	146	1,362	±	153	1,505	±	207	1,794	±	293	4,493	±	1,000	4,163	±	853
May	2,130	±	232	2,128	±	253	2,303	±	331	2,691	±	444	6,733	±	2,176	5,234	±	1,792
June	288	±	48	252	±	59	257	±	45	242	±	50	157	±	54	137	±	53
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	7,733	±	1,028	7,750	±	1,124	8,100	±	1,085	8,460	±	1,002	13,324	±	2,650	11,073	±	2,091
(b) CVP																		
October	5	±	1	5	±	1	4	±	1	4	±	1	3	±	1	5	±	1
November	6	±	0	5	±	1	6	±	0	5	±	1	5	±	1	3	±	1
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	7	±	1	7	±	1	7	±	1	6	±	1	5	±	1	5	±	1
February	117	±	24	109	±	21	90	±	23	111	±	24	47	±	22	37	±	22
March	4,465	±	773	4,059	±	729	3,948	±	730	4,022	±	930	1,831	±	1,061	1,704	±	802
April	327	±	26	327	±	27	349	±	42	369	±	55	645	±	122	616	±	130
May	844	±	64	848	±	73	852	±	60	912	±	116	1,739	±	301	1,427	±	377
June	89	±	15	88	±	12	70	±	12	65	±	11	56	±	17	39	±	16
July	5	±	0	5	±	0	4	±	0	4	±	0	3	±	1	2	±	1
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	5,865	±	763	5,452	±	721	5,329	±	724	5,498	±	899	4,332	±	1,064	3,838	±	989

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Table B-79. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Normalized Salvage Data) of Juvenile Fall-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Dry Water Years

Month	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
	Avg.	±	95% CI	Avg.	±	95% CI	Avg.	±	95% CI	Avg.	±	95% CI	Avg.	±	95% CI	Avg.	±	95% CI
(a) SWP																		
October	171	±	75	125	±	52	114	±	47	81	±	36	122	±	54	102	±	43
November	13	±	5	8	±	4	8	±	4	7	±	4	9	±	4	8	±	4
December	1	±	0	1	±	1	1	±	1	1	±	0	1	±	1	1	±	1
January	8	±	3	7	±	3	7	±	3	8	±	3	8	±	3	6	±	3
February	17	±	4	17	±	4	16	±	4	15	±	4	17	±	4	16	±	4
March	590	±	232	585	±	229	551	±	214	545	±	210	563	±	214	455	±	196
April	4,639	±	1,727	4,938	±	1,822	5,260	±	2,098	5,003	±	2,070	10,905	±	4,028	9,719	±	3,744
May	11,589	±	3,336	11,282	±	3,251	12,654	±	3,814	13,060	±	3,835	15,875	±	5,432	13,965	±	4,981
June	52	±	13	54	±	13	53	±	13	42	±	10	26	±	7	23	±	7
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	15	±	6	13	±	5	12	±	5	11	±	5	5	±	3	6	±	3
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	17,094	±	5,209	17,032	±	5,235	18,676	±	6,040	18,772	±	5,967	27,533	±	9,026	24,301	±	8,358
(b) CVP																		
October	4	±	1	3	±	1	3	±	1	3	±	1	3	±	1	3	±	1
November	2	±	1	2	±	1	2	±	1	2	±	1	2	±	1	1	±	1
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	24	±	9	24	±	9	25	±	10	24	±	9	21	±	9	17	±	8
February	25	±	5	25	±	5	25	±	5	23	±	5	18	±	4	18	±	4
March	310	±	118	316	±	119	320	±	119	282	±	107	226	±	94	204	±	88
April	1,174	±	365	1,143	±	354	1,337	±	427	1,267	±	402	2,032	±	643	1,913	±	651
May	806	±	69	798	±	67	787	±	65	787	±	68	1,298	±	145	1,082	±	136
June	202	±	27	186	±	26	160	±	24	129	±	17	119	±	20	96	±	16
July	2	±	1	1	±	1	1	±	1	1	±	0	1	±	0	1	±	0
August	3	±	1	3	±	1	2	±	1	2	±	1	2	±	1	1	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	2,551	±	521	2,502	±	514	2,662	±	581	2,520	±	545	3,722	±	807	3,336	±	807

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Table B-80. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Normalized Salvage Data) of Juvenile Fall-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Critical Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	171	±	44	188	±	50	175	±	36	171	±	43	201	±	56	186	±	36
March	80	±	23	80	±	27	71	±	23	68	±	25	72	±	31	70	±	33
April	1,304	±	461	1,357	±	430	1,198	±	366	1,064	±	297	1,656	±	419	1,563	±	498
May	23,573	±	3,591	21,851	±	4,267	22,693	±	4,309	20,562	±	6,628	17,660	±	6,383	18,406	±	7,012
June	4,072	±	1,046	3,926	±	1,105	3,723	±	1,026	3,167	±	968	2,228	±	553	2,468	±	861
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	29,200	±	3,818	27,402	±	4,135	27,860	±	4,760	25,032	±	6,864	21,817	±	6,848	22,693	±	7,208
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	10	±	2	9	±	2	9	±	2	9	±	2	9	±	2	5	±	2
February	120	±	28	109	±	32	123	±	26	105	±	28	89	±	20	102	±	32
March	80	±	26	86	±	31	74	±	25	68	±	24	60	±	18	52	±	20
April	1,193	±	133	1,171	±	119	1,126	±	131	1,116	±	135	1,198	±	205	1,174	±	236
May	9,903	±	682	9,640	±	593	9,296	±	850	8,986	±	588	8,959	±	1,904	8,149	±	1,627
June	387	±	30	374	±	16	350	±	27	399	±	87	256	±	95	261	±	88
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	11,693	±	766	11,389	±	675	10,979	±	982	10,683	±	727	10,569	±	2,125	9,742	±	1,844

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Table B-81. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Fall-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for All Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	61	±	13	44	±	9	37	±	8	30	±	7	41	±	9	31	±	7
November	34	±	5	23	±	4	23	±	4	22	±	4	21	±	4	21	±	4
December	5	±	1	5	±	1	5	±	1	5	±	1	4	±	1	5	±	1
January	272	±	32	277	±	34	281	±	35	278	±	34	158	±	23	125	±	20
February	4,199	±	509	4,269	±	522	4,338	±	537	4,041	±	502	1,452	±	253	1,492	±	257
March	1,711	±	170	1,748	±	177	1,749	±	180	1,697	±	177	540	±	76	420	±	64
April	2,903	±	422	3,014	±	447	3,089	±	458	3,194	±	470	4,335	±	662	4,011	±	620
May	12,769	±	1,300	13,222	±	1,446	14,007	±	1,483	14,108	±	1,480	15,916	±	1,675	13,476	±	1,434
June	3,919	±	345	3,910	±	352	3,704	±	326	3,264	±	286	1,961	±	208	1,492	±	160
July	188	±	19	185	±	19	177	±	18	165	±	18	86	±	11	77	±	11
August	22	±	3	21	±	3	21	±	3	20	±	3	7	±	1	7	±	1
September	131	±	25	122	±	23	119	±	23	110	±	21	63	±	13	62	±	13
Annual Average	26,213	±	2,034	26,839	±	2,200	27,551	±	2,248	26,932	±	2,209	24,585	±	2,241	21,219	±	1,956
(b) CVP																		
October	9	±	1	8	±	1	7	±	1	7	±	1	7	±	1	7	±	1
November	12	±	1	11	±	1	12	±	1	11	±	1	10	±	1	7	±	1
December	2	±	0	2	±	0	2	±	0	2	±	0	2	±	0	2	±	0
January	1,953	±	373	1,931	±	373	1,938	±	377	1,870	±	367	1,084	±	261	900	±	226
February	4,302	±	514	4,136	±	504	4,179	±	509	4,230	±	518	1,383	±	254	1,436	±	271
March	1,291	±	115	1,289	±	116	1,264	±	114	1,233	±	115	323	±	50	339	±	50
April	1,113	±	98	1,102	±	97	1,155	±	102	1,172	±	103	1,237	±	128	1,169	±	126
May	3,618	±	304	3,596	±	302	3,667	±	313	3,626	±	306	3,846	±	327	3,599	±	318
June	2,232	±	238	2,215	±	238	1,960	±	217	1,764	±	195	1,171	±	143	918	±	117
July	42	±	6	41	±	6	36	±	5	31	±	5	23	±	4	21	±	4
August	3	±	0	3	±	0	3	±	0	3	±	0	2	±	0	2	±	0
September	8	±	1	7	±	1	7	±	1	6	±	1	5	±	1	4	±	1
Annual Average	14,585	±	1,247	14,343	±	1,230	14,229	±	1,233	13,955	±	1,221	9,091	±	781	8,405	±	724

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Table B-82. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Fall-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Wet Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	10	±	3	8	±	2	7	±	2	5	±	1	6	±	2	5	±	1
November	98	±	25	71	±	20	70	±	20	64	±	20	49	±	17	46	±	16
December	6	±	2	7	±	2	7	±	3	7	±	3	4	±	2	4	±	2
January	479	±	71	491	±	75	509	±	77	492	±	74	59	±	26	68	±	25
February	10,434	±	2,351	10,544	±	2,405	10,937	±	2,490	10,391	±	2,390	111	±	151	220	±	272
March	1,986	±	640	2,090	±	678	2,135	±	690	2,060	±	673	81	±	75	61	±	64
April	1,960	±	793	2,062	±	855	2,077	±	860	2,128	±	869	1,190	±	683	1,181	±	668
May	21,650	±	6,406	23,729	±	7,250	24,327	±	7,325	23,507	±	7,248	13,183	±	4,695	10,502	±	3,784
June	10,618	±	1,479	11,013	±	1,538	9,919	±	1,407	9,011	±	1,233	4,568	±	953	2,767	±	722
July	452	±	69	455	±	69	451	±	68	422	±	65	186	±	38	224	±	43
August	33	±	11	34	±	12	34	±	12	33	±	11	8	±	4	8	±	4
September	56	±	11	52	±	11	52	±	10	46	±	10	22	±	6	25	±	7
Annual Average	47,782	±	9,003	50,555	±	9,965	50,525	±	10,102	48,167	±	9,825	19,467	±	5,192	15,111	±	4,282
(b) CVP																		
October	19	±	4	17	±	4	16	±	3	14	±	3	13	±	3	15	±	4
November	28	±	6	27	±	6	26	±	6	25	±	5	20	±	5	17	±	4
December	6	±	1	6	±	1	6	±	1	5	±	1	4	±	1	4	±	1
January	5,262	±	1,701	5,496	±	1,807	5,544	±	1,823	5,457	±	1,796	1,012	±	696	1,065	±	681
February	10,170	±	2,298	10,200	±	2,338	10,449	±	2,376	10,695	±	2,430	0	±	N/A	149	±	210
March	1,528	±	321	1,545	±	333	1,565	±	336	1,586	±	341	0	±	N/A	95	±	81
April	1,445	±	399	1,441	±	398	1,458	±	402	1,489	±	409	762	±	345	746	±	348
May	9,012	±	1,821	8,978	±	1,812	9,313	±	1,883	8,921	±	1,823	4,680	±	1,292	4,852	±	1,304
June	7,777	±	1,082	7,802	±	1,091	7,312	±	1,042	6,360	±	933	3,398	±	704	2,225	±	526
July	112	±	27	112	±	27	98	±	25	84	±	23	79	±	22	73	±	21
August	6	±	2	6	±	2	6	±	2	6	±	2	4	±	1	4	±	1
September	3	±	1	3	±	1	3	±	1	2	±	1	2	±	1	2	±	1
Annual Average	35,367	±	5,719	35,633	±	5,744	35,796	±	5,853	34,644	±	5,866	9,974	±	1,920	9,247	±	1,907

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Table B-83. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Fall-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Above Normal Water Years

Month	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
	Avg.	±	95% CI	Avg.	±	95% CI	Avg.	±	95% CI	Avg.	±	95% CI	Avg.	±	95% CI	Avg.	±	95% CI
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	12	±	6	12	±	6	12	±	6	12	±	6	10	±	5	11	±	6
January	14	±	4	15	±	5	16	±	5	16	±	5	7	±	3	6	±	3
February	5,666	±	2,675	5,687	±	2,726	5,802	±	2,838	5,688	±	2,743	947	±	883	915	±	695
March	2,548	±	1,076	2,489	±	1,045	2,548	±	1,088	2,606	±	1,168	444	±	447	134	±	227
April	1,953	±	666	1,942	±	662	2,065	±	705	2,294	±	771	3,283	±	1,629	2,924	±	1,586
May	7,539	±	1,403	7,531	±	1,399	8,430	±	1,748	8,815	±	1,728	15,944	±	5,226	14,952	±	5,409
June	5,605	±	1,956	5,400	±	1,934	5,503	±	1,867	4,552	±	1,457	3,577	±	1,470	2,932	±	1,071
July	80	±	27	81	±	27	77	±	26	69	±	25	42	±	20	35	±	20
August	26	±	12	27	±	13	28	±	13	28	±	13	11	±	8	11	±	8
September	556	±	264	544	±	260	570	±	270	561	±	268	279	±	155	306	±	162
Annual Average	24,000	±	7,602	23,730	±	7,503	25,050	±	7,953	24,640	±	7,607	24,543	±	7,187	22,226	±	7,054
(b) CVP																		
October	2	±	1	2	±	1	2	±	1	1	±	1	2	±	1	2	±	1
November	5	±	2	4	±	2	5	±	2	4	±	2	3	±	2	2	±	1
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	162	±	62	156	±	59	137	±	54	153	±	59	92	±	49	84	±	46
February	4,386	±	1,798	3,838	±	1,742	4,201	±	1,849	4,290	±	1,813	835	±	828	1,112	±	926
March	1,476	±	476	1,496	±	489	1,402	±	469	1,343	±	465	63	±	96	144	±	192
April	911	±	243	906	±	242	949	±	255	1,021	±	274	1,114	±	457	960	±	434
May	2,180	±	488	2,178	±	487	2,333	±	568	2,386	±	565	3,088	±	1,174	3,634	±	1,339
June	664	±	171	680	±	166	566	±	150	543	±	140	384	±	122	391	±	120
July	15	±	4	15	±	4	11	±	3	9	±	3	6	±	2	7	±	3
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	30	±	14	25	±	12	27	±	13	27	±	13	16	±	9	17	±	9
Annual Average	9,831	±	3,117	9,301	±	3,036	9,632	±	3,164	9,777	±	3,169	5,602	±	1,839	6,353	±	1,841

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Table B-84. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Fall-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Below Normal Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	59	±	17	60	±	18	64	±	20	54	±	15	19	±	9	27	±	14
March	5,311	±	1,069	5,389	±	1,197	5,422	±	1,260	5,021	±	1,246	2,620	±	1,139	2,066	±	900
April	1,856	±	198	1,852	±	207	2,047	±	281	2,439	±	399	6,108	±	1,360	5,660	±	1,160
May	2,896	±	316	2,893	±	345	3,131	±	450	3,659	±	603	9,155	±	2,958	7,117	±	2,437
June	392	±	66	343	±	80	349	±	61	329	±	68	213	±	74	186	±	72
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	10,514	±	1,398	10,537	±	1,529	11,013	±	1,476	11,503	±	1,363	18,115	±	3,603	15,056	±	2,843
(b) CVP																		
October	7	±	1	7	±	1	6	±	1	5	±	1	5	±	1	6	±	1
November	8	±	0	7	±	1	8	±	1	7	±	1	6	±	1	4	±	1
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	10	±	1	10	±	1	10	±	1	9	±	2	6	±	2	6	±	2
February	159	±	32	148	±	29	122	±	31	151	±	33	63	±	30	50	±	30
March	6,070	±	1,051	5,518	±	991	5,368	±	992	5,469	±	1,264	2,489	±	1,443	2,317	±	1,090
April	445	±	35	444	±	37	474	±	57	501	±	74	877	±	165	838	±	176
May	1,148	±	88	1,152	±	99	1,158	±	81	1,239	±	158	2,365	±	409	1,940	±	512
June	121	±	20	120	±	16	95	±	16	89	±	14	76	±	23	53	±	22
July	7	±	0	7	±	0	6	±	1	5	±	1	3	±	1	3	±	1
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	7,974	±	1,038	7,412	±	981	7,246	±	984	7,475	±	1,223	5,890	±	1,447	5,218	±	1,345

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Table B-85. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Fall-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Dry Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	214	±	93	157	±	65	142	±	58	101	±	45	153	±	67	127	±	54
November	16	±	7	10	±	5	10	±	5	9	±	5	11	±	5	10	±	5
December	2	±	1	2	±	1	2	±	1	1	±	1	2	±	1	2	±	1
January	12	±	5	12	±	5	12	±	5	13	±	5	13	±	5	10	±	5
February	24	±	5	24	±	5	23	±	5	21	±	5	24	±	6	23	±	6
March	728	±	292	722	±	288	680	±	270	672	±	264	695	±	269	562	±	246
April	5,701	±	2,180	6,068	±	2,299	6,463	±	2,644	6,148	±	2,608	13,401	±	5,083	11,943	±	4,722
May	14,632	±	4,192	14,245	±	4,084	15,977	±	4,793	16,490	±	4,819	20,044	±	6,829	17,632	±	6,262
June	51	±	13	54	±	13	52	±	13	42	±	10	26	±	7	23	±	7
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	25	±	10	21	±	9	20	±	8	17	±	8	9	±	4	10	±	5
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	21,404	±	6,546	21,315	±	6,580	23,381	±	7,589	23,514	±	7,497	34,377	±	11,350	30,341	±	10,507
(b) CVP																		
October	5	±	2	4	±	2	4	±	1	3	±	1	4	±	1	4	±	2
November	2	±	1	2	±	1	2	±	1	2	±	1	2	±	1	1	±	1
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	39	±	15	39	±	15	41	±	16	38	±	15	35	±	14	28	±	13
February	32	±	6	32	±	6	32	±	7	30	±	7	24	±	6	23	±	6
March	384	±	149	392	±	150	396	±	149	350	±	135	280	±	118	253	±	111
April	1,439	±	462	1,401	±	449	1,638	±	542	1,553	±	510	2,490	±	814	2,343	±	823
May	966	±	126	957	±	124	944	±	121	944	±	123	1,556	±	234	1,297	±	211
June	207	±	21	191	±	20	164	±	20	132	±	12	122	±	17	98	±	14
July	2	±	1	2	±	1	2	±	1	2	±	1	1	±	1	1	±	1
August	5	±	1	4	±	1	4	±	1	3	±	1	3	±	1	2	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	3,081	±	686	3,024	±	676	3,226	±	759	3,057	±	712	4,516	±	1,054	4,051	±	1,045

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Table B-86. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Fall-Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Critical Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	37	±	9	40	±	11	38	±	8	37	±	9	43	±	12	40	±	8
March	17	±	5	17	±	6	15	±	5	15	±	5	16	±	7	15	±	7
April	280	±	99	291	±	92	257	±	79	228	±	64	356	±	90	336	±	107
May	5,061	±	771	4,691	±	916	4,872	±	925	4,415	±	1,423	3,791	±	1,370	3,952	±	1,505
June	874	±	225	843	±	237	799	±	220	680	±	208	478	±	119	530	±	185
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	6,269	±	820	5,883	±	888	5,981	±	1,022	5,374	±	1,474	4,684	±	1,470	4,872	±	1,548
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	2	±	0	2	±	0	2	±	0	2	±	0	2	±	0	1	±	0
February	26	±	6	23	±	7	26	±	6	23	±	6	19	±	4	22	±	7
March	17	±	6	18	±	7	16	±	5	15	±	5	13	±	4	11	±	4
April	256	±	29	251	±	26	242	±	28	240	±	29	257	±	44	252	±	51
May	2,126	±	146	2,070	±	127	1,996	±	183	1,929	±	126	1,923	±	409	1,750	±	349
June	83	±	6	80	±	3	75	±	6	86	±	19	55	±	20	56	±	19
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	2,510	±	164	2,445	±	145	2,357	±	211	2,294	±	156	2,269	±	456	2,092	±	396

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Table B-87. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Normalized Salvage Data) of Juvenile Late Fall–Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for All Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	17	±	3	12	±	2	10	±	2	8	±	1	11	±	2	9	±	1
November	26	±	4	18	±	3	17	±	3	17	±	3	16	±	3	16	±	3
December	83	±	7	84	±	7	82	±	7	80	±	7	68	±	6	71	±	7
January	598	±	120	609	±	125	619	±	128	610	±	126	347	±	85	275	±	72
February	156	±	32	159	±	33	161	±	33	150	±	31	54	±	15	56	±	16
March	1	±	0	1	±	0	1	±	0	1	±	0	0	±	0	0	±	0
April	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	4	±	1	4	±	1	4	±	1	4	±	1	1	±	0	1	±	0
September	4	±	1	3	±	1	3	±	1	3	±	1	2	±	0	2	±	0
Annual Average	890	±	148	892	±	154	899	±	158	875	±	153	502	±	97	431	±	82
(b) CVP																		
October	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
November	13	±	2	12	±	2	12	±	2	11	±	1	10	±	1	7	±	1
December	695	±	142	736	±	151	719	±	148	653	±	139	537	±	121	527	±	121
January	150	±	30	148	±	30	149	±	30	143	±	29	83	±	21	69	±	18
February	13	±	3	12	±	2	12	±	2	12	±	3	4	±	1	4	±	1
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	74	±	17	74	±	17	77	±	18	78	±	18	83	±	21	78	±	21
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	94	±	21	93	±	21	82	±	19	74	±	17	49	±	13	39	±	10
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	1,039	±	208	1,076	±	216	1,052	±	212	974	±	200	767	±	165	726	±	158

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Table B-88. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Normalized Salvage Data) of Juvenile Late Fall–Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Wet Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	34	±	12	25	±	9	21	±	8	18	±	7	19	±	7	17	±	6
November	2	±	1	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
December	64	±	20	66	±	21	68	±	21	69	±	22	37	±	14	39	±	16
January	1,620	±	611	1,662	±	637	1,724	±	656	1,664	±	635	200	±	170	232	±	164
February	456	±	167	461	±	171	478	±	177	454	±	169	5	±	9	10	±	17
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	12	±	4	12	±	4	12	±	4	12	±	4	3	±	2	3	±	2
September	3	±	1	2	±	1	2	±	1	2	±	1	1	±	0	1	±	1
Annual Average	2,664	±	925	2,712	±	962	2,807	±	989	2,698	±	956	291	±	217	333	±	206
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	16	±	5	15	±	5	15	±	5	14	±	5	11	±	4	10	±	4
December	1,689	±	585	1,706	±	596	1,709	±	598	1,631	±	578	1,097	±	478	1,178	±	499
January	367	±	126	383	±	134	386	±	135	380	±	133	71	±	51	74	±	50
February	33	±	12	33	±	12	34	±	12	35	±	12	0	±	0	0	±	1
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	234	±	92	233	±	92	236	±	92	241	±	94	123	±	76	121	±	76
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	324	±	116	325	±	117	304	±	111	265	±	98	141	±	64	93	±	46
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	3,319	±	1,107	3,361	±	1,127	3,347	±	1,124	3,199	±	1,081	1,800	±	720	1,841	±	725

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Table B-89. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Normalized Salvage Data) of Juvenile Late Fall–Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Above Normal Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	15	±	8	10	±	5	8	±	4	6	±	3	10	±	5	7	±	4
November	70	±	37	49	±	30	49	±	29	51	±	33	49	±	26	52	±	27
December	163	±	34	166	±	34	166	±	34	166	±	34	134	±	31	154	±	39
January	173	±	51	188	±	59	197	±	64	191	±	61	81	±	35	73	±	32
February	51	±	25	52	±	25	53	±	26	52	±	25	9	±	8	8	±	6
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	12	±	6	12	±	6	12	±	6	12	±	6	6	±	3	7	±	4
Annual Average	485	±	142	477	±	142	485	±	146	478	±	142	289	±	85	300	±	87
(b) CVP																		
October	3	±	2	3	±	1	2	±	1	2	±	1	3	±	1	3	±	1
November	21	±	11	21	±	11	22	±	11	20	±	10	15	±	9	11	±	6
December	31	±	7	34	±	7	34	±	7	31	±	7	23	±	6	21	±	6
January	17	±	5	16	±	5	14	±	5	16	±	5	10	±	4	9	±	4
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	17	±	9	18	±	9	15	±	7	14	±	7	10	±	6	10	±	6
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	90	±	22	92	±	22	88	±	22	83	±	20	61	±	17	54	±	15

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Table B-90. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Normalized Salvage Data) of Juvenile Late Fall–Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Below Normal Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	38	±	5	39	±	6	40	±	7	37	±	9	36	±	12	31	±	10
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	38	±	5	39	±	6	40	±	7	37	±	9	36	±	12	31	±	10
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	18	±	2	17	±	2	17	±	2	15	±	3	11	±	3	11	±	3
February	1	±	0	1	±	0	1	±	0	1	±	0	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	18	±	2	18	±	2	18	±	2	16	±	3	11	±	3	11	±	3

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Table B-91. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Normalized Salvage Data) of Juvenile Late Fall–Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Dry Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	3	±	1	2	±	1	2	±	1	1	±	1	2	±	1	2	±	1
November	25	±	11	16	±	7	15	±	7	14	±	8	17	±	7	16	±	7
December	75	±	25	77	±	25	75	±	25	72	±	25	80	±	27	80	±	27
January	5	±	2	5	±	2	5	±	2	5	±	2	5	±	2	4	±	2
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	3	±	1	2	±	1	2	±	1	2	±	1	2	±	1	2	±	1
April	3	±	1	3	±	1	3	±	1	3	±	1	7	±	3	6	±	3
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	112	±	39	106	±	36	103	±	36	98	±	34	113	±	39	109	±	38
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	5	±	2	5	±	2	5	±	2	5	±	2	5	±	2	3	±	2
December	19	±	7	21	±	8	20	±	8	18	±	7	17	±	7	15	±	6
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	24	±	9	26	±	10	25	±	10	23	±	9	22	±	9	18	±	8

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Table B-92. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Normalized Salvage Data) of Juvenile Late Fall–Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Critical Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	84	±	18	78	±	20	72	±	22	79	±	16	87	±	18	40	±	20
February	42	±	11	46	±	12	43	±	9	42	±	11	50	±	14	46	±	9
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	126	±	24	125	±	30	115	±	27	121	±	25	136	±	30	86	±	18
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	30	±	5	32	±	5	30	±	5	23	±	7	28	±	5	27	±	8
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	8	±	2	7	±	2	8	±	2	7	±	2	6	±	1	7	±	2
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	38	±	7	40	±	7	38	±	7	30	±	9	34	±	6	34	±	9

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Table B-93. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Late Fall–Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for All Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	10	±	2	7	±	1	6	±	1	5	±	1	7	±	1	5	±	1
November	34	±	4	24	±	3	23	±	3	22	±	3	22	±	3	22	±	3
December	117	±	13	118	±	14	115	±	13	113	±	13	95	±	12	100	±	13
January	134	±	23	136	±	24	138	±	25	137	±	24	78	±	16	61	±	14
February	9	±	2	9	±	2	10	±	2	9	±	2	3	±	1	3	±	1
March	1	±	0	1	±	0	1	±	0	1	±	0	0	±	0	0	±	0
April	1	±	0	1	±	0	1	±	0	1	±	0	2	±	0	2	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	2	±	1	2	±	1	2	±	1	2	±	1	1	±	0	1	±	0
September	2	±	0	2	±	0	2	±	0	2	±	0	1	±	0	1	±	0
Annual Average	312	±	29	302	±	29	300	±	30	292	±	29	209	±	22	196	±	21
(b) CVP																		
October	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
November	11	±	1	10	±	1	11	±	1	10	±	1	9	±	1	6	±	1
December	19	±	1	20	±	1	19	±	1	18	±	1	14	±	1	14	±	1
January	8	±	1	8	±	1	8	±	1	8	±	1	5	±	1	4	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	2	±	0	2	±	0	2	±	0	2	±	0	1	±	0	1	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	42	±	2	42	±	2	42	±	2	39	±	2	30	±	2	27	±	2

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Table B-94. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Late Fall–Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Wet Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	21	±	8	15	±	6	13	±	5	11	±	4	12	±	5	10	±	4
November	49	±	15	35	±	12	35	±	12	32	±	12	24	±	10	23	±	10
December	185	±	56	189	±	58	195	±	59	197	±	60	105	±	40	113	±	46
January	46	±	14	47	±	15	49	±	15	47	±	15	6	±	4	7	±	4
February	2	±	1	2	±	1	2	±	1	2	±	1	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	7	±	2	7	±	3	7	±	3	7	±	3	2	±	1	2	±	1
September	2	±	1	2	±	1	2	±	1	1	±	0	1	±	0	1	±	0
Annual Average	310	±	56	297	±	58	302	±	59	297	±	60	149	±	40	155	±	47
(b) CVP																		
October	2	±	1	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
November	18	±	3	17	±	3	16	±	3	15	±	3	12	±	3	11	±	3
December	21	±	3	21	±	3	21	±	3	20	±	3	13	±	3	14	±	3
January	13	±	3	14	±	3	14	±	3	14	±	3	3	±	1	3	±	1
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	1	±	0	1	±	0	1	±	0	1	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	1	±	0	1	±	0	1	±	0	1	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	55	±	4	55	±	5	54	±	5	52	±	5	30	±	4	30	±	3

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Table B-95. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Late Fall–Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Above Normal Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	10	±	5	7	±	3	5	±	3	4	±	2	6	±	3	4	±	2
November	44	±	24	31	±	19	31	±	19	32	±	21	31	±	17	33	±	17
December	90	±	20	92	±	20	92	±	20	92	±	20	74	±	18	85	±	23
January	96	±	31	104	±	36	109	±	39	105	±	37	45	±	21	40	±	19
February	32	±	16	32	±	16	33	±	17	32	±	16	5	±	5	5	±	4
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	8	±	4	8	±	4	8	±	4	8	±	4	4	±	2	4	±	2
Annual Average	280	±	92	273	±	91	278	±	94	274	±	91	166	±	54	172	±	55
(b) CVP																		
October	2	±	1	2	±	1	1	±	1	1	±	1	2	±	1	2	±	1
November	14	±	7	13	±	7	14	±	7	13	±	7	10	±	6	7	±	4
December	18	±	4	19	±	4	20	±	5	18	±	4	13	±	4	12	±	4
January	11	±	4	11	±	4	10	±	4	11	±	4	6	±	3	6	±	3
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	11	±	5	11	±	5	9	±	5	9	±	4	6	±	4	6	±	4
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	56	±	14	56	±	15	54	±	14	51	±	13	38	±	11	33	±	10

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Table B-96. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Late Fall–Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Below Normal Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	24	±	3	25	±	4	25	±	4	23	±	5	23	±	8	20	±	7
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	24	±	3	25	±	4	25	±	4	23	±	5	23	±	8	20	±	7
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	11	±	1	11	±	2	11	±	1	10	±	2	7	±	2	7	±	2
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	12	±	1	11	±	2	11	±	2	10	±	2	7	±	2	7	±	2

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Table B-97. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Late Fall–Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Dry Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	4	±	2	3	±	1	2	±	1	2	±	1	3	±	1	2	±	1
November	34	±	15	22	±	10	22	±	10	19	±	10	23	±	10	22	±	10
December	116	±	33	120	±	34	117	±	34	112	±	34	124	±	36	124	±	37
January	7	±	3	7	±	3	7	±	3	7	±	3	7	±	3	6	±	2
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	3	±	1	3	±	1	3	±	1	3	±	1	3	±	1	3	±	1
April	4	±	2	4	±	2	5	±	2	5	±	2	10	±	4	9	±	4
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	169	±	52	160	±	48	155	±	48	147	±	46	170	±	53	165	±	52
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	8	±	3	7	±	3	7	±	3	7	±	3	7	±	3	5	±	2
December	26	±	10	29	±	11	28	±	11	26	±	10	23	±	9	21	±	9
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	34	±	13	36	±	14	35	±	13	32	±	13	30	±	12	25	±	11

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Table B-98. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI], Based on Nonnormalized Salvage Data) of Juvenile Late Fall–Run Chinook Salmon for Six Model Scenarios at the SWP and CVP Salvage Facilities for Critical Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	24	±	5	22	±	6	21	±	6	23	±	4	25	±	5	12	±	6
February	12	±	3	13	±	4	12	±	3	12	±	3	14	±	4	13	±	3
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	36	±	7	36	±	9	33	±	8	35	±	7	39	±	9	25	±	5
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	9	±	2	9	±	1	9	±	2	6	±	2	8	±	1	8	±	2
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	2	±	1	2	±	1	2	±	1	2	±	1	2	±	0	2	±	1
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	11	±	2	11	±	2	11	±	2	9	±	2	10	±	2	10	±	3

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Table B-99. Average Annual Juvenile Fall-Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

Water-Year Type	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
CVP						
Wet	-35625 (-71%)	-36649 (-73%)	-35926 (-71%)	-36951 (-73%)	-36194 (-71%)	-35583 (-72%)
Above Normal	-4084 (-42%)	-3326 (-34%)	-3580 (-39%)	-2822 (-31%)	-3889 (-41%)	-3268 (-34%)
Below Normal	-1533 (-26%)	-2027 (-35%)	-1119 (-21%)	-1614 (-30%)	-997 (-19%)	-1660 (-30%)
Dry	1170 (46%)	785 (31%)	1220 (49%)	834 (33%)	1059 (40%)	816 (32%)
Critical	-1124 (-10%)	-1951 (-17%)	-820 (-7%)	-1647 (-14%)	-410 (-4%)	-941 (-9%)
All Years	-6854 (-35%)	-7801 (-40%)	-6535 (-34%)	-7482 (-39%)	-6382 (-34%)	-6964 (-37%)
SWP						
Wet	-45937 (-59%)	-52782 (-68%)	-50564 (-61%)	-57409 (-70%)	-50844 (-62%)	-54025 (-68%)
Above Normal	308 (1%)	-1933 (-8%)	578 (3%)	-1663 (-7%)	-683 (-3%)	-2465 (-10%)
Below Normal	5591 (72%)	3340 (43%)	5574 (72%)	3323 (43%)	5224 (64%)	2613 (31%)
Dry	10439 (61%)	7207 (42%)	10501 (62%)	7269 (43%)	8857 (47%)	5529 (29%)
Critical	-7383 (-25%)	-6507 (-22%)	-5585 (-20%)	-4709 (-17%)	-6043 (-22%)	-2339 (-9%)
All Years	-2643 (-7%)	-7187 (-20%)	-3484 (-10%)	-8027 (-22%)	-4442 (-12%)	-8080 (-22%)
Combined Losses						
Wet	-81562 (-64%)	-89431 (-70%)	-86491 (-65%)	-94360 (-71%)	-87038 (-65%)	-89608 (-70%)
Above Normal	-3776 (-11%)	-5259 (-16%)	-3002 (-9%)	-4485 (-14%)	-4573 (-14%)	-5733 (-17%)
Below Normal	4058 (30%)	1313 (10%)	4454 (34%)	1709 (13%)	4227 (31%)	953 (7%)
Dry	11609 (59%)	7992 (41%)	11721 (60%)	8103 (41%)	9916 (46%)	6345 (30%)
Critical	-8507 (-21%)	-8458 (-21%)	-6405 (-17%)	-6356 (-16%)	-6453 (-17%)	-3280 (-9%)
All Years	-9497 (-17%)	-14988 (-27%)	-10018 (-18%)	-15509 (-28%)	-10824 (-19%)	-15044 (-27%)

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Table B-100. Average Annual Juvenile Fall-Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

Water-Year Type	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
CVP						
Wet	-25394 (-72%)	-26120 (-74%)	-25660 (-72%)	-26386 (-74%)	-25823 (-72%)	-25397 (-73%)
Above Normal	-4229 (-43%)	-3478 (-35%)	-3699 (-40%)	-2948 (-32%)	-4030 (-42%)	-3425 (-35%)
Below Normal	-2084 (-26%)	-2756 (-35%)	-1522 (-21%)	-2194 (-30%)	-1355 (-19%)	-2257 (-30%)
Dry	1434 (47%)	970 (31%)	1491 (49%)	1027 (34%)	1289 (40%)	994 (33%)
Critical	-241 (-10%)	-419 (-17%)	-176 (-7%)	-354 (-14%)	-88 (-4%)	-202 (-9%)
All Years	-5494 (-38%)	-6181 (-42%)	-5252 (-37%)	-5939 (-41%)	-5138 (-36%)	-5551 (-40%)
SWP						
Wet	-28315 (-59%)	-32671 (-68%)	-31089 (-61%)	-35444 (-70%)	-31058 (-61%)	-33056 (-69%)
Above Normal	543 (2%)	-1774 (-7%)	813 (3%)	-1504 (-6%)	-507 (-2%)	-2414 (-10%)
Below Normal	7601 (72%)	4542 (43%)	7578 (72%)	4518 (43%)	7103 (64%)	3553 (31%)
Dry	12973 (61%)	8937 (42%)	13062 (61%)	9026 (42%)	10997 (47%)	6827 (29%)
Critical	-1585 (-25%)	-1397 (-22%)	-1199 (-20%)	-1011 (-17%)	-1297 (-22%)	-502 (-9%)
All Years	-1628 (-6%)	-4994 (-19%)	-2254 (-8%)	-5620 (-21%)	-2966 (-11%)	-5712 (-21%)
Combined Losses						
Wet	-53709 (-65%)	-58791 (-71%)	-56748 (-66%)	-61830 (-72%)	-56880 (-66%)	-58453 (-71%)
Above Normal	-3685 (-11%)	-5252 (-16%)	-2886 (-9%)	-4452 (-13%)	-4536 (-13%)	-5838 (-17%)
Below Normal	5517 (30%)	1785 (10%)	6056 (34%)	2324 (13%)	5747 (31%)	1296 (7%)
Dry	14408 (59%)	9907 (40%)	14554 (60%)	10053 (41%)	12286 (46%)	7821 (29%)
Critical	-1826 (-21%)	-1816 (-21%)	-1375 (-17%)	-1365 (-16%)	-1385 (-17%)	-704 (-9%)
All Years	-7122 (-17%)	-11175 (-27%)	-7506 (-18%)	-11559 (-28%)	-8104 (-19%)	-11263 (-28%)

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Table B-101. Average Annual Juvenile Late Fall–Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

Water-Year Type	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
CVP						
Wet	-1519 (-46%)	-1478 (-45%)	-1561 (-46%)	-1520 (-45%)	-1547 (-46%)	-1358 (-42%)
Above Normal	-29 (-32%)	-36 (-40%)	-31 (-33%)	-38 (-41%)	-27 (-30%)	-29 (-35%)
Below Normal	-7 (-39%)	-7 (-40%)	-7 (-37%)	-7 (-37%)	-7 (-37%)	-5 (-29%)
Dry	-2 (-10%)	-6 (-24%)	-4 (-15%)	-7 (-29%)	-3 (-13%)	-5 (-21%)
Critical	-4 (-11%)	-4 (-11%)	-6 (-15%)	-6 (-14%)	-4 (-11%)	4 (14%)
All Years	-272 (-26%)	-314 (-30%)	-308 (-29%)	-350 (-33%)	-285 (-27%)	-248 (-25%)
SWP						
Wet	-2373 (-89%)	-2331 (-87%)	-2420 (-89%)	-2378 (-88%)	-2516 (-90%)	-2364 (-88%)
Above Normal	-196 (-40%)	-184 (-38%)	-188 (-39%)	-176 (-37%)	-196 (-40%)	-178 (-37%)
Below Normal	-2 (-4%)	-7 (-18%)	-3 (-8%)	-8 (-21%)	-4 (-10%)	-6 (-16%)
Dry	0 (0%)	-3 (-3%)	7 (7%)	4 (3%)	10 (10%)	12 (12%)
Critical	11 (8%)	-40 (-32%)	12 (9%)	-38 (-31%)	21 (18%)	-35 (-29%)
All Years	-389 (-44%)	-459 (-52%)	-390 (-44%)	-461 (-52%)	-397 (-44%)	-444 (-51%)
Combined Losses						
Wet	-3892 (-65%)	-3809 (-64%)	-3981 (-66%)	-3899 (-64%)	-4062 (-66%)	-3722 (-63%)
Above Normal	-225 (-39%)	-221 (-38%)	-218 (-38%)	-214 (-38%)	-223 (-39%)	-207 (-37%)
Below Normal	-9 (-16%)	-14 (-25%)	-10 (-17%)	-15 (-26%)	-10 (-18%)	-11 (-20%)
Dry	-2 (-2%)	-9 (-7%)	3 (2%)	-4 (-3%)	7 (5%)	7 (6%)
Critical	6 (4%)	-44 (-27%)	6 (4%)	-44 (-27%)	17 (11%)	-31 (-20%)
All Years	-661 (-34%)	-773 (-40%)	-698 (-35%)	-811 (-41%)	-682 (-35%)	-692 (-37%)

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Table B-102. Average Annual Juvenile Late Fall–Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

Water-Year Type	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
CVP						
Wet	-25 (-45%)	-25 (-46%)	-24 (-44%)	-25 (-45%)	-24 (-44%)	-22 (-43%)
Above Normal	-18 (-33%)	-23 (-41%)	-19 (-33%)	-23 (-41%)	-16 (-30%)	-18 (-35%)
Below Normal	-5 (-39%)	-5 (-40%)	-4 (-37%)	-4 (-37%)	-4 (-37%)	-3 (-29%)
Dry	-3 (-10%)	-8 (-24%)	-5 (-15%)	-10 (-29%)	-4 (-13%)	-7 (-21%)
Critical	-1 (-11%)	-1 (-11%)	-2 (-15%)	-2 (-14%)	-1 (-11%)	1 (14%)
All Years	-12 (-28%)	-16 (-37%)	-12 (-28%)	-16 (-37%)	-11 (-27%)	-12 (-31%)
SWP						
Wet	-161 (-52%)	-155 (-50%)	-148 (-50%)	-142 (-48%)	-153 (-51%)	-142 (-48%)
Above Normal	-114 (-41%)	-107 (-38%)	-107 (-39%)	-101 (-37%)	-112 (-40%)	-101 (-37%)
Below Normal	-1 (-4%)	-4 (-18%)	-2 (-8%)	-5 (-21%)	-2 (-10%)	-4 (-16%)
Dry	1 (1%)	-3 (-2%)	10 (6%)	5 (3%)	14 (9%)	18 (12%)
Critical	3 (8%)	-11 (-32%)	3 (9%)	-11 (-31%)	6 (18%)	-10 (-29%)
All Years	-103 (-33%)	-116 (-37%)	-93 (-31%)	-106 (-35%)	-91 (-30%)	-97 (-33%)
Combined Losses						
Wet	-186 (-51%)	-180 (-49%)	-172 (-49%)	-167 (-47%)	-177 (-50%)	-164 (-47%)
Above Normal	-132 (-39%)	-130 (-39%)	-126 (-38%)	-124 (-38%)	-128 (-39%)	-119 (-37%)
Below Normal	-6 (-16%)	-9 (-25%)	-6 (-17%)	-9 (-26%)	-7 (-18%)	-7 (-20%)
Dry	-2 (-1%)	-12 (-6%)	5 (2%)	-5 (-3%)	10 (5%)	11 (6%)
Critical	2 (4%)	-13 (-27%)	2 (4%)	-13 (-27%)	5 (11%)	-9 (-20%)
All Years	-115 (-32%)	-131 (-37%)	-105 (-31%)	-122 (-35%)	-102 (-30%)	-108 (-33%)

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Table B-103. Average Annual Juvenile Fall-Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	35,304	36,145	37,103	36,197	32,661	28,117
CVP Jones	19,478	19,159	19,006	18,640	12,624	11,676
Combined	54,782	55,303	56,109	54,838	45,285	39,794
Percentage of fall-run juvenile index of abundance	0.24%	0.24%	0.24%	0.24%	0.20%	0.17%

Table B-104. Wet Year Juvenile Fall-Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	77,691	82,318	82,598	78,934	31,754	24,909
CVP Jones	50,277	50,578	50,846	49,211	14,652	13,627
Combined	127,968	132,897	133,443	128,145	46,406	38,537
Percentage of fall-run juvenile index of abundance	0.56%	0.58%	0.58%	0.56%	0.20%	0.17%

Table B-105. Above Normal Year Juvenile Fall-Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	23,219	22,949	24,210	23,751	23,527	21,286
CVP Jones	9,657	9,153	9,463	9,599	5,573	6,331
Combined	32,876	32,102	33,672	33,350	29,100	27,616
Percentage of fall-run juvenile index of abundance	0.14%	0.14%	0.15%	0.14%	0.13%	0.12%

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Table B-106. Below Normal Year Juvenile Fall-Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	7,733	7,750	8,100	8,460	13,324	11,073
CVP Jones	5,865	5,452	5,329	5,498	4,332	3,838
Combined	13,598	13,202	13,429	13,958	17,656	14,911
Percentage of fall-run juvenile index of abundance	0.06%	0.06%	0.06%	0.06%	0.08%	0.06%

Table B-107. Dry Year Juvenile Fall-Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	17,094	17,032	18,676	18,772	27,533	24,301
CVP Jones	2,551	2,502	2,662	2,520	3,722	3,336
Combined	19,645	19,534	21,338	21,292	31,254	27,637
Percentage of fall-run juvenile index of abundance	0.09%	0.08%	0.09%	0.09%	0.14%	0.12%

Table B-108. Critical Year Juvenile Fall-Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	29,200	27,402	27,860	25,032	21,817	22,693
CVP Jones	11,693	11,389	10,979	10,683	10,569	9,742
Combined	40,893	38,791	38,839	35,715	32,386	32,435
Percentage of fall-run juvenile index of abundance	0.18%	0.17%	0.17%	0.16%	0.14%	0.14%

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Table B-109. Average Annual Juvenile Fall-Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	26,213	26,839	27,551	26,932	24,585	21,219
CVP Jones	14,585	14,343	14,229	13,955	9,091	8,405
Combined	40,799	41,183	41,780	40,887	33,676	29,624
Percentage of fall-run juvenile index of abundance	0.18%	0.18%	0.18%	0.18%	0.15%	0.13%

Table B-110. Wet Year Juvenile Fall-Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	47,782	50,555	50,525	48,167	19,467	15,111
CVP Jones	35,367	35,633	35,796	34,644	9,974	9,247
Combined	83,149	86,189	86,321	82,812	29,441	24,358
Percentage of fall-run juvenile index of abundance	0.36%	0.37%	0.38%	0.36%	0.13%	0.11%

Table B-111. Above Normal Year Juvenile Fall-Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	24,000	23,730	25,050	24,640	24,543	22,226
CVP Jones	9,831	9,301	9,632	9,777	5,602	6,353
Combined	33,831	33,031	34,682	34,417	30,146	28,579
Percentage of fall-run juvenile index of abundance	0.15%	0.14%	0.15%	0.15%	0.13%	0.12%

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Table B-112. Below Normal Year Juvenile Fall-Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	10,514	10,537	11,013	11,503	18,115	15,056
CVP Jones	7,974	7,412	7,246	7,475	5,890	5,218
Combined	18,488	17,950	18,259	18,978	24,006	20,274
Percentage of fall-run juvenile index of abundance	0.08%	0.08%	0.08%	0.08%	0.10%	0.09%

Table B-113. Dry Year Juvenile Fall-Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	21,404	21,315	23,381	23,514	34,377	30,341
CVP Jones	3,081	3,024	3,226	3,057	4,516	4,051
Combined	24,485	24,339	26,607	26,571	38,893	34,392
Percentage of fall-run juvenile index of abundance	0.11%	0.11%	0.12%	0.12%	0.17%	0.15%

Table B-114. Critical Year Juvenile Fall-Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	6,269	5,883	5,981	5,374	4,684	4,872
CVP Jones	2,510	2,445	2,357	2,294	2,269	2,092
Combined	8,779	8,328	8,338	7,668	6,953	6,964
Percentage of fall-run juvenile index of abundance	0.04%	0.04%	0.04%	0.03%	0.03%	0.03%

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Table B-115. Average Annual Juvenile Late Fall–Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	890	892	899	875	502	431
CVP Jones	1,039	1,076	1,052	974	767	726
Combined	1,929	1,967	1,951	1,848	1,269	1,156
Percentage of late fall–run juvenile index of abundance	0.19%	0.20%	0.20%	0.18%	0.13%	0.12%

Table B-116. Wet Year Juvenile Late Fall–Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	2,664	2,712	2,807	2,698	291	333
CVP Jones	3,319	3,361	3,347	3,199	1,800	1,841
Combined	5,983	6,073	6,154	5,897	2,092	2,174
Percentage of late fall–run juvenile index of abundance	0.60%	0.61%	0.62%	0.59%	0.21%	0.22%

Table B-117. Above Normal Year Juvenile Late Fall–Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	485	477	485	478	289	300
CVP Jones	90	92	88	83	61	54
Combined	575	568	573	561	350	354
Percentage of late fall–run juvenile index of abundance	0.06%	0.06%	0.06%	0.06%	0.04%	0.04%

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Table B-118. Below Normal Year Juvenile Late Fall–Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	38	39	40	37	36	31
CVP Jones	18	18	18	16	11	11
Combined	56	57	58	52	47	42
Percentage of late fall–run juvenile index of abundance	0.01%	0.01%	0.01%	0.01%	0.00%	0.00%

Table B-119. Dry Year Juvenile Late Fall–Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	112	106	103	98	113	109
CVP Jones	24	26	25	23	22	18
Combined	137	131	128	121	134	128
Percentage of late fall–run juvenile index of abundance	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%

Table B-120. Critical Year Juvenile Late Fall–Run Chinook Salmon Losses Calculated Using Normalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	126	125	115	121	136	86
CVP Jones	38	40	38	30	34	34
Combined	164	164	154	151	170	120
Percentage of late fall–run juvenile index of abundance	0.02%	0.02%	0.02%	0.02%	0.02%	0.01%

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Table B-121. Average Annual Juvenile Late Fall–Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	312	302	300	292	209	196
CVP Jones	42	42	42	39	30	27
Combined	354	344	341	331	239	222
Percentage of late fall–run juvenile index of abundance	0.04%	0.03%	0.03%	0.03%	0.02%	0.02%

Table B-122. Wet Year Juvenile Late Fall–Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	310	297	302	297	149	155
CVP Jones	55	55	54	52	30	30
Combined	366	352	356	349	180	185
Percentage of late fall–run juvenile index of abundance	0.04%	0.04%	0.04%	0.03%	0.02%	0.02%

Table B-123. Above Normal Year Juvenile Late Fall–Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	280	273	278	274	166	172
CVP Jones	56	56	54	51	38	33
Combined	335	330	332	325	203	205
Percentage of late fall–run juvenile index of abundance	0.03%	0.03%	0.03%	0.03%	0.02%	0.02%

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Table B-124. Below Normal Year Juvenile Late Fall–Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	24	25	25	23	23	20
CVP Jones	12	11	11	10	7	7
Combined	36	36	37	33	30	27
Percentage of late fall–run juvenile index of abundance	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Table B-125. Dry Year Juvenile Late Fall–Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	169	160	155	147	170	165
CVP Jones	34	36	35	32	30	25
Combined	202	195	190	180	200	191
Percentage of late fall–run juvenile index of abundance	0.02%	0.02%	0.02%	0.02%	0.02%	0.02%

Table B-126. Critical Year Juvenile Late Fall–Run Chinook Salmon Losses Calculated Using Nonnormalized Salvage Densities for Model Scenarios at the SWP and CVP South Delta Export Facilities

	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
SWP Banks	36	36	33	35	39	25
CVP Jones	11	11	11	9	10	10
Combined	47	47	44	43	49	34
Percentage of late fall–run juvenile index of abundance	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

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B.4.1.4.2 Delta Passage Model Salvage Estimates

Sacramento River–Origin Fall-Run Chinook Salmon

The estimated percentage of juvenile Sacramento River–origin fall-run Chinook salmon salvaged at the SWP/CVP south Delta export facilities averaged around 0.03–0.06% for EBC scenarios and 0.04% for PP scenarios (Table B-127). Percentages in individual years ranged from around 0.015 (PP scenarios in 1983, a wet year) to 0.16–0.17 (EBC1, EBC2, and EBC2_ELT in 1982, a wet year). On average, there was an approximate 21–28% decrease (0.01–0.02% in absolute terms) in percentage salvage in most comparisons from EBC to PP scenarios, except for an average increase of around 0.016% (relative increase of 43%) from EBC2_LLT to PP_LLT (Table B-128).

Table B-127. Estimated Proportion of Sacramento River–Origin Juvenile Fall-Run Chinook Salmon Entering the Delta Salvaged at the SWP/CVP South Delta Export Facilities from Delta Passage Model Runs of DSM2-Simulated Water Years 1975–1991 for the Six Model Scenarios

Water-Year (Type)	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1975 (W)	0.0680	0.0662	0.0663	0.0367	0.0493	0.0522
1976 (C)	0.0438	0.0458	0.0427	0.0212	0.0432	0.0392
1977 (C)	0.0297	0.0276	0.0275	0.0156	0.0308	0.0227
1978 (AN)	0.0746	0.0821	0.0844	0.0513	0.0225	0.0263
1979 (BN)	0.0667	0.0716	0.0665	0.0353	0.0841	0.0822
1980 (AN)	0.0459	0.0440	0.0431	0.0250	0.0484	0.0527
1981 (D)	0.0409	0.0380	0.0363	0.0229	0.0527	0.0529
1982 (W)	0.1698	0.1579	0.1735	0.0828	0.0151	0.0166
1983 (W)	0.0652	0.0982	0.0974	0.0675	0.0147	0.0150
1984 (W)	0.0579	0.0666	0.0589	0.0308	0.0577	0.0514
1985 (D)	0.0386	0.0408	0.0426	0.0211	0.0621	0.0402
1986 (W)	0.0715	0.0582	0.1130	0.0760	0.0543	0.0477
1987 (D)	0.0296	0.0310	0.0323	0.0178	0.0463	0.0453
1988 (C)	0.0363	0.0322	0.0325	0.0180	0.0307	0.0284
1989 (D)	0.0305	0.0293	0.0296	0.0162	0.0330	0.0191
1990 (C)	0.0275	0.0272	0.0288	0.0173	0.0281	0.0292
1991 (C)	0.0316	0.0310	0.0305	0.0189	0.0394	0.0382
Average	0.0546	0.0557	0.0592	0.0338	0.0419	0.0388

Table B-128. Change in Estimated Salvage of Sacramento River–Origin Juvenile Fall-Run Chinook Salmon at the SWP/CVP South Delta Export Facilities from Delta Passage Model Runs of DSM2-Simulated Water Years 1975–1991 for the Six Model Scenarios

Water-Year (Type)	PP_ELT vs. EBC1	PP_LLT vs. EBC1	PP_ELT vs. EBC2	PP_LLT vs. EBC2	PP_ELT vs. EBC2_ELT	PP_LLT vs. EBC2_LLT
1975 (W)	-0.0187 (-28%)	-0.0158 (-23%)	-0.017 (-26%)	-0.014 (-21%)	-0.0171 (-26%)	0.0156 (43%)
1976 (C)	-0.0006 (-1%)	-0.0046 (-10%)	-0.0026 (-6%)	-0.0066 (-14%)	0.0005 (1%)	0.018 (85%)
1977 (C)	0.0011 (4%)	-0.007 (-24%)	0.0032 (12%)	-0.0049 (-18%)	0.0033 (12%)	0.007 (45%)
1978 (AN)	-0.0522 (-70%)	-0.0484 (-65%)	-0.0596 (-73%)	-0.0558 (-68%)	-0.0619 (-73%)	-0.025 (-49%)
1979 (BN)	0.0174 (26%)	0.0155 (23%)	0.0125 (17%)	0.0106 (15%)	0.0176 (26%)	0.047 (133%)
1980 (AN)	0.0026 (6%)	0.0069 (15%)	0.0044 (10%)	0.0087 (20%)	0.0054 (12%)	0.0278 (111%)
1981 (D)	0.0117 (29%)	0.012 (29%)	0.0147 (39%)	0.015 (39%)	0.0164 (45%)	0.0301 (131%)
1982 (W)	-0.1547 (-91%)	-0.1532 (-90%)	-0.1428 (-90%)	-0.1412 (-89%)	-0.1584 (-91%)	-0.0662 (-80%)
1983 (W)	-0.0506 (-78%)	-0.0502 (-77%)	-0.0836 (-85%)	-0.0832 (-85%)	-0.0827 (-85%)	-0.0525 (-78%)
1984 (W)	-0.0002 (0%)	-0.0066 (-11%)	-0.0089 (-13%)	-0.0153 (-23%)	-0.0013 (-2%)	0.0206 (67%)
1985 (D)	0.0235 (61%)	0.0016 (4%)	0.0213 (52%)	-0.0006 (-1%)	0.0195 (46%)	0.0191 (91%)
1986 (W)	-0.0172 (-24%)	-0.0239 (-33%)	-0.0039 (-7%)	-0.0106 (-18%)	-0.0586 (-52%)	-0.0283 (-37%)
1987 (D)	0.0166 (56%)	0.0157 (53%)	0.0153 (49%)	0.0143 (46%)	0.014 (43%)	0.0275 (154%)
1988 (C)	-0.0056 (-15%)	-0.0078 (-22%)	-0.0015 (-5%)	-0.0037 (-12%)	-0.0018 (-6%)	0.0105 (58%)
1989 (D)	0.0025 (8%)	-0.0114 (-37%)	0.0037 (13%)	-0.0102 (-35%)	0.0034 (11%)	0.0029 (18%)
1990 (C)	0.0006 (2%)	0.0017 (6%)	0.0009 (3%)	0.002 (7%)	-0.0007 (-2%)	0.0119 (69%)
1991 (C)	0.0078 (25%)	0.0066 (21%)	0.0084 (27%)	0.0072 (23%)	0.0089 (29%)	0.0193 (102%)
Average	-0.0187 (-28%)	-0.0158 (-23%)	-0.017 (-26%)	-0.014 (-21%)	-0.0171 (-26%)	0.0156 (43%)

San Joaquin River–Origin Fall-Run Chinook Salmon

The estimated percentage of juvenile San Joaquin River–origin fall-run Chinook salmon salvaged at the SWP/CVP south Delta export facilities averaged around 1.7–1.8% for EBC scenarios and 1.5–1.7% for PP scenarios (Table B-129). Percentages in individual years ranged from around 0.28 (PP scenarios in 1983, a wet year) to 3 (EBC2_LLT in 1986, a wet year). On average, there was an approximate 4–21% decrease (0.07–0.38% in absolute terms) in percentage salvage from EBC to PP scenarios (Table B-130), with the greatest decreases being from EBC2_LLT to PP_LLT.

Table B-129. Estimated Proportion of San Joaquin River–Origin Juvenile Fall-Run Chinook Salmon Entering the Delta Salvaged at the SWP/CVP South Delta Export Facilities from Delta Passage Model Runs of DSM2-Simulated Water Years 1975–1991 for the Six Model Scenarios

Water-Year (Type)	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1975 (W)	2.5113	2.6106	2.6452	2.5315	2.0037	2.0523
1976 (C)	1.9306	1.9286	1.8784	1.9984	1.9800	1.7026
1977 (C)	1.2368	1.1203	1.2044	1.1372	1.3556	0.8993
1978 (AN)	1.9162	2.1594	1.9650	1.9793	0.7263	0.8242
1979 (BN)	2.4279	2.3663	2.3344	2.3997	2.6129	2.7258
1980 (AN)	1.9075	1.7560	1.7562	1.7327	1.6583	1.8353
1981 (D)	1.8355	1.7141	1.7535	1.8854	2.1821	2.1794
1982 (W)	1.9043	1.8930	1.9657	1.9153	0.3963	0.4761
1983 (W)	0.6986	0.9540	0.8737	0.9997	0.2775	0.2755
1984 (W)	2.3990	2.3733	2.4877	2.4859	2.3116	2.0505
1985 (D)	1.7805	1.7183	1.8548	1.9009	2.4828	1.8164
1986 (W)	2.2037	1.8124	2.7637	3.0390	1.6590	1.7105
1987 (D)	1.4619	1.5764	1.6304	1.6197	2.1965	1.8357
1988 (C)	1.6196	1.5161	1.5515	1.5554	1.5345	1.2278
1989 (D)	1.4825	1.4102	1.5015	1.4513	1.8520	0.8231
1990 (C)	1.1806	1.2016	1.2288	1.3368	1.3496	1.0855
1991 (C)	1.3099	1.3689	1.3511	1.3676	1.7628	1.3055
Average	1.7533	1.7341	1.8086	1.8433	1.6672	1.4603

Table B-130. Change in Estimated Salvage of San Joaquin River–Origin Juvenile Fall-Run Chinook Salmon at the SWP/CVP South Delta Export Facilities from Delta Passage Model Runs of DSM2-Simulated Water Years 1975–1991 for the Six Model Scenarios

Water-Year (Type)	PP_ELT vs. EBC1	PP_LLT vs. EBC1	PP_ELT vs. EBC2	PP_LLT vs. EBC2	PP_ELT vs. EBC2_ELT	PP_LLT vs. EBC2_LLT
1975 (W)	-0.5076 (-20%)	-0.4591 (-18%)	-0.6069 (-23%)	-0.5583 (-21%)	-0.6415 (-24%)	-0.4792 (-19%)
1976 (C)	0.0495 (3%)	-0.228 (-12%)	0.0514 (3%)	-0.226 (-12%)	0.1016 (5%)	-0.2958 (-15%)
1977 (C)	0.1188 (10%)	-0.3375 (-27%)	0.2353 (21%)	-0.221 (-20%)	0.1512 (13%)	-0.2379 (-21%)
1978 (AN)	-1.1898 (-62%)	-1.092 (-57%)	-1.4331 (-66%)	-1.3352 (-62%)	-1.2387 (-63%)	-1.1551 (-58%)
1979 (BN)	0.185 (8%)	0.2979 (12%)	0.2466 (10%)	0.3595 (15%)	0.2784 (12%)	0.3261 (14%)
1980 (AN)	-0.2492 (-13%)	-0.0722 (-4%)	-0.0978 (-6%)	0.0792 (5%)	-0.0979 (-6%)	0.1025 (6%)
1981 (D)	0.3467 (19%)	0.3439 (19%)	0.468 (27%)	0.4653 (27%)	0.4286 (24%)	0.294 (16%)
1982 (W)	-1.5079 (-79%)	-1.4282 (-75%)	-1.4967 (-79%)	-1.4169 (-75%)	-1.5694 (-80%)	-1.4392 (-75%)
1983 (W)	-0.421 (-60%)	-0.4231 (-61%)	-0.6764 (-71%)	-0.6784 (-71%)	-0.5961 (-68%)	-0.7242 (-72%)
1984 (W)	-0.0874 (-4%)	-0.3485 (-15%)	-0.0617 (-3%)	-0.3228 (-14%)	-0.1761 (-7%)	-0.4354 (-18%)
1985 (D)	0.7023 (39%)	0.036 (2%)	0.7645 (44%)	0.0982 (6%)	0.628 (34%)	-0.0845 (-4%)
1986 (W)	-0.5446 (-25%)	-0.4932 (-22%)	-0.1533 (-8%)	-0.1019 (-6%)	-1.1047 (-40%)	-1.3284 (-44%)
1987 (D)	0.7346 (50%)	0.3738 (26%)	0.6202 (39%)	0.2593 (16%)	0.5662 (35%)	0.216 (13%)
1988 (C)	-0.0851 (-5%)	-0.3918 (-24%)	0.0184 (1%)	-0.2883 (-19%)	-0.017 (-1%)	-0.3276 (-21%)
1989 (D)	0.3696 (25%)	-0.6594 (-44%)	0.4419 (31%)	-0.5871 (-42%)	0.3505 (23%)	-0.6282 (-43%)
1990 (C)	0.169 (14%)	-0.0951 (-8%)	0.148 (12%)	-0.1161 (-10%)	0.1208 (10%)	-0.2513 (-19%)
1991 (C)	0.453 (35%)	-0.0044 (0%)	0.3939 (29%)	-0.0634 (-5%)	0.4117 (30%)	-0.0621 (-5%)
Average	-0.0861 (-5%)	-0.293 (-17%)	-0.0669 (-4%)	-0.2738 (-16%)	-0.1414 (-8%)	-0.383 (-21%)

B.4.1.5 *Delta Smelt*

B.4.1.5.1 Larva

Particle-Tracking Modeling

ENTRAINMENT SOLELY AT THE SWP/CVP SOUTH DELTA DIVERSIONS

Entrainment of larval delta smelt at the SWP/CVP diversions in the south Delta, as reflected in the comparison of the percentage of particles injected into the PTM whose fate was estimated to be entrainment at the export facilities, appears to vary primarily in response to the starting distribution and secondarily to the number of days that particles were tracked and to the flow scenario (EBC1, EBC2, etc.) examined (Figure B-28 through Figure B-34). Greatest entrainment was estimated under the Uniform Distribution, which had a high proportion of the population in the San Joaquin River and south Delta. The lowest entrainment was estimated with the Dry All Female February and Wet All Female March Distributions, which had a low proportion of delta smelt in the San Joaquin River and south Delta regions. Entrainment generally was greater for 60-day particle tracking, as would be expected. Kimmerer and Nobriga (2008) noted that growth of delta smelt over the period simulated during 60 days of particle tracking would result in better swimming ability and behavior less akin to passive particles. Entrainment for the different flow scenarios is similar for the various starting distributions, with the variation in the starting distribution affecting the magnitude of predicted entrainment (ranging from approximately 0 to over 25%).

The PTM results indicate that entrainment under the preliminary proposal (in both the early and late long-term) is generally comparable or lower than that under existing biological conditions during the February, March and June runs (Figure B-28 through Figure B-34). Results of these PTM simulations predict that the percentage of particles whose fate was entrainment into the export facilities was reduced during February, March, and June operations by approximately 0 to 5% under BDCP operations compared to existing biological conditions operations. During the April and May PTM simulations, entrainment was typically comparable or increased by up to approximately 5–10% under BDCP operations compared to existing biological conditions. The relative change in the percentage of particles estimated to be entrained in April and May varied among years in response to a number of factors that included differences in south Delta export operations, differences in hydrologic conditions that affect the movement and geographic distribution of particles, and the initial distribution of particles injected into the PTM. The same pattern is seen when isolating the effect of the preliminary proposal from those of climate change by comparing the preliminary proposal under the early long-term and late long-term to the existing biological conditions (PP_ELT vs. EBC_ELT and PP_LLT vs. EBC_LLT, respectively).

Table B-131 shows the difference in average entrainment based on the PTM results in which the percentage of particles entrained was greater under BDCP operations compared to existing biological conditions (Higher Entrainment) and for those scenarios when BDCP entrainment was

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lower than that under existing biological conditions operations (Lower Entrainment). Results of this analysis showed that overall average differences in entrainment for larval delta smelt between existing biological conditions and BDCP operations, estimated from results of PTM simulations, generally are predicted to be within 4% absolute difference, with the exception being the uniform distribution which has a relatively large proportion of particles in the south Delta. The majority of comparisons showed average differences between existing biological conditions and preliminary proposal conditions that were typically within 1–2%. Given the relatively small range of differences in average entrainment among the existing biological conditions and BDCP conditions, it is evident generally that overall the entrainment of larval delta smelt is comparable for existing biological conditions and BDCP operations.

The discussion above presents the range of variability in entrainment among starting distributions, based on average entrainment across hydrologic scenarios. Evaluation of the range of variability among hydrologic scenarios indicates that entrainment could vary widely depending on the hydrologic scenario considered. For example, entrainment ranges from close to zero in the April 1986 hydrologic scenario to approximately 20–25% in the March 1961 scenario for the uniform distribution; the magnitude of the differences among project scenarios varies among hydrologic scenarios.

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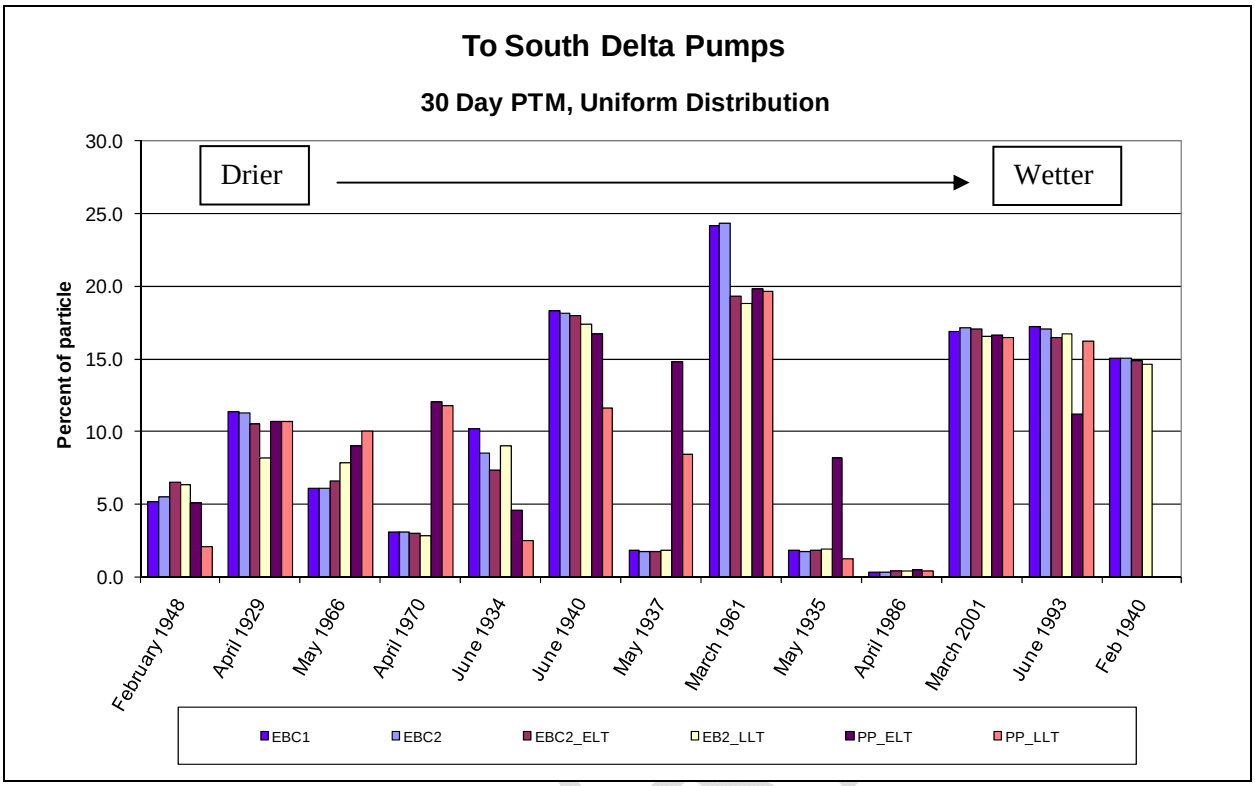


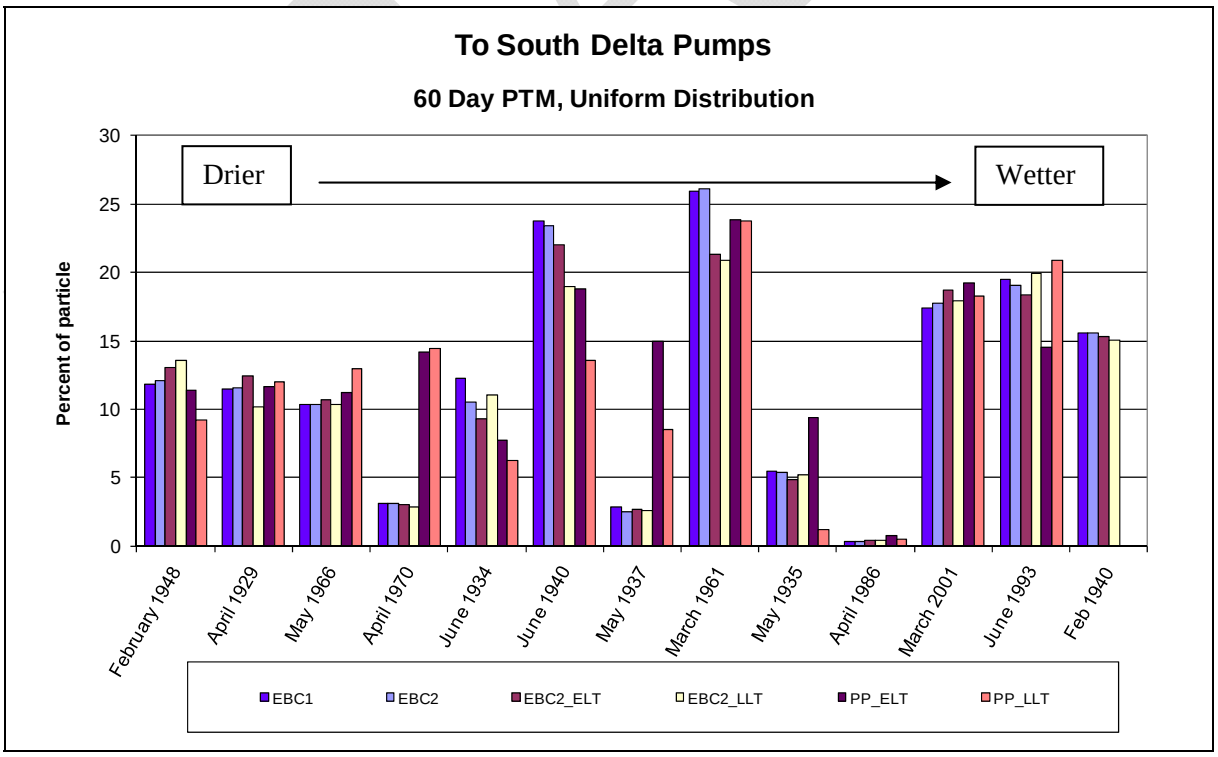
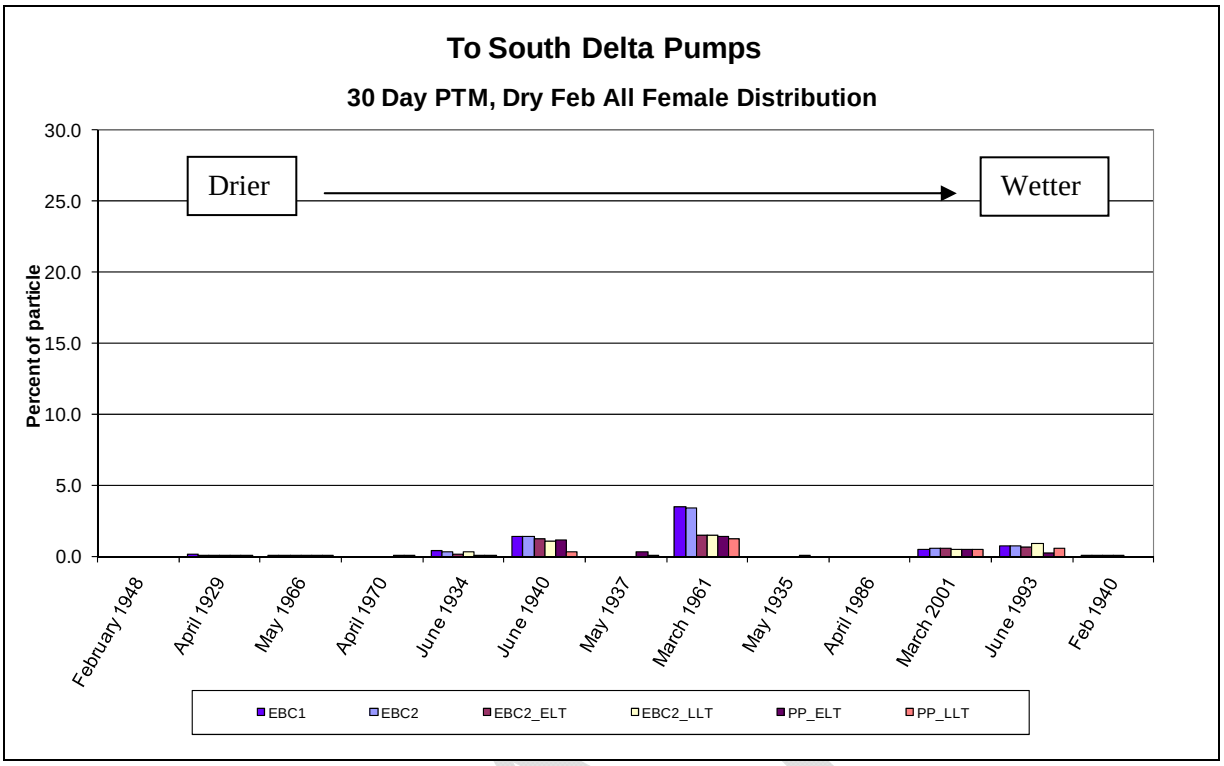


Figure B-28. Percentage of Particles Entrained at South Delta Diversions; Uniform Distribution



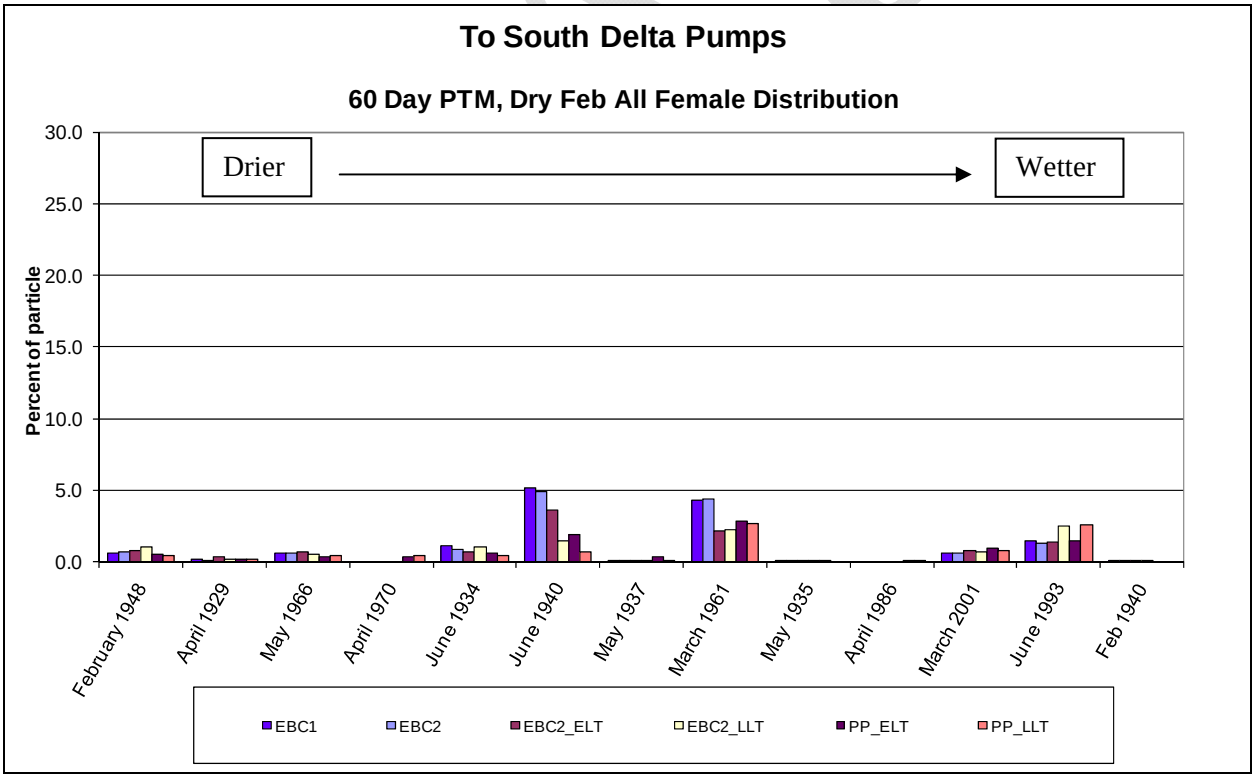
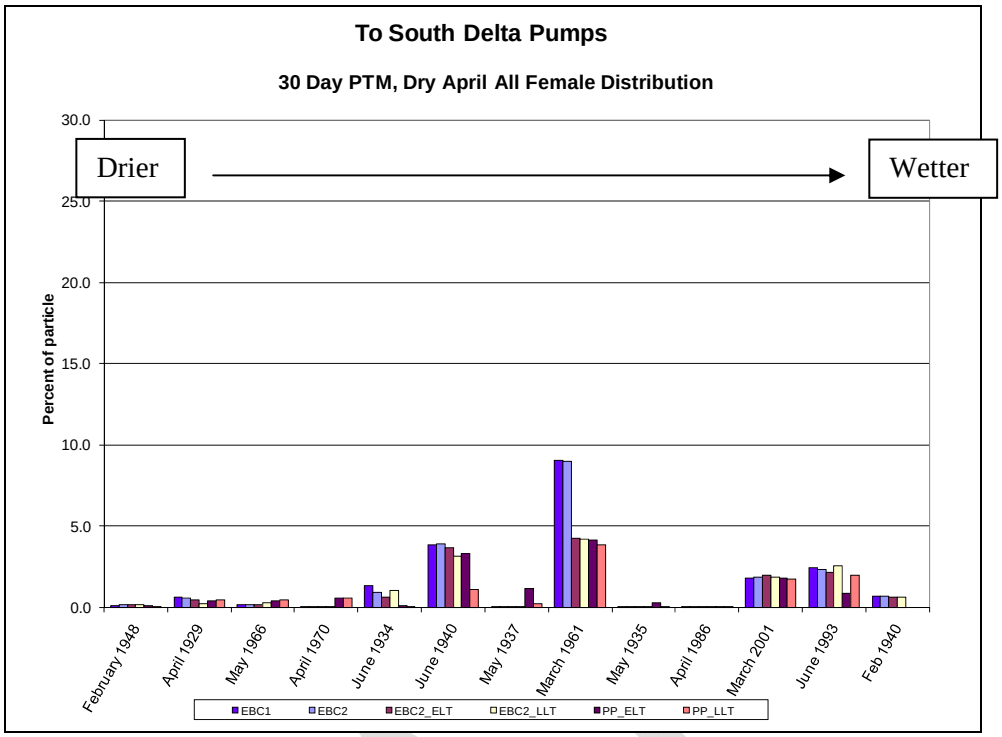


Figure B-29. Percentage of Particles Entrained at South Delta Diversions; Dry February All Female Distribution



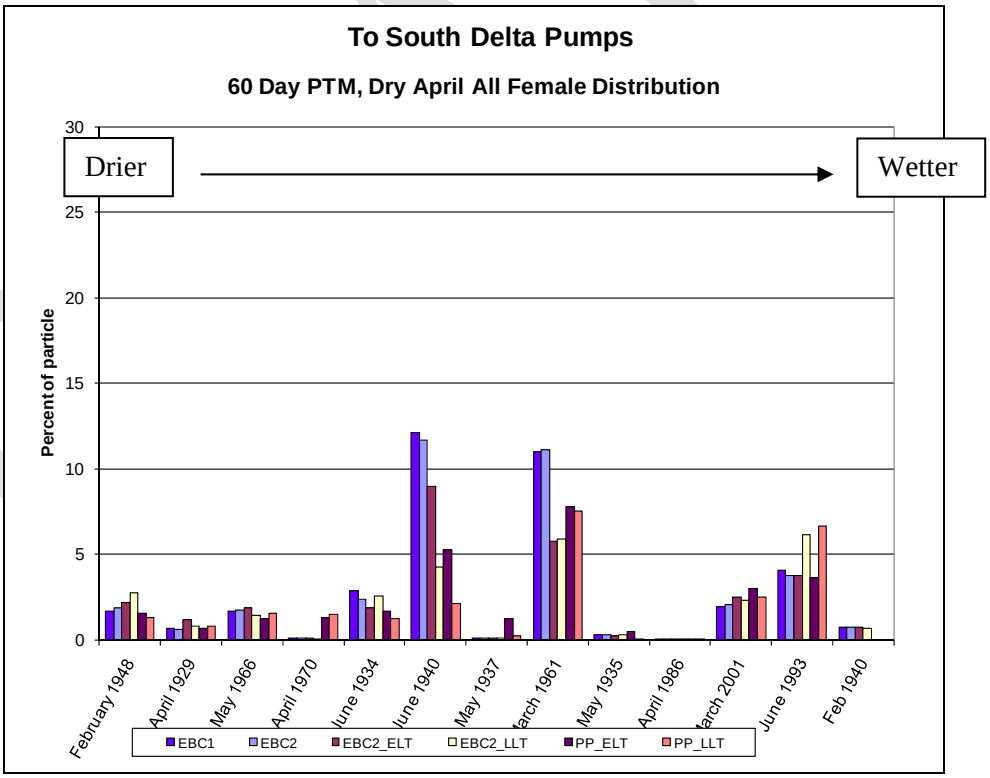
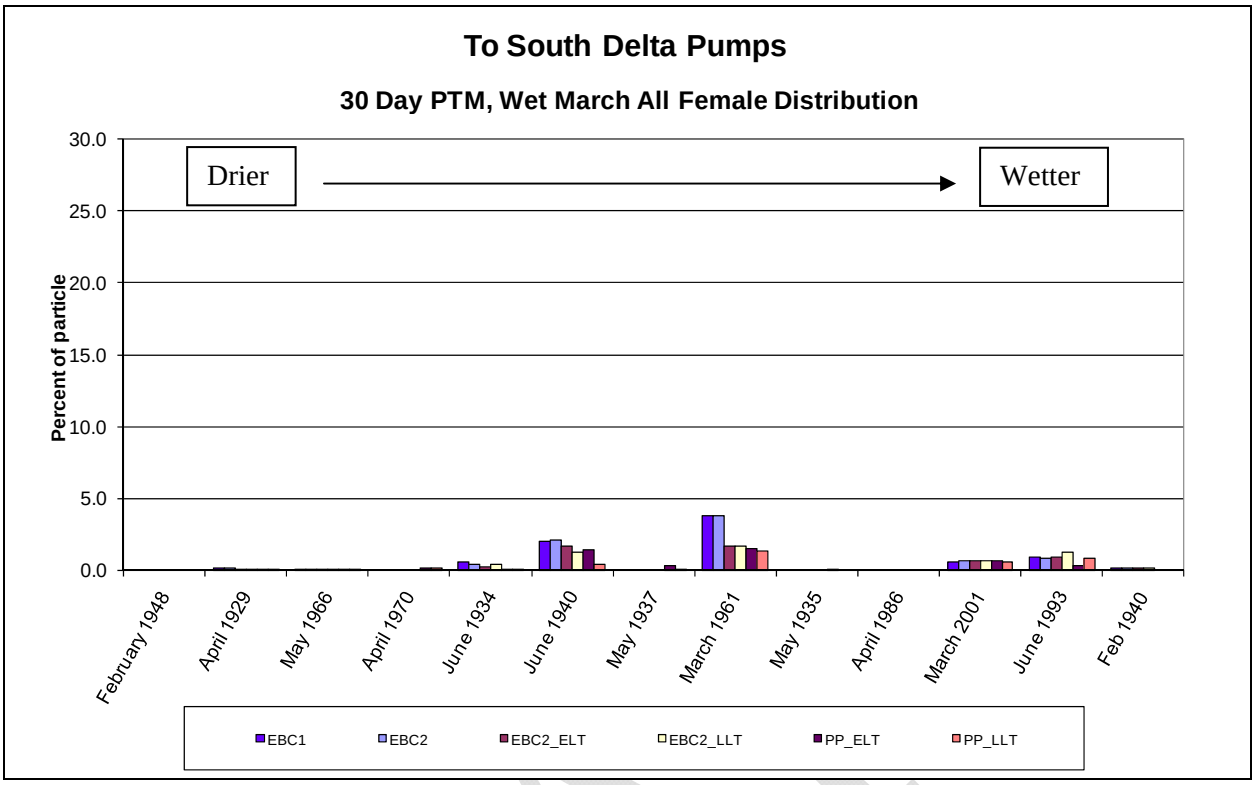


Figure B-30. Percentage of Particles Entrained at South Delta Diversions; Dry April All Female Distribution



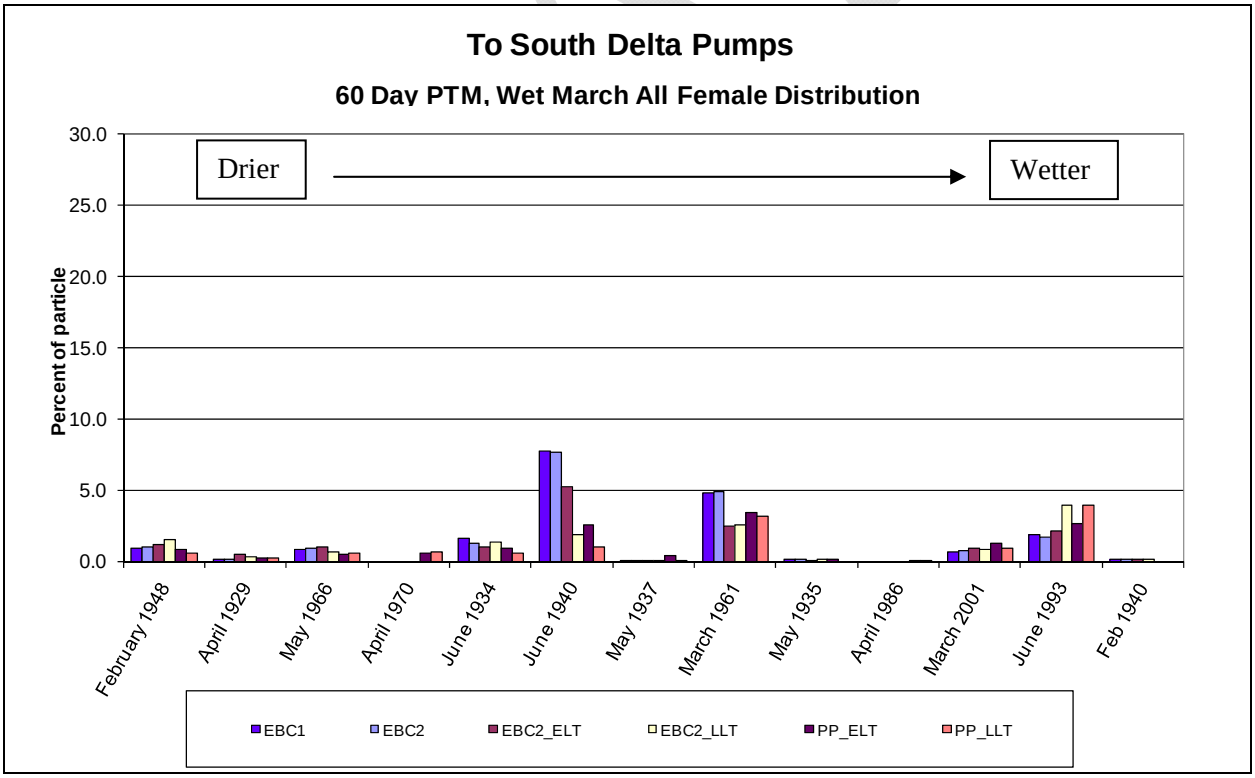
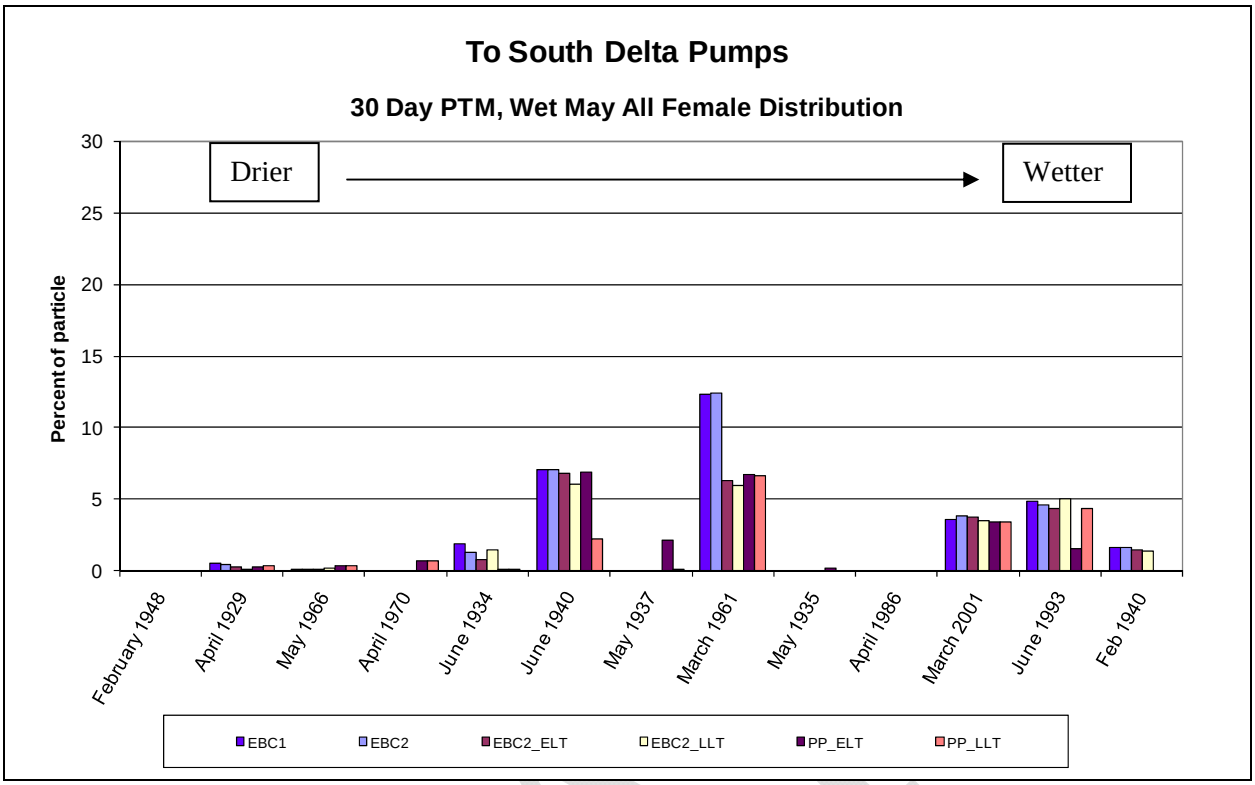


Figure B-31. Percentage of Particles Entrained at South Delta Diversions; Wet March All Female Distribution



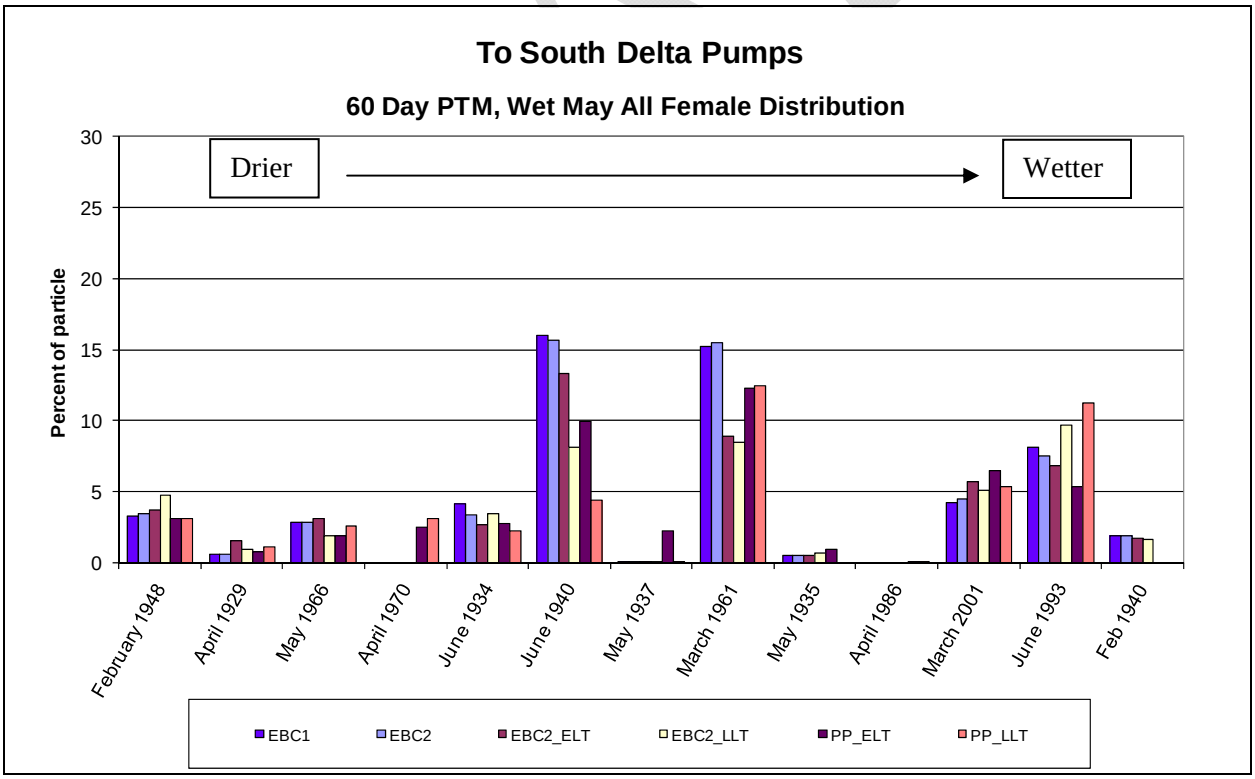
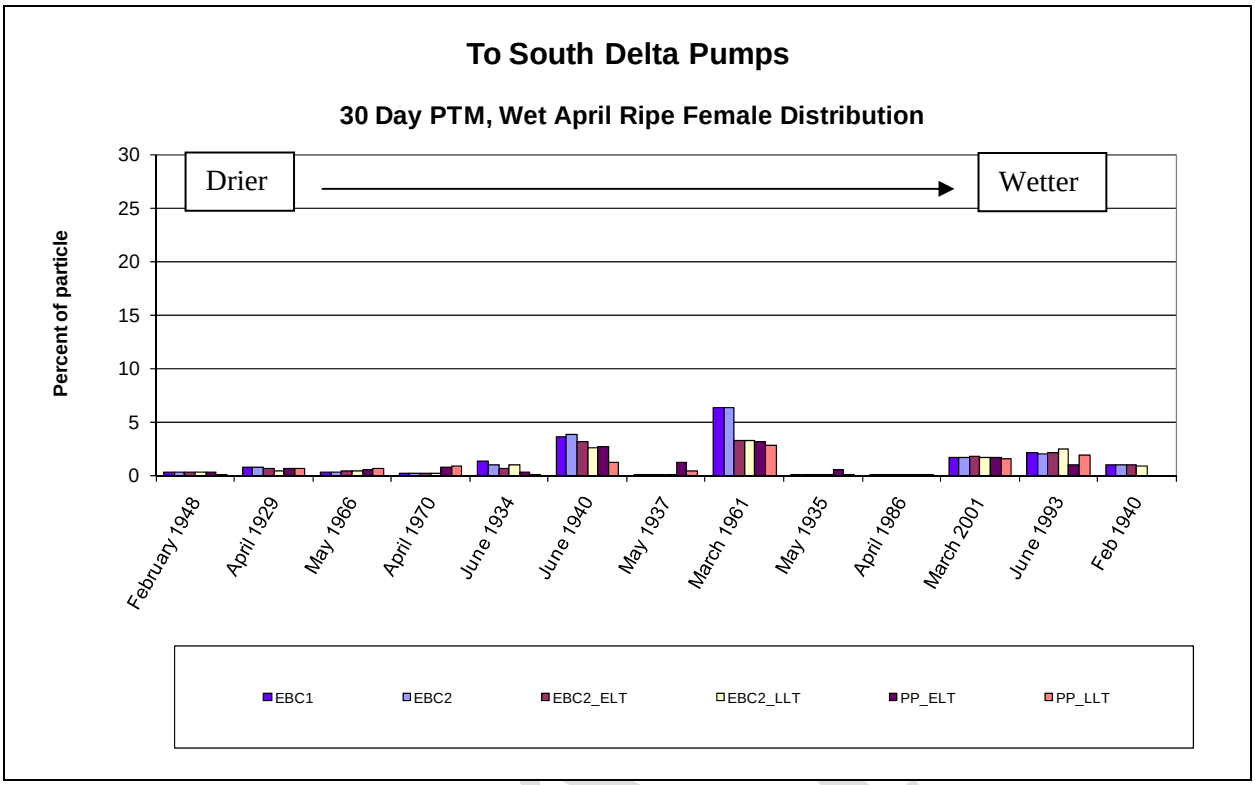


Figure B-32. Percentage of Particles Entrained at South Delta Diversions; Wet May All Female Distribution



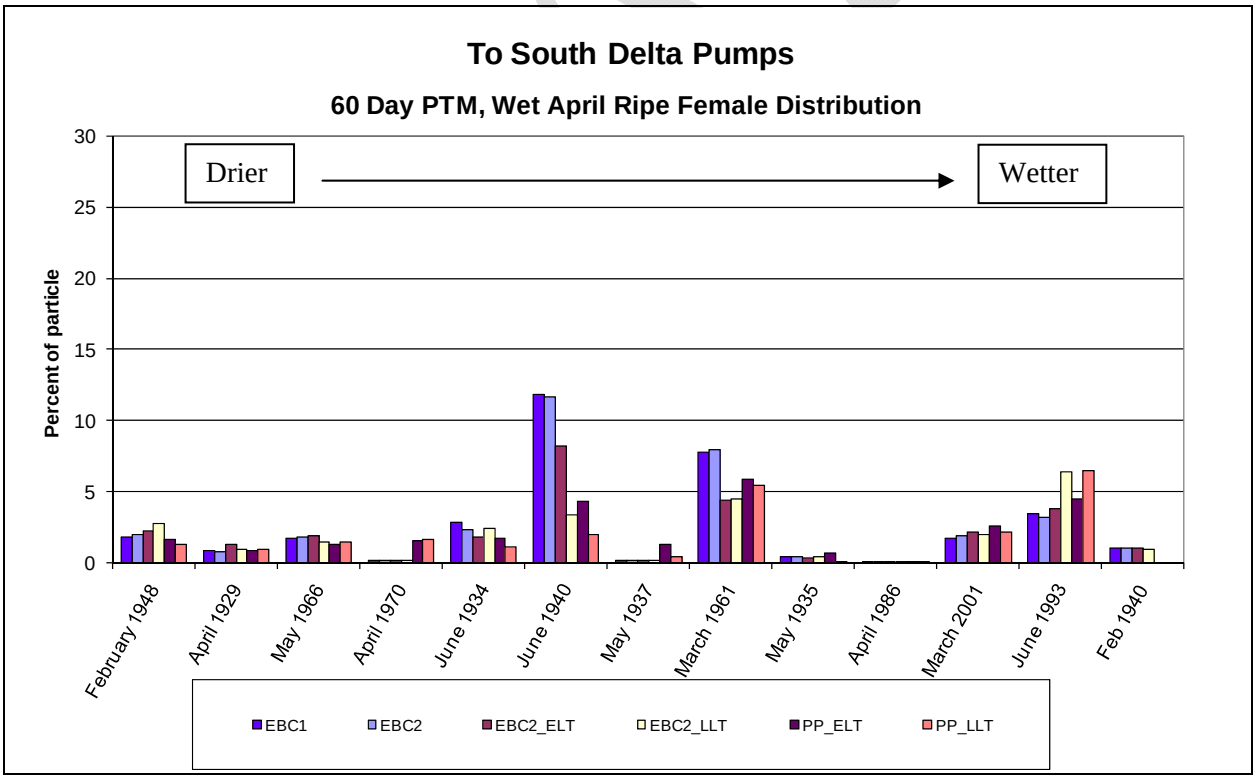
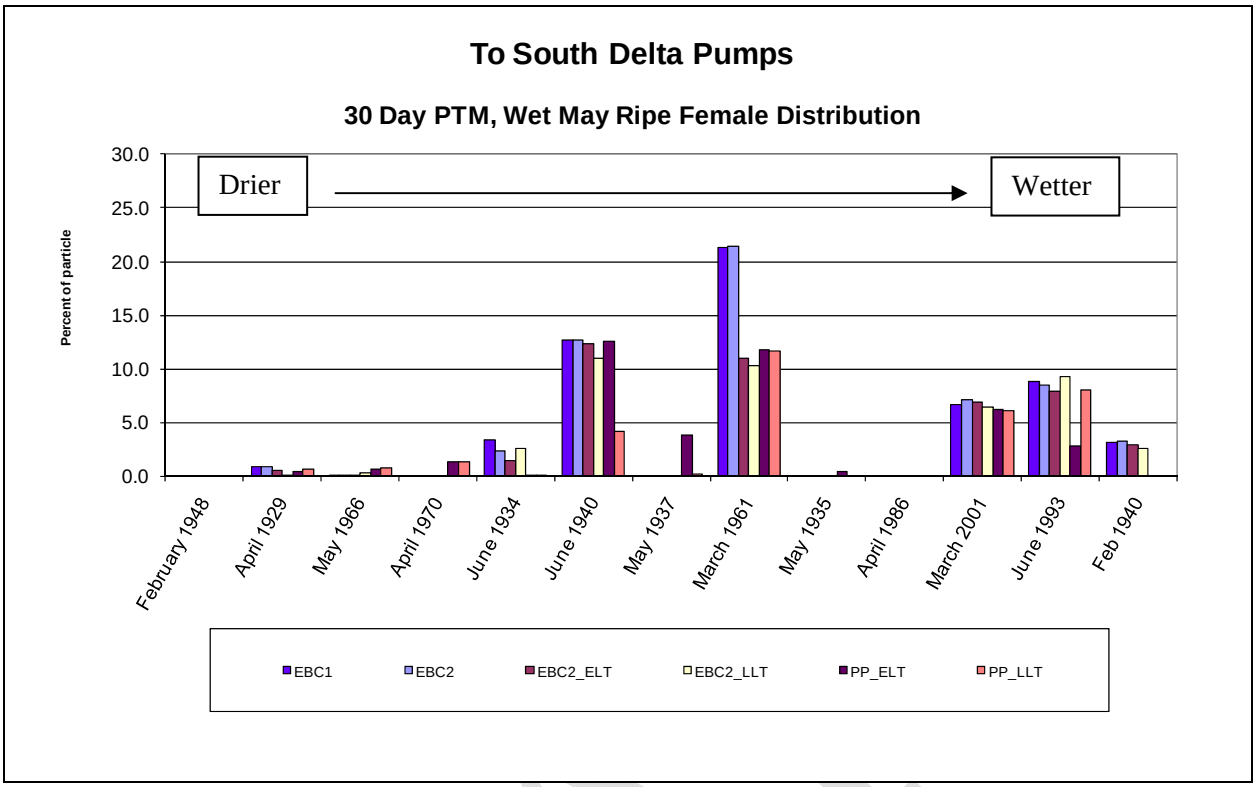


Figure B-33. Percentage of Particles Entrained at South Delta Diversions; Wet April Ripe Female Distribution



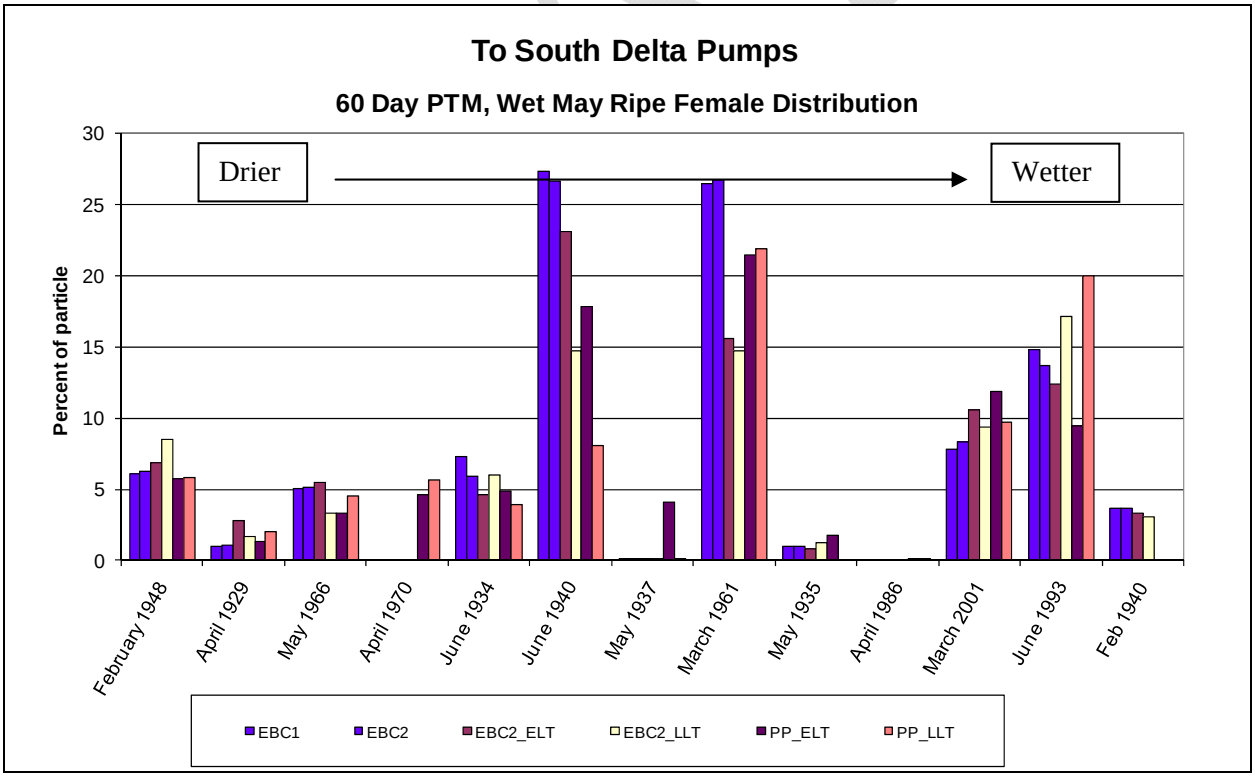


Figure B-34. Percentage of Particles Entrained at South Delta Diversions; Wet May Ripe Female Distribution

Table B-131. Average Difference[1] (Number of Runs) between Model Scenarios for Entrainment at South Delta Diversions for Particle-Tracking Runs after (A) 30 Days and (B) 60 Days

	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs. PP_LLT	EBC2_ELT vs. PP_ELT	EBC2_LLT vs. PP_LLT
(A) 30 Days, Starting Distribution						
Uniform Distribution						
Higher Entrainment	6.3 (5)	4.8 (4)	6.3 (5)	4.9 (4)	4.5 (7)	3.5 (6)
Lower Entrainment	-4.2 (8)	-4.4 (9)	-4.1 (8)	-4.3 (9)	-4.3 (6)	-4.6 (7)
Dry February All Female Distribution						
Higher Entrainment	0.1 (5)	0.1 (3)	0.1 (4)	0.1 (3)	0.1 (4)	0.1 (4)
Lower Entrainment	-0.6 (6)	-0.6 (7)	-0.5 (7)	-0.6 (7)	-0.2 (7)	-0.3 (6)
Dry April All Female Distribution						
Higher Entrainment	0.4 (6)	0.2 (4)	0.4 (5)	0.3 (4)	0.4 (5)	0.2 (5)
Lower Entrainment	-1.3 (7)	-1.2 (9)	-1.1 (8)	-1.1 (9)	-0.4 (8)	-0.6 (8)
Wet March All Female Distribution						
Higher Entrainment	0.1 (5)	0.1 (3)	0.1 (4)	0.1 (3)	0.1 (4)	0.1 (4)
Lower Entrainment	-0.7 (6)	-0.7 (7)	-0.6 (7)	-0.7 (7)	-0.2 (7)	-0.4 (6)
Wet May All Female Distribution						
Higher Entrainment	0.8 (4)	0.4 (3)	0.8 (4)	0.4 (3)	0.6 (6)	0.4 (5)
Lower Entrainment	-1.9 (7)	-2.1 (7)	-1.8 (7)	-2.1 (7)	-1.1 (5)	-1.5 (5)
Wet April Ripe Female Distribution						
Higher Entrainment	0.4 (6)	0.3 (4)	0.5 (5)	0.3 (4)	0.4 (6)	0.3 (5)
Lower Entrainment	-1.0 (7)	-1.0 (9)	-0.9 (8)	-0.9 (9)	-0.5 (7)	-0.6 (8)
Wet May Ripe Female Distribution						
Higher Entrainment	1.5 (4)	0.7 (3)	1.5 (4)	0.7 (3)	1.2 (6)	0.8 (5)
Lower Entrainment	-3.3 (7)	-3.8 (7)	-3.2 (7)	-3.6 (7)	-2.0 (5)	-2.7 (5)
(B) 60 Days, Starting Distribution						
Uniform Distribution						
Higher Entrainment	4.3 (7)	3.2 (7)	4.3 (7)	3.3 (7)	4.6 (7)	3.3 (8)
Lower Entrainment	-5.4 (6)	-6.8 (6)	-5.1 (6)	-6.5 (6)	-4.4 (6)	-6.7 (5)
Dry February All Female Distribution						
Higher Entrainment	0.2 (7)	0.3 (6)	0.2 (7)	0.3 (6)	0.3 (7)	0.2 (5)
Lower Entrainment	-0.9 (6)	-1.0 (7)	-0.9 (6)	-1.0 (7)	-0.4 (6)	-0.3 (8)
Dry April All Female Distribution						
Higher Entrainment	0.6 (6)	0.8 (6)	0.6 (6)	0.8 (6)	0.8 (6)	0.5 (8)
Lower Entrainment	-1.9 (7)	-2.4 (7)	-1.7 (7)	-2.3 (7)	-0.9 (7)	-1.2 (5)
Wet March All Female Distribution						
Higher Entrainment	0.3 (7)	0.6 (5)	0.4 (7)	0.6 (5)	0.4 (7)	0.3 (5)
Lower Entrainment	-1.3 (6)	-1.3 (8)	-1.3 (6)	-1.3 (8)	-0.7 (6)	-0.4 (8)
Wet May All Female Distribution						
Higher Entrainment	1.3 (6)	1.3 (6)	1.2 (6)	1.4 (6)	1.3 (7)	1.2 (8)
Lower Entrainment	-2.3 (7)	-2.7 (7)	-2.1 (7)	-2.6 (7)	-1.5 (6)	-1.8 (5)

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	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs. PP_LLT	EBC2_ELT vs. PP_ELT	EBC2_LLT vs. PP_LLT
Wet April Ripe Female Distribution						
Higher Entrainment	0.7 (7)	0.9 (6)	0.7 (7)	0.9 (6)	0.8 (7)	0.4 (7)
Lower Entrainment	-2.0 (6)	-2.3 (7)	-2.0 (6)	-2.2 (7)	-1.1 (6)	-0.9 (6)
Wet May Ripe Female Distribution						
Higher Entrainment	2.3 (6)	2.3 (6)	2.2 (6)	2.4 (6)	2.4 (7)	2.2 (8)
Lower Entrainment	-4.0 (7)	-4.7 (7)	-3.6 (7)	-4.4 (7)	-2.7 (6)	-3.1 (5)

[1] Values represent the difference in the percentage of particles reaching this destination. Negative values indicate lower entrainment under the preliminary proposal compared to the EBC.

Overall Entrainment at All Delta Diversions

The overall entrainment to larval delta smelt at all Delta diversions based on the PTM as described above is shown in Figure B-35 through Figure B-41. Overall entrainment was lowest for the Dry February All Female Distribution, generally below 10%, and highest for the Wet May Ripe Female Distribution, generally 14 to 30% but as high as 50% for some runs. Overall entrainment under the PP_ELT and PP_LLT scenarios was lower than the EBC for almost all hydrologic scenarios and all starting distributions, except mostly for the Uniform Distribution (discussed below). The average percentage that PP scenarios were less than EBC1 and EBC2 scenarios was 1.7 to over 6% (Table B-132). Under future climate conditions, entrainment would be lower in the preliminary proposal than the existing biological conditions for almost all hydrologic scenarios and starting distributions except mostly the Uniform Distribution. The difference ranged from 1.5 to 4.9% lower under the PP_ELT relative to the EBC_ELT and 1.3 to 4.2% lower under the PP_LLT relative to the EBC_LLT.

Using the Uniform Distribution, the overall entrainment in the PP_ELT and PP_LLT would be lower relative to the EBC more frequently than it would be higher (Table B-132). The average difference in entrainment in model runs in which entrainment was higher is estimated to be 3.5–7.1% of the population for the PP_ELT and PP_LLT, respectively. The average difference in entrainment in model runs in which entrainment was lower is predicted to be 3.2–6.1 % for the PP_ELT and PP_LLT, respectively.

As described in the SWP/CVP Entrainment section, larval entrainment is projected to vary substantially among the hydrologic scenarios analyzed. In addition, the magnitude of the differences among project scenarios varies among hydrologic scenarios. However, overall in-Delta entrainment is shown to decrease under the project for the majority of the hydrologic scenarios analyzed for three of seven starting distributions, and to decrease under the project for all of the hydrologic scenarios analyzed for the remaining four starting distributions.

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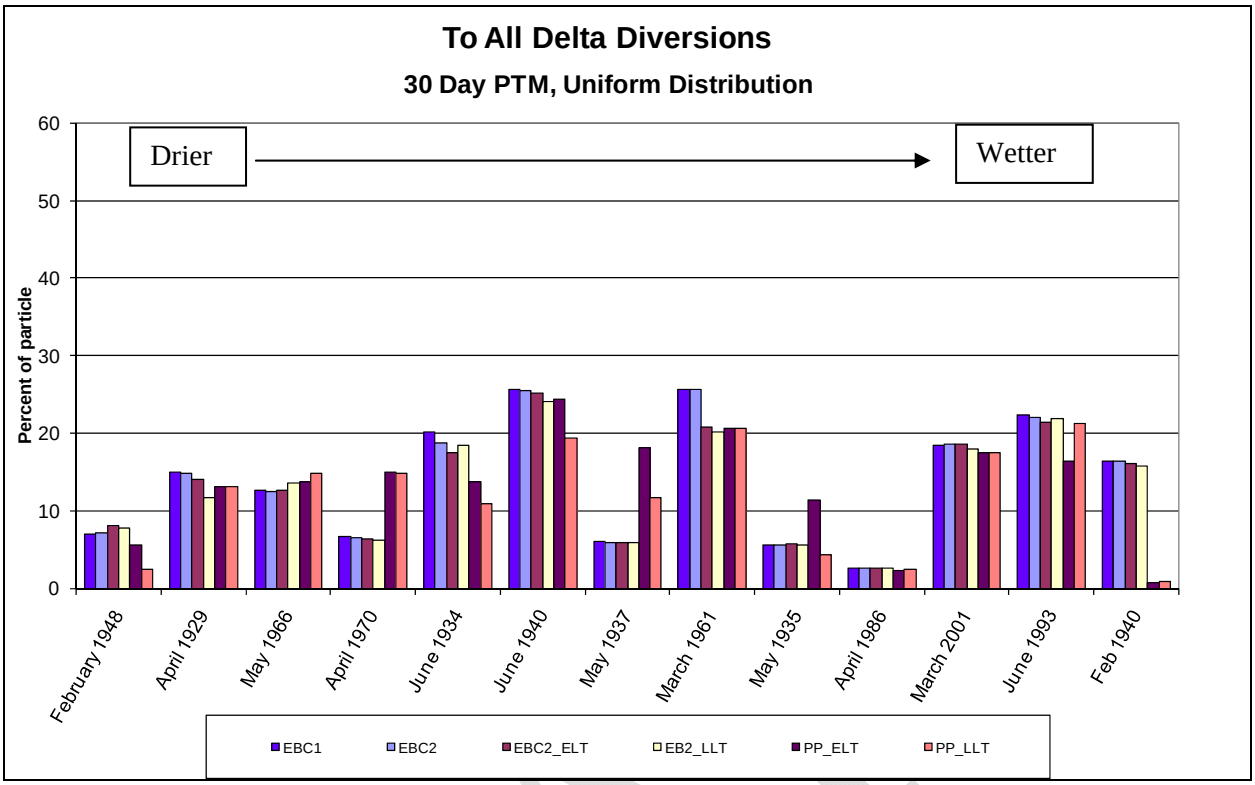


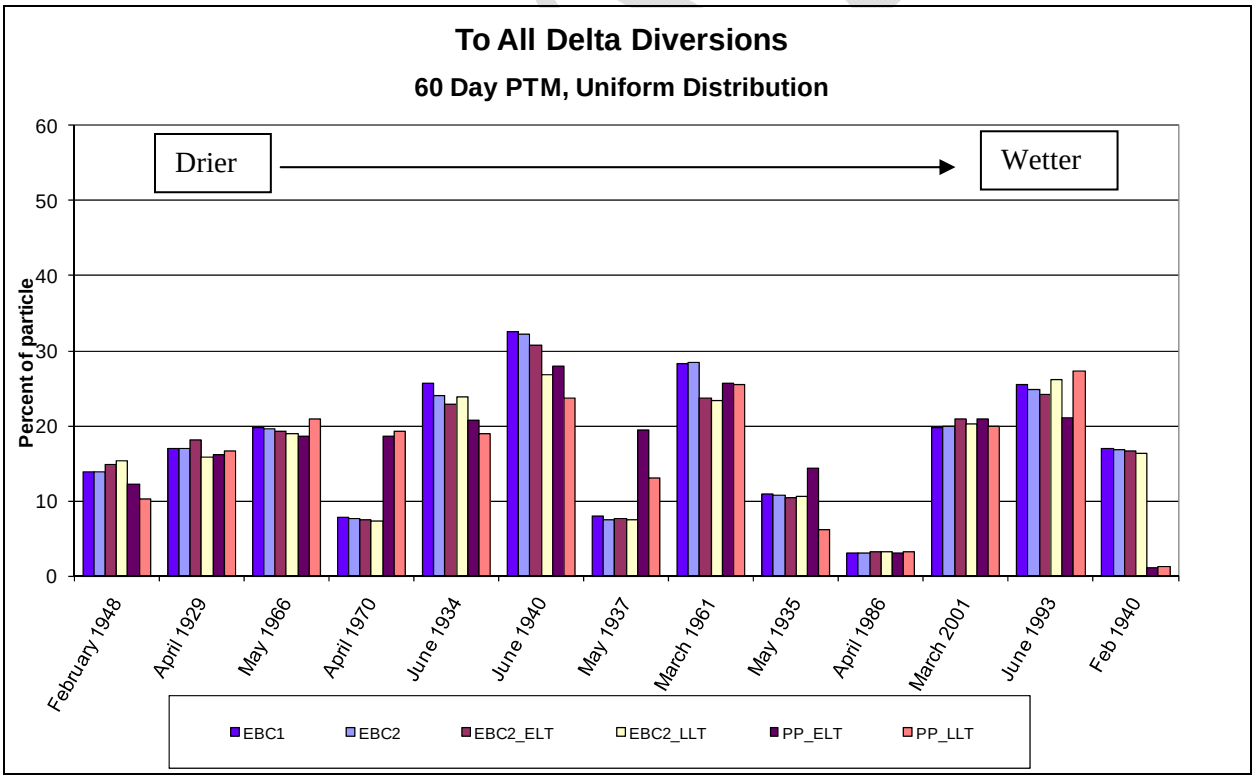
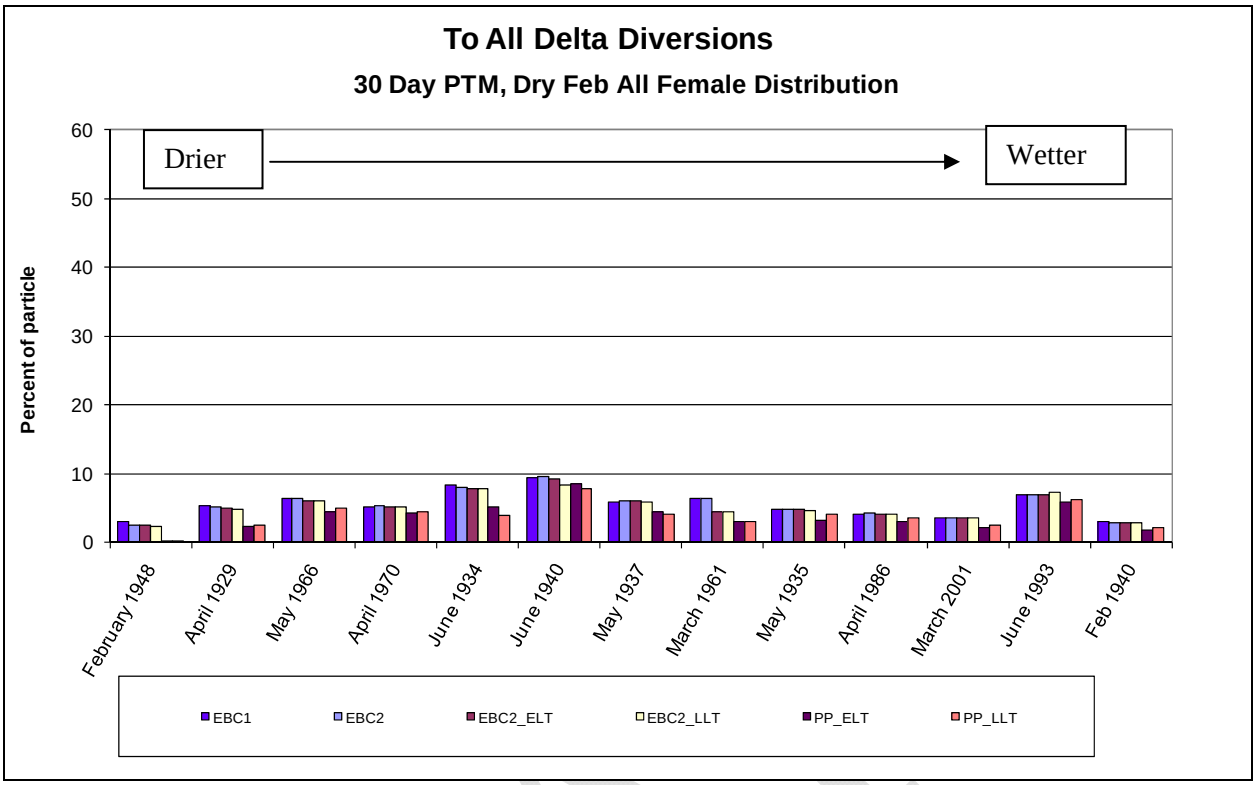


Figure B-35. Percentage of Particles All Delta Diversions Combined; Uniform Distribution



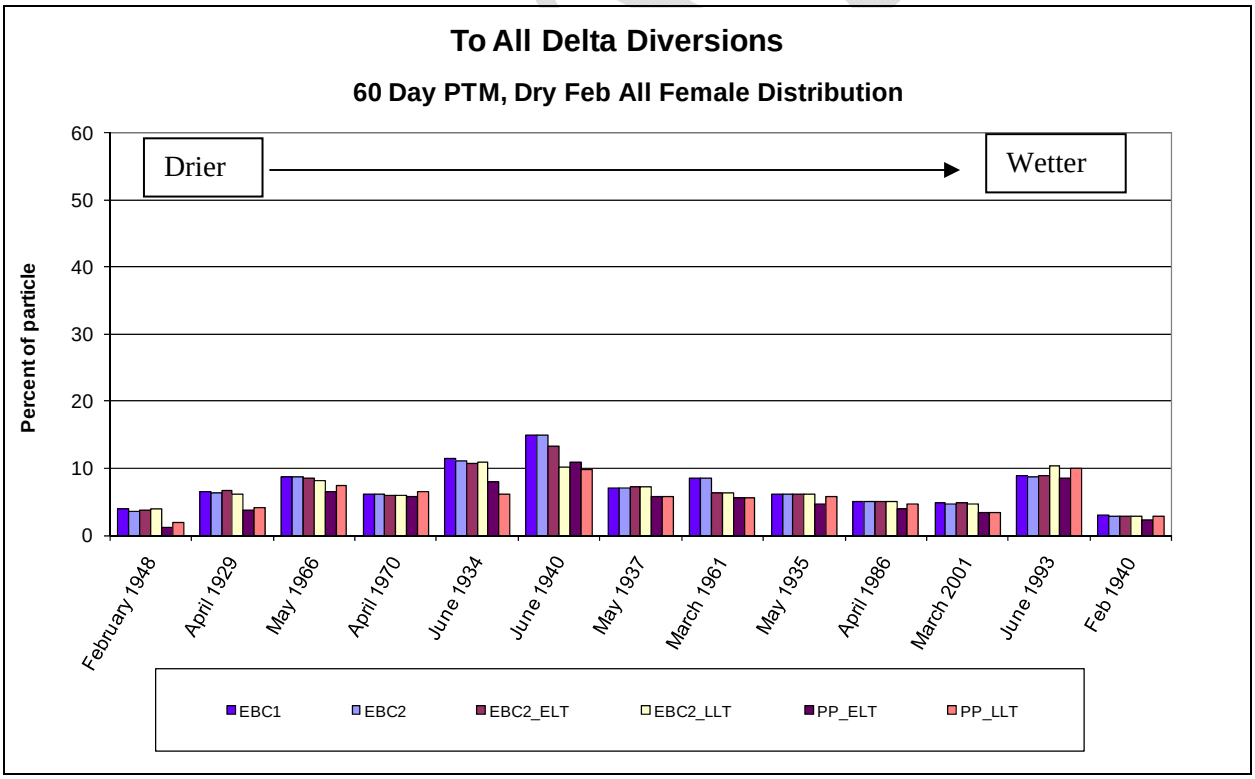
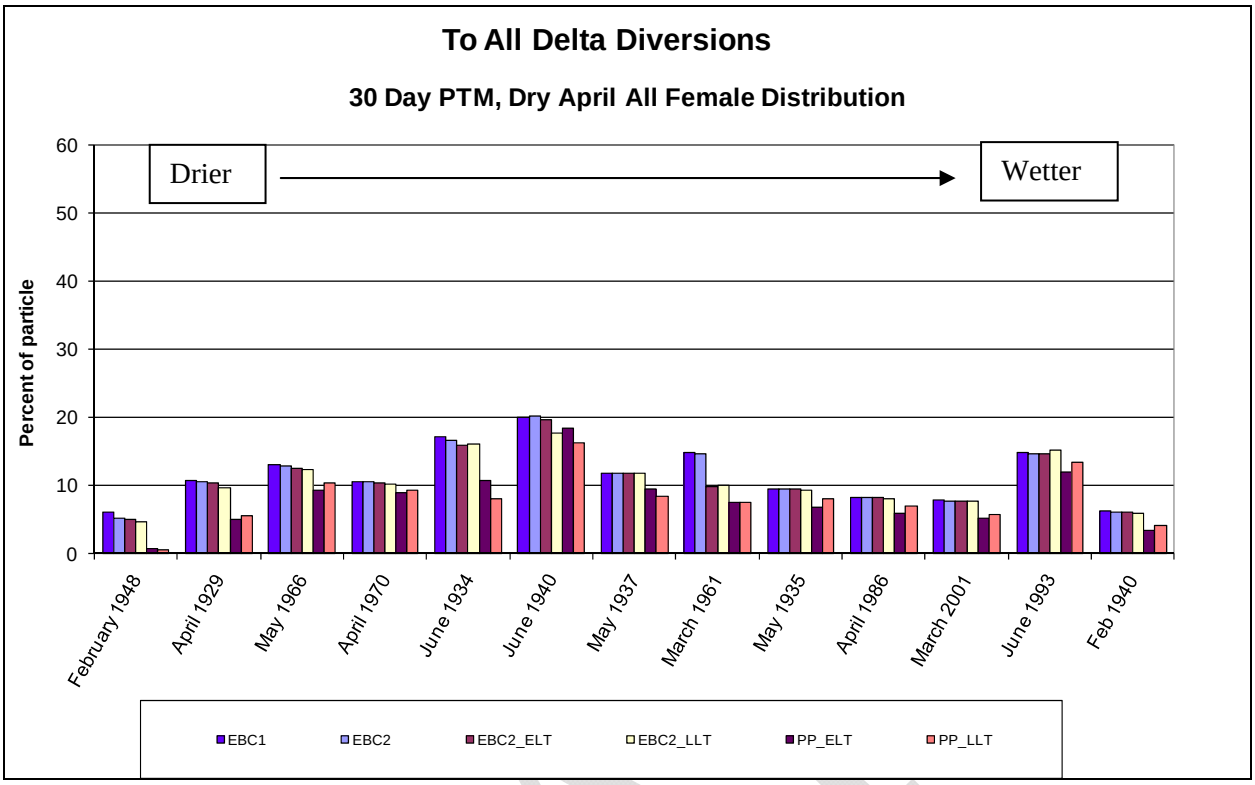


Figure B-36. Percentage of Particles All Delta Diversions Combined; Dry February All Female Distribution



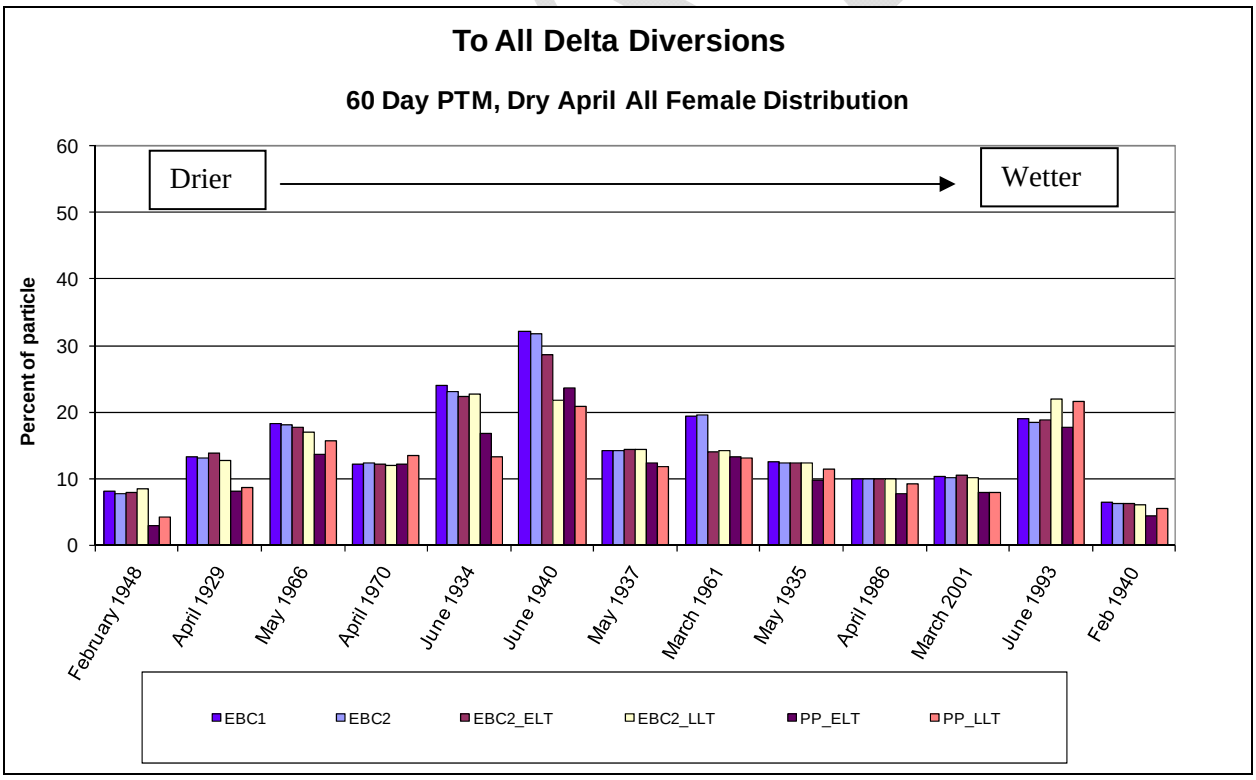
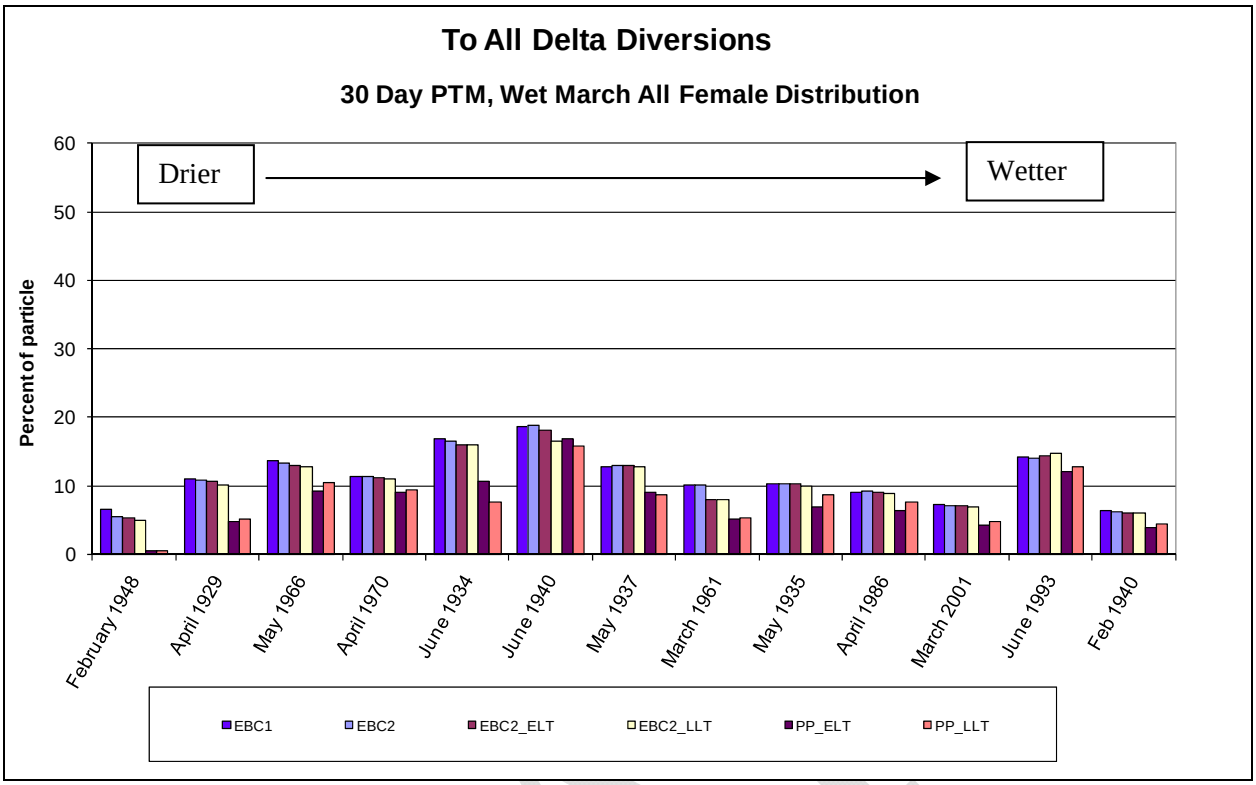


Figure B-37. Percentage of Particles All Delta Diversions Combined; Dry April All Female Distribution



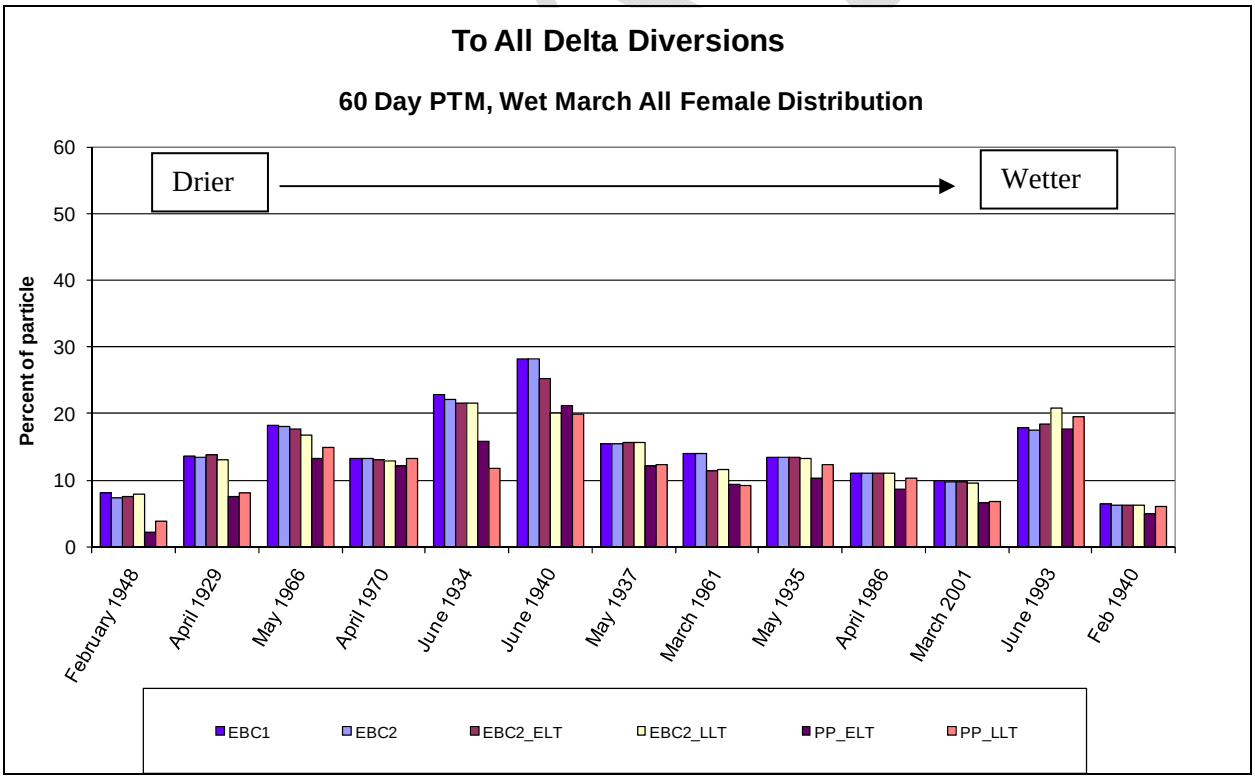
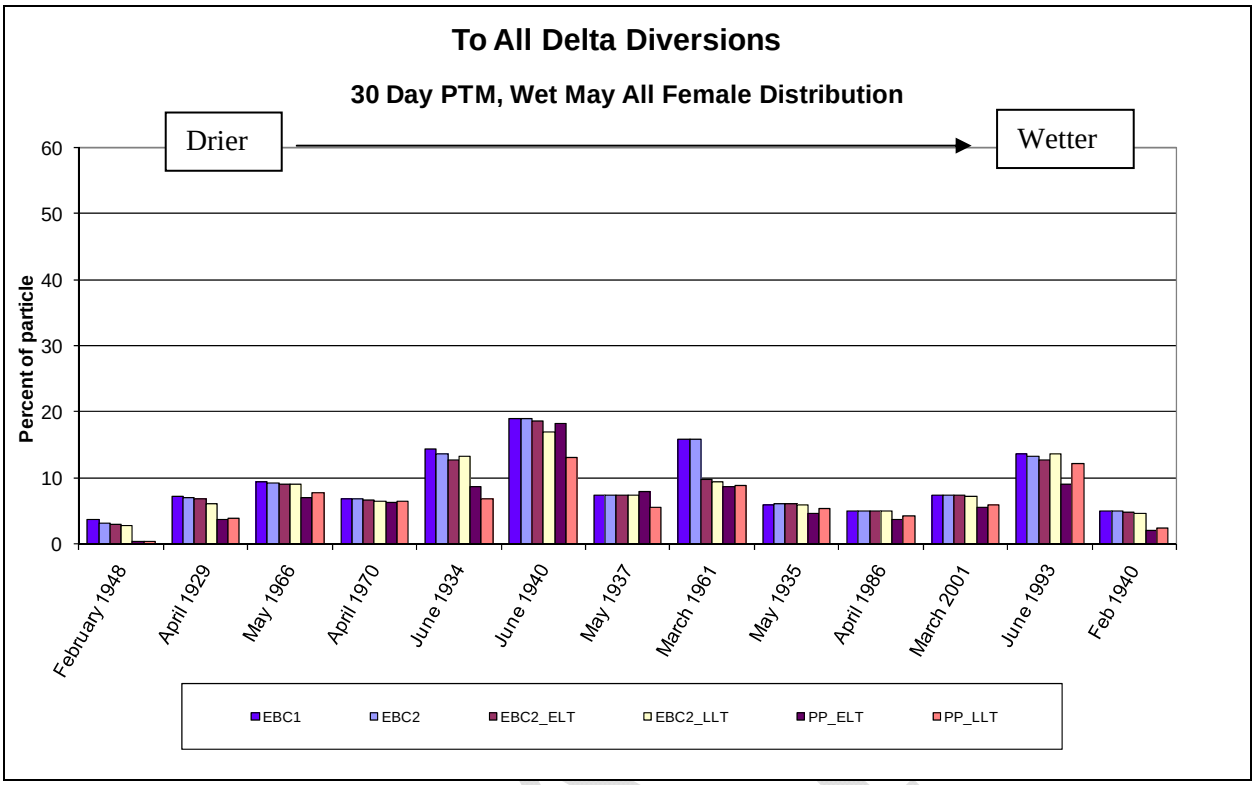


Figure B-38. Percentage of Particles All Delta Diversions Combined; Wet March All Female Distribution



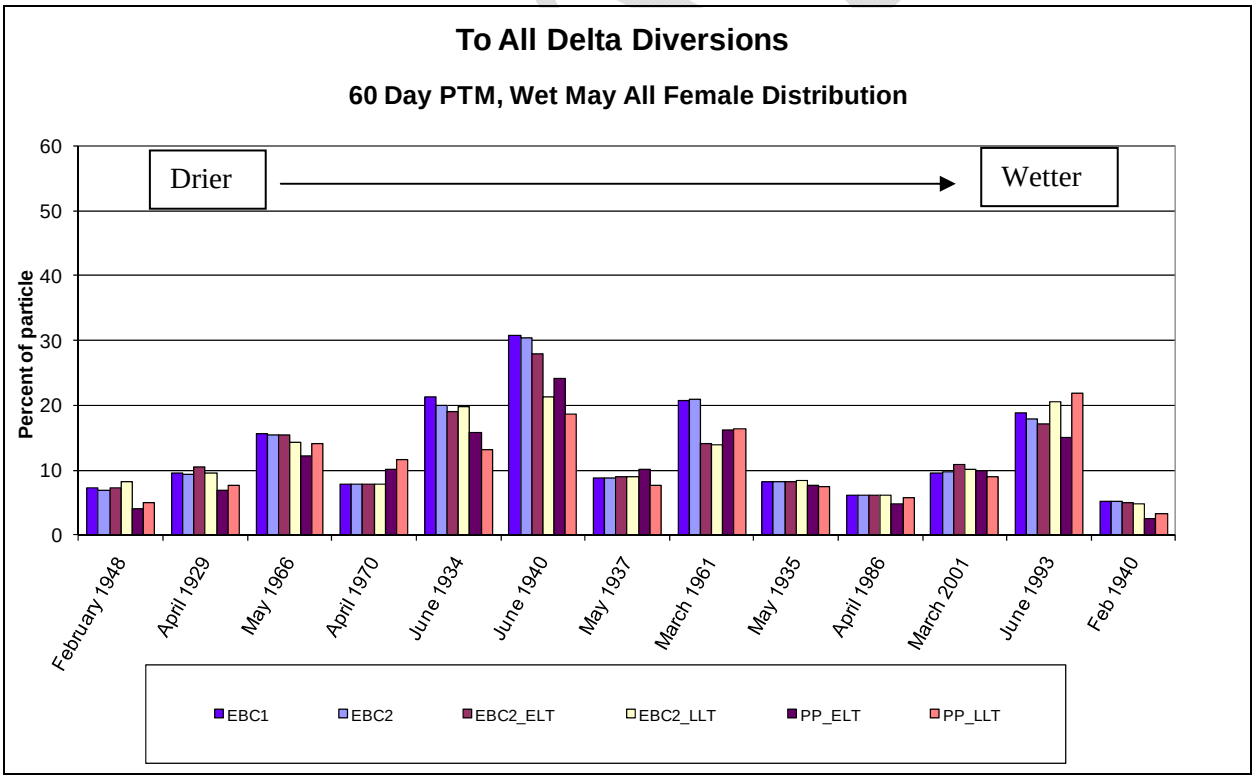
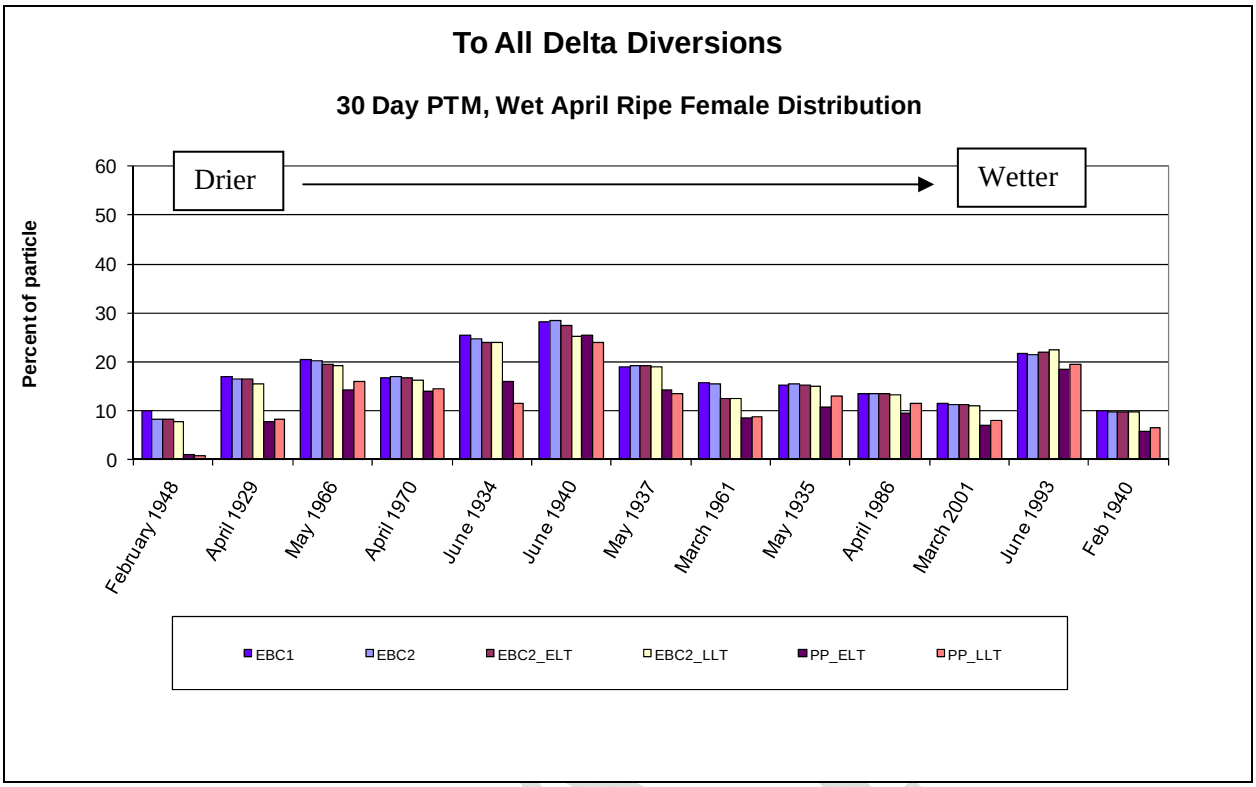


Figure B-39. Percentage of Particles All Delta Diversions Combined; Wet May All Female Distribution



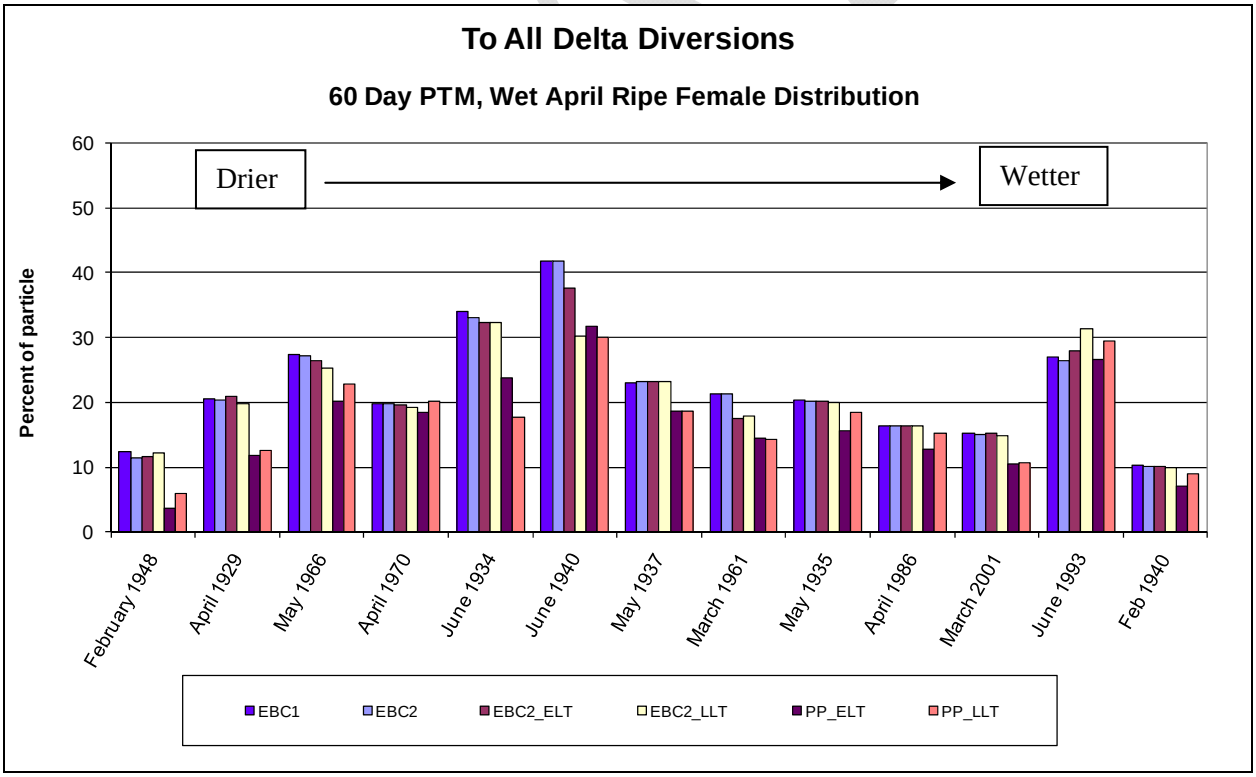
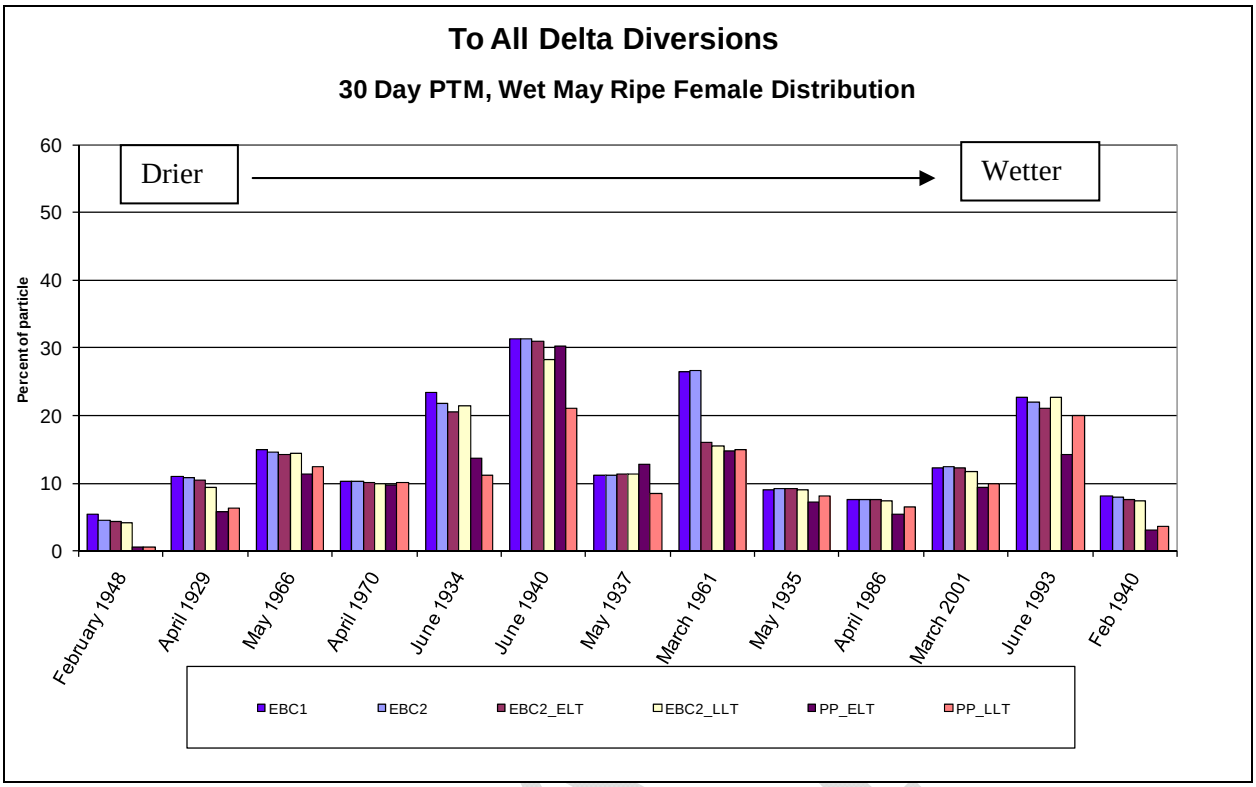


Figure B-40. Percentage of Particles All Delta Diversions Combined; Wet April Ripe Female Distribution



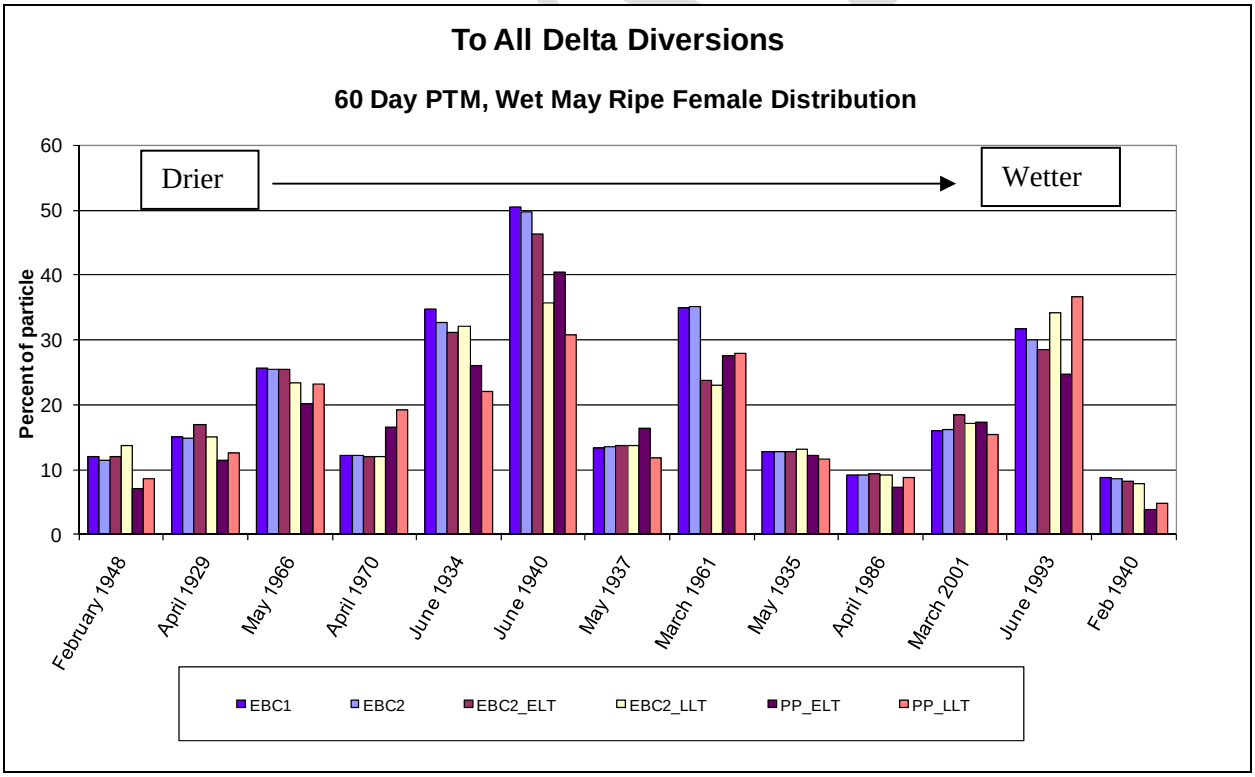


Figure B-41. Percentage of Particles All Delta Diversions Combined; Wet May Ripe Female Distribution

Table B-132. Average Difference[1] (Number of Runs) between Model Scenarios for Overall Entrainment at All Delta Diversions Combined for Particle-Tracking Runs after (A) 30 Days and (B) 60 Days

	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs. PP_LLT	EBC2_ELT vs. PP_ELT	EBC2_LLT vs. PP_LLT
(A) 30 Days, Starting Distribution						
Uniform Distribution						
Higher Entrainment	6.8 (4)	5.3 (3)	6.9 (4)	5.5 (3)	6.9 (4)	3.5 (5)
Lower Entrainment	-4.3 (9)	-4.6 (10)	-4.1 (9)	-4.4 (10)	-3.3 (9)	-4.4 (8)
Dry February All Female Distribution						
Higher Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Lower Entrainment	-1.8 (13)	-1.8 (13)	-1.7 (13)	-1.7 (13)	-1.5 (13)	-1.3 (13)
Dry April All Female Distribution						
Higher Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Lower Entrainment	-3.7 (13)	-3.6 (13)	-3.5 (13)	-3.4 (13)	-3.0 (13)	-2.7 (13)
Wet March All Female Distribution						
Higher Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Lower Entrainment	-3.8 (13)	-3.6 (13)	-3.6 (13)	-3.4 (13)	-3.3 (13)	-2.9 (13)
Wet May All Female Distribution						
Higher Entrainment	0.5 (1)	- (0)	0.5 (1)	- (0)	0.4 (1)	- (0)
Lower Entrainment	-3.0 (12)	-2.9 (13)	-2.8 (12)	-2.7 (13)	-2.1 (12)	-1.9 (13)
Wet April Ripe Female Distribution						
Higher Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Lower Entrainment	-5.5 (13)	-5.3 (13)	-5.3 (13)	-5.0 (13)	-4.8 (13)	-4.2 (13)
Wet May Ripe Female Distribution						
Higher Entrainment	1.6 (1)	- (0)	1.5 (1)	- (0)	1.4 (1)	0.2 (1)
Lower Entrainment	-4.7 (12)	-4.7 (13)	-4.5 (12)	-4.4 (13)	-3.2 (12)	-3.3 (12)
(B) 60 Days, Starting Distribution						
Uniform Distribution						
Higher Entrainment	6.7 (4)	3.3 (6)	6.8 (4)	4.2 (5)	7.1 (4)	3.4 (7)
Lower Entrainment	-4.0 (9)	-6.1 (7)	-3.7 (9)	-5.1 (8)	-3.2 (9)	-5.5 (6)
Dry February All Female Distribution						
Higher Entrainment	- (0)	0.7 (2)	- (0)	0.8 (2)	- (0)	0.4 (1)
Lower Entrainment	-1.9 (13)	-2.1 (11)	-1.8 (13)	-2.0 (11)	-1.5 (13)	-1.2 (12)
Dry April All Female Distribution						
Higher Entrainment	- (0)	2.0 (2)	- (0)	2.2 (2)	- (0)	1.6 (1)
Lower Entrainment	-3.8 (13)	-4.3 (11)	-3.6 (13)	-4.1 (11)	-2.9 (13)	-2.4 (12)
Wet March All Female Distribution						
Higher Entrainment	- (0)	0.9 (2)	0.2 (1)	2.1 (1)	- (0)	0.3 (1)
Lower Entrainment	-3.9 (13)	-4.1 (11)	-4.0 (12)	-3.6 (12)	-3.3 (13)	-2.7 (12)
Wet May All Female Distribution						
Higher Entrainment	1.3 (3)	3.4 (2)	1.2 (3)	3.8 (2)	1.8 (3)	2.5 (3)
Lower Entrainment	-3.4 (10)	-3.2 (11)	-3.1 (10)	-3.0 (11)	-2.5 (10)	-2.0 (10)

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	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs. PP_LLT	EBC2_ELT vs. PP_ELT	EBC2_LLT vs. PP_LLT
Wet April Ripe Female Distribution						
Higher Entrainment	- (0)	1.5 (2)	0.2 (1)	1.8 (2)	- (0)	1.0 (1)
Lower Entrainment	-5.7 (13)	-6.1 (11)	-5.9 (12)	-5.9 (11)	-4.9 (13)	-4.0 (12)
Wet May Ripe Female Distribution						
Higher Entrainment	2.9 (3)	6.0 (2)	2.8 (3)	6.8 (2)	3.7 (3)	4.8 (3)
Lower Entrainment	-5.4 (10)	-5.0 (11)	-4.9 (10)	-4.7 (11)	-3.8 (10)	-3.2 (10)

[1] Values represent the difference in the percentage of particles reaching this destination. Negative values indicate lower entrainment under the preliminary proposal compared to the EBC.

A separate analysis was conducted to determine the potential effects of differences in OMR flows under the project relative to existing conditions on the larval entrainment loss. For this analysis, relationships between loss of particles to all Delta diversions and OMR flows were developed to predict larval entrainment. These relationships were based on the seven starting distributions used in the analyses described above. Of the relationships developed, only that based on the uniform starting distribution was strong (i.e., the R^2 value for the relationship based on the uniform distribution was 0.92, whereas R^2 values for relationships based on the other distributions ranged from 0.16 to 0.56) (Figure B-42). Because the uniform distribution places a larger proportion of the delta smelt population in the south Delta than has been observed in recent years, or would be expected to occur in this area in the future, this analysis provides a conservative scenario regarding larval entrainment under the project.

The mean, median, minimum, and maximum OMR flows projected for each project scenario during the larval period (February–June) are shown in Table B-133 and can be interpreted in light of the relationship shown in Figure B-42 to gain a sense of the maximum level of entrainment expected under each scenario. The skewed nature of the OMR flows suggests that examination of median as well as mean flows is appropriate. Across all water years, there would be a 2.1–4.7% absolute decrease (14–36% relative decrease) in entrainment from EBC scenarios to PP scenarios for mean and median OMR flows (Table B-134). Reductions in entrainment under PP scenarios relative to EBC scenarios were most pronounced in wet (10.8–13.5% absolute decrease; 82–94% relative decrease), above normal (6.8–7.9% absolute decrease; 42–49% relative decrease), and below normal years (1.9–3.1% absolute decrease; 12–20% relative decrease); whereas there were only minor increases or decreases in entrainment between PP and EBC scenarios in dry (0.7% absolute decrease to 0.6% absolute increase) and critical (0.3–0.8% absolute decrease) years for mean and median flows. Relative to mean and median flows, minimum flows gave little change or slight increases in entrainment in all and below normal water years, smaller decreases in wet and above normal years, and similar decreases in dry and critical years. Relative to mean and median flows, maximum flows gave greater reductions in entrainment under PP scenarios compared to EBC scenarios in above normal, below normal, and dry years; and similar entrainment in critical years.

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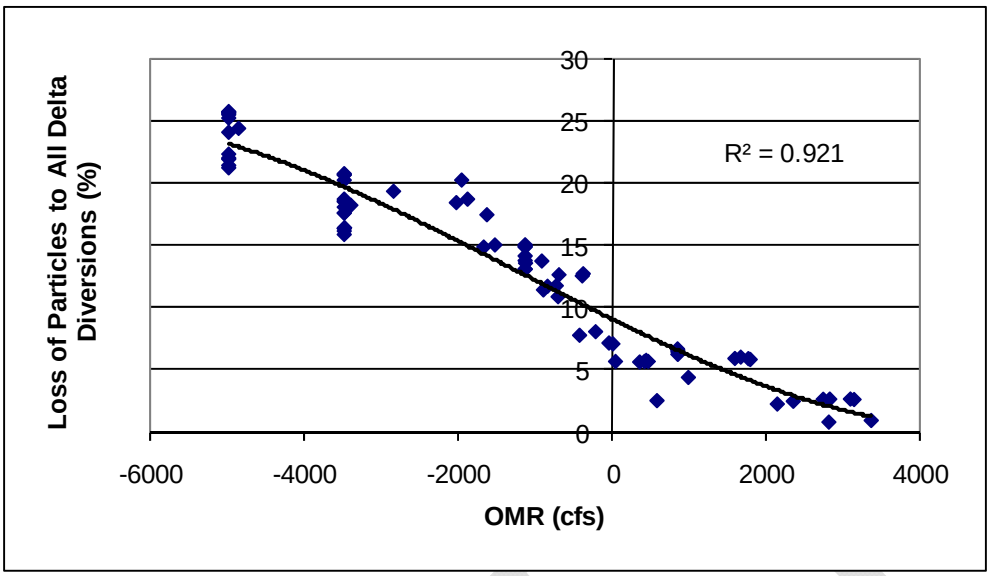

Figure B-42. Percent Loss of Particles to All Delta Diversions As a Function of Old and Middle River Flows (cfs), During Particle Tracking Model Simulations of Delta Smelt Larval Entrainment

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Table B-133. Mean, Median, Minimum, and Maximum[1] Old and Middle River Flows during the February–June Larval Period of Delta Smelt under Model Scenarios, by Water-Year Type

All Years	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
Mean	-1308	-1322	-1249	-1239	-2	184
Median	-2158	-2107	-2053	-2067	-1392	-1164
Minimum	-3051	-3232	-3118	-3294	-3202	-2693
Maximum	*10613*	*9732*	*10455*	*9949*	*17365*	*17484*
Wet						
Mean	-809	-984	-799	-829	3887	3828
Median	-1805	-1964	-1820	-1719	2503	3028
Minimum	-2774	-2810	-2810	-2626	-1130	-918
Maximum	*10613*	*9732*	*10455*	*9949*	*17365*	*17484*
Above Normal						
Mean	-2144	-2107	-2053	-2046	265	317
Median	-2395	-2307	-2223	-2438	146	-131
Minimum	-3051	-3232	-3118	-3294	-2331	-1943
Maximum	657	1258	1452	1552	3329	*3552*
Below Normal						
Mean	-2158	-2072	-2018	-2114	-1392	-1164
Median	-2274	-2138	-2163	-2138	-1526	-1508
Minimum	-2684	-2596	-2716	-2668	-3202	-2693
Maximum	-593	-514	-184	-1074	1542	2053
Dry						
Mean	-2211	-2231	-2275	-2067	-2284	-2006
Median	-2214	-2241	-2310	-2082	-2410	-2093
Minimum	-2678	-2679	-2824	-2665	-2864	-2669
Maximum	-1517	-1486	-1741	-1369	-1115	-1111
Critical						
Mean	-1884	-1940	-1864	-1717	-1674	-1630
Median	-1822	-1876	-1787	-1747	-1645	-1591
Minimum	-2759	-2777	-2728	-2483	-2681	-2656
Maximum	-1160	-1146	-1008	-789	-938	-815

[1] Values in italics denote flows greater than the maximum used for developing the regression equation between percentage of particles entrained and OMR flows.

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Table B-134. Percent Loss of Particles Based on Modeled Old and Middle River Flows during the February–June Larval Period of Delta Smelt under Model Scenarios, by Water-Year Type[1]

All Years	PP_ELT vs. EBC1	PP_LLT vs. EBC1	PP_ELT vs. EBC2	PP_LLT vs. EBC2	PP_ELT vs. EBC2_ELT	PP_LLT vs. EBC2_LLT
Mean	-4.1 (-31%)	-4.6 (-35%)	-4.1 (-31%)	-4.7 (-36%)	-3.9 (-30%)	-4.4 (-34%)
Median	-2.4 (-15%)	-3.1 (-20%)	-2.2 (-14%)	-3.0 (-19%)	-2.1 (-13%)	-2.8 (-18%)
Minimum	0.4 (2%)	-1.0 (-6%)	-0.1 (0%)	-1.6 (-8%)	0.2 (1%)	-1.7 (-9%)
Maximum	NA	NA	NA	NA	NA	NA
Wet						
Mean	-10.8 (-94%)	-10.8 (-94%)	-11.4 (-94%)	-11.3 (-94%)	-10.8 (-94%)	-10.9 (-94%)
Median	-12.1 (-82%)	-13.0 (-89%)	-12.6 (-83%)	-13.5 (-89%)	-12.1 (-82%)	-12.7 (-88%)
Minimum	-5.1 (-29%)	-5.8 (-33%)	-5.2 (-29%)	-5.9 (-33%)	-5.2 (-29%)	-5.3 (-31%)
Maximum	NA	NA	NA	NA	NA	NA
Above Normal						
Mean	-7.5 (-48%)	-7.7 (-49%)	-7.4 (-47%)	-7.5 (-48%)	-7.2 (-47%)	-7.4 (-48%)
Median	-7.9 (-48%)	-7.1 (-43%)	-7.7 (-47%)	-6.8 (-42%)	-7.4 (-46%)	-7.2 (-43%)
Minimum	-2.1 (-12%)	-3.3 (-18%)	-2.6 (-14%)	-3.8 (-20%)	-2.3 (-12%)	-4.0 (-21%)
Maximum	-5.8 (-82%)	-6.1 (-86%)	-4.2 (-77%)	-4.4 (-82%)	-3.7 (-74%)	NA
Below Normal						
Mean	-2.4 (-15%)	-3.1 (-20%)	-2.1 (-14%)	-2.9 (-18%)	-2.0 (-13%)	-3.0 (-19%)
Median	-2.3 (-14%)	-2.4 (-15%)	-1.9 (-12%)	-2.0 (-13%)	-2.0 (-13%)	-2.0 (-13%)
Minimum	1.5 (9%)	0.0 (0%)	1.8 (10%)	0.3 (2%)	1.4 (8%)	0.1 (0%)
Maximum	-6.1 (-57%)	-7.3 (-68%)	-5.9 (-56%)	-7.1 (-67%)	-4.9 (-51%)	-8.8 (-72%)
Dry						
Mean	0.2 (1%)	-0.6 (-4%)	0.2 (1%)	-0.7 (-4%)	0.0 (0%)	-0.2 (-1%)
Median	0.6 (4%)	-0.4 (-2%)	0.5 (3%)	-0.5 (-3%)	0.3 (2%)	0.0 (0%)
Minimum	0.5 (3%)	0.0 (0%)	0.5 (3%)	0.0 (0%)	0.1 (1%)	0.0 (0%)
Maximum	-1.3 (-9%)	-1.3 (-9%)	-1.2 (-9%)	-1.2 (-9%)	-2.0 (-14%)	-0.8 (-6%)
Critical						
Mean	-0.7 (-4%)	-0.8 (-5%)	-0.8 (-6%)	-1.0 (-6%)	-0.6 (-4%)	-0.3 (-2%)
Median	-0.6 (-4%)	-0.7 (-5%)	-0.7 (-5%)	-0.9 (-6%)	-0.4 (-3%)	-0.5 (-3%)
Minimum	-0.2 (-1%)	-0.3 (-2%)	-0.3 (-2%)	-0.4 (-2%)	-0.1 (-1%)	0.5 (3%)
Maximum	-0.7 (-6%)	-1.1 (-9%)	-0.7 (-5%)	-1.0 (-8%)	-0.2 (-2%)	0.1 (1%)

[1] NA indicates that calculation was not made because input flow data were greater than the maximum value used for developing the regression equation between percentage of particles entrained and OMR flows.

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B.4.1.5.2 Juvenile

Salvage-Density Method

Entrainment loss of juvenile delta smelt during May–July at the SWP south Delta export facilities generally was estimated to be an order of magnitude greater than at the CVP south Delta export facilities and averaged tens to hundreds of fish per year, depending on water-year type (Table B-135 to Table B-146). Across all water-year types, there was an estimated reduction in May–July entrainment loss under PP scenarios compared to EBC scenarios of around 90–145 fish (24–38%) (Table B-141). The greatest reductions in entrainment loss under PP scenarios compared to EBC scenarios were found in wet years (335–455 fish; 51–66% reduction) with reductions under PP generally also occurring in dry (50–85 fish; 18–29% reduction) and critical years (20–50 fish; 20–35% reduction) (Table B-142, Table B-145, and Table B-146). Increased entrainment loss under PP scenarios compared to EBC scenarios was estimated to occur in above normal and below normal years, ranging from 0 to 55 fish (0–30% increase) (Table B-143 and Table B-144).

Table B-135. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI]) of Juvenile Delta Smelt for Six Model Scenarios at the SWP and CVP Salvage Facilities in May–July for All Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
May	110	±	11	114	±	12	120	±	13	121	±	13	137	±	14	116	±	12
June	212	±	23	211	±	23	200	±	21	177	±	19	106	±	13	81	±	10
July	19	±	3	19	±	3	18	±	3	17	±	3	9	±	2	8	±	2
(b) CVP																		
May	29	±	2	28	±	2	29	±	3	29	±	2	30	±	3	28	±	3
June	10	±	1	10	±	1	9	±	1	8	±	1	5	±	1	4	±	1
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0

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Table B-136. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI]) of Juvenile Delta Smelt for Six Model Scenarios at the SWP and CVP Salvage Facilities in May–July for Wet Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
May	200	±	64	219	±	73	224	±	74	217	±	73	122	±	47	97	±	38
June	380	±	120	395	±	124	355	±	113	323	±	101	164	±	66	99	±	47
July	39	±	13	39	±	13	39	±	13	37	±	12	16	±	6	19	±	7
(b) CVP																		
May	25	±	8	25	±	8	26	±	8	25	±	8	13	±	5	14	±	5
June	10	±	3	11	±	3	10	±	3	9	±	3	5	±	2	3	±	1
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0

Table B-137. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI]) of Juvenile Delta Smelt for Six Model Scenarios at the SWP and CVP Salvage Facilities in May–July for Above Normal Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
May	65	±	16	65	±	16	73	±	19	76	±	19	138	±	52	130	±	53
June	84	±	19	84	±	19	83	±	18	69	±	13	54	±	15	44	±	11
July	2	±	1	2	±	1	2	±	1	2	±	1	1	±	1	1	±	1
(b) CVP																		
May	15	±	5	15	±	5	16	±	6	16	±	6	21	±	11	24	±	12
June	4	±	1	5	±	1	4	±	1	4	±	1	3	±	1	3	±	1
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0

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Table B-138. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI]) of Juvenile Delta Smelt for Six Model Scenarios at the SWP and CVP Salvage Facilities in May–July for Below Normal Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
May	44	±	5	44	±	5	48	±	7	56	±	9	140	±	45	109	±	37
June	135	±	23	134	±	23	120	±	21	113	±	23	73	±	25	64	±	25
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
(b) CVP																		
May	10	±	1	10	±	1	11	±	1	11	±	1	22	±	4	18	±	5
June	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0

Table B-139. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI]) of Juvenile Delta Smelt for Six Model Scenarios at the SWP and CVP Salvage Facilities in May–July for Dry Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
May	100	±	27	100	±	27	110	±	30	113	±	31	138	±	43	121	±	39
June	165	±	49	170	±	50	167	±	48	134	±	38	84	±	27	73	±	26
July	16	±	6	16	±	6	15	±	6	14	±	6	9	±	4	6	±	4
(b) CVP																		
May	8	±	1	8	±	1	8	±	1	8	±	1	12	±	2	10	±	2
June	2	±	0	2	±	0	1	±	0	1	±	0	1	±	0	1	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0

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Table B-140. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI]) of Juvenile Delta Smelt for Six Model Scenarios at the SWP and CVP Salvage Facilities in May–July for Critical Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
May	47	±	7	49	±	7	46	±	9	41	±	13	36	±	13	37	±	14
June	74	±	19	73	±	16	68	±	19	58	±	18	41	±	10	45	±	16
July	4	±	1	4	±	1	3	±	1	3	±	1	1	±	1	1	±	0
(b) CVP																		
May	12	±	1	12	±	1	12	±	1	11	±	1	11	±	2	10	±	2
June	6	±	0	6	±	1	5	±	0	6	±	1	4	±	1	4	±	1
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0

Table B-141. Estimated Absolute and Percent Differences between Model Scenarios in Juvenile Delta Smelt Entrainment Index (Number of Fish Lost) at the SWP and CVP Salvage Facilities in May–July during All Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
May	29 (21%)	6 (4%)	25 (18%)	2 (2%)	18 (12%)	-6 (-4%)
June	-111 (-50%)	-137 (-62%)	-110 (-50%)	-137 (-62%)	-98 (-47%)	-100 (-54%)
July	-10 (-54%)	-11 (-59%)	-10 (-53%)	-11 (-58%)	-9 (-51%)	-9 (-53%)
Annual Average	-92 (-24%)	-142 (-38%)	-95 (-25%)	-145 (-38%)	-89 (-24%)	-114 (-33%)

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Table B-142. Estimated Absolute and Percent Differences between Model Scenarios in Juvenile Delta Smelt Entrainment Index (Number of Fish Lost) at the SWP and CVP Salvage Facilities in May–July during Wet Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
May	-90 (-40%)	-114 (-51%)	-109 (-45%)	-134 (-55%)	-116 (-46%)	-131 (-54%)
June	-223 (-57%)	-289 (-74%)	-237 (-58%)	-303 (-75%)	-197 (-54%)	-229 (-69%)
July	-23 (-59%)	-20 (-50%)	-23 (-59%)	-20 (-51%)	-23 (-59%)	-17 (-47%)
Annual Average	-336 (-51%)	-423 (-65%)	-369 (-54%)	-457 (-66%)	-336 (-51%)	-378 (-62%)

Table B-143. Estimated Absolute and Percent Differences between Model Scenarios in Juvenile Delta Smelt Entrainment Index (Number of Fish Lost) at the SWP and CVP Salvage Facilities in May–July during Above Normal Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
May	79 (99%)	74 (93%)	79 (99%)	74 (93%)	70 (79%)	62 (67%)
June	-32 (-36%)	-42 (-47%)	-32 (-36%)	-42 (-47%)	-30 (-35%)	-25 (-35%)
July	-1 (-48%)	-1 (-56%)	-1 (-49%)	-1 (-56%)	-1 (-45%)	-1 (-48%)
Annual Average	45 (27%)	31 (18%)	46 (27%)	31 (18%)	39 (22%)	35 (21%)

Table B-144. Estimated Absolute and Percent Differences between Model Scenarios in Juvenile Delta Smelt Entrainment Index (Number of Fish Lost) at the SWP and CVP Salvage Facilities in May–July during Below Normal Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
May	107 (195%)	72 (131%)	107 (195%)	72 (131%)	103 (177%)	59 (88%)
June	-62 (-46%)	-72 (-53%)	-61 (-45%)	-70 (-52%)	-47 (-39%)	-50 (-44%)
July	0 (-50%)	0 (-54%)	0 (-50%)	0 (-54%)	0 (-49%)	0 (-52%)
Annual Average	45 (24%)	0 (0%)	46 (24%)	2 (1%)	56 (31%)	10 (5%)

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Table B-145. Estimated Absolute and Percent Differences between Model Scenarios in Juvenile Delta Smelt Entrainment Index (Number of Fish Lost) at the SWP and CVP Salvage Facilities in May–July during Dry Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
May	42 (39%)	23 (21%)	42 (39%)	23 (22%)	33 (28%)	11 (9%)
June	-81 (-49%)	-92 (-56%)	-87 (-51%)	-98 (-57%)	-84 (-50%)	-61 (-45%)
July	-7 (-45%)	-10 (-64%)	-7 (-44%)	-10 (-64%)	-6 (-40%)	-9 (-60%)
Annual Average	-47 (-16%)	-80 (-27%)	-52 (-18%)	-85 (-29%)	-57 (-19%)	-59 (-22%)

Table B-146. Estimated Absolute and Percent Differences between Model Scenarios in Juvenile Delta Smelt Entrainment Index (Number of Fish Lost) at the SWP and CVP Salvage Facilities in May–July during Critical Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
May	-13 (-22%)	-13 (-21%)	-14 (-24%)	-14 (-23%)	-11 (-18%)	-5 (-10%)
June	-36 (-44%)	-31 (-39%)	-35 (-44%)	-30 (-38%)	-29 (-39%)	-15 (-23%)
July	-3 (-73%)	-4 (-83%)	-3 (-72%)	-4 (-83%)	-2 (-66%)	-2 (-72%)
Annual Average	-52 (-36%)	-47 (-33%)	-52 (-36%)	-48 (-33%)	-42 (-31%)	-22 (-19%)

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Proportional Loss Equation

ESTIMATES OF PROPORTIONAL LOSS BASED ON KIMMERER (2008)

The average annual proportions of the juveniles plus larvae population lost at the south Delta facilities, as estimated from the regression equation described in Section B.5.4.1.1. that was run on CALSIM estimates of average May–July OMR flows, are given in Figure B-43 for each of the scenarios for all years combined and for each water-year type. The proportion of juveniles and larvae lost is estimated to be essentially the same for EBC in the near term with (EBC2) and without (EBC1) Fall X2 requirements, and ranges from over 0.08 in critical years to over 0.11 in dry years but is estimated to decline by 0.01–0.02 from these near term EBCs to EBC_LLT. The proportion is estimated to be substantially lower with the PP in both the early and late long-term, ranging from 0.04 in wet years (PP_LLT) to 0.08 in below normal years (PP_ELT). The percentage of years in which 0.05 (i.e., 5%) or more of the population is estimated to be lost was 92–95% under EBC scenarios and decreased to 63% of years under PP_ELT and 51% of years under PP_LLT (Figure B-44). The percentage of years in which 0.10 (i.e., 10%) or more of the population is estimated to be lost was 30–64% under EBC scenarios and decreased to 10% of years under PP_ELT and 5% of years under PP_LLT (Figure B-44).

For all years combined, the proportion lost in both the early long-term and the late long-term is estimated to be about 0.033–0.047 lower with the PP than under the EBC, with a decrease from between 0.088–0.099 of the population lost under EBC to 0.052–0.060 under PP. This represents a decrease of 36–47% (Table B-147). The difference between EBC and PP varies across water-year types, from the largest declines in wet years (0.04–0.05 decreases in the proportion of the juvenile-larval population lost, representing a decrease of around 49–56% from EBC to PP) to lower declines in the remaining water-year types (reductions under EBC of around 23–49%; Table B-147).

Table B-147. Average Estimated Change in Annual Proportional Loss of Juvenile and Larval Delta Smelt at SWP/CVP South Delta Export Facilities by Water-Year Type for the Six Study Scenarios, Using Estimates Based on Kimmerer (2008)

WY Type	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
All	-0.0397 (-40%)	-0.047 (-47%)	-0.0388 (-39%)	-0.0462 (-47%)	-0.0334 (-36%)	-0.0353 (-40%)
Wet	-0.0445 (-50%)	-0.0493 (-56%)	-0.0459 (-51%)	-0.0507 (-56%)	-0.0433 (-49%)	-0.0456 (-54%)
Above Normal	-0.0407 (-39%)	-0.0421 (-40%)	-0.0426 (-40%)	-0.044 (-41%)	-0.0318 (-33%)	-0.0251 (-28%)
Below Normal	-0.0311 (-28%)	-0.0429 (-39%)	-0.03 (-27%)	-0.0418 (-38%)	-0.0243 (-23%)	-0.0332 (-33%)
Dry	-0.0396 (-35%)	-0.0539 (-48%)	-0.0381 (-34%)	-0.0524 (-47%)	-0.0323 (-31%)	-0.039 (-40%)
Critical	-0.0382 (-45%)	-0.0416 (-49%)	-0.031 (-40%)	-0.0344 (-45%)	-0.026 (-36%)	-0.0204 (-32%)

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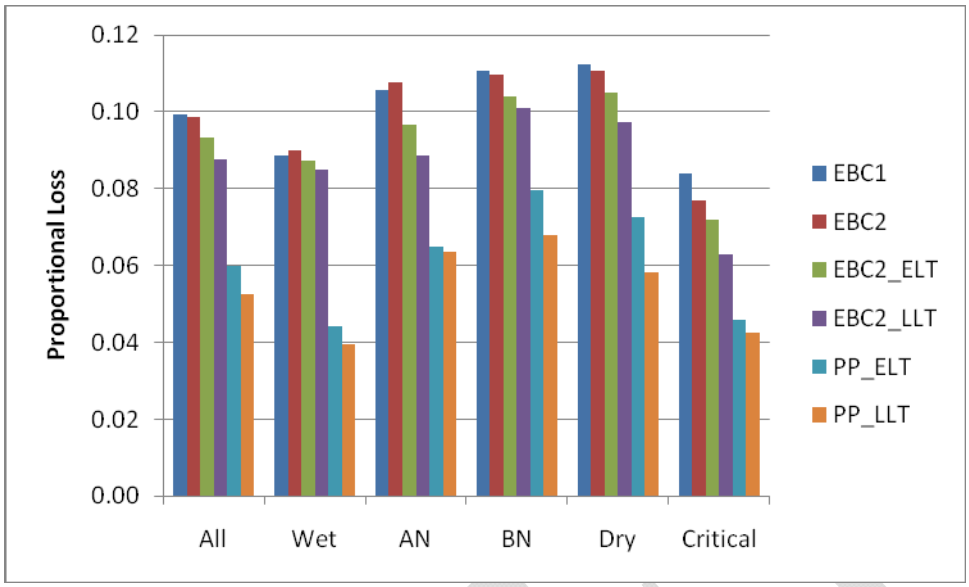

Figure B-43. Average Annual Estimated Proportion of the Juvenile Plus Larvae Delta Smelt Population Lost to Entrainment at the SWP/CVP South Delta Export Facilities by Water-Year Type and All Years Combined for the Six Study Scenarios

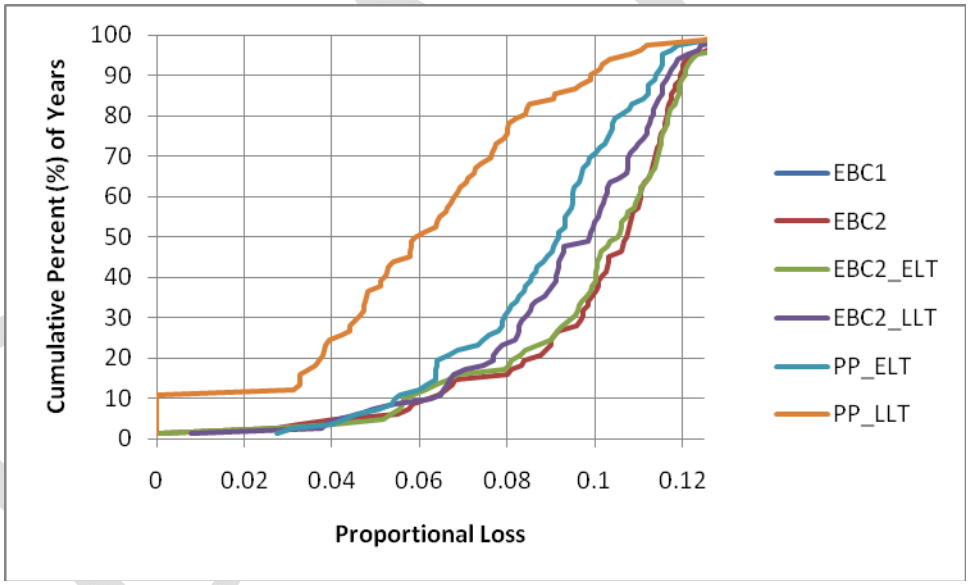

Figure B-44. Estimated Annual Proportional Loss of Juvenile and Larval Delta Smelt at SWP/CVP South Delta Export Facilities by Cumulative Percentage of Years for the Six Study Scenarios

ESTIMATES OF PROPORTIONAL LOSS BASED ON MILLER (2011)

The following describes the results of applying the "adjusted Kimmerer approach" (Miller 2011) to the six study scenarios based on three assumptions regarding future trends in Secchi depths in the southeast Delta.

Assumption 1: Historical Trends in Secchi Depths Continue

Under this assumption, estimated average annual larval-juvenile proportional entrainment losses were nearly the same under EBC1 and EBC2, ranging from averages of under 0.02 (2%) of the population in wet years just under 0.10 (10%) in critical years (Figure B-45). Similar average annual levels of proportional entrainment were estimated for the remaining scenarios. Consequently, the preliminary proposal scenarios resulted in relatively small changes in average annual entrainment losses relative to the baseline scenarios, ranging from a decrease of 0.05 (0.5%) (e.g., EBC2_LLT vs. PP_LLT in wet years) to an increase of 0.01 (1%) (e.g., EBC1 vs. PP_LLT in dry years). The percentage of years in which 5% or more of the population is estimated to be entrained under the EBC scenarios was 46–50%, compared to 57–60% under the preliminary proposal scenarios (Figure B-46). The percentage of years in which 10% or more of the population is estimated to be entrained under the EBC scenarios was 8–9%, compared to 8–12% under the preliminary proposal scenarios.

Table B-148. Average Estimated Change in Annual Proportional Loss of Juvenile and Larval Delta Smelt at SWP/CVP South Delta Export Facilities by Water-Year Type for the Six Study Scenarios, Using Estimates Based on Miller (2011) (Assuming Historical Increase in Southeast Delta Secchi Depths Continues in the Future)

WY Type	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
All	0.0035 (7%)	0.0031 (6%)	0.0027 (5%)	0.0023 (4%)	0.0021 (4%)	-0.0009 (-2%)
Wet	0.0008 (6%)	0.002 (13%)	0.0001 (1%)	0.0012 (8%)	-0.002 (-11%)	-0.0059 (-26%)
Above Normal	-0.0009 (-3%)	0.0023 (8%)	-0.0018 (-6%)	0.0014 (4%)	-0.0026 (-8%)	-0.0054 (-14%)
Below Normal	0.009 (16%)	0.007 (13%)	0.0082 (15%)	0.0062 (11%)	0.0074 (13%)	0.0018 (3%)
Dry	0.0098 (13%)	0.0059 (8%)	0.0088 (12%)	0.0049 (6%)	0.0073 (9%)	0.0052 (7%)
Critical	-0.0025 (-3%)	-0.0026 (-3%)	-0.0032 (-3%)	-0.0033 (-3%)	0.0008 (1%)	0.0022 (2%)

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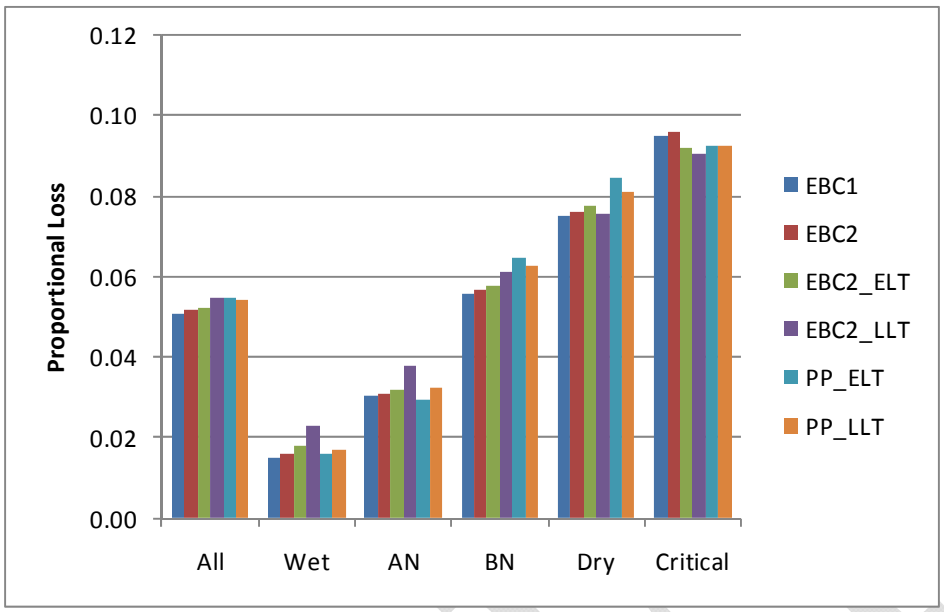

Figure B-45. Average Annual Estimated Proportion of the Larval-Juvenile Delta Smelt Population Lost to Entrainment at the SWP/CVP South Delta Export Facilities by Water-Year Type and All Years Combined for the Six Study Scenarios (Assuming Historical Increase in Southeast Delta Secchi Depths Continues in the Future)

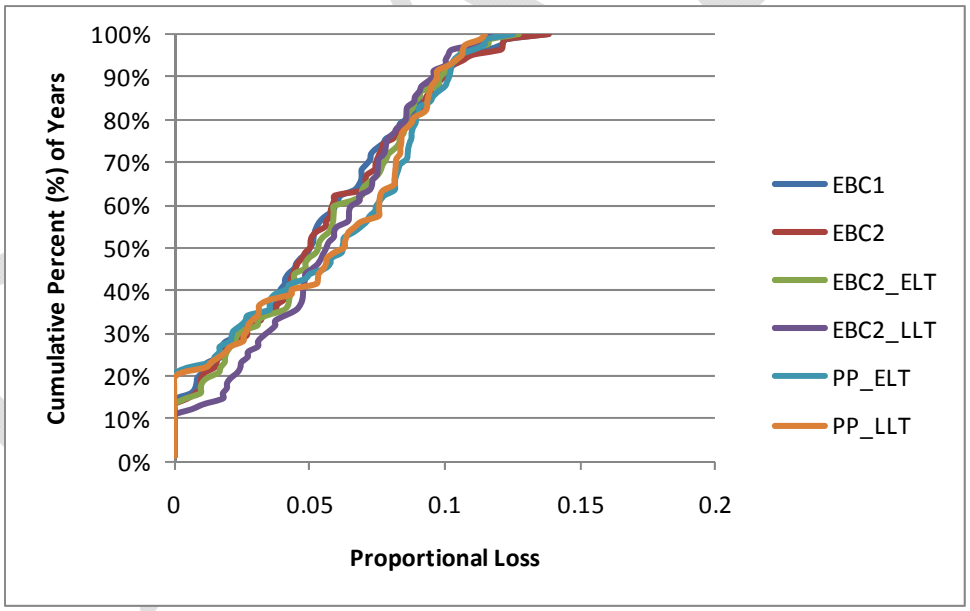

Figure B-46. Estimated Annual Proportional Loss of Larval-Juvenile Delta Smelt at SWP/CVP South Delta Export Facilities by Cumulative Percentage of Years for the Six Study Scenarios (Assuming Historical Increase in Southeast Delta Secchi Depths Continues in the Future)

Assumption 2: Secchi Depths Remain at 2010 Levels

Under this assumption, the relative differences in estimated average larval-juvenile entrainment among water years and scenarios were exactly the same as those based on the previous assumption (Figure B-47 and Figure B-45; Table B-148 and Table B-149). However, maintaining Secchi depth values at 2010 levels resulted in estimates that were very similar or 0.01 (1%) higher than those based on a continued increase in Secchi depths over time. The percentage of years in which 5% or more of the population is estimated to be entrained under the EBC scenarios was 49–65%, compared to 57–58% under the preliminary proposal scenarios (Figure B-48). The percentage of years in which 10% or more of the population is estimated to be entrained under the EBC scenarios was 7–13%, compared to 15–18% under the preliminary proposal scenarios.

Table B-149. Average Estimated Change in Annual Proportional Loss of Juvenile and Larval Delta Smelt at SWP/CVP South Delta Export Facilities by Water-Year Type for the Six Study Scenarios, Using Estimates Based on Miller (2011) (Assuming Southeast Delta Secchi Depths Remain at 2010 Levels)

WY Type	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
All	0.0063 (12%)	0.0094 (18%)	0.0055 (11%)	0.0085 (16%)	0.0022 (4%)	-0.001 (-2%)
Wet	0.0017 (11%)	0.0041 (27%)	0.001 (6%)	0.0034 (21%)	-0.0021 (-11%)	-0.0067 (-26%)
Above Normal	0.0007 (2%)	0.0064 (21%)	-0.0003 (-1%)	0.0055 (18%)	-0.0027 (-8%)	-0.0062 (-14%)
Below Normal	0.0124 (22%)	0.0145 (26%)	0.0116 (20%)	0.0137 (24%)	0.0078 (13%)	0.002 (3%)
Dry	0.0141 (19%)	0.0151 (20%)	0.0132 (17%)	0.0141 (19%)	0.0077 (9%)	0.0058 (7%)
Critical	0.0022 (2%)	0.0073 (8%)	0.0015 (2%)	0.0066 (7%)	0.0009 (1%)	0.0025 (2%)

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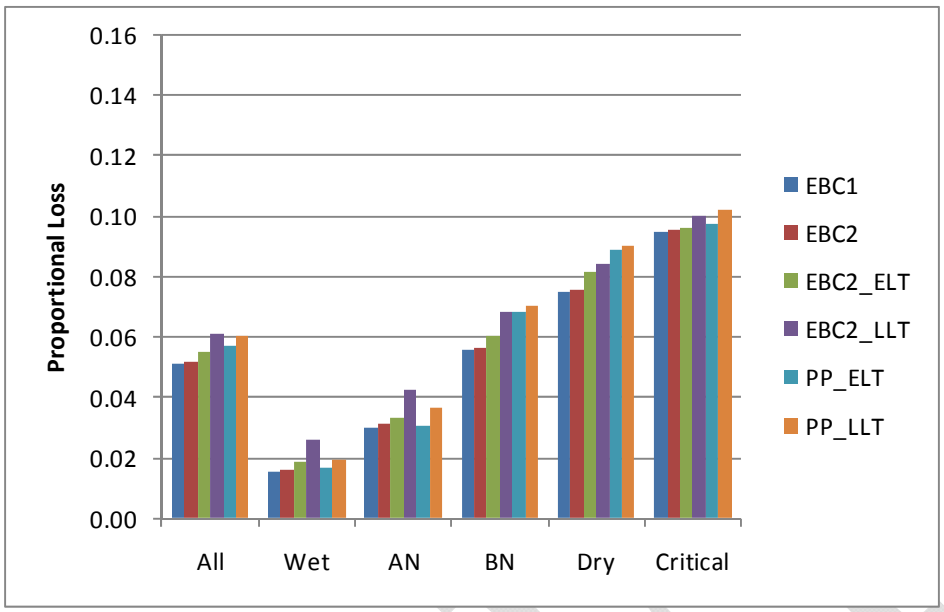

Figure B-47. Average Annual Estimated Proportion of the Larval-Juvenile Delta Smelt Population Lost to Entrainment at the SWP/CVP South Delta Export Facilities by Water-Year Type and All Years Combined for the Six Study Scenarios (Assuming Southeast Delta Secchi Depths Remain at 2010 Levels)

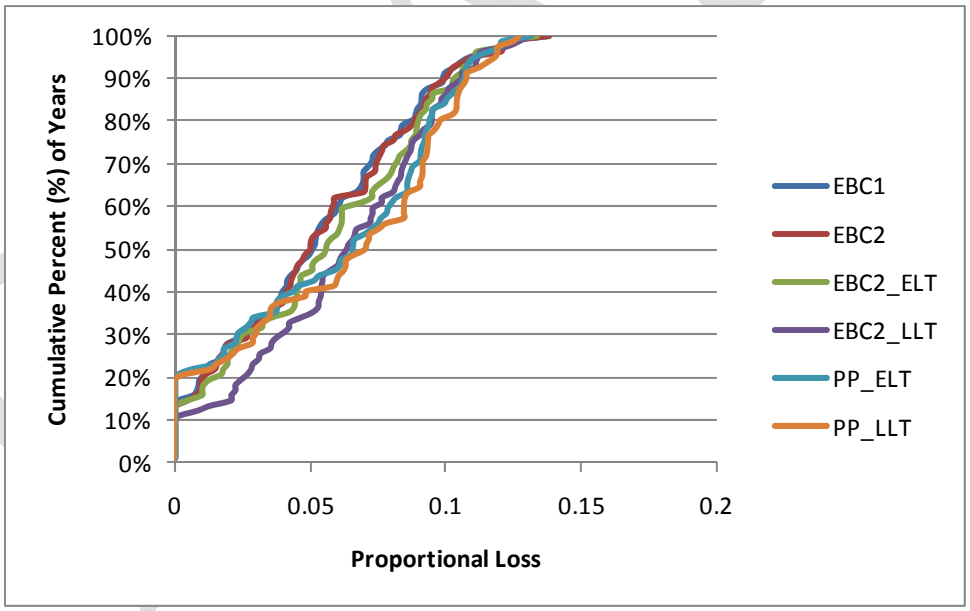

Figure B-48. Estimated Annual Proportional Loss of Larval-Juvenile Delta Smelt at SWP/CVP South Delta Export Facilities by Cumulative Percentage of Years for the Six Study Scenarios (Assuming Southeast Delta Secchi Depths Remain at 2010 Levels)

Assumption 3: Secchi Depths Remain at 1990 Levels

The results of applying this assumption gave relative differences between scenarios that were exactly the same but the magnitude of the larval-juvenile entrainment estimates was slightly

greater (Figure B-49). Maintaining Secchi depth values at 1990 levels resulted in average annual entrainment values that were <0.01 (<1%) higher than those based on maintaining Secchi depths at 2010 levels, and 0.01–0.03% lower than those based on a continued increase in Secchi depths over time. The percentage of years in which 5% or more of the population is estimated to be entrained under the EBC scenarios was 52–66%, compared to 57–61% under the preliminary proposal scenarios (Figure B-50). The percentage of years in which 10% or more of the population is estimated to be entrained under the EBC scenarios was 12–21%, compared to 21–27% under the preliminary proposal scenarios.

Table B-150. Average Estimated Change in Annual Proportional Loss of Juvenile and Larval Delta Smelt at SWP/CVP South Delta Export Facilities by Water-Year Type for the Six Study Scenarios, Using Estimates Based on Miller (2011) (Assuming Southeast Delta Secchi Depths Remain at 1990 Levels)

WY Type	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
All	0.0068 (12%)	0.0101 (18%)	0.0059 (11%)	0.0092 (16%)	0.0023 (4%)	-0.0011 (-2%)
Wet	0.0018 (11%)	0.0044 (27%)	0.001 (6%)	0.0036 (21%)	-0.0023 (-11%)	-0.0072 (-26%)
Above Normal	0.0007 (2%)	0.0069 (21%)	-0.0003 (-1%)	0.0059 (18%)	-0.0029 (-8%)	-0.0067 (-14%)
Below Normal	0.0134 (22%)	0.0156 (26%)	0.0125 (21%)	0.0148 (24%)	0.0084 (13%)	0.0022 (3%)
Dry	0.0152 (19%)	0.0163 (20%)	0.0142 (17%)	0.0152 (19%)	0.0083 (9%)	0.0063 (7%)
Critical	0.0024 (2%)	0.0079 (8%)	0.0016 (2%)	0.0071 (7%)	0.0009 (1%)	0.0027 (2%)

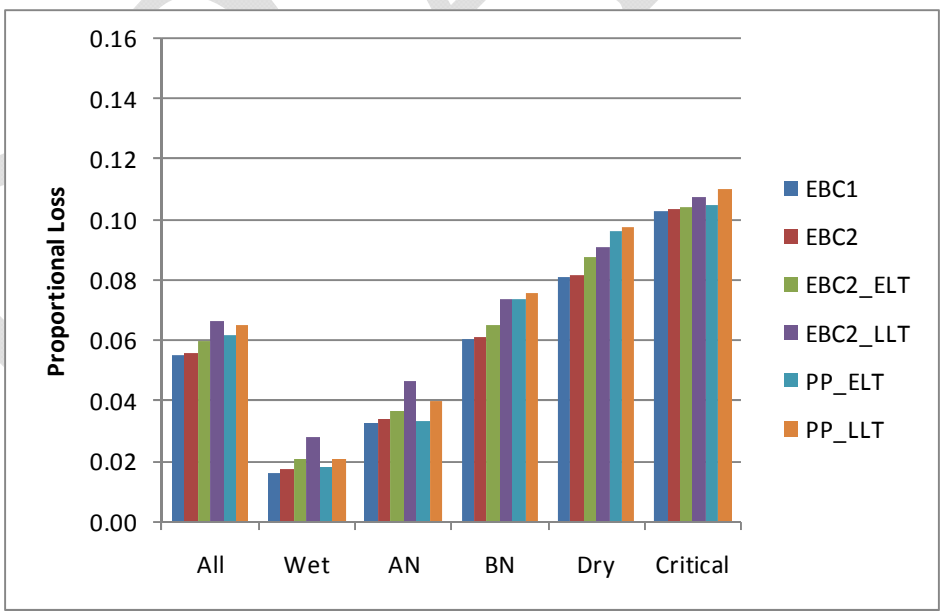

Figure B-49. Average Annual Estimated Proportion of the Larval-Juvenile Delta Smelt Population Lost to Entrainment at the SWP/CVP South Delta Export Facilities by Water-Year Type and All Years Combined for the Six Study Scenarios (Assuming Southeast Delta Secchi Depths Remain at 1990 Levels)

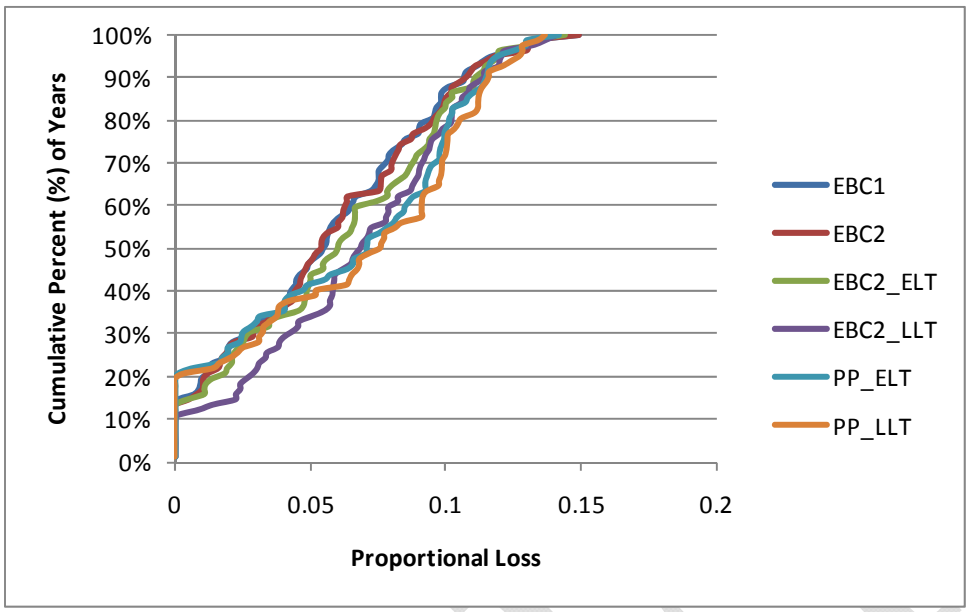

Figure B-50. Estimated Annual Proportional Loss of Larval-Juvenile Delta Smelt at SWP/CVP South Delta Export Facilities by Cumulative Percentage of Years for the Six Study Scenarios (Assuming Southeast Delta Secchi Depths Remain at 1990 Levels)

B.4.1.5.3 Adult

Salvage-Density Method

Estimated entrainment loss of adult delta smelt in December–April was higher at the SWP south Delta export facilities than at the CVP south Delta export facilities, generally by an order of magnitude or less (Table B-151to Table B-156). Entrainment loss was greatest during above normal and below normal water years, when tens of fish per month were estimated to be entrained at the SWP facility. Entrainment loss during other years was estimated to be considerably lower. Across all water years, the estimated reduction in entrainment loss under PP scenarios relative to EBC scenarios averaged just under 20 fish per year (~50% reduction) (Table B-157). By water-year type, the greatest reductions under PP scenarios relative to EBC scenarios were in above normal years (45–50 fish per year; ~50% reduction), and although the absolute changes in number of fish entrained were similar in wet and below normal years (15–20 fish reduction under PP scenarios), the percentage reduction was considerably greater in wet years (88–90%) than below normal years (29–37%) (Table B-158, Table B-159, and Table B-160). During dry and critical water years it was estimated that very few adult delta smelt would be entrained, so the differences between EBC and PP scenarios were very low (Table B-161 and Table B-162).

Table B-151. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI]) of Adult Delta Smelt for Six Model Scenarios at the SWP and CVP Salvage Facilities in December–April for All Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
December	5	±	1	5	±	1	5	±	1	5	±	1	4	±	1	4	±	1
January	14	±	2	14	±	2	14	±	2	14	±	2	8	±	1	6	±	1
February	6	±	0	6	±	0	6	±	0	5	±	0	2	±	0	2	±	0
March	4	±	0	4	±	0	4	±	0	3	±	0	1	±	0	1	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
(b) CVP																		
December	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
January	3	±	0	3	±	0	3	±	0	2	±	0	1	±	0	1	±	0
February	2	±	0	2	±	0	2	±	0	2	±	0	1	±	0	1	±	0
March	3	±	0	3	±	0	3	±	0	3	±	0	1	±	0	1	±	0
April	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0

Table B-152. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI]) of Adult Delta Smelt for Six Model Scenarios at the SWP and CVP Salvage Facilities in December–April for Wet Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
December	1	±	0	1	±	0	1	±	0	1	±	0	0	±	0	0	±	0
January	3	±	1	3	±	1	3	±	1	3	±	1	0	±	0	0	±	0
February	5	±	1	5	±	1	5	±	1	4	±	1	0	±	0	0	±	0
March	3	±	1	3	±	1	3	±	1	3	±	1	0	±	0	0	±	0
April	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
(b) CVP																		
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	1	±	0	1	±	0	1	±	0	1	±	0	0	±	N/A	0	±	0
March	3	±	1	3	±	1	3	±	1	3	±	1	0	±	N/A	0	±	0
April	1	±	0	1	±	0	1	±	0	1	±	0	0	±	0	0	±	0

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Table B-153. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI]) of Adult Delta Smelt for Six Model Scenarios at the SWP and CVP Salvage Facilities in December–April for Above Normal Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
December	22	±	11	23	±	11	22	±	11	22	±	11	18	±	9	21	±	11
January	45	±	18	45	±	18	51	±	22	49	±	21	21	±	12	19	±	11
February	14	±	2	14	±	2	14	±	2	14	±	2	2	±	1	2	±	1
March	3	±	1	2	±	1	3	±	1	3	±	1	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
(b) CVP																		
December	2	±	1	2	±	1	2	±	1	2	±	1	1	±	1	1	±	1
January	4	±	1	4	±	1	3	±	1	4	±	1	2	±	1	2	±	1
February	1	±	0	1	±	0	1	±	0	1	±	0	0	±	0	0	±	0
March	1	±	0	1	±	0	1	±	0	1	±	0	0	±	0	0	±	0
April	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0

Table B-154. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI]) of Adult Delta Smelt for Six Model Scenarios at the SWP and CVP Salvage Facilities in December–April for Below Normal Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	26	±	3	26	±	3	28	±	5	26	±	6	25	±	8	21	±	7
February	7	±	2	7	±	2	7	±	2	6	±	2	2	±	1	3	±	2
March	14	±	3	14	±	3	14	±	3	13	±	3	7	±	3	5	±	2
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
(b) CVP																		
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	3	±	0	3	±	0	3	±	0	3	±	0	2	±	1	2	±	1
February	1	±	0	1	±	0	1	±	0	1	±	0	0	±	0	0	±	0
March	2	±	0	2	±	0	2	±	0	2	±	0	1	±	1	1	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	1	±	0	1	±	0

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Table B-155. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI]) of Adult Delta Smelt for Six Model Scenarios at the SWP and CVP Salvage Facilities in December–April for Dry Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
December	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
January	3	±	1	3	±	1	3	±	1	3	±	1	3	±	1	2	±	1
February	1	±	1	1	±	1	1	±	0	1	±	0	1	±	1	1	±	1
March	2	±	0	2	±	0	2	±	0	2	±	0	2	±	0	1	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
(b) CVP																		
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	1	±	0	1	±	0	1	±	0	1	±	0	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0

Table B-156. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI]) of Adult Delta Smelt for Six Model Scenarios at the SWP and CVP Salvage Facilities in December–April for Critical Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	2	±	0	2	±	0	1	±	0	1	±	0	2	±	0	1	±	0
February	5	±	1	5	±	1	5	±	1	5	±	1	6	±	2	6	±	1
March	3	±	1	3	±	1	3	±	1	3	±	1	3	±	1	3	±	1
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
(b) CVP																		
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	0	±	0
February	3	±	1	3	±	1	3	±	1	2	±	1	2	±	0	2	±	1
March	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0

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Table B-157. Estimated Absolute and Percent Differences between Model Scenarios in Adult Delta Smelt Entrainment Index (Number of Fish Lost) at the SWP and CVP Salvage Facilities in December–April during All Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
December	-1 (-19%)	-1 (-16%)	-1 (-21%)	-1 (-17%)	-1 (-19%)	-1 (-12%)
January	-7 (-42%)	-9 (-54%)	-7 (-43%)	-9 (-55%)	-7 (-44%)	-9 (-55%)
February	-5 (-66%)	-5 (-65%)	-5 (-66%)	-5 (-65%)	-5 (-67%)	-5 (-64%)
March	-5 (-71%)	-5 (-75%)	-5 (-72%)	-5 (-75%)	-5 (-71%)	-5 (-74%)
April	0 (23%)	0 (15%)	0 (22%)	0 (14%)	0 (17%)	0 (8%)
Annual Average	-18 (-47%)	-20 (-52%)	-18 (-48%)	-20 (-53%)	-18 (-48%)	-19 (-52%)

Table B-158. Estimated Absolute and Percent Differences between Model Scenarios in Adult Delta Smelt Entrainment Index (Number of Fish Lost) at the SWP and CVP Salvage Facilities in December–April during Wet Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
December	0 (-43%)	0 (-38%)	0 (-44%)	0 (-40%)	0 (-46%)	0 (-42%)
January	-3 (-87%)	-3 (-85%)	-3 (-87%)	-3 (-86%)	-3 (-88%)	-3 (-86%)
February	-6 (-99%)	-6 (-98%)	-6 (-99%)	-6 (-98%)	-6 (-99%)	-6 (-98%)
March	-6 (-98%)	-6 (-95%)	-7 (-98%)	-6 (-95%)	-7 (-98%)	-6 (-95%)
April	-1 (-43%)	-1 (-43%)	-1 (-44%)	-1 (-45%)	-1 (-45%)	-1 (-47%)
Annual Average	-16 (-89%)	-15 (-88%)	-16 (-90%)	-16 (-88%)	-16 (-90%)	-16 (-88%)

Table B-159. Estimated Absolute and Percent Differences between Model Scenarios in Adult Delta Smelt Entrainment Index (Number of Fish Lost) at the SWP and CVP Salvage Facilities in December–April during Above Normal Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
December	-4 (-18%)	-2 (-7%)	-6 (-23%)	-3 (-12%)	-5 (-20%)	-2 (-9%)
January	-26 (-52%)	-28 (-57%)	-25 (-52%)	-28 (-57%)	-31 (-57%)	-32 (-61%)
February	-13 (-83%)	-13 (-83%)	-13 (-83%)	-13 (-83%)	-13 (-83%)	-13 (-83%)
March	-3 (-86%)	-3 (-93%)	-3 (-86%)	-3 (-93%)	-3 (-86%)	-3 (-93%)
April	0 (30%)	0 (12%)	0 (30%)	0 (12%)	0 (24%)	0 (0%)
Annual Average	-45 (-49%)	-45 (-49%)	-46 (-50%)	-47 (-50%)	-51 (-52%)	-50 (-52%)

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Table B-160. Estimated Absolute and Percent Differences between Model Scenarios in Adult Delta Smelt Entrainment Index (Number of Fish Lost) at the SWP and CVP Salvage Facilities in December–April during Below Normal Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
December	0 (-20%)	0 (-18%)	0 (-21%)	0 (-19%)	0 (-20%)	0 (-13%)
January	-2 (-8%)	-6 (-20%)	-2 (-8%)	-6 (-20%)	-4 (-12%)	-5 (-17%)
February	-5 (-67%)	-4 (-56%)	-5 (-67%)	-4 (-56%)	-6 (-68%)	-4 (-52%)
March	-8 (-52%)	-10 (-61%)	-8 (-51%)	-10 (-61%)	-8 (-52%)	-9 (-59%)
April	0 (97%)	0 (88%)	0 (97%)	0 (88%)	0 (85%)	0 (67%)
Annual Average	-15 (-29%)	-20 (-37%)	-16 (-29%)	-20 (-37%)	-17 (-31%)	-17 (-33%)

Table B-161. Estimated Absolute and Percent Differences between Model Scenarios in Adult Delta Smelt Entrainment Index (Number of Fish Lost) at the SWP and CVP Salvage Facilities in December–April during Dry Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
December	0 (4%)	0 (4%)	0 (-1%)	0 (-1%)	0 (3%)	0 (7%)
January	0 (1%)	-1 (-19%)	0 (3%)	-1 (-18%)	0 (3%)	-1 (-20%)
February	0 (-9%)	0 (-13%)	0 (-8%)	0 (-12%)	0 (-5%)	0 (-1%)
March	0 (-8%)	0 (-24%)	0 (-9%)	-1 (-26%)	0 (-3%)	0 (-18%)
April	0 (108%)	0 (89%)	0 (103%)	0 (84%)	0 (83%)	0 (75%)
Annual Average	0 (0%)	-1 (-13%)	0 (0%)	-1 (-13%)	0 (3%)	-1 (-9%)

Table B-162. Estimated Absolute and Percent Differences between Model Scenarios in Adult Delta Smelt Entrainment Index (Number of Fish Lost) at the SWP and CVP Salvage Facilities in December–April during Critical Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
December	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
January	0 (-3%)	-1 (-53%)	0 (-2%)	-1 (-53%)	0 (10%)	-1 (-49%)
February	0 (2%)	0 (0%)	0 (-4%)	0 (-6%)	0 (0%)	0 (5%)
March	-1 (-14%)	-1 (-19%)	0 (-8%)	-1 (-13%)	0 (-4%)	0 (-4%)
April	0 (17%)	0 (12%)	0 (17%)	0 (11%)	0 (26%)	0 (30%)
Annual Average	0 (-3%)	-2 (-14%)	-1 (-5%)	-2 (-15%)	0 (1%)	-1 (-6%)

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Proportional Loss Equations

ESTIMATES OF PROPORTIONAL LOSS BASED ON KIMMERER (2008)

The estimated proportion of the adult delta smelt population lost at the SWP/CVP south Delta export facilities, as estimated from the regression equation described in Section B.5.4.1.1 using CALSIM estimates of average December–April OMR flows, is given in Figure B-51 for each of the scenarios. The annual average proportion of adults lost under the EBC scenarios ranged from around 0.075 (wet years) to nearly 0.10 (dry years), and averages between 0.08 and 0.09 across all years. The proportional loss is estimated to be appreciably lower under PP than EBC across all time periods, with PP loss ranging from around 0.03 in wet years to between 0.09 and 0.10 in dry years. The percentage of years in which 0.05 (5%) or more of the population is estimated to be lost was 93–95% under EBC scenarios, whereas this threshold was estimated to be exceeded in 65–68% of year under PP scenarios (Figure B-52). The percentage of years in which 0.10 (10%) or more of the population is estimated to be lost was 20–25% under EBC scenarios, 10% of years under PP_ELT, and 5% of years under PP_LLT (Figure B-52).

Across all water years, PP changes in average annual proportional loss are estimated to be reductions of around 36–47% from EBC, with ranges from 61–64% reductions in wet years to minimal reductions (1–7%) in dry years (Table B-163).

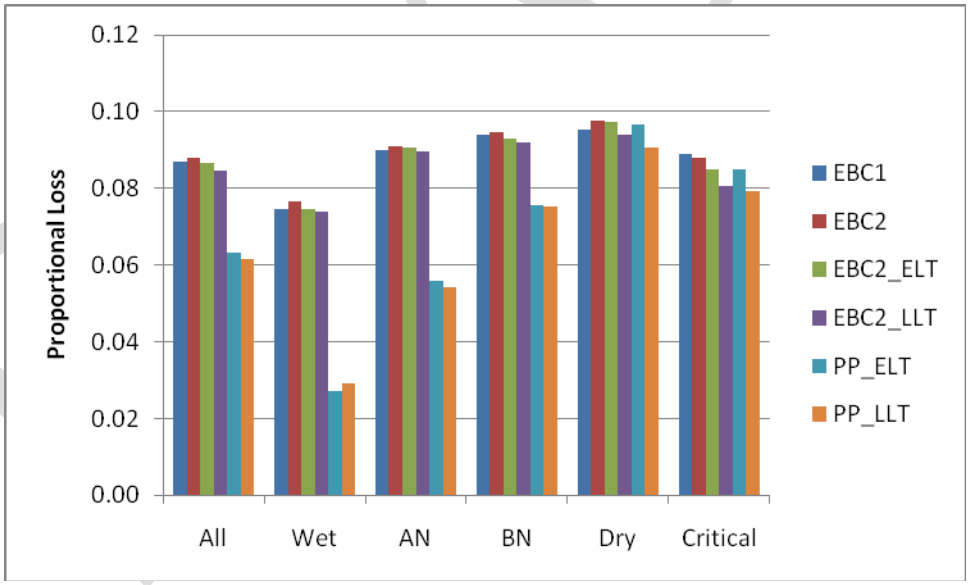

Figure B-51. Annual Average Estimated Proportion of the Adult Delta Smelt Population Lost to Entrainment at the SWP/CVP South Delta Export Facilities by Water-Year Type and All Years Combined for the Six Study Scenarios

Table B-163. Average Change in Estimated Annual Proportional Loss of Adult Delta Smelt at SWP/CVP South Delta Pumps by Water-Year Type for the Six Study Scenarios

WY Type	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
All	-0.0234 (-27%)	-0.0254 (-29%)	-0.0246 (-28%)	-0.0266 (-30%)	-0.0233 (-27%)	-0.0233 (-28%)
Wet	-0.0473 (-63%)	-0.0455 (-61%)	-0.0493 (-64%)	-0.0476 (-62%)	-0.0473 (-63%)	-0.045 (-61%)
Above Normal	-0.0341 (-38%)	-0.0357 (-40%)	-0.035 (-38%)	-0.0366 (-40%)	-0.0346 (-38%)	-0.0355 (-40%)
Below Normal	-0.0185 (-20%)	-0.0188 (-20%)	-0.0191 (-20%)	-0.0194 (-21%)	-0.0177 (-19%)	-0.017 (-18%)
Dry	0.0013 (1%)	-0.0048 (-5%)	-0.0008 (-1%)	-0.0069 (-7%)	-0.0007 (-1%)	-0.0034 (-4%)
Critical	-0.004 (-4%)	-0.0097 (-11%)	-0.0031 (-4%)	-0.0088 (-10%)	-0.0002 (0%)	-0.0015 (-2%)

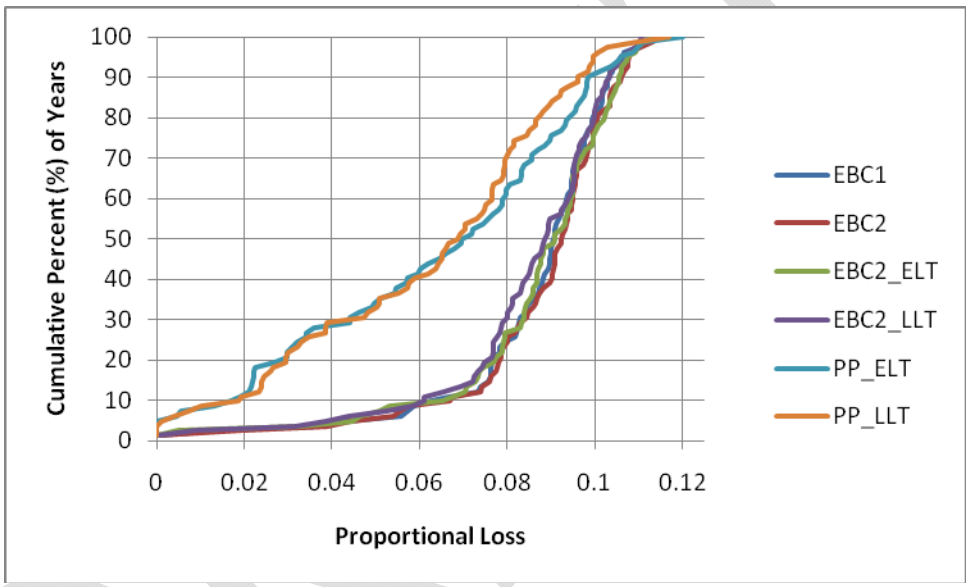

Figure B-52. Estimated Annual Proportional Loss of Adult Delta Smelt at SWP/CVP South Delta Export Facilities by Cumulative Percentage of Years for the Six Study Scenarios

ESTIMATES OF PROPORTIONAL LOSS BASED ON MILLER (2011)

The following describes the results of applying the "adjusted Kimmerer approach" (Miller 2011) to the six study scenarios based on three assumptions regarding future trends in Secchi depths in the southeast Delta.

Assumption 1: Historical Trends in Secchi Depths Continue

Under this assumption, adult entrainment losses were limited to wet and above normal years of EBC1 and EBC2 (Figure B-53; Table B-164). No entrainment losses would be expected to occur for EBC2_ELT, EBC2_LLT, PP_ELT, or PP_LLT. Estimated average annual entrainment estimates for EBC1 and EBC2 ranged from 0–0.02 (0–2%). Annual entrainment losses ranged from 0–5% with <1% of the years with losses of 5% (Figure B-54).

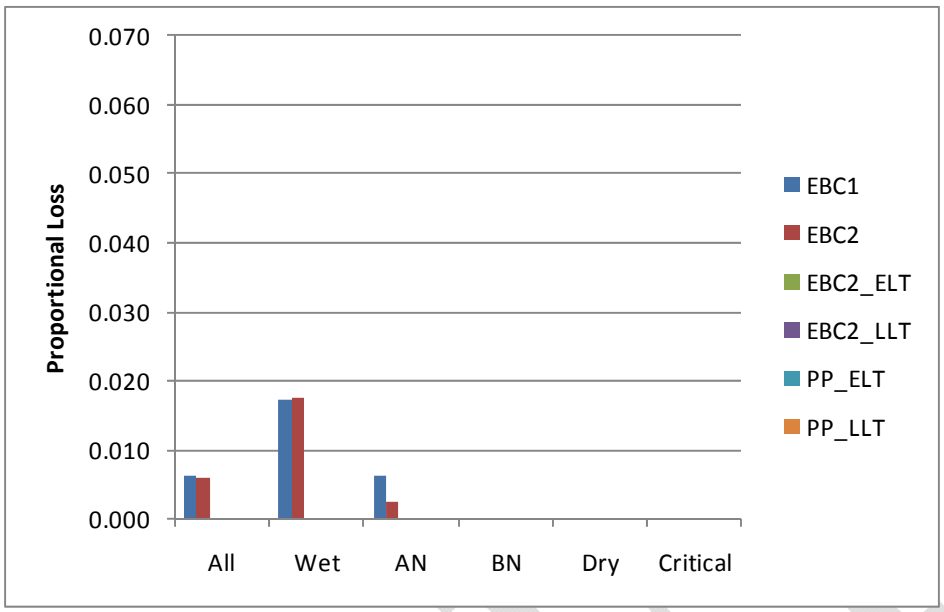

Figure B-53. Average Annual Estimated Proportion of the Adult Delta Smelt Population Lost to Entrainment at the SWP/CVP South Delta Export Facilities by Water-Year Type and All Years Combined for the Six Study Scenarios (Assuming Historical Increase in Southeast Delta Secchi Depths Continues in the Future)

Table B-164. Average Estimated Change in Annual Proportional Loss of Adult Delta Smelt at SWP/CVP South Delta Export Facilities by Water-Year Type for the Six Study Scenarios, Using Estimates Based on Miller (2011) (Assuming Historical Increase in Southeast Delta Secchi Depths Continues in the Future)

WY Type	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
All	-0.0064 (-100%)	-0.0064 (-100%)	-0.0059 (-100%)	-0.0059 (-100%)	0.000	0.000
Wet	-0.0173 (-100%)	-0.0173 (-100%)	-0.0175 (-100%)	-0.0175 (-100%)	0.000	0.000
Above Normal	-0.0062 (-100%)	-0.0062 (-100%)	-0.0024 (-100%)	-0.0024 (-100%)	0.000	0.000
Below Normal	0.000	0.000	0.000	0.000	0.000	0.000
Dry	0.000	0.000	0.000	0.000	0.000	0.000
Critical	0.000	0.000	0.000	0.000	0.000	0.000

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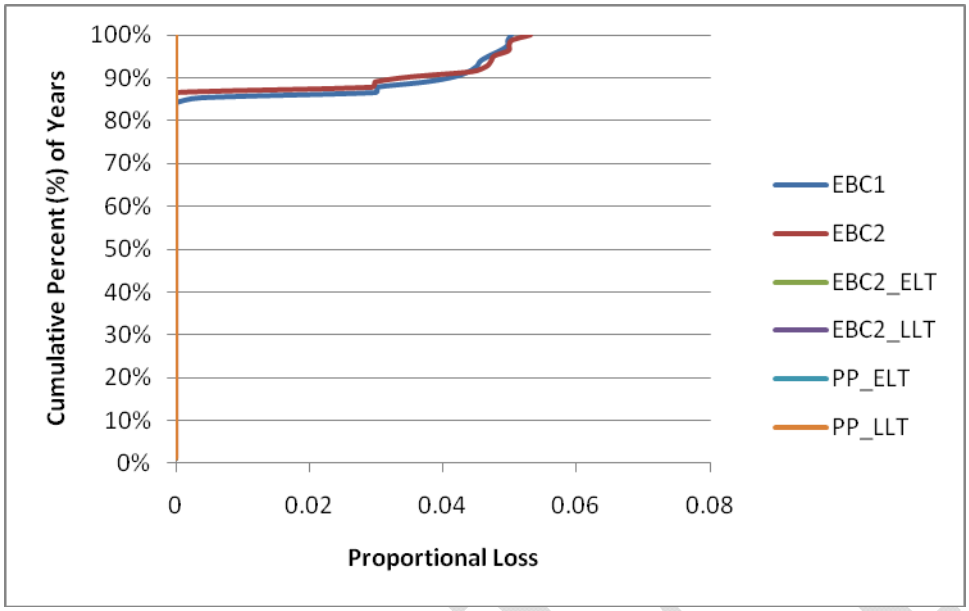

Figure B-54. Estimated Annual Proportional Loss of Adult Delta Smelt at SWP/CVP South Delta Export Facilities by Cumulative Percentage of Years for the Six Study Scenarios (Assuming Historical Increase in Southeast Delta Secchi Depths Continues in the Future)

Assumption 2: Secchi Depths Remain at 2010 Levels

Under this assumption, estimated adult entrainment losses were limited to wet and above normal years of the baseline and preliminary proposal scenarios (Figure B-55). As expected, estimated entrainment losses for EBC1 and EBC2 were identical to those based on the previous assumption of increasing Secchi depths over time (starting at 2010 levels). Estimated average annual entrainment losses for all EBC scenarios ranged from 0–0.02 (0–2%), with the highest losses occurring in wet years. Estimated average annual entrainment losses for the preliminary proposal scenarios were very small in both wet and above normal years (<1%). Thus losses under the preliminary proposal were less than under EBC scenarios (Table B-165). The percentage of years in which 5% or more of the adult population is estimated to be entrained under the baseline scenarios was <5%, while annual losses of adults under the preliminary proposal scenarios were less than 5% in all years (Figure B-56).

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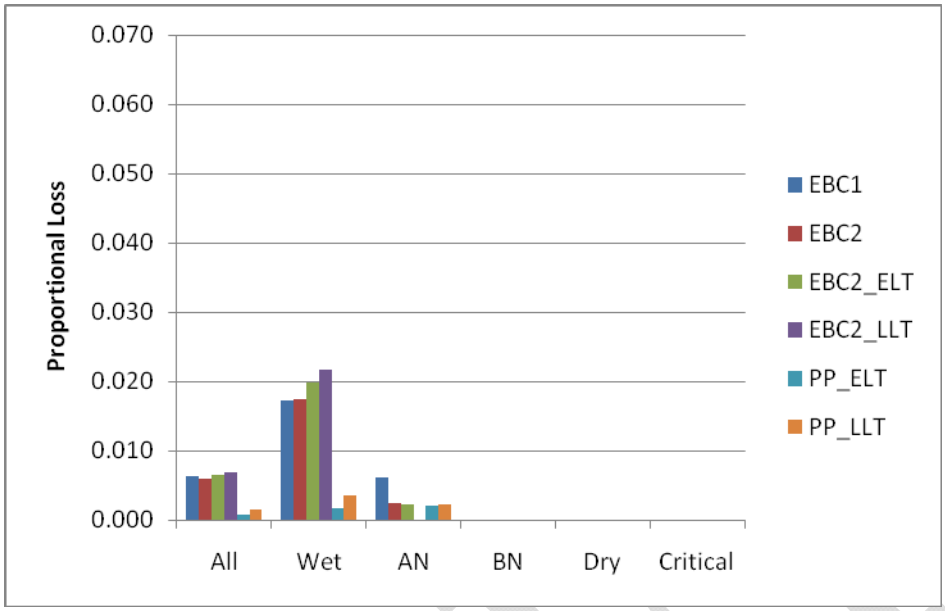

Figure B-55. Average Annual Estimated Proportion of the Adult Delta Smelt Population Lost to Entrainment at the SWP/CVP South Delta Export Facilities by Water-Year Type and All Years Combined for the Six Study Scenarios (Assuming Southeast Delta Secchi Depths Remain at 2010 Levels)

Table B-165. Average Estimated Change in Annual Proportional Loss of Adult Delta Smelt at SWP/CVP South Delta Export Facilities by Water-Year Type for the Six Study Scenarios, Using Estimates Based on Miller (2011) (Assuming Southeast Delta Secchi Depths Remain at 2010 Levels)

WY Type	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
All	-0.0056 (-87%)	-0.0049 (-77%)	-0.0051 (-86%)	-0.0044 (-75%)	-0.0058 (-88%)	-0.0054 (-79%)
Wet	-0.0157 (-91%)	-0.0137 (-79%)	-0.0159 (-91%)	-0.0139 (-79%)	-0.0182 (-92%)	-0.0181 (-84%)
Above Normal	-0.0041 (-67%)	-0.004 (-65%)	-0.0004 (-16%)	-0.0003 (-10%)	-0.0001 (-6%)	0.002
Below Normal	0.000	0.000	0.000	0.000	0.000	0.000
Dry	0.000	0.000	0.000	0.000	0.000	0.000
Critical	0.000	0.000	0.000	0.000	0.000	0.000

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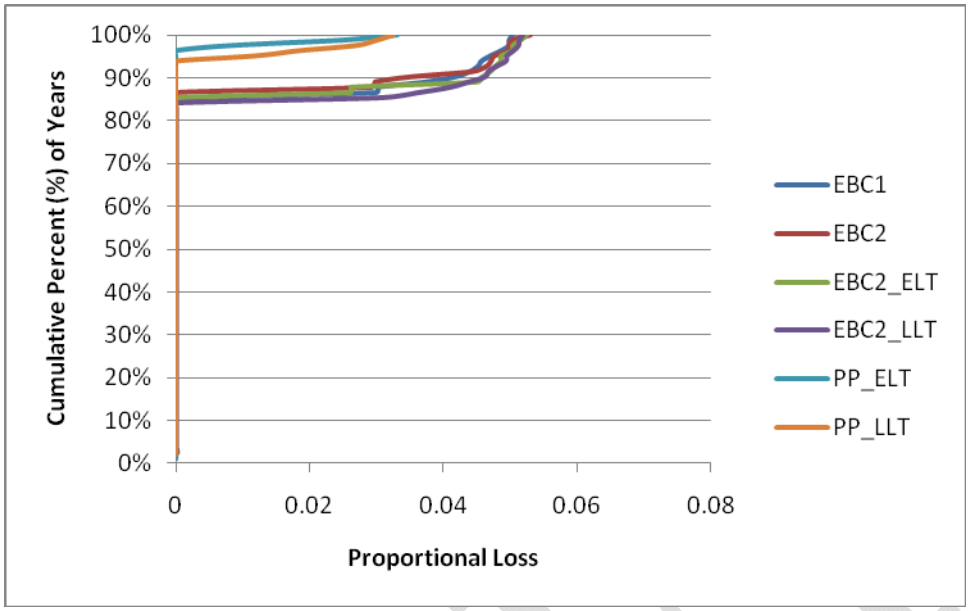

Figure B-56. Estimated Annual Proportional Loss of Adult Delta Smelt at SWP/CVP South Delta Export Facilities by Cumulative Percentage of Years for the Six Study Scenarios (Assuming Southeast Delta Secchi Depths Remain at 2010 Levels)

Assumption 3: Secchi Depths Remain at 1990 Levels

Under this assumption, estimated adult entrainment losses were substantially higher than those based on the previous turbidity assumptions because turbidity was higher at the 1990 levels. The relative differences in average annual entrainment losses among the scenarios varied with water year and were lower under preliminary proposal scenarios than existing biological conditions in wet, above normal, and below normal years (Figure B-57; Table B-166). EBC scenarios generally had similar estimated entrainment losses of around 0.05 across all water years, and ranging from 0.02-0.03 in critical water years to 0.06 in above normal water years. Differences in proportional entrainment between PP and EBC scenarios ranged from decreases under PP scenarios of 0.04-0.05 (80% relative difference) in wet years to increases under PP scenarios of less than 0.01 (up to 25% relative difference) in dry and critical years. The percentage of years in which 5% or more of the population is estimated to be entrained was 53–71% for EBC scenarios; and 16–24% for PP_ELT and PP_LLT (Figure B-58). Entrainment estimates of 10% or more occurred in 12% of years under EBC1 and did not occur in any other scenario.

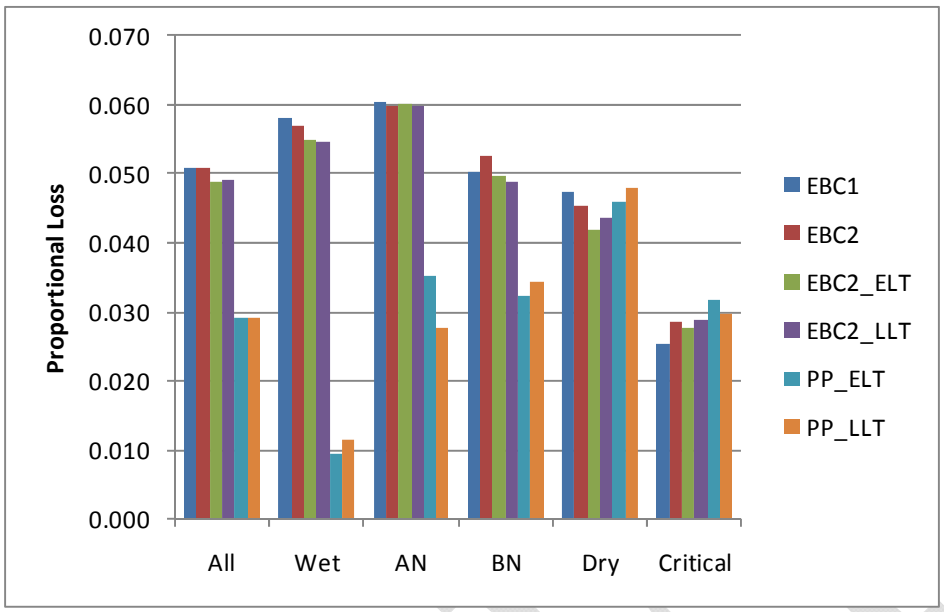

Figure B-57. Average Annual Estimated Proportion of the Adult Delta Smelt Population Lost to Entrainment at the SWP/CVP South Delta Export Facilities by Water-Year Type and All Years Combined for the Six Study Scenarios (Assuming Southeast Delta Secchi Depths Remain at 1990 Levels)

Table B-166. Average Estimated Change in Annual Proportional Loss of Adult Delta Smelt at SWP/CVP South Delta Export Facilities by Water-Year Type for the Six Study Scenarios, Using Estimates Based on Miller (2011) (Assuming Southeast Delta Secchi Depths Remain at 1990 Levels)

WY Type	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
All	-0.0218 (-43%)	-0.0216 (-43%)	-0.0218 (-43%)	-0.0216 (-42%)	-0.0198 (-40%)	-0.0198 (-40%)
Wet	-0.0488 (-84%)	-0.0467 (-80%)	-0.0474 (-83%)	-0.0454 (-80%)	-0.0456 (-83%)	-0.0431 (-79%)
Above Normal	-0.0253 (-42%)	-0.0327 (-54%)	-0.0248 (-41%)	-0.0322 (-54%)	-0.0249 (-42%)	-0.032 (-54%)
Below Normal	-0.018 (-36%)	-0.0159 (-32%)	-0.0202 (-38%)	-0.0181 (-34%)	-0.0173 (-35%)	-0.0142 (-29%)
Dry	-0.0014 (-3%)	0.0007 (1%)	0.0006 (1%)	0.0026 (6%)	0.004 (10%)	0.0044 (10%)
Critical	0.0063 (25%)	0.0045 (18%)	0.003 (11%)	0.0012 (4%)	0.004 (14%)	0.0008 (3%)

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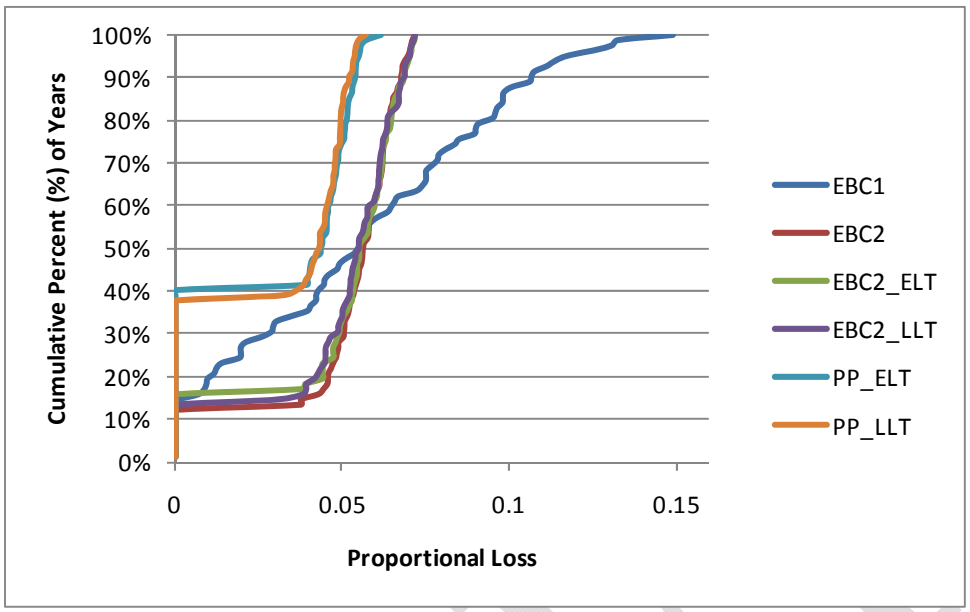

Figure B-58. Estimated Annual Proportional Loss of Adult Delta Smelt at SWP/CVP South Delta Export Facilities by Cumulative Percentage of Years for the Six Study Scenarios (Assuming Southeast Delta Secchi Depths Remain at 1990 Levels)

Manly (2011) Salvage Estimation Equation

The estimates of December–January adult delta smelt salvage from the Manly (2011) equation for the 1975–1991 DSM2 simulation period generally indicate appreciable decreases in salvage under PP scenarios compared to EBC scenarios. Given the complexity of the equation, it is instructive to examine the changes in light of the simulated flows in each year (Table B-167), although note that summarized flows are annual averages of the four 14-day average flow periods actually used in the equations. Three years (1977, 1984, and 1991) had very low or zero salvage under all scenarios (Table B-168). For 1977 and 1991, very low Sacramento River flows presumably would not have caused major increases in turbidity in December–January, so salvage was low. In contrast, salvage in 1984 was estimated to be low because OMR flows were relatively high and positive, regardless of Sacramento River flow being very high (around 70,000 cfs). High Sacramento River flow occurred in 1982, similar to 1984, but salvage was very high under EBC scenarios (around 6,400–7,300 adult delta smelt) for which OMR flows were below -5,000 cfs; under PP scenarios, OMR flows were positive (~190–1,200 cfs) and salvage was reduced by 98% or more (Table B-169). Although the CALSIM/DSM2 modeling aimed to reflect the 2008 USFWS BO pumping restrictions, this may be an example where in actuality the Smelt Working Group would have recommended reduced pumping in order to avoid these low OMR flows.

Another example of substantial (94–98%) reductions in salvage under PP is 1980, for which salvage under EBC scenarios was around 2,000–4,000 adult delta smelt and 80–120 adult delta smelt under PP scenarios. The patterns were attributable to moderately high Sacramento River flows (37,000–38,000 cfs) across all scenarios coupled with very low OMR flows under EBC

(-5,000 to over -7,600 cfs) and less negative OMR flows under PP (-2,000 cfs to nearly -3,300 cfs). Again, it seems likely the Smelt Working Group would have recommended reductions in pumping to increase OMR flows under EBC. The year 1978 offers a similar example, wherein the main difference between EBC and PP scenarios was OMR flows that were just greater than -5,000 cfs for EBC and were -1,300 to -3,500 cfs under PP, with the result that PP salvage was 80–99% lower than salvage under EBC.

A number of years (1975, 1976, 1981, 1988, and 1990) had reductions in salvage from EBC to PP scenarios generally on the order of 15–50%. This group has in common Sacramento River flows of around 14,000–22,000 cfs and OMR flows that were similar between EBC and PP or slightly lower under PP. There were two water years in which estimated salvage was higher under PP than EBC at a time when appreciable numbers of adult delta smelt were being salvaged. These were 1985 (15–20% increases from EBC2_ELT to PP_ELT and EBC2_LLT to PP_LLT) and 1986 (108% increase [150 fish] from EBC2_LLT to PP_LLT). In both years, more negative OMR flows (by 500–1,000 cfs) under PP at levels of -7,000 to -8,000 cfs were the main drivers of these differences.

Removing the three years (1977, 1984, and 1991) with very low or zero salvage under all scenarios, across all years there were average reductions in December–January salvage from EBC scenarios to PP scenarios of 160–780 (30–50%) adult delta smelt per year.

Table B-167. Average Flows (Sacramento River at Freeport/Old and Middle Rivers [cfs]) during the Four 14-Day Flow Periods Used to Estimate Adult Delta Smelt Salvage at SWP/CVP South Delta Export Facilities in December–January of DSM2-Simulated Water Years 1975–1991 for the Six Model Scenarios

Water-Year (Type)	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1975 (W)	16,516/-7,543	15,103/-7,509	15,083/-7,416	14,997/-7,148	15,301/-6,157	14,890/-5,453
1976 (C)	14,714/-7,598	14,360/-7,260	14,258/-7,271	14,129/-7,068	16,680/-6,028	14,092/-5,566
1977 (C)	10,241/-4,467	8,806/-2,706	9,692/-2,633	11,770/-1,761	11,633/-3,518	8,420/-1,785
1978 (AN)	27,082/-4,781	27,378/-4,788	28,502/-4,761	30,501/-4,712	27,436/-3,527	30,674/-1,277
1979 (BN)	15,475/-5,672	17,735/-7,181	17,858/-7,216	18,040/-7,171	15,793/-5,613	17,380/-6,815
1980 (AN)	38,137/-7,092	38,108/-8,045	38,377/-6,513	36,980/-4,975	37,298/-2,013	35,446/-3,273
1981 (D)	15,289/-6,732	14,814/-7,588	14,922/-7,602	15,021/-7,379	14,417/-6,509	15,984/-6,016
1982 (W)	65,770/-5,421	65,649/-5,437	69,153/-5,383	68,135/-5,297	68,618/187	67,738/1,201
1983 (W)	54,741/3,934	54,742/2,058	57,023/2,418	57,715/2,625	54,402/12,687	56,107/13,291
1984 (W)	67,606/3,495	67,710/3,581	72,438/6,201	71,887/4,374	71,127/14,088	70,841/12,710
1985 (D)	20,477/-7,592	19,706/-7,704	19,008/-7,709	17,470/-7,547	20,064/-7,996	18,484/-8,082
1986 (W)	18,623/-6,087	18,548/-6,039	18,730/-5,677	18,507/-5,178	17,733/-5,842	18,379/-6,864
1987 (D)	13,462/-6,604	13,698/-6,752	13,429/-6,567	13,486/-6,476	13,172/-4,472	14,150/-5,208
1988 (C)	21,659/-4,744	21,847/-4,648	21,864/-4,610	22,120/-4,543	20,618/-4,581	20,794/-4,555
1989 (D)	11,037/-4,617	11,663/-5,061	11,630/-4,906	11,227/-3,495	11,528/-4,309	12,311/-2,914
1990 (C)	15,893/-6,036	15,588/-5,660	14,838/-5,244	13,178/-3,381	15,949/-5,193	14,729/-4,001
1991 (C)	7,432/-1,987	8,869/-2,187	7,410/-2,060	6,887/-733	7,380/-2,043	6,742/-630

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Table B-168. Estimated Adult Delta Smelt Salvage at the SWP/CVP South Delta Export Facilities in December–January of DSM2-Simulated Water Years 1975–1991 for the Six Model Scenarios

Water-Year (Type)	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
1975 (W)	210	177	172	156	104	119
1976 (C)	144	151	147	139	101	118
1977 (C)	6	1	1	0	5	0
1978 (AN)	360	368	390	418	74	3
1979 (BN)	117	202	200	196	61	127
1980 (AN)	3191	3853	3211	1937	81	118
1981 (D)	131	149	154	148	89	125
1982 (W)	7217	7276	6420	6644	122	7
1983 (W)	1	85	32	17	0	0
1984 (W)	2	2	0	1	0	0
1985 (D)	696	534	437	323	527	373
1986 (W)	260	263	215	139	162	289
1987 (D)	84	93	80	79	14	34
1988 (C)	92	89	86	85	70	70
1989 (D)	11	20	17	3	8	4
1990 (C)	92	80	61	14	49	12
1991 (C)	0	0	0	0	0	0
Median[1]	117	149	147	139	70	34

[1]The median was used because of the skewed nature of the salvage estimates.

Table B-169. Change in Estimated December–January Salvage of Adult Delta Smelt at SWP/CVP South Delta Pumps in December–January of DSM2-Simulated Water Years 1975–1991 for the Six Model Scenarios

Water-Year (Type)	PP_ELT vs. EBC1	PP_LLT vs. EBC1	PP_ELT vs. EBC2	PP_LLT vs. EBC2	PP_ELT vs. EBC2_ELT	PP_LLT vs. EBC2_LLT
1975 (W)	-106 (-51%)	-91 (-43%)	-73 (-41%)	-58 (-33%)	-68 (-40%)	-37 (-24%)
1976 (C)	-43 (-30%)	-26 (-18%)	-50 (-33%)	-33 (-22%)	-46 (-31%)	-21 (-15%)
1977 (C)	-1 (-20%)	-6 (-97%)	4 (888%)	0 (-67%)	4 (843%)	0 (-30%)
1978 (AN)	-287 (-80%)	-357 (-99%)	-294 (-80%)	-365 (-99%)	-316 (-81%)	-415 (-99%)
1979 (BN)	-56 (-48%)	10 (9%)	-142 (-70%)	-75 (-37%)	-139 (-70%)	-69 (-35%)
1980 (AN)	-3110 (-97%)	-3073 (-96%)	-3772 (-98%)	-3735 (-97%)	-3129 (-97%)	-1819 (-94%)
1981 (D)	-42 (-32%)	-5 (-4%)	-60 (-40%)	-24 (-16%)	-66 (-43%)	-22 (-15%)
1982 (W)	-7095 (-98%)	-7211 (-100%)	-7154 (-98%)	-7270 (-100%)	-6298 (-98%)	-6637 (-100%)
1983 (W)	-1 (-100%)	-1 (-100%)	-85 (-100%)	-85 (-100%)	-32 (-100%)	-17 (-100%)
1984 (W)	-2 (-100%)	-2 (-100%)	-2 (-100%)	-2 (-100%)	0 (-100%)	-1 (-100%)
1985 (D)	-169 (-24%)	-324 (-46%)	-7 (-1%)	-161 (-30%)	90 (21%)	49 (15%)
1986 (W)	-98 (-38%)	30 (11%)	-101 (-38%)	27 (10%)	-53 (-25%)	150 (108%)
1987 (D)	-70 (-84%)	-50 (-60%)	-79 (-85%)	-59 (-64%)	-67 (-83%)	-45 (-57%)
1988 (C)	-22 (-24%)	-21 (-23%)	-19 (-22%)	-19 (-21%)	-16 (-19%)	-15 (-17%)
1989 (D)	-3 (-28%)	-7 (-68%)	-12 (-61%)	-16 (-82%)	-9 (-54%)	0 (12%)
1990 (C)	-43 (-47%)	-80 (-87%)	-31 (-39%)	-68 (-85%)	-13 (-20%)	-2 (-16%)
1991 (C)	0 (-57%)	0 (-97%)	0 (-70%)	0 (-98%)	0 (-5%)	0 (-62%)
Median[1]	-43 (-48%)	-21 (-68%)	-60 (-61%)	-58 (-67%)	-46 (-43%)	-17 (-30%)

[1] The median was used because of the skewed nature of the salvage estimates.

B.4.1.6 *Longfin Smelt*

B.4.1.6.1 Larva

Particle-Tracking Modeling

ENTRAINMENT SOLELY AT THE SWP/CVP SOUTH DELTA EXPORT FACILITIES

In the results plots presented below, the runs to the left of and including January 1929 reflect drier periods (Delta outflow of less than 17,000 cfs) and thus may be more reflective of entrainment for longfin smelt, which generally tend to be entrained more in drier years. At the south Delta diversions, the PTM predicts that the magnitude of the entrainment would vary primarily in response to the starting distribution and duration of particle tracking (with 60-day being greater than 30-day, as would be expected) (Figure B-59 and Figure B-60), with the largest entrainment occurring in January and March. Entrainment is greater with the drier starting distributions, reflecting greater abundance further upstream that is more susceptible to entrainment in the south Delta. The starting distributions would affect the magnitude of entrainment at the south Delta diversions, but not the overall patterns of differences among runs (Figure B-59 and Figure B-60). The 30-day PTM results suggest that entrainment under PP_ELT and PP_LLT generally would be comparable to or lower than that under EBC scenarios; the same is true of the 60-day results although there are incidences of increased entrainment under PP scenarios relative to EBC scenarios (e.g., March 1961 when comparing EBC2_ELT and EBC2_LLT to PP_ELT and PP_LLT). The results generally reflect the reduction in water flow toward the south Delta facilities under the preliminary proposal.

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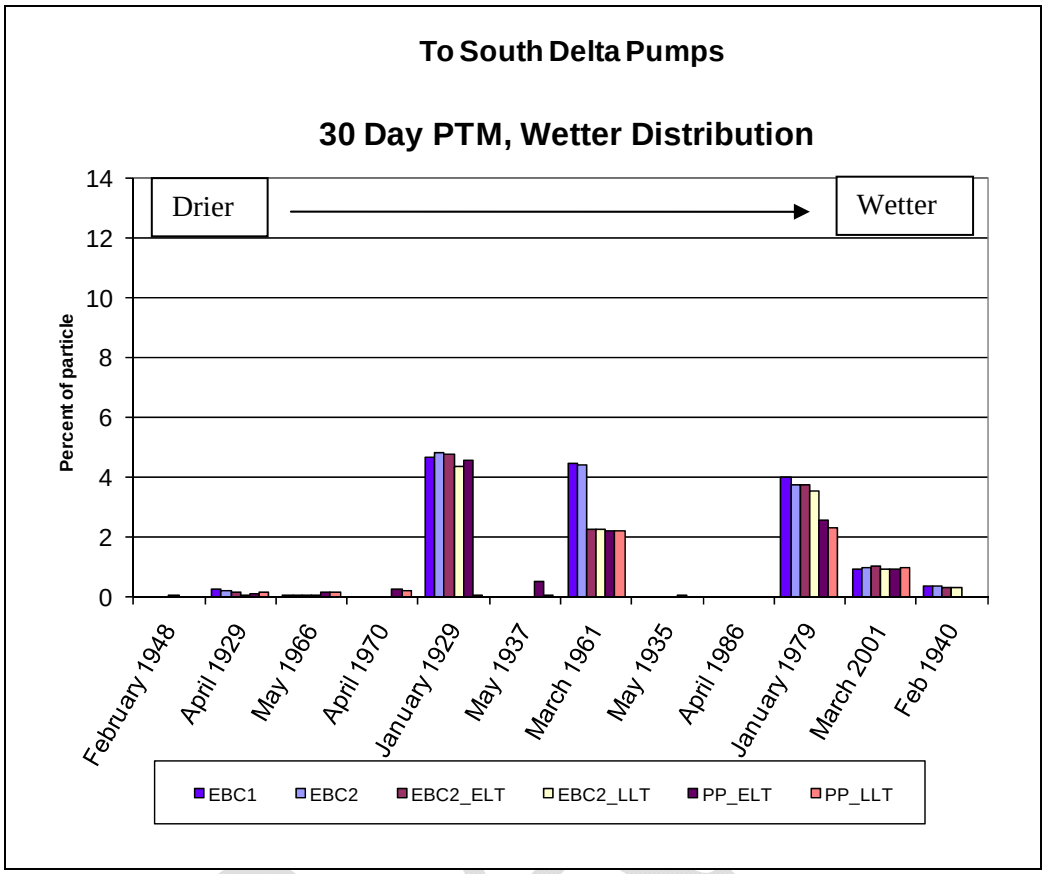


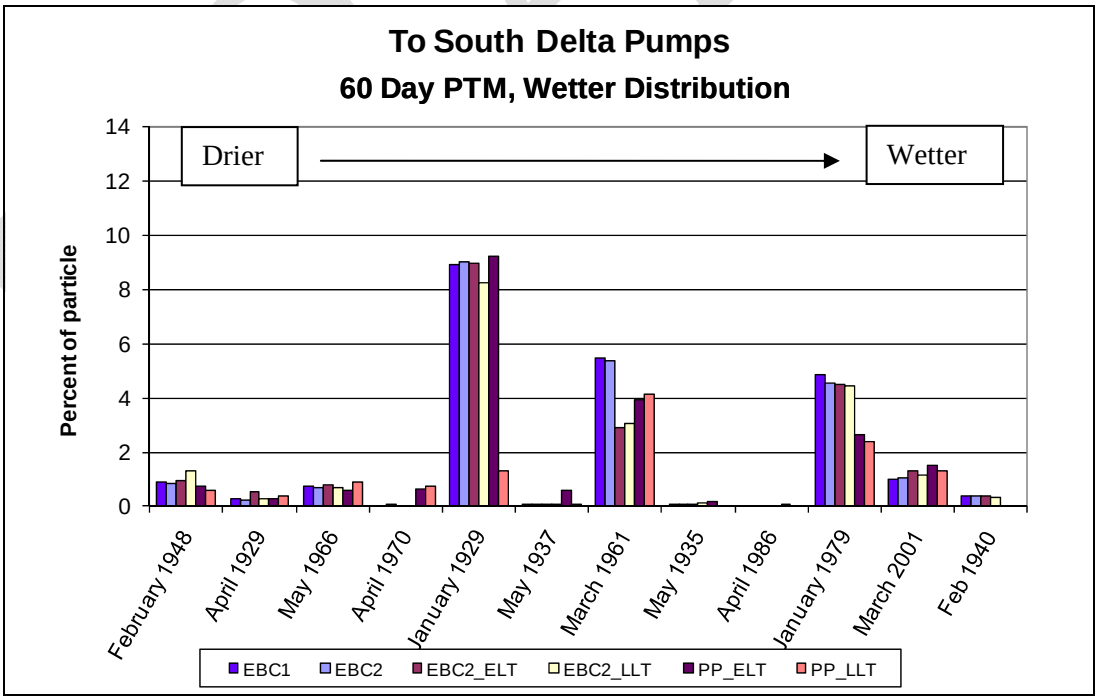
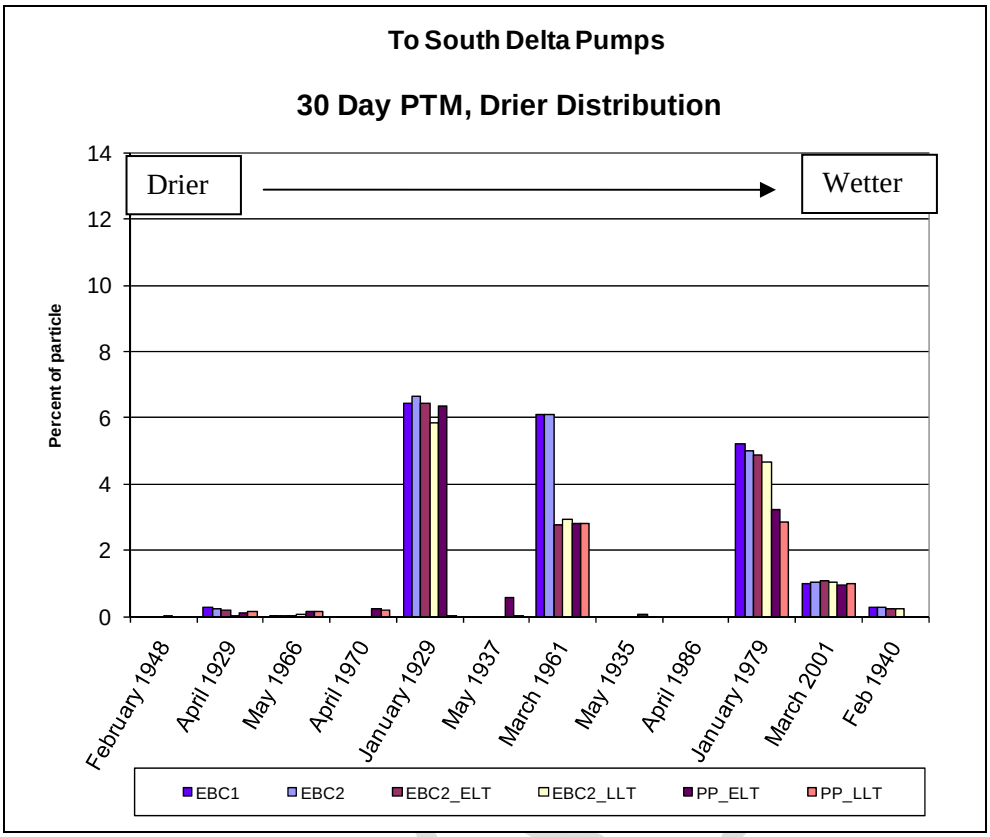


Figure B-59. Percentage of Particles Entrained at South Delta Diversions, Wetter Distribution



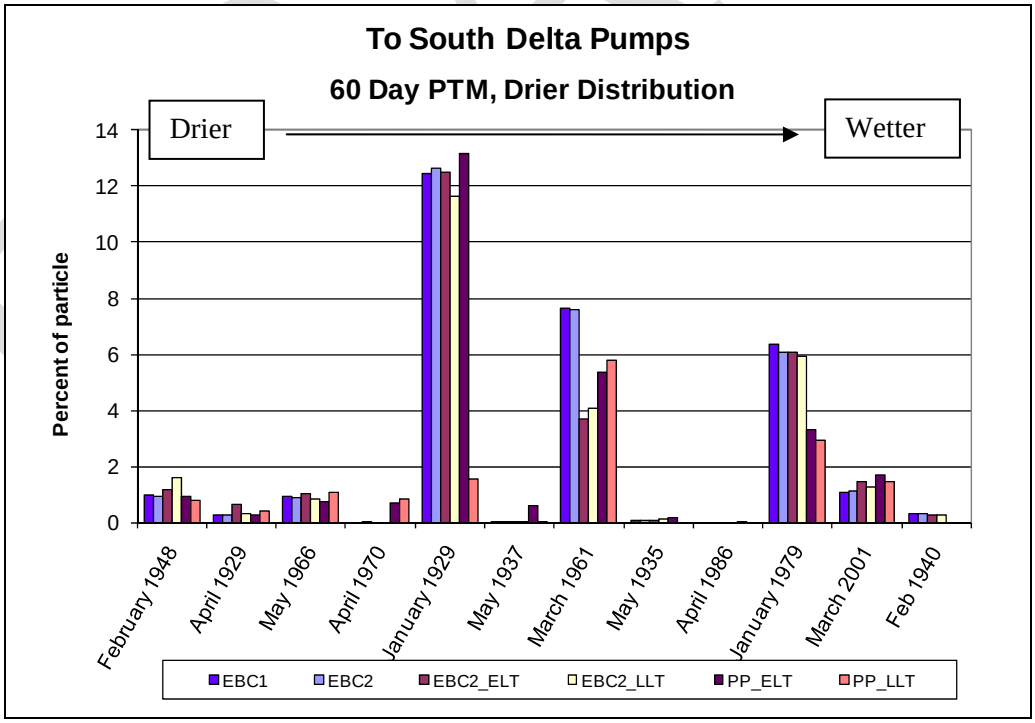


Figure B-60. Percentage of Particles Entrained at South Delta Diversions, Drier Distribution

Table B-170 reports differences in predicted average entrainment between model scenarios for periods when the preliminary proposal decreased and increased entrainment. The average decrease (0.3–2.8% of the particles released) in entrainment is estimated to be generally larger than the average increase (0.1–0.6% of the particles released) in entrainment for both starting distributions and tracking durations (30-day and 60-day). There was a relatively even split in the number of runs with higher or lower entrainment under PP scenarios compared to EBC scenarios.

Table B-170. Average Difference[1] (Number of Runs) between Model Scenarios in Entrainment at South Delta Diversions for Particle-Tracking Runs after (A) 30 Days and (B) 60 Days (%)

	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs. PP_LLT	EBC2_ELT vs. PP_ELT	EBC2_LLT vs. PP_LLT
(A) 30 Days, Starting Distribution						
Wetter Distribution						
Higher Entrainment	0.2 (4)	0.1 (4)	0.2 (4)	0.1 (3)	0.2 (4)	0.1 (5)
Lower Entrainment	-0.7 (6)	-1.8 (5)	-0.7 (6)	-1.5 (6)	-0.3 (6)	-1.2 (5)
Drier Distribution						
Higher Entrainment	0.3 (4)	0.1 (4)	0.3 (4)	0.1 (3)	0.2 (5)	0.1 (4)
Lower Entrainment	-1.0 (6)	-2.5 (5)	-1.0 (6)	-2.1 (6)	-0.4 (5)	-1.3 (6)
(B) 60 Days, Starting Distribution						
Wetter Distribution						
Higher Entrainment	0.3 (7)	0.3 (5)	0.3 (7)	0.3 (5)	0.4 (7)	0.4 (6)
Lower Entrainment	-0.9 (5)	-2.0 (6)	-0.8 (5)	-2.0 (6)	-0.6 (5)	-2.0 (5)
Drier Distribution						
Higher Entrainment	0.5 (6)	0.3 (5)	0.3 (8)	0.3 (5)	0.6 (7)	0.6 (5)
Lower Entrainment	-1.0 (6)	-2.8 (6)	-1.4 (4)	-2.8 (6)	-0.8 (5)	-2.4 (6)

[1] Values represent the difference in the percentage of particles reaching this destination. Negative values indicate lower entrainment under the preliminary proposal compared to the EBC.

As described for delta smelt larvae, larval longfin smelt entrainment at the SWP and CVP and the magnitude of the difference in entrainment among project scenarios are projected to vary substantially among the hydrologic scenarios analyzed. However, entrainment is estimated to be very low under all hydrologic scenarios and starting distributions.

The sensitivity analysis that evaluated starting distributions of 2, 10, and 15% of the longfin smelt population in the south Delta (increased from 0.43 and 0.79% for the drier and wetter distributions, respectively) suggested that overall entrainment would increase with more particles originating in the south Delta, as would be expected (Figure B-61, Figure B-62, and Figure B-63).The relative differences between EBC and PP scenarios generally were consistent for all three sensitivity analysis starting distributions. At higher levels of entrainment (above 1–2%), the entrainment under PP scenarios was comparable to or less than under EBC scenarios (e.g.,

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January 1929 or March 1961) whereas entrainment was enhanced under PP scenarios when entrainment was quite low (e.g., May 1966 and April 1970). Runs with decreases in entrainment under PP scenarios compared to EBC scenarios generally had comparable or lower decreases (0.5–7.4%) than the corresponding increases in entrainment (0.1–2.1%) (Table B-171).

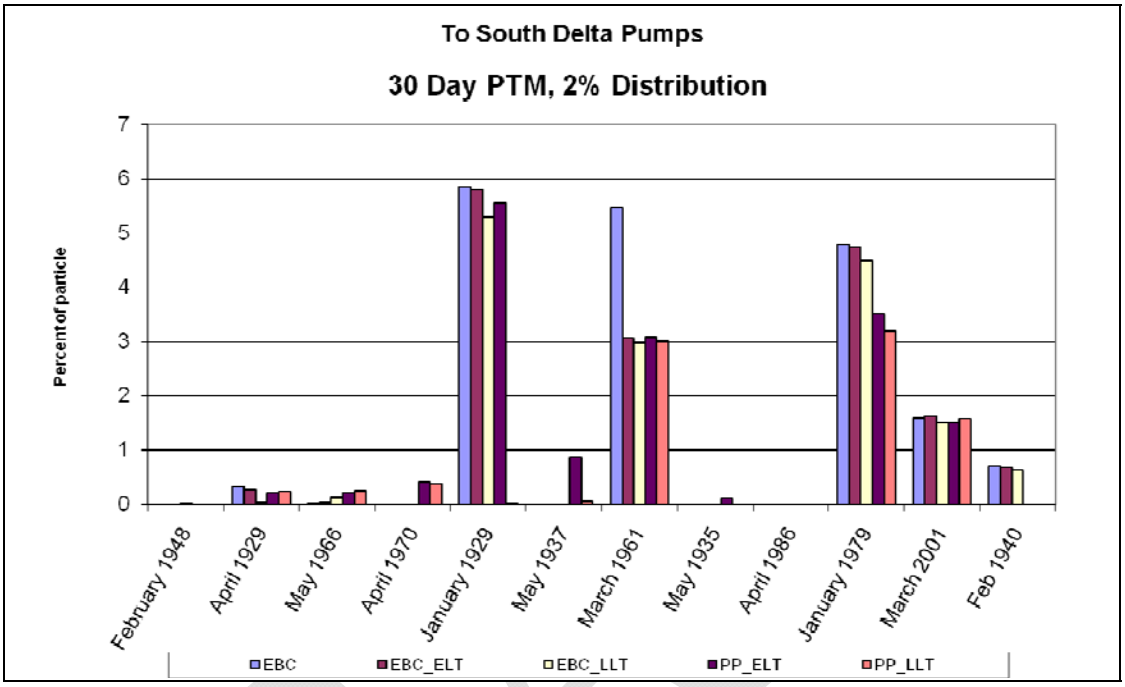

Figure B-61. Percentage of Particles Entrained at South Delta Diversions, 2% Sensitivity Distribution (Note: EBC = EBC2)

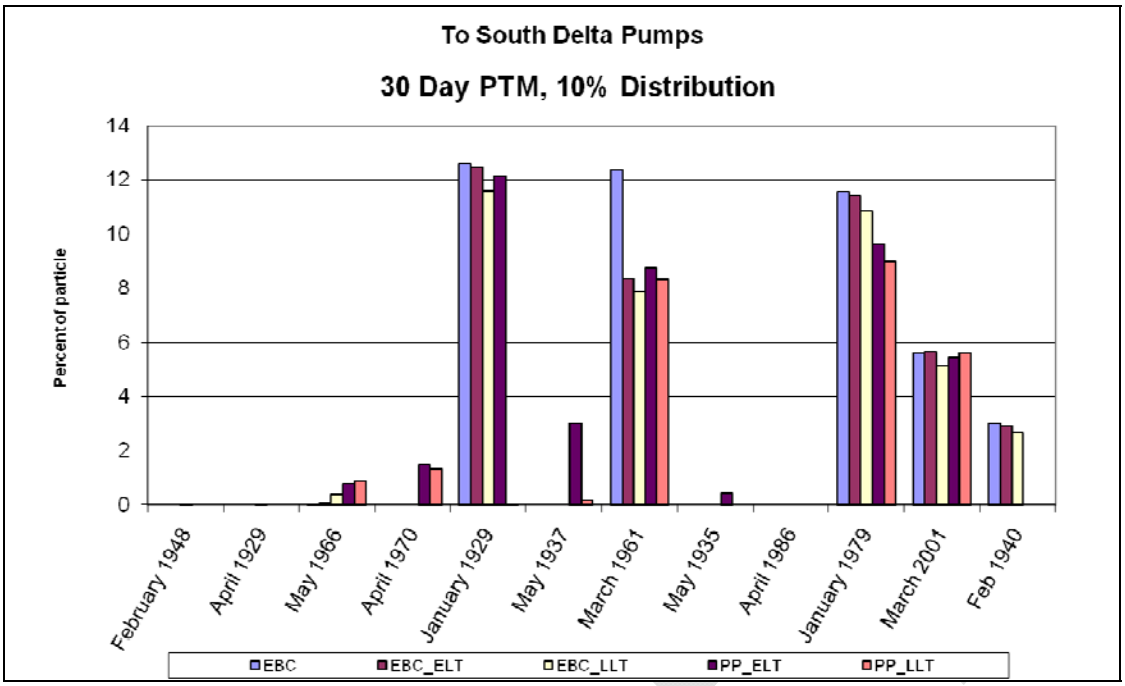

Figure B-62. Percentage of Particles Entrained at South Delta Diversions, 10% Sensitivity Distribution (Note: EBC = EBC2)

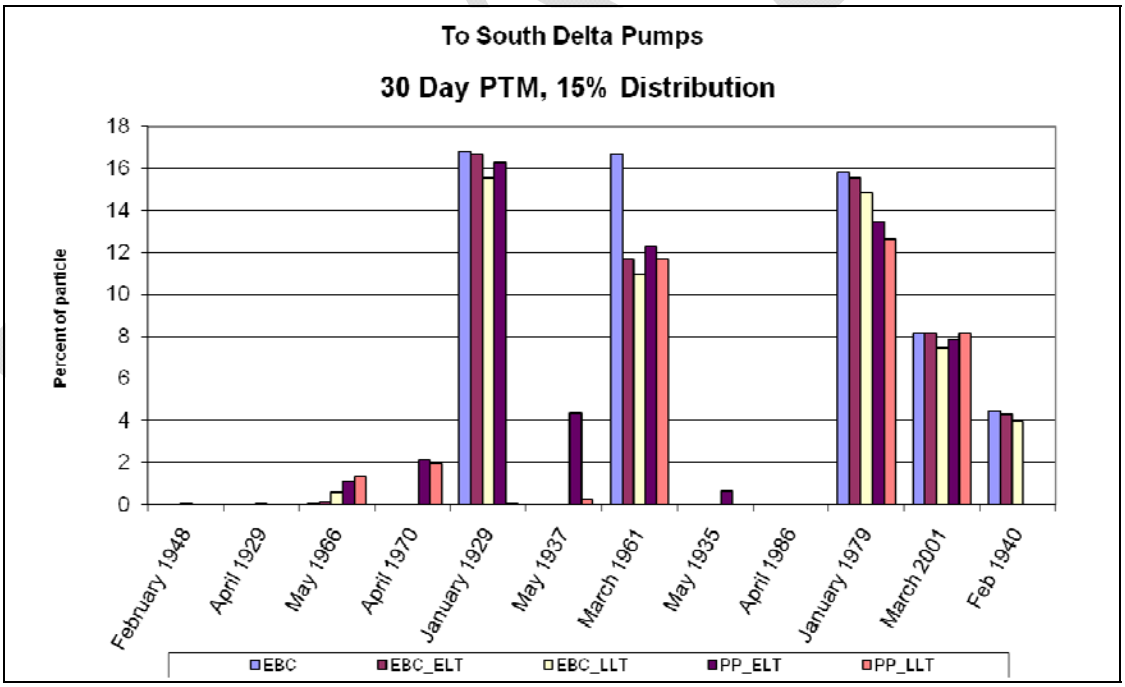

Figure B-63. Percentage of Particles Entrained at South Delta Diversions, 15% Sensitivity Distribution (Note: EBC = EBC2)

Table B-171. Average Difference between Model Scenarios in Entrainment at South Delta Diversions for Particle-Tracking Runs after 30 Days (%)

Starting Distribution	PP_ELT v. EBC2	PP_LLT v. EBC2	PP_ELT v. EBC2_ELT	PP_LLT v. EBC2_LLT
2% Distribution				
Higher Entrainment	0.4	0.2	0.3	0.1
Lower Entrainment	-0.8	-1.8	-0.5	-1.8
10% Distribution				
Higher Entrainment	1.4	0.8	1.2	0.6
Lower Entrainment	-1.8	-4.4	-1.3	-3.2
15% Distribution				
Higher Entrainment	2.1	0.9	1.8	0.9
Lower Entrainment	-2.4	-7.4	-1.8	-4.3
Values represent the difference in the percentage of particles reaching this destination. Negative values indicate lower entrainment under the preliminary proposal compared to the EBC.				

Overall Entrainment at All Delta Diversions

The entrainment of larval longfin smelt from all Delta diversions based on the PTM is presented in Figure B-64 and Figure B-65. Overall entrainment under PP_ELT and PP_LLT scenarios is estimated to be lower than that under the EBC for all runs, starting distributions, and tracking durations (30-day and 60-day), with the exception of the January 1929 model where the PP_ELT entrainment was comparable to entrainment under EBC scenarios. In most cases, there would be a decrease in overall entrainment under PP scenarios, ranging from an average of 2.3–4.6% when compared to EBC1 and EBC2 and, when isolating the effect of climate change, 2.2–3.7% when compared to EBC2_ELT and EBC2_LLT (Table B-172).Overall in-Delta entrainment is projected to be lower under the project for the majority of hydrologic scenarios analyzed; however, entrainment is projected to be very low under all hydrologic scenarios and starting distributions.

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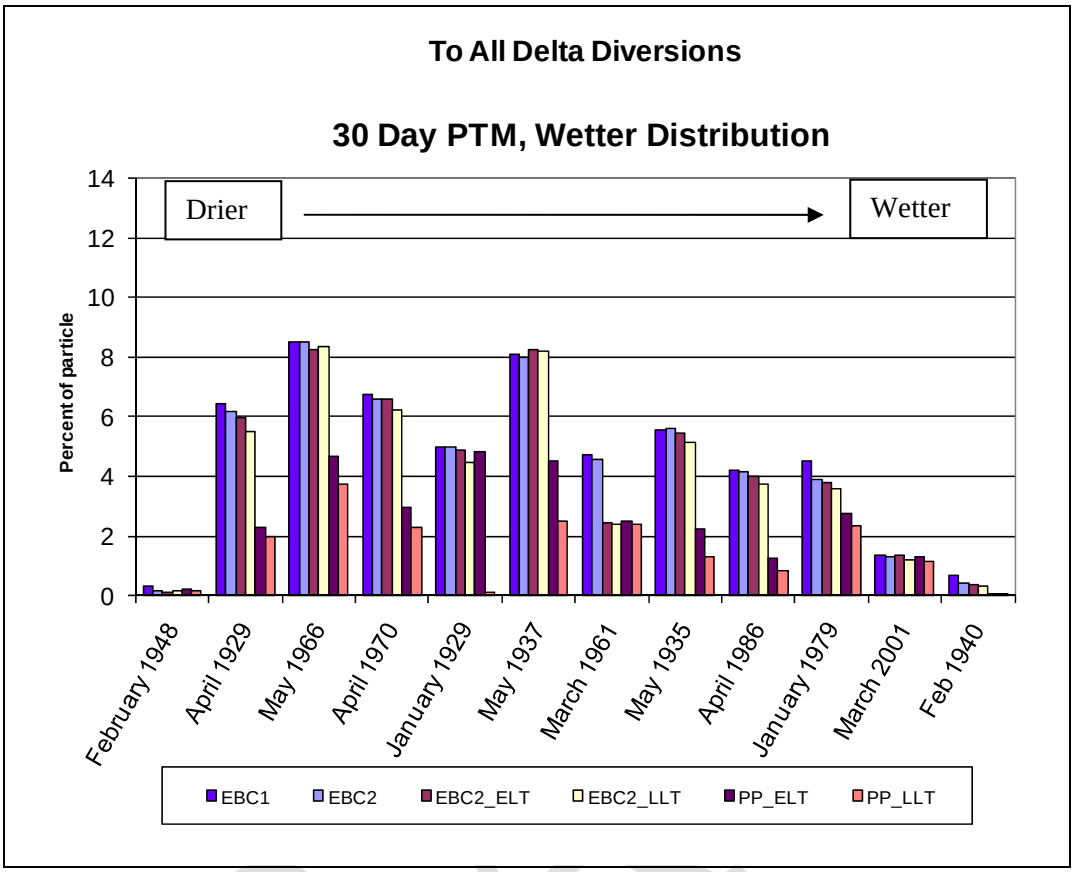


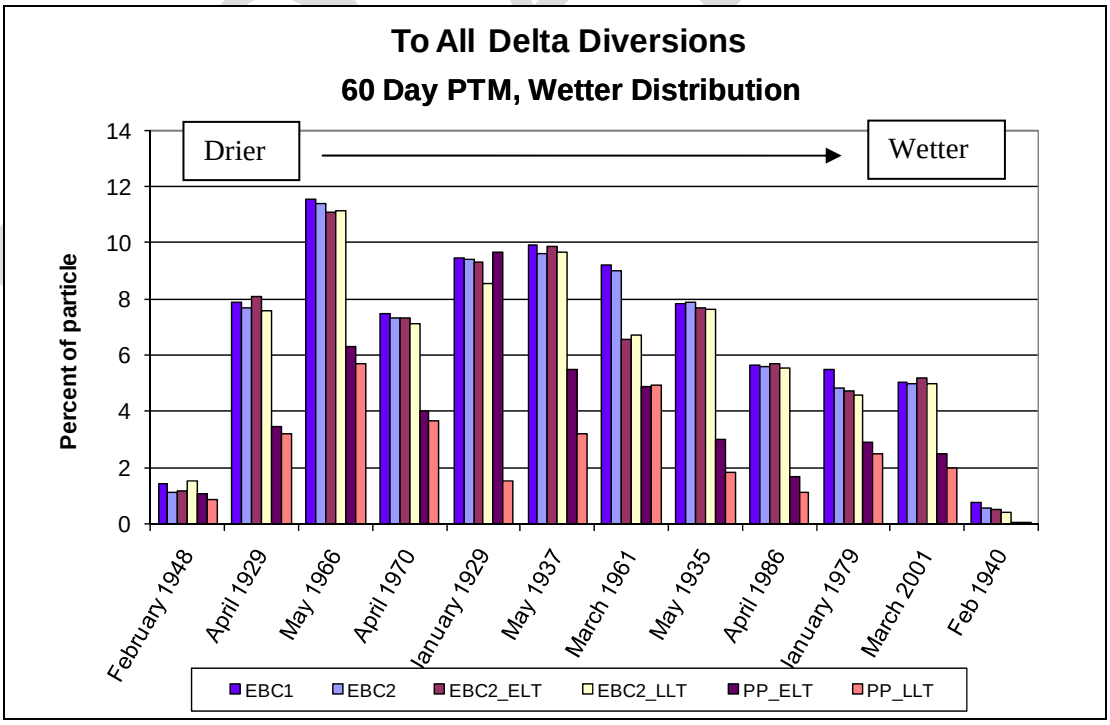
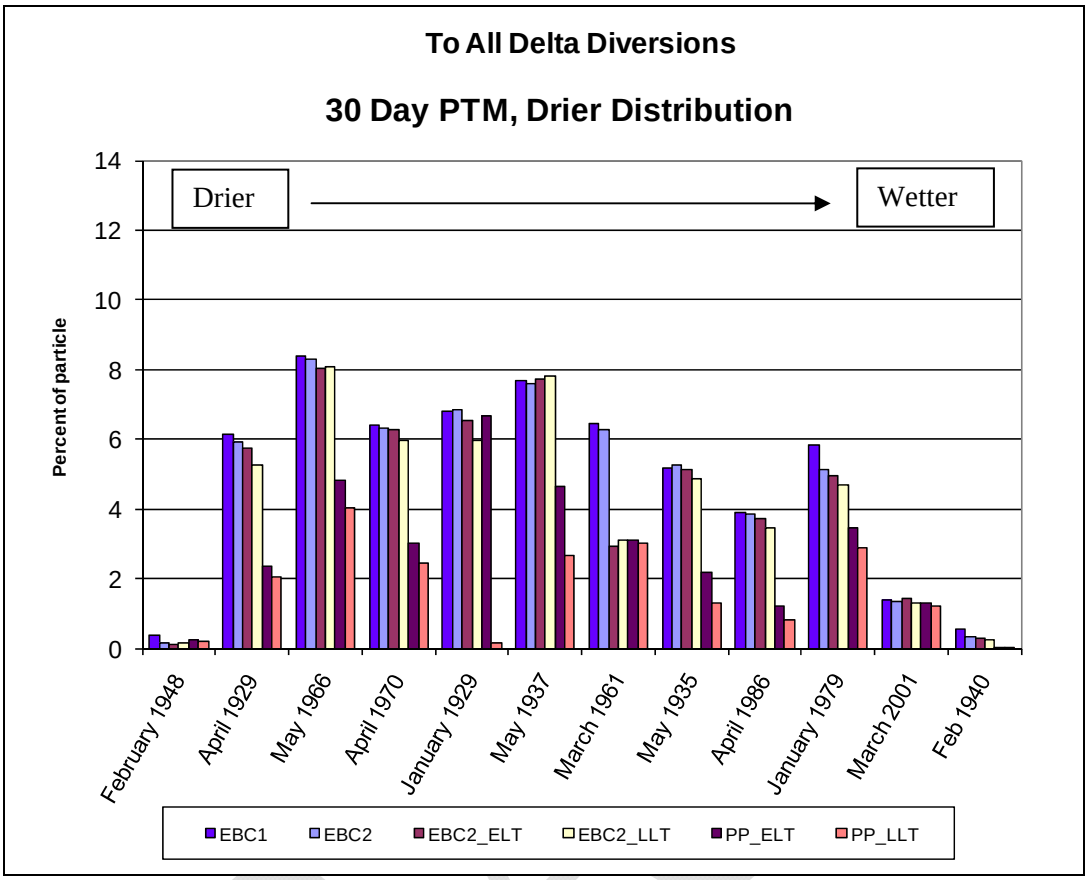


Figure B-64. Percentage of Particles Entrained at All Delta Diversions Combined, Wetter Distribution



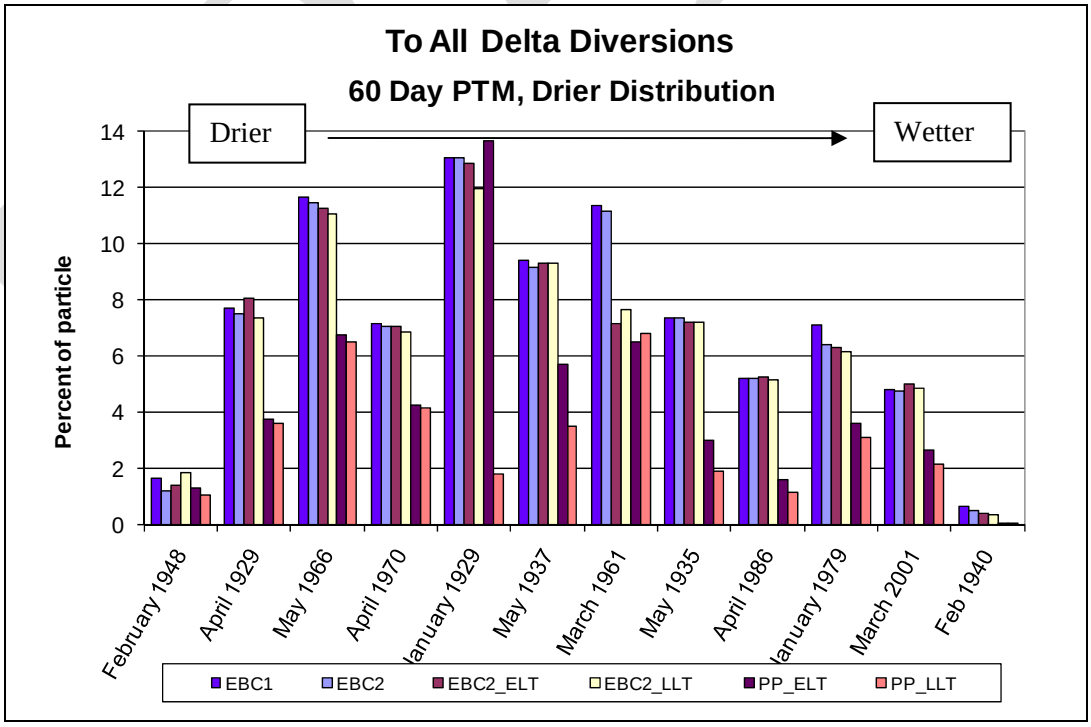


Figure B-65. Percentage of Particles Entrained at All Delta Diversions Combined, Drier Distribution

Table B-172. Average Difference[1] (Number of Runs) in Overall Entrainment for Model Scenarios at All Delta Diversions Combined for Particle-Tracking Runs after (A) 30 Days and (B) 60 Days (%)

(A) 30 Days Starting Distribution	**EBC1 vs. PP_ELT**	**EBC1 vs. PP_LLT**	**EBC2 vs. PP_ELT**	**EBC2 vs. PP_LLT**	**EBC2_ELT vs. PP_ELT**	**EBC2_LLT vs. PP_LLT**
Wetter Distribution						
Higher Entrainment	- (0)	- (0)	0.0 (1)	- (0)	0.1 (2)	- (0)
Lower Entrainment	-2.4 (11)	-3.3 (11)	-2.3 (11)	-3.0 (12)	-2.2 (10)	-2.5 (12)
Drier Distribution						
Higher Entrainment	- (0)	- (0)	0.1 (1)	0.0 (1)	0.1 (3)	0.0 (1)
Lower Entrainment	-2.3 (11)	-3.4 (11)	-2.2 (11)	-3.3 (11)	-2.2 (9)	-2.7 (11)
(B) 60 Days Starting Distribution	**EBC1 vs. PP_ELT**	**EBC1 vs. PP_LLT**	**EBC2 vs. PP_ELT**	**EBC2 vs. PP_LLT**	**EBC2_ELT vs. PP_ELT**	**EBC2_LLT vs. PP_LLT**
Wetter Distribution						
Higher Entrainment	0.2 (1)	- (0)	0.3 (1)	- (0)	0.4 (1)	- (0)
Lower Entrainment	-3.6 (10)	-4.6 (11)	-3.1 (11)	-4.1 (12)	-2.9 (11)	-3.7 (12)
Drier Distribution						
Higher Entrainment	0.6 (1)	- (0)	0.3 (2)	- (0)	0.8 (1)	- (0)
Lower Entrainment	-3.4 (10)	-4.6 (11)	-3.3 (10)	-4.1 (12)	-2.7 (11)	-3.7 (12)

[1] Values represent the difference in the percentage of particles reaching this destination. Negative values indicate lower entrainment under the preliminary proposal compared to the EBC.

Sensitivity analyses with greater percentages of particles originating in the south Delta provided much the same patterns of relative change in entrainment between PP and EBC scenarios as described above (Figure B-66, Figure B-67, and Figure B-68; Table B-173).

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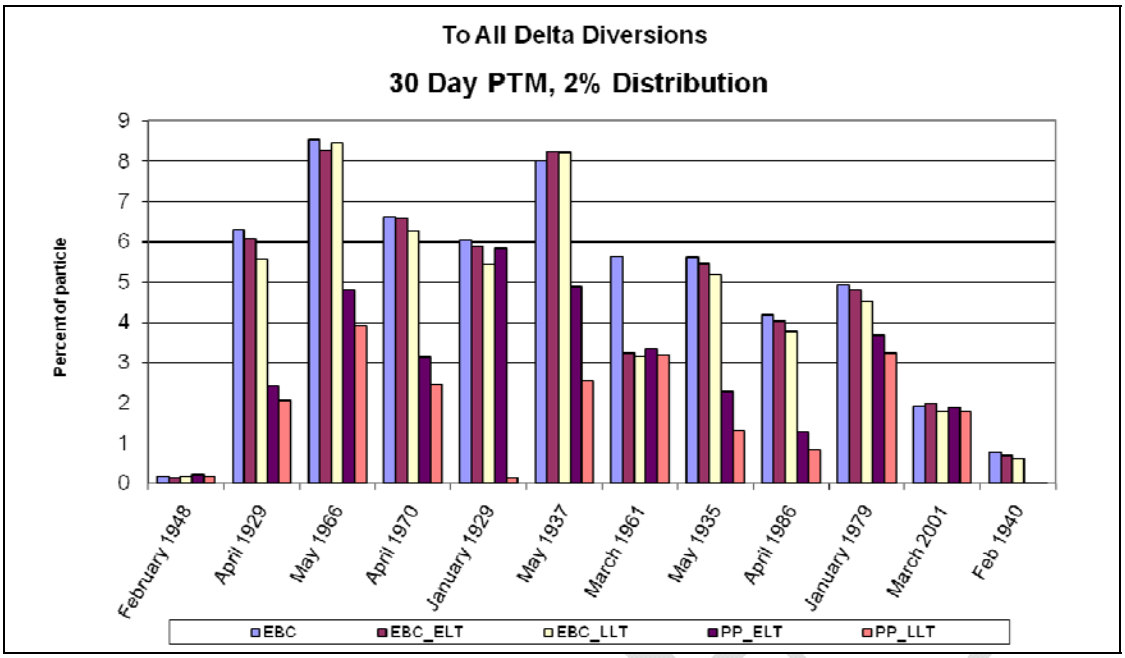

Figure B-66. Percentage of Particles Entrained at All Delta Diversions, 2% Sensitivity Distribution (Note: EBC = EBC2)

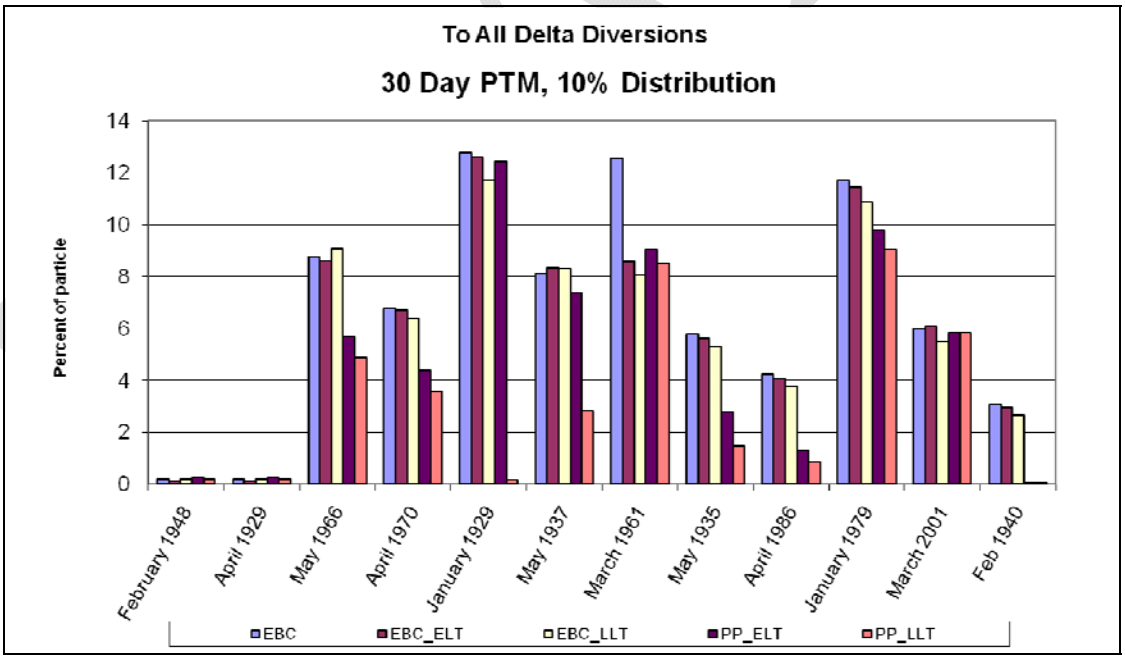

Figure B-67. Percentage of Particles Entrained at All Delta Diversions, 10% Sensitivity Distribution (Note: EBC = EBC2)

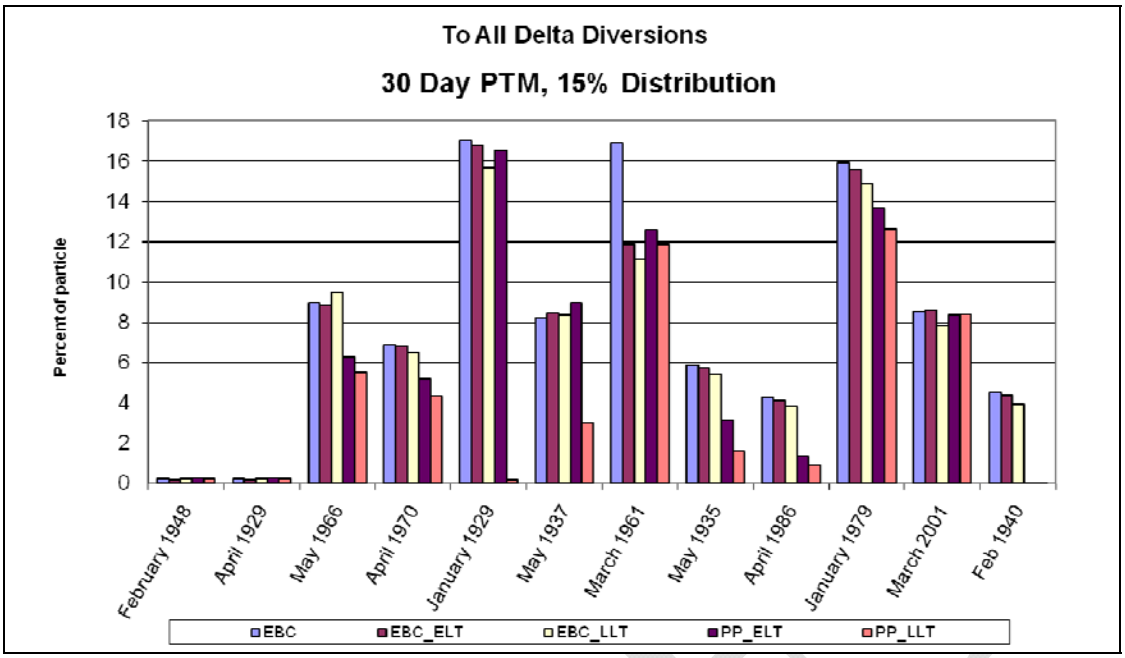

Figure B-68. Percentage of Particles Entrained at All Delta Diversions, 15% Sensitivity Distribution (Note: EBC = EBC2)

Table B-173. Average Difference between Model Scenarios in Entrainment at All Delta Diversions for Particle-Tracking Runs after 30 Days (%)

Starting Distribution	PP_ELT v. EBC2	PP_LLT v. EBC2	PP_ELT v. EBC2_ELT	PP_LLT v. EBC2_LLT
2% Distribution				
Higher Entrainment	0.0	-	0.1	0.0
Lower Entrainment	-2.3	-3.1	-2.2	-2.9
10% Distribution				
Higher Entrainment	0.1	-	0.2	0.4
Lower Entrainment	-2.1	-3.5	-1.9	-3.5
15% Distribution				
Higher Entrainment	0.3	-	0.4	0.7
Lower Entrainment	-2.4	-4.1	-2.0	-4.0
Values represent the difference in the percentage of particles reaching this destination. Negative values indicate lower entrainment under the preliminary proposal compared to the EBC.				

A separate analysis was conducted to determine the potential effects of differences in OMR flows under the project relative to existing conditions on the larval entrainment loss. For this analysis, a relationship between loss of particles to all Delta diversions and OMR flows were developed to estimate larval longfin smelt entrainment (as described in Section B.5.5.2). The relationship was based on the uniform starting distribution was strong (Figure B-42). Because the uniform distribution places a larger proportion of the larval longfin smelt population in the south Delta than has been observed in recent years, or than probably would be expected to occur in this

area in the future, this analysis provides a conservative scenario regarding larval entrainment under the project.

The mean, median, minimum, and maximum OMR flows projected for each project scenario during the larval period (January–May) are shown in Table B-133 and can be interpreted in light of the relationship shown in Figure B-42 to gain a sense of the maximum level of entrainment expected under each scenario. The skewed nature of the OMR flows suggests that examination of median as well as mean flows is appropriate. Across all water years, there was estimated to be a 3.2–6.6% absolute decrease (21–49% relative decrease) in entrainment from EBC scenarios to PP scenarios for mean and median OMR flows and relatively small increases or declines for minimum OMR flows (Table B-137). Reductions in entrainment under PP scenarios relative to EBC scenarios were most pronounced in above normal (6.6–7.7% absolute decrease; 46–55% relative decrease) and were also appreciable in below normal years (2.1–2.7% absolute decrease; 14–18% relative decrease). There were relatively small differences in entrainment between PP and EBC scenarios in dry (-0.8% absolute decrease to 1.1% absolute increase) and critical (0.1–2.3% absolute decrease) years. Maximum flows were not modeled in all, wet, or above normal years because these flow values were outside the range of flows used to develop the OMR-particle loss regression. For the other water-year types, maximum flows had a greater decrease entrainment decrease from EBC to PP scenarios compared to mean and median flows in below normal years and to some extent also in dry years; and little change in critical years. When compared to entrainment estimated from mean and median flows, estimates of changes in entrainment from EBC to PP scenarios for minimum flows were similar in dry and critical years, slightly increased in below normal years, lower decreases in above normal years, and little changed from zero in all water years combined.

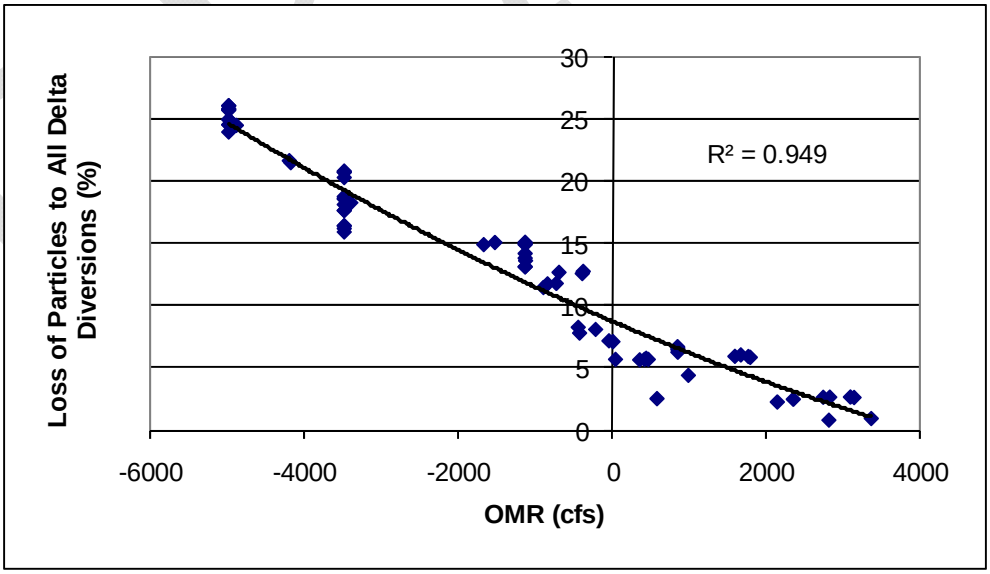

Figure B-69. Percent Loss of Particles to All Delta Diversions as a Function of Old and Middle River Flows

Table B-174. Mean, Median, Minimum, and Maximum[1] Old and Middle River Flows during the January–May Larval Period of Longfin Smelt under Model Scenarios, by Water-Year Type

All Years	EBC1	EBC2	EBC2_ELT	EBC2_LLT	PP_ELT	PP_LLT
Mean	-1634	-1696	-1619	-1573	522	701
Median	-2213	-2251	-2212	-2163	-1164	-834
Minimum	-3363	-3363	-3316	-3265	-3446	-3218
Maximum	*11646*	*11067*	*11755*	*11691*	*18617*	*19384*
Wet						
Mean	-340	-555	-299	-276	*4986*	*4838*
Median	-1488	-1536	-1340	-1398	*3930*	*3584*
Minimum	-2716	-2752	-2752	-2568	-16	-177
Maximum	*11646*	*11067*	*11755*	*11691*	*18617*	*19384*
Above Normal						
Mean	-1902	-1907	-1824	-1845	719	892
Median	-2090	-2105	-1968	-2220	374	374
Minimum	-2716	-2796	-3060	-3265	-3102	-1820
Maximum	1293	1473	1969	2382	*5524*	*5843*
Below Normal						
Mean	-2175	-2137	-2164	-2190	-1472	-1301
Median	-2280	-2233	-2325	-2243	-1475	-1540
Minimum	-2854	-2855	-3016	-3181	-3433	-3213
Maximum	-861	-798	-489	-440	635	1415
Dry						
Mean	-2483	-2509	-2608	-2483	-2748	-2310
Median	-2558	-2612	-2698	-2578	-2884	-2310
Minimum	-2993	-2980	-3124	-3029	-3446	-3218
Maximum	-1560	-1636	-1671	-1669	-1690	-585
Critical						
Mean	-2260	-2225	-2152	-2025	-2116	-1600
Median	-2277	-2220	-2105	-2081	-1987	-1515
Minimum	-3363	-3363	-3316	-3071	-3269	-2428
Maximum	-1160	-1126	-974	-571	-1175	-910

[1]Values in italics denote flows greater than the maximum used for developing the regression equation between percentage of particles entrained and OMR flows.

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Table B-175. Percent Loss of Particles Based on Modeled Old and Middle River Flows during the January–May Larval Period of Longfin Smelt under Model Scenarios, by Water-Year Type[1]

All Years	PP_ELT vs. EBC1	PP_LLT vs. EBC1	PP_ELT vs. EBC2	PP_LLT vs. EBC2	PP_ELT vs. EBC2_ELT	PP_LLT vs. EBC2_LLT
Mean	-6.0 (-45%)	-6.4 (-48%)	-6.1 (-46%)	-6.6 (-49%)	-5.9 (-45%)	-6.2 (-47%)
Median	-3.2 (-21%)	-4.1 (-27%)	-3.3 (-22%)	-4.2 (-28%)	-3.2 (-21%)	-3.9 (-26%)
Minimum	0.3 (1%)	-0.5 (-3%)	0.3 (1%)	-0.5 (-3%)	0.4 (2%)	-0.2 (-1%)
Maximum	NA	NA	NA	NA	NA	NA
Wet						
Mean	NA	NA	NA	NA	NA	NA
Median	NA	NA	NA	NA	NA	NA
Minimum	-7.9 (-48%)	-7.5 (-45%)	-8.0 (-48%)	-7.6 (-45%)	-8.0 (-48%)	-7.0 (-43%)
Maximum	NA	NA	NA	NA	NA	NA
Above Normal						
Mean	-7.3 (-51%)	-7.7 (-55%)	-7.3 (-52%)	-7.7 (-55%)	-7.0 (-51%)	-7.5 (-54%)
Median	-7.0 (-47%)	-7.0 (-47%)	-7.0 (-48%)	-7.0 (-48%)	-6.6 (-46%)	-7.4 (-49%)
Minimum	1.3 (8%)	-2.8 (-17%)	1.0 (6%)	-3.1 (-18%)	0.1 (1%)	-4.6 (-25%)
Maximum	NA	NA	NA	NA	NA	NA
Below Normal						
Mean	-2.1 (-14%)	-2.6 (-18%)	-2.0 (-14%)	-2.5 (-17%)	-2.1 (-14%)	-2.7 (-18%)
Median	-2.5 (-16%)	-2.3 (-15%)	-2.3 (-15%)	-2.1 (-14%)	-2.6 (-17%)	-2.1 (-14%)
Minimum	1.9 (11%)	1.2 (7%)	1.9 (11%)	1.2 (7%)	1.4 (8%)	0.1 (1%)
Maximum	-4.0 (-36%)	-5.9 (-53%)	-3.8 (-35%)	-5.7 (-52%)	-3.0 (-30%)	-4.7 (-48%)
Dry						
Mean	0.8 (5%)	-0.5 (-3%)	0.8 (5%)	-0.6 (-4%)	0.5 (3%)	-0.5 (-3%)
Median	1.1 (7%)	-0.8 (-5%)	0.9 (5%)	-1.0 (-6%)	0.6 (4%)	-0.8 (-5%)
Minimum	1.5 (9%)	0.7 (4%)	1.6 (9%)	0.8 (4%)	1.1 (6%)	0.6 (4%)
Maximum	0.4 (3%)	-2.8 (-21%)	0.2 (1%)	-3.0 (-23%)	0.1 (0%)	-3.1 (-23%)
Critical						
Mean	-0.4 (-3%)	-2.0 (-13%)	-0.3 (-2%)	-1.9 (-13%)	-0.1 (-1%)	-1.3 (-9%)
Median	-0.9 (-6%)	-2.3 (-15%)	-0.7 (-5%)	-2.1 (-14%)	-0.4 (-2%)	-1.7 (-12%)
Minimum	-0.3 (-2%)	-3.1 (-16%)	-0.3 (-2%)	-3.1 (-16%)	-0.2 (-1%)	-2.1 (-12%)
Maximum	0.0 (0%)	-0.7 (-6%)	0.1 (1%)	-0.6 (-5%)	0.6 (5%)	0.9 (9%)

[1] NA indicates that calculation was not made because input flow data were greater than the maximum value used for developing the regression equation between percentage of particles entrained and OMR flows.

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B.4.1.6.2 Juvenile

Salvage-Density Method

The estimated entrainment loss of juvenile longfin smelt in March–June had two notable features: loss was considerably (1–2 orders of magnitude) greater at SWP than at CVP (Table B-176), and loss varied considerably among water years, with highest loss (hundreds of fish) occurring in dry and critical years and zero or very little loss in other water-year types (Table B-177 to Table B-187). Across all years, entrainment loss was estimated to change under PP scenarios relative to EBC scenarios by averages ranging from a decrease of two fish (2% decrease from EBC2_LLT compared to PP_LLT) to increased loss under PP of 6–30 fish (4–25% increase under PP relative to EBC) (Table B-182). In low-flow years, when most entrainment of juvenile longfin smelt would occur, increases in dry-year entrainment loss under PP scenarios compared to EBC scenarios ranged from 40 to 115 fish (14–47% increase) and decreases in critical-year entrainment losses ranged from 12 to 50 fish (5–20% decrease) (Table B-186 and Table B-187).

Table B-176. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI]) of Juvenile Longfin Smelt for Six Model Scenarios at the SWP and CVP Salvage Facilities in March–June for All Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	15	±	2	16	±	3	16	±	3	17	±	3	23	±	4	21	±	3
May	100	±	22	104	±	24	110	±	25	111	±	25	125	±	28	106	±	24
June	2	±	0	2	±	0	2	±	0	2	±	0	1	±	0	1	±	0
(b) CVP																		
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	4	±	1	4	±	1	4	±	1	4	±	1	4	±	1	4	±	1
May	5	±	1	5	±	1	5	±	1	5	±	1	6	±	1	5	±	1
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0

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Table B-177. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI]) of Juvenile Longfin Smelt for Six Model Scenarios at the SWP and CVP Salvage Facilities in March–June for Wet Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	30	±	13	31	±	14	31	±	14	32	±	15	18	±	11	18	±	11
May	1	±	0	1	±	0	1	±	0	1	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
(b) CVP																		
March	0	±	0	0	±	0	0	±	0	0	±	N/A	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0

Table B-178. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI]) of Juvenile Longfin Smelt for Six Model Scenarios at the SWP and CVP Salvage Facilities in March–June for Above Normal Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	1	±	0	1	±	0	1	±	0	1	±	0	1	±	1	1	±	1
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
(b) CVP																		
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	1	±	0	1	±	0	1	±	0	1	±	0	1	±	1	1	±	1
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0

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Table B-179. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI]) of Juvenile Longfin Smelt for Six Model Scenarios at the SWP and CVP Salvage Facilities in March–June for Below Normal Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	1	±	0	1	±	0	1	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
(b) CVP																		
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	1	±	0	1	±	0	1	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0

Table B-180. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI]) of Juvenile Longfin Smelt for Six Model Scenarios at the SWP and CVP Salvage Facilities in March–June for Dry Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	15	±	7	16	±	7	18	±	8	17	±	8	36	±	15	32	±	14
May	211	±	87	206	±	85	231	±	98	238	±	99	290	±	135	255	±	123
June	4	±	2	4	±	2	4	±	2	3	±	1	2	±	1	2	±	1
(b) CVP																		
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	8	±	3	8	±	3	9	±	4	9	±	4	14	±	6	13	±	6
May	12	±	5	12	±	5	12	±	5	12	±	5	20	±	8	17	±	7
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0

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Table B-181. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI]) of Juvenile Longfin Smelt for Six Model Scenarios at the SWP and CVP Salvage Facilities in March–June for Critical Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
March	2	±	1	2	±	1	2	±	1	2	±	1	2	±	1	2	±	1
April	23	±	8	24	±	8	21	±	7	19	±	5	29	±	7	28	±	9
May	227	±	35	211	±	41	219	±	42	198	±	64	170	±	62	177	±	68
June	1	±	0	1	±	0	1	±	0	0	±	0	0	±	0	0	±	0
(b) CVP																		
March	1	±	0	1	±	0	1	±	0	1	±	0	0	±	0	0	±	0
April	8	±	1	8	±	1	8	±	1	8	±	1	8	±	1	8	±	2
May	7	±	0	7	±	0	7	±	1	7	±	0	7	±	1	6	±	1
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0

Table B-182. Estimated Absolute and Percent Differences between Model Scenarios in Juvenile Longfin Smelt Entrainment Index (Number of Fish Lost) at the SWP and CVP Salvage Facilities in March–June during All Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
March	0 (-71%)	0 (-75%)	0 (-71%)	0 (-75%)	0 (-71%)	0 (-74%)
April	8 (42%)	6 (32%)	7 (38%)	5 (28%)	7 (34%)	4 (21%)
May	25 (24%)	6 (5%)	22 (20%)	2 (2%)	15 (13%)	-5 (-4%)
June	-1 (-50%)	-1 (-62%)	-1 (-50%)	-1 (-62%)	-1 (-47%)	-1 (-54%)
Annual Average	31 (25%)	10 (8%)	27 (21%)	6 (4%)	21 (15%)	-2 (-2%)

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Table B-183. Estimated Absolute and Percent Differences between Model Scenarios in Juvenile Longfin Smelt Entrainment Index (Number of Fish Lost) at the SWP and CVP Salvage Facilities in March–June during Wet Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
March	0 (-96%)	0 (-97%)	0 (-96%)	0 (-97%)	0 (-96%)	0 (-97%)
April	-12 (-39%)	-12 (-40%)	-13 (-42%)	-13 (-43%)	-13 (-43%)	-14 (-45%)
May	0 (-40%)	0 (-51%)	0 (-45%)	0 (-55%)	0 (-46%)	0 (-55%)
June	0 (-57%)	0 (-74%)	0 (-58%)	0 (-75%)	0 (-54%)	0 (-69%)
Annual Average	-12 (-39%)	-12 (-40%)	-14 (-42%)	-14 (-43%)	-14 (-43%)	-15 (-45%)

Table B-184. Estimated Absolute and Percent Differences between Model Scenarios in Juvenile Longfin Smelt Entrainment Index (Number of Fish Lost) at the SWP and CVP Salvage Facilities in March–June during Above Normal Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
March	0 (-83%)	0 (-95%)	0 (-82%)	0 (-95%)	0 (-83%)	0 (-95%)
April	1 (35%)	1 (18%)	1 (36%)	1 (18%)	1 (29%)	1 (4%)
May	0 (79%)	0 (84%)	0 (79%)	0 (84%)	0 (63%)	0 (62%)
June	0 (-36%)	0 (-48%)	0 (-34%)	0 (-46%)	0 (-35%)	0 (-36%)
Annual Average	1 (40%)	1 (36%)	1 (41%)	1 (38%)	1 (32%)	1 (30%)

Table B-185. Estimated Absolute and Percent Differences between Model Scenarios in Juvenile Longfin Smelt Entrainment Index (Number of Fish Lost) at the SWP and CVP Salvage Facilities in March–June during Below Normal Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
March	0 (-59%)	0 (-62%)	0 (-55%)	0 (-58%)	0 (-54%)	0 (-58%)
April	1 (97%)	1 (88%)	1 (97%)	1 (89%)	1 (85%)	1 (67%)
May	0 (155%)	0 (103%)	0 (155%)	0 (103%)	0 (145%)	0 (75%)
June	0 (-46%)	0 (-53%)	0 (-38%)	0 (-46%)	0 (-39%)	0 (-44%)
Annual Average	1 (99%)	1 (63%)	1 (105%)	1 (68%)	1 (98%)	1 (51%)

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Table B-186. Estimated Absolute and Percent Differences between Model Scenarios in Juvenile Longfin Smelt Entrainment Index (Number of Fish Lost) at the SWP and CVP Salvage Facilities in March–June during Dry Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
March	27 (-26%)	22 (-33%)	26 (-27%)	21 (-35%)	24 (-28%)	20 (-27%)
April	86 (113%)	48 (93%)	91 (107%)	53 (87%)	67 (88%)	21 (79%)
May	-2 (38%)	-2 (21%)	-2 (42%)	-2 (24%)	-2 (27%)	-1 (8%)
June	0 (-49%)	0 (-56%)	0 (-51%)	0 (-58%)	0 (-50%)	0 (-45%)
Annual Average	111 (44%)	68 (27%)	115 (47%)	72 (29%)	88 (32%)	40 (14%)

Table B-187. Estimated Absolute and Percent Differences between Model Scenarios in Juvenile Longfin Smelt Entrainment Index (Number of Fish Lost) at the SWP and CVP Salvage Facilities in March–June during Critical Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
March	6 (-13%)	4 (-18%)	6 (-14%)	4 (-19%)	9 (-3%)	9 (-3%)
April	-58 (20%)	-51 (14%)	-41 (17%)	-34 (11%)	-49 (30%)	-21 (35%)
May	0 (-25%)	0 (-22%)	0 (-19%)	0 (-16%)	0 (-22%)	0 (-10%)
June	0 (-45%)	0 (-39%)	0 (-43%)	0 (-37%)	0 (-40%)	0 (-22%)
Annual Average	-52 (-19%)	-47 (-18%)	-36 (-14%)	-31 (-12%)	-40 (-16%)	-12 (-5%)

B.4.1.6.3 Adult

Salvage-Density Method

Estimated entrainment loss of adult longfin smelt from December to March, which was based on modeling of historical salvage data and simulated export flows, was zero or minimal across all water years (Table B-188 to Table B-193), resulting in very little change in absolute estimate (Table B-194 to Table B-199). Note that the percentage changes detailed in Table B-194 to Table B-199 result from changes in very small loss densities of fish that are rounded to zero.

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Table B-188. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI]) of Adult Longfin Smelt for Six Model Scenarios at the SWP and CVP Salvage Facilities in December–March for All Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	1	±	0	1	±	0	1	±	0	1	±	0	0	±	0	0	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
(b) CVP																		
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0

Table B-189. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI]) of Adult Longfin Smelt for Six Model Scenarios at the SWP and CVP Salvage Facilities in December–March for Wet Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
(b) CVP																		
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	N/A	0	±	0	0	±	0

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Table B-190. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI]) of Adult Longfin Smelt for Six Model Scenarios at the SWP and CVP Salvage Facilities in December–March for Above Normal Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
(b) CVP																		
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0

Table B-191. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI]) of Adult Longfin Smelt for Six Model Scenarios at the SWP and CVP Salvage Facilities in December–March for Below Normal Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
(b) CVP																		
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0

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Table B-192. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI]) of Adult Longfin Smelt for Six Model Scenarios at the SWP and CVP Salvage Facilities in December–March for Dry Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
(b) CVP																		
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0

Table B-193. Estimated Mean Monthly Entrainment Index (Number of Fish Lost with 95% Confidence Interval [CI]) of Adult Longfin Smelt for Six Model Scenarios at the SWP and CVP Salvage Facilities in December–March for Critical Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	5	±	1	5	±	1	5	±	1	5	±	1	6	±	1	3	±	1
February	2	±	0	2	±	1	2	±	0	2	±	0	2	±	1	2	±	0
March	2	±	1	2	±	1	2	±	1	2	±	1	2	±	1	2	±	1
(b) CVP																		
December	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
March	1	±	0	1	±	0	1	±	0	1	±	0	0	±	0	0	±	0

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Table B-194. Estimated Absolute and Percent Differences between Model Scenarios in Adult Longfin Smelt Entrainment Index (Number of Fish Lost) at the SWP and CVP Salvage Facilities in December–March during All Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
December	0 (-22%)	0 (-23%)	0 (-26%)	0 (-27%)	0 (-25%)	0 (-19%)
January	0 (-42%)	0 (-54%)	0 (-43%)	0 (-55%)	0 (-44%)	0 (-55%)
February	0 (-66%)	0 (-65%)	0 (-66%)	0 (-65%)	0 (-67%)	0 (-64%)
March	0 (-71%)	0 (-75%)	0 (-71%)	0 (-75%)	0 (-71%)	0 (-74%)
Annual Average	-1 (-56%)	-1 (-62%)	-1 (-57%)	-1 (-63%)	-1 (-57%)	-1 (-62%)

Table B-195. Estimated Absolute and Percent Differences between Model Scenarios in Adult Longfin Smelt Entrainment Index (Number of Fish Lost) at the SWP and CVP Salvage Facilities in December–March during Wet Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
December	0 (-38%)	0 (-33%)	0 (-39%)	0 (-34%)	0 (-39%)	0 (-33%)
January	0 (-86%)	0 (-84%)	0 (-86%)	0 (-84%)	0 (-86%)	0 (-84%)
February	0 (-100%)	0 (-98%)	0 (-100%)	0 (-98%)	0 (-100%)	0 (-98%)
March	0 (-96%)	0 (-97%)	0 (-96%)	0 (-97%)	0 (-96%)	0 (-97%)
Annual Average	0 (-78%)	0 (-76%)	0 (-79%)	0 (-77%)	0 (-79%)	0 (-77%)

Table B-196. Estimated Absolute and Percent Differences between Model Scenarios in Adult Longfin Smelt Entrainment Index (Number of Fish Lost) at the SWP and CVP Salvage Facilities in December–March during Above Normal Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
December	0 (-20%)	0 (-15%)	0 (-23%)	0 (-19%)	0 (-24%)	0 (-16%)
January	0 (-52%)	0 (-57%)	0 (-55%)	0 (-59%)	0 (-56%)	0 (-60%)
February	0 (-83%)	0 (-84%)	0 (-83%)	0 (-84%)	0 (-84%)	0 (-84%)
March	0 (-83%)	0 (-95%)	0 (-82%)	0 (-95%)	0 (-83%)	0 (-95%)
Annual Average	0 (-51%)	0 (-54%)	0 (-53%)	0 (-57%)	0 (-54%)	0 (-57%)

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Table B-197. Estimated Absolute and Percent Differences between Model Scenarios in Adult Longfin Smelt Entrainment Index (Number of Fish Lost) at the SWP and CVP Salvage Facilities in December–March during Below Normal Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
December	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
January	0 (-5%)	0 (-19%)	0 (-9%)	0 (-22%)	0 (-11%)	0 (-16%)
February	0 (-68%)	0 (-54%)	0 (-69%)	0 (-55%)	0 (-71%)	0 (-50%)
March	0 (-59%)	0 (-62%)	0 (-55%)	0 (-58%)	0 (-54%)	0 (-58%)
Annual Average	0 (-17%)	0 (-27%)	0 (-19%)	0 (-28%)	0 (-21%)	0 (-24%)

Table B-198. Estimated Absolute and Percent Differences between Model Scenarios in Adult Longfin Smelt Entrainment Index (Number of Fish Lost) at the SWP and CVP Salvage Facilities in December–March during Dry Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
December	0 (-11%)	0 (-20%)	0 (-20%)	0 (-28%)	0 (-17%)	0 (-19%)
January	0 (-1%)	0 (-20%)	0 (0%)	0 (-20%)	0 (0%)	0 (-21%)
February	0 (-18%)	0 (-20%)	0 (-18%)	0 (-21%)	0 (-18%)	0 (-13%)
March	0 (-26%)	0 (-33%)	0 (-27%)	0 (-35%)	0 (-28%)	0 (-27%)
Annual Average	0 (-17%)	0 (-29%)	0 (-18%)	0 (-29%)	0 (-18%)	0 (-24%)

Table B-199. Estimated Absolute and Percent Differences between Model Scenarios in Adult Longfin Smelt Entrainment Index (Number of Fish Lost) at the SWP and CVP Salvage Facilities in December–March during Critical Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
December	0 (-7%)	0 (-10%)	0 (-14%)	0 (-16%)	0 (-7%)	0 (20%)
January	0 (3%)	-3 (-52%)	1 (10%)	-3 (-49%)	1 (19%)	-3 (-49%)
February	0 (5%)	0 (2%)	0 (1%)	0 (-2%)	0 (2%)	0 (6%)
March	0 (-13%)	-1 (-18%)	0 (-14%)	-1 (-19%)	0 (-3%)	0 (-3%)
Annual Average	0 (-1%)	-3 (-29%)	0 (0%)	-3 (-28%)	1 (8%)	-2 (-23%)

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B.4.1.7 *Sacramento Splittail*

B.4.1.7.1 Juvenile

Salvage-Density Method

DELTA INFLOW—ESTIMATED SALVAGE DENSITY

Across all water years, May–July salvage of juvenile Sacramento splittail under the preliminary proposal (PP_ELT and PP_LLT) was estimated generally to be about four to five times as high at the CVP facilities as at the SWP facilities (Table B-200), with the differences in salvage estimates between the facilities diminishing with lower Delta inflow (Table B-201 to Table B-205). Salvage estimates ranged from averages of several million in wet water years through thousands in above normal, below normal, and dry water years to hundreds in critical water years.

Salvage generally was estimated to decrease under PP scenarios relative to EBC scenarios, reflecting the general decrease in SWP/CVP south Delta pumping. Across all water years, reductions in estimated salvage under PP scenarios compared to EBC scenarios at both facilities ranged from just over 40% to around 85% (Table B-200), with greater decreases when comparing ELT and LLT time periods. Given that the bulk of salvage occurs in wet years, the results for wet years were very similar to those for all years (Table B-201). In contrast, reductions under PP in above normal years were low at around 3–15%, and there was an instance (PP_LLT vs. EBC_LLT) where salvage under PP increased relative to EBC by 11% (Table B-202). In the remaining water-year types (below normal, dry, and critical), reductions in salvage under PP relative to EBC generally were in the range of 25–60% (Table B-203 to Table B-205).

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Table B-200. Estimated Average May–July Salvage (Estimated from Delta Inflow) of Juvenile Sacramento Splittail at the South Delta SWP and CVP Export Facilities under Each Model Scenario and Percentage Difference between Model Scenarios, All Water Years

Scenario	Mean	Lower 95% Confidence Limit	Upper 95% Confidence Limit	Percent Difference		
				PP_ELT or PP_LLT vs. EBC1	PP_ELT or PP_LLT vs. EBC2	PP_ELT or PP_LLT vs. EBC2_ELT or EBC2_LLT
SWP						
EBC1	271,904	22,145	4,078,817			
EBC2	365,562	27,192	5,802,036			
EBC2_ ELT	580,762	36,443	10,760,666			
PP_ELT	84,094	6,709	1,447,520	-69.1	-77.0	-85.5
EBC2_ LLT	537,723	34,113	9,758,856			
PP_LLT	148,961	10,364	2,623,525	-45.2	-59.3	-72.3
CVP						
EBC1	1,133,520	50,411	30,964,986			
EBC2	1,112,466	49,539	30,344,684			
EBC2_ ELT	1,822,320	66,305	59,388,783			
PP_ELT	439,132	20,098	13,061,582	-61.3	-60.5	-75.9
EBC2_ LLT	1,679,551	61,686	53,363,052			
PP_LLT	630,258	24,826	19,616,142	-44.4	-43.3	-62.5

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Table B-201. Estimated Average May–July Salvage (Estimated from Delta Inflow) of Juvenile Sacramento Splittail at the South Delta SWP and CVP Export Facilities under Each Model Scenario and Percentage Difference between Model Scenarios, Wet Water Years

Scenario	Mean	Lower 95% Confidence Limit	Upper 95% Confidence Limit	Percent Difference		
				PP_ELT or PP_LLT vs. EBC1	PP_ELT or PP_LLT vs. EBC2	PP_ELT or PP_LLT vs. EBC2_ELT or EBC2_LLT
SWP						
EBC1	851,311	67,072	12,848,770			
EBC2	1,146,937	83,101	18,284,077			
EBC2_ ELT	1,825,187	112,203	33,920,775			
PP_ELT	259,944	19,064	4,550,607	-69.5	-77.3	-85.8
EBC2_ LLT	1,690,128	105,125	30,762,970			
PP_LLT	464,821	30,820	8,259,376	-45.4	-59.5	-72.5
CVP						
EBC1	3,562,487	154,289	97,622,012			
EBC2	3,496,420	151,681	95,666,429			
EBC2_ ELT	5,735,796	204,986	187,266,797			
PP_ELT	1,374,786	59,974	41,159,615	-61.4	-60.7	-76.0
EBC2_ LLT	5,286,679	190,862	168,265,327			
PP_LLT	1,977,385	74,970	61,829,542	-44.5	-43.4	-62.6

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Table B-202. Estimated Average May–July Salvage (Estimated from Delta Inflow) of Juvenile Sacramento Splittail at the South Delta SWP and CVP Export Facilities under Each Model Scenario and Percentage Difference between Model Scenarios, Above Normal Water Years

Scenario	Mean	Lower 95% Confidence Limit	Upper 95% Confidence Limit	Percent Difference		
				PP_ELT or PP_LLT vs. EBC1	PP_ELT or PP_LLT vs. EBC2	PP_ELT or PP_LLT vs. EBC2_ELT or EBC2_LLT
SWP						
EBC1	9,040	3,320	25,283			
EBC2	8,758	3,218	24,563			
EBC2_ ELT	9,851	3,454	29,103			
PP_ELT	8,453	2,797	26,540	-6.5	-3.5	-14.2
EBC2_ LLT	8,569	2,995	25,609			
PP_LLT	8,301	2,612	27,655	-8.2	-5.2	-3.1
CVP						
EBC1	18,939	5,784	64,440			
EBC2	18,727	5,732	63,866			
EBC2_ ELT	18,202	5,273	65,687			
PP_ELT	16,126	4,301	63,231	-14.9	-13.9	-11.4
EBC2_ LLT	16,269	4,615	60,806			
PP_LLT	18,055	4,814	71,426	-4.7	-3.6	11.0

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Table B-203. Estimated Average May–July Salvage (Estimated from Delta Inflow) of Juvenile Sacramento Splittail at the South Delta SWP and CVP Export Facilities under Each Model Scenario and Percentage Difference between Model Scenarios, Below Normal Water Years

Scenario	Mean	Lower 95% Confidence Limit	Upper 95% Confidence Limit	Percent Difference		
				PP_ELT or PP_LLT vs. EBC1	PP_ELT or PP_LLT vs. EBC2	PP_ELT or PP_LLT vs. EBC2_ELT or EBC2_LLT
SWP						
EBC1	2,110	1,145	3,948			
EBC2	1,976	1,080	3,677			
EBC2_ ELT	2,013	1,087	3,811			
PP_ELT	1,581	854	2,966	-25.1	-20.0	-21.5
EBC2_ LLT	1,939	1,053	3,652			
PP_LLT	1,377	735	2,637	-34.7	-30.3	-29.0
CVP						
EBC1	3,906	1,914	8,139			
EBC2	3,675	1,828	7,566			
EBC2_ ELT	3,295	1,615	6,936			
PP_ELT	3,188	1,506	6,933	-18.4	-13.2	-3.2
EBC2_ LLT	3,004	1,475	6,324			
PP_LLT	2,108	1,050	4,278	-46.0	-42.6	-29.8

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Table B-204. Estimated Average May–July Salvage (Estimated from Delta Inflow) of Juvenile Sacramento Splittail at the South Delta SWP and CVP Export Facilities under Each Model Scenario and Percentage Difference between Model Scenarios, Dry Water Years

Scenario	Mean	Lower 95% Confidence Limit	Upper 95% Confidence Limit	Percent Difference		
				PP_ELT or PP_LLT vs. EBC1	PP_ELT or PP_LLT vs. EBC2	PP_ELT or PP_LLT vs. EBC2_ELT or EBC2_LLT
SWP						
EBC1	1,023	661	1,601			
EBC2	1,010	654	1,579			
EBC2_ ELT	931	609	1,438			
PP_ELT	648	417	1,020	-36.6	-35.8	-30.3
EBC2_ LLT	916	593	1,433			
PP_LLT	500	317	797	-51.2	-50.5	-45.5
CVP						
EBC1	1,891	1,127	3,225			
EBC2	1,790	1,067	3,058			
EBC2_ ELT	1,603	954	2,753			
PP_ELT	1,216	717	2,103	-35.7	-32.1	-24.1
EBC2_ LLT	1,448	860	2,491			
PP_LLT	1,022	596	1,781	-46.0	-42.9	-29.4

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Table B-205. Estimated Average May–July Salvage (Estimated from Delta Inflow) of Juvenile Sacramento Splittail at the South Delta SWP and CVP Export Facilities under Each Model Scenario and Percentage Difference between Model Scenarios, Critical Water Years

Scenario	Mean	Lower 95% Confidence Limit	Upper 95% Confidence Limit	Percent Difference		
				PP_ELT or PP_LLT vs. EBC1	PP_ELT or PP_LLT vs. EBC2	PP_ELT or PP_LLT vs. EBC2_ELT or EBC2_LLT
SWP						
EBC1	468	350	626	626		
EBC2	397	301	525	525		
EBC2_ ELT	376	283	501	501		
PP_ELT	159	120	212	212	-59.9	-57.6
EBC2_ LLT	295	222	393	393		
PP_LLT	132	99	177	177	-66.7	-55.2
CVP						
EBC1	664	472	937	937		
EBC2	570	407	802	802		
EBC2_ ELT	509	363	715	715		
PP_ELT	360	258	505	505	-36.8	-29.2
EBC2_ LLT	511	361	727	727		
PP_LLT	382	271	538	538	-33.0	-25.3

Yolo Bypass Inundation—Estimated Salvage Density

Across all water years, May–July salvage of juvenile Sacramento splittail under the preliminary proposal (PP_ELT and PP_LLT) was estimated generally several times higher at the CVP facilities as at the SWP facilities (Table B-200), with the differences in salvage estimates between the facilities diminishing with lower Delta inflow (Table B-201 to Table B-205). Salvage estimates ranged from averages of hundreds of thousands or millions in wet water years, through tens or hundreds of thousands in above normal years, thousands to tens of thousands in below normal water years, thousands in dry water years, to hundreds in critical water years.

In contrast to estimates of salvage from Delta inflow (see above), salvage estimated from days of Yolo Bypass inundation generally was estimated to increase considerably under PP scenarios relative to EBC scenarios, reflecting the increased inundation of the Yolo

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Bypass under PP scenarios. Across all water years, increases in estimated salvage under PP scenarios compared to EBC scenarios at both facilities ranged from around 150% to 400% (Table B-200). Given that the bulk of salvage occurs in wet years, the results for wet years were very similar to those for all years (Table B-201). Increases in estimated salvage under PP were greatest in above normal years at around 900–1300% more than EBC scenarios (Table B-208). There were generally reductions in salvage under PP scenarios compared to EBC scenarios in critical water years ranging from averages of 1 to 60% (Table B-211). In the remaining water-year types (below normal and dry, and critical), average increases in salvage under PP relative to EBC ranged from 20 to 630% (Table B-203 to Table B-205).

Table B-206. Estimated Average May–July Salvage (Estimated from Number of Days of Yolo Bypass Inundation) of Juvenile Sacramento Splittail at the South Delta SWP and CVP Export Facilities under Each Model Scenario and Percentage Difference between Model Scenarios, All Water Years

Scenario	Mean	Lower 95% Confidence Limit	Upper 95% Confidence Limit	Percent Difference		
				PP_ELT or PP_LLT vs. EBC1	PP_ELT or PP_LLT vs. EBC2	PP_ELT or PP_LLT vs. EBC2_ELT or EBC2_LLT
SWP						
EBC1	74,371	7,737	967,981			
EBC2	74,162	7,705	971,463			
EBC2_ ELT	91,098	8,315	1,352,228			
PP_ELT	251,449	11,429	7,937,060	238.1	239.1	176.0
EBC2_ LLT	88,120	7,814	1,369,578			
PP_LLT	223,957	10,663	5,956,614	201.1	202.0	154.2
CVP						
EBC1	196,525	14,664	3,654,068			
EBC2	188,460	14,215	3,521,237			
EBC2_ ELT	235,451	14,909	5,132,472			
PP_ELT	951,890	26,827	47,370,481	384.4	405.1	304.3
EBC2_ LLT	216,739	13,271	4,980,384			
PP_LLT	724,454	22,897	30,064,437	268.6	284.4	234.3

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Table B-207. Estimated Average May–July Salvage (Estimated from Number of Days of Yolo Bypass Inundation) of Juvenile Sacramento Splittail at the South Delta SWP and CVP Export Facilities under Each Model Scenario and Percentage Difference between Model Scenarios, Wet Water Years

Scenario	Mean	Lower 95% Confidence Limit	Upper 95% Confidence Limit	Percent Difference		
				PP_ELT or PP_LLT vs. EBC1	PP_ELT or PP_LLT vs. EBC2	PP_ELT or PP_LLT vs. EBC2_ELT or EBC2_LLT
SWP						
EBC1	223,383	19,562	3,010,518			
EBC2	224,166	19,739	3,031,642			
EBC2_ ELT	276,091	21,505	4,223,400			
PP_ELT	693,128	25,725	23,627,073	210.3	209.2	151.1
EBC2_ LLT	268,007	20,370	4,283,084			
PP_LLT	619,874	24,817	17,569,968	177.5	176.5	131.3
CVP						
EBC1	598,325	37,861	11,423,788			
EBC2	574,890	36,748	11,026,573			
EBC2_ ELT	722,792	39,589	16,099,263			
PP_ELT	2,787,832	67,479	145,211,584	365.9	384.9	285.7
EBC2_ LLT	666,677	35,331	15,629,837			
PP_LLT	2,095,184	56,215	91,399,531	250.2	264.4	214.3

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Table B-208. Estimated Average May–July Salvage (Estimated from Number of Days of Yolo Bypass Inundation) of Juvenile Sacramento Splittail at the South Delta SWP and CVP Export Facilities under Each Model Scenario and Percentage Difference between Model Scenarios, Above Normal Water Years

Scenario	Mean	Lower 95% Confidence Limit	Upper 95% Confidence Limit	Percent Difference		
				PP_ELT or PP_LLT vs. EBC1	PP_ELT or PP_LLT vs. EBC2	PP_ELT or PP_LLT vs. EBC2_ELT or EBC2_LLT
SWP						
EBC1	18,080	4,941	84,736			
EBC2	15,226	4,559	63,076			
EBC2_ ELT	18,512	5,034	82,732			
PP_ELT	199,408	15,779	2,986,805	1002.9	1209.6	977.2
EBC2_ LLT	16,019	4,402	72,346			
PP_LLT	174,106	13,852	2,592,426	863.0	1043.5	986.8
CVP						
EBC1	35,771	8,587	205,162			
EBC2	31,863	8,348	158,544			
EBC2_ ELT	33,145	7,787	177,891			
PP_ELT	425,146	24,568	8,902,697	1088.5	1234.3	1182.7
EBC2_ LLT	27,817	6,547	157,106			
PP_LLT	384,407	25,215	7,296,252	974.6	1106.4	1281.9

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Table B-209. Estimated Average May–July Salvage (Estimated from Number of Days of Yolo Bypass Inundation) of Juvenile Sacramento Splittail at the South Delta SWP and CVP Export Facilities under Each Model Scenario and Percentage Difference between Model Scenarios, Below Normal Water Years

Scenario	Mean	Lower 95% Confidence Limit	Upper 95% Confidence Limit	Percent Difference		
				PP_ELT or PP_LLT vs. EBC1	PP_ELT or PP_LLT vs. EBC2	PP_ELT or PP_LLT vs. EBC2_ELT or EBC2_LLT
SWP						
EBC1	2,061	1,791	2,447			
EBC2	1,952	1,716	2,293			
EBC2_ ELT	2,091	1,764	2,611			
PP_ELT	10,814	3,345	42,400	424.6	454.1	417.1
EBC2_ LLT	1,960	1,704	2,350			
PP_LLT	8,465	2,754	31,531	310.6	333.7	331.8
CVP						
EBC1	3,765	3,223	4,574			
EBC2	3,724	3,198	4,528			
EBC2_ ELT	3,562	2,899	4,692			
PP_ELT	25,959	6,422	130,867	589.5	597.0	628.9
EBC2_ LLT	3,090	2,611	3,870			
PP_LLT	16,488	4,393	84,222	338.0	342.7	433.6

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Table B-210. Estimated Average May–July Salvage (Estimated from Number of Days of Yolo Bypass Inundation) of Juvenile Sacramento Splittail at the South Delta SWP and CVP Export Facilities under Each Model Scenario and Percentage Difference between Model Scenarios, Dry Water Years

Scenario	Mean	Lower 95% Confidence Limit	Upper 95% Confidence Limit	Percent Difference		
				PP_ELT or PP_LLT vs. EBC1	PP_ELT or PP_LLT vs. EBC2	PP_ELT or PP_LLT vs. EBC2_ELT or EBC2_LLT
SWP						
EBC1	1,736	1,563	2,031			
EBC2	1,729	1,556	2,023			
EBC2_ ELT	1,630	1,481	1,891			
PP_ELT	2,630	1,498	5,147	51.4	52.1	61.3
EBC2_ LLT	1,636	1,441	1,979			
PP_LLT	1,947	1,117	3,691	12.2	12.6	19.0
CVP						
EBC1	3,204	2,827	3,893			
EBC2	3,085	2,704	3,783			
EBC2_ ELT	2,889	2,466	3,705			
PP_ELT	5,090	2,701	10,794	58.9	65.0	76.2
EBC2_ LLT	2,645	2,232	3,440			
PP_LLT	3,932	2,175	7,785	22.7	27.4	48.7

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Table B-211. Estimated Average May–July Salvage (Estimated from Number of Days of Yolo Bypass Inundation) of Juvenile Sacramento Splittail at the South Delta SWP and CVP Export Facilities under Each Model Scenario and Percentage Difference between Model Scenarios, Critical Water Years

Scenario	Mean	Lower 95% Confidence Limit	Upper 95% Confidence Limit	Percent Difference		
				PP_ELT or PP_LLT vs. EBC1	PP_ELT or PP_LLT vs. EBC2	PP_ELT or PP_LLT vs. EBC2_ELT or EBC2_LLT
SWP						
EBC1	1,114	1,114	1,114	626		
EBC2	986	986	986	525		
EBC2_ ELT	910	910	910	501		
PP_ELT	489	429	594	212	-50.4	-46.3
EBC2_ LLT	711	711	711	393		
PP_LLT	411	352	515	177	-58.3	-42.1
CVP						
EBC1	1,585	1,585	1,585	937		
EBC2	1,380	1,380	1,380	802		
EBC2_ ELT	1,232	1,232	1,232	715		
PP_ELT	1,215	1,001	1,623	505	-11.9	-1.3
EBC2_ LLT	1,197	1,197	1,197	727		
PP_LLT	1,325	1,062	1,817	538	-3.9	10.8

B.4.1.7.2 Adult

Salvage-Density Method

The main entrainment period for adult Sacramento splittail occurs from December to March, and the entrainment analyses were focused on this period. General trends in estimated salvage for adult Sacramento splittail include higher salvage at SWP than CVP and decreasing salvage as water years become drier (Table B-212 to Table B-217). Salvage under the PP scenarios was lower than EBC scenarios, but the differences decreased as water years become drier.

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Over all water years, differences between EBC and PP scenarios were quite consistent, with decreases under PP scenarios compared to EBC scenarios of 62–66% (2,200–2,300) adult Sacramento splittail (Table B-218). Decreases under PP scenarios compared to EBC scenarios were found for wet years (3,600–3,900, >90%; Table B-219), above normal years (3,600–3,900, 76–81%; Table B-220), below normal years (1,500–1,800, 50%; Table B-221), and dry years (50–400 fish, 2–17%; Table B-222). In critical years, salvage was low, and differences between PP and EBC scenarios ranged from an increase under PP_ELT compared to EBC2_ELT (~190 fish, 6%) to a decrease under PP_LLT compared to EBC2 (~290 fish, 9%) (Table B-223).

Table B-212. Estimated Mean Monthly and Annual Entrainment Index (Number of Fish as Expanded Salvage with 95% Confidence Interval [CI]) of Adult Sacramento Splittail for Six Model Scenarios at the SWP and CVP Salvage Facilities in December–March for All Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
December	128	±	14	129	±	14	126	±	14	124	±	14	104	±	12	110	±	14
January	322	±	23	327	±	24	332	±	25	328	±	24	187	±	18	148	±	15
February	741	±	60	753	±	61	766	±	64	713	±	59	256	±	31	263	±	32
March	1203	±	94	1228	±	98	1229	±	100	1193	±	99	380	±	43	295	±	37
(b) CVP																		
December	47	±	4	50	±	5	49	±	4	44	±	4	36	±	4	36	±	4
January	285	±	16	281	±	17	282	±	17	272	±	16	158	±	13	131	±	12
February	255	±	16	245	±	16	248	±	16	251	±	17	82	±	9	85	±	10
March	507	±	41	506	±	41	496	±	41	484	±	41	127	±	18	133	±	18

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Table B-213. Estimated Mean Monthly and Annual Entrainment Index (Number of Fish as Expanded Salvage with 95% Confidence Interval [CI]) of Adult Sacramento Splittail for Six Model Scenarios at the SWP and CVP Salvage Facilities in December–March for Wet Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
December	178	±	58	182	±	60	188	±	62	190	±	63	101	±	41	109	±	48
January	241	±	43	247	±	45	256	±	46	247	±	45	30	±	15	34	±	14
February	423	±	70	427	±	72	443	±	74	421	±	72	4	±	5	9	±	9
March	1,289	±	265	1,357	±	281	1,386	±	286	1,337	±	280	53	±	35	39	±	30
(b) CVP																		
December	61	±	12	62	±	12	62	±	12	59	±	12	40	±	10	43	±	11
January	256	±	46	267	±	49	270	±	50	265	±	49	49	±	22	52	±	22
February	418	±	56	420	±	58	430	±	59	440	±	60	0	±	N/A	6	±	7
March	1,093	±	204	1,105	±	212	1,120	±	214	1,134	±	217	0	±	N/A	68	±	54

Table B-214. Estimated Mean Monthly and Annual Entrainment Index (Number of Fish as Expanded Salvage with 95% Confidence Interval [CI]) of Adult Sacramento Splittail for Six Model Scenarios at the SWP and CVP Salvage Facilities in December–March for Above Normal Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
December	105	±	23	107	±	24	107	±	23	107	±	23	86	±	21	99	±	26
January	375	±	94	405	±	112	425	±	122	413	±	116	175	±	70	158	±	64
February	840	±	349	843	±	356	860	±	371	843	±	359	140	±	119	136	±	93
March	2,201	±	895	2,151	±	869	2,202	±	905	2,251	±	973	383	±	376	115	±	192
(b) CVP																		
December	27	±	7	29	±	7	29	±	8	26	±	7	20	±	6	18	±	6
January	462	±	104	443	±	97	389	±	94	435	±	100	263	±	96	239	±	92
February	359	±	122	314	±	120	343	±	127	351	±	123	68	±	60	91	±	67
March	453	±	64	459	±	68	430	±	68	412	±	71	19	±	23	44	±	45

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Table B-215. Estimated Mean Monthly and Annual Entrainment Index (Number of Fish as Expanded Salvage with 95% Confidence Interval [CI]) of Adult Sacramento Splittail for Six Model Scenarios at the SWP and CVP Salvage Facilities in December–March for Below Normal Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
December	81	±	15	84	±	13	78	±	14	78	±	16	72	±	21	72	±	26
January	196	±	23	204	±	31	208	±	35	191	±	45	188	±	62	160	±	54
February	952	±	278	973	±	289	1,043	±	325	880	±	243	306	±	143	441	±	230
March	881	±	177	894	±	199	900	±	209	833	±	207	435	±	189	343	±	149
(b) CVP																		
December	24	±	1	25	±	2	24	±	2	22	±	3	18	±	4	19	±	4
January	338	±	40	324	±	45	327	±	44	287	±	56	207	±	63	207	±	62
February	99	±	20	92	±	18	76	±	19	94	±	20	39	±	19	31	±	19
March	811	±	140	737	±	132	717	±	133	730	±	169	332	±	193	309	±	146

Table B-216. Estimated Mean Monthly and Annual Entrainment Index (Number of Fish as Expanded Salvage with 95% Confidence Interval [CI]) of Adult Sacramento Splittail for Six Model Scenarios at the SWP and CVP Salvage Facilities in December–March for Dry Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
December	179	±	57	185	±	59	180	±	59	172	±	58	190	±	62	191	±	63
January	427	±	148	419	±	146	415	±	145	436	±	152	439	±	155	352	±	143
February	599	±	148	598	±	153	565	±	143	511	±	135	598	±	164	561	±	166
March	667	±	182	662	±	179	623	±	167	616	±	163	637	±	165	515	±	158
(b) CVP																		
December	87	±	31	97	±	35	93	±	34	86	±	33	78	±	29	70	±	28
January	213	±	77	215	±	78	225	±	82	210	±	78	189	±	73	152	±	65
February	86	±	22	87	±	21	88	±	22	81	±	22	64	±	18	64	±	20
March	189	±	38	192	±	37	194	±	37	172	±	34	137	±	32	124	±	31

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Table B-217. Estimated Mean Monthly and Annual Entrainment Index (Number of Fish as Expanded Salvage with 95% Confidence Interval [CI]) of Adult Sacramento Splittail for Six Model Scenarios at the SWP and CVP Salvage Facilities in December–March for Critical Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
December	0	±	N/A	0	±	N/A	0	±	N/A	0	±	N/A	0	±	N/A	0	±	N/A
January	154	±	34	144	±	37	133	±	42	146	±	29	160	±	34	74	±	36
February	1,724	±	445	1,891	±	502	1,765	±	361	1,723	±	438	2,024	±	564	1,875	±	368
March	791	±	227	786	±	266	695	±	230	667	±	246	713	±	306	684	±	324
(b) CVP																		
December	0	±	N/A	0	±	N/A	0	±	N/A	0	±	N/A	0	±	N/A	0	±	N/A
January	337	±	55	299	±	60	312	±	62	292	±	71	284	±	76	151	±	61
February	270	±	63	244	±	71	277	±	59	237	±	64	199	±	45	229	±	72
March	69	±	22	74	±	27	64	±	21	58	±	21	51	±	16	45	±	17

Table B-218. Estimated Absolute and Percent Differences between Model Scenarios in Adult Sacramento Splittail Entrainment Index (Number of Fish as Expanded Salvage) at the SWP and CVP Salvage Facilities in December–March during All Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
December	-35 (-20%)	-29 (-17%)	-39 (-22%)	-34 (-19%)	-34 (-20%)	-23 (-13%)
January	-261 (-43%)	-327 (-54%)	-264 (-43%)	-330 (-54%)	-270 (-44%)	-322 (-54%)
February	-658 (-66%)	-648 (-65%)	-660 (-66%)	-650 (-65%)	-675 (-67%)	-616 (-64%)
March	-1203 (-70%)	-1281 (-75%)	-1228 (-71%)	-1306 (-75%)	-1219 (-71%)	-1248 (-74%)
Annual Average	-2157 (-62%)	-2286 (-66%)	-2191 (-62%)	-2320 (-66%)	-2199 (-62%)	-2208 (-65%)

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Table B-219. Estimated Absolute and Percent Differences between Model Scenarios in Adult Sacramento Splittail Entrainment Index (Number of Fish as Expanded Salvage) at the SWP and CVP Salvage Facilities in December–March during Wet Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
December	-98 (-41%)	-87 (-37%)	-103 (-42%)	-93 (-38%)	-109 (-44%)	-97 (-39%)
January	-418 (-84%)	-410 (-83%)	-435 (-85%)	-428 (-83%)	-447 (-85%)	-427 (-83%)
February	-837 (-99%)	-826 (-98%)	-842 (-99%)	-832 (-98%)	-869 (-99%)	-846 (-98%)
March	-2330 (-98%)	-2275 (-96%)	-2409 (-98%)	-2355 (-96%)	-2453 (-98%)	-2365 (-96%)
Annual Average	-3682 (-93%)	-3599 (-91%)	-3790 (-93%)	-3708 (-91%)	-3877 (-93%)	-3735 (-91%)

Table B-220. Estimated Absolute and Percent Differences between Model Scenarios in Adult Sacramento Splittail Entrainment Index (Number of Fish as Expanded Salvage) at the SWP and CVP Salvage Facilities in December–March during Above Normal Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
December	-25 (-19%)	-15 (-11%)	-29 (-22%)	-19 (-14%)	-30 (-22%)	-16 (-12%)
January	-400 (-48%)	-441 (-53%)	-411 (-48%)	-452 (-53%)	-376 (-46%)	-450 (-53%)
February	-990 (-83%)	-972 (-81%)	-948 (-82%)	-930 (-80%)	-995 (-83%)	-967 (-81%)
March	-2252 (-85%)	-2495 (-94%)	-2207 (-85%)	-2450 (-94%)	-2229 (-85%)	-2504 (-94%)
Annual Average	-3666 (-76%)	-3922 (-81%)	-3595 (-76%)	-3852 (-81%)	-3630 (-76%)	-3938 (-81%)

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Table B-221. Estimated Absolute and Percent Differences between Model Scenarios in Adult Sacramento Splittail Entrainment Index (Number of Fish as Expanded Salvage) at the SWP and CVP Salvage Facilities in December–March during Below Normal Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
December	-14 (-13%)	-13 (-13%)	-19 (-17%)	-18 (-17%)	-11 (-11%)	-9 (-9%)
January	-139 (-26%)	-166 (-31%)	-134 (-25%)	-160 (-30%)	-140 (-26%)	-111 (-23%)
February	-705 (-67%)	-578 (-55%)	-719 (-68%)	-592 (-56%)	-773 (-69%)	-501 (-51%)
March	-925 (-55%)	-1040 (-61%)	-864 (-53%)	-979 (-60%)	-849 (-53%)	-911 (-58%)
Annual Average	-1783 (-53%)	-1796 (-53%)	-1735 (-52%)	-1749 (-52%)	-1774 (-53%)	-1532 (-49%)

Table B-222. Estimated Absolute and Percent Differences between Model Scenarios in Sacramento Splittail Entrainment Index (Number of Fish as Expanded Salvage) at the SWP and CVP Salvage Facilities during Dry Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
December	2 (1%)	-5 (-2%)	-14 (-5%)	-21 (-8%)	-5 (-2%)	4 (1%)
January	-12 (-2%)	-136 (-21%)	-5 (-1%)	-130 (-21%)	-11 (-2%)	-142 (-22%)
February	-24 (-3%)	-61 (-9%)	-23 (-3%)	-60 (-9%)	9 (1%)	33 (6%)
March	-81 (-10%)	-217 (-25%)	-79 (-9%)	-215 (-25%)	-43 (-5%)	-149 (-19%)
Annual Average	-115 (-5%)	-419 (-17%)	-122 (-5%)	-426 (-17%)	-50 (-2%)	-254 (-11%)

Table B-223. Estimated Absolute and Percent Differences between Model Scenarios in Sacramento Splittail Entrainment Index (Number of Fish as Expanded Salvage) at the SWP and CVP Salvage Facilities during Critical Water Years

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
December	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
January	-47 (-10%)	-266 (-54%)	1 (0%)	-219 (-49%)	-1 (0%)	-213 (-49%)
February	229 (11%)	110 (6%)	88 (4%)	-31 (-1%)	182 (9%)	144 (7%)
March	-96 (-11%)	-131 (-15%)	-96 (-11%)	-131 (-15%)	5 (1%)	4 (1%)
Annual Average	86 (3%)	-288 (-9%)	-7 (0%)	-381 (-11%)	186 (6%)	-65 (-2%)

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B.4.1.8 *White Sturgeon (Juvenile)*

B.4.1.8.1 Salvage-Density Method

Analysis Based on Sacramento Valley Water Year–Type Classification

WETTER YEAR ANALYSIS

The mean entrainment indices for white sturgeon at the SWP and CVP export facilities based on Sacramento Valley wet and above normal water-year types are estimated to be variable throughout the year (Figure B-70, Figure B-71, and Table B-224). The SWP salvage estimates suggest peaks in November and February under all model scenarios (although more pronounced under EBC scenarios) and lows in April and May. Salvage is estimated to peak in October and November at the CVP facility under all model scenarios. Total annual average salvage of juvenile white sturgeon at SWP was estimated around 135–160 fish under EBC scenarios and just over 60 fish under the two PP scenarios. At the CVP, EBC scenario annual salvage ranged from 110 to 130 white sturgeon, and PP scenario salvage was about 80 white sturgeon.

Reductions in salvage under PP scenarios compared to EBC scenarios ranged from very little change in April–June (7 or fewer fish per month) to considerable changes in January–March (14–24 fewer fish, or ~95% reduction) (Table B-225). The overall annual average reduction in salvage of juvenile white sturgeon from EBC scenarios to PP scenarios is estimated to be around 100–150 fish (42–50% reduction).

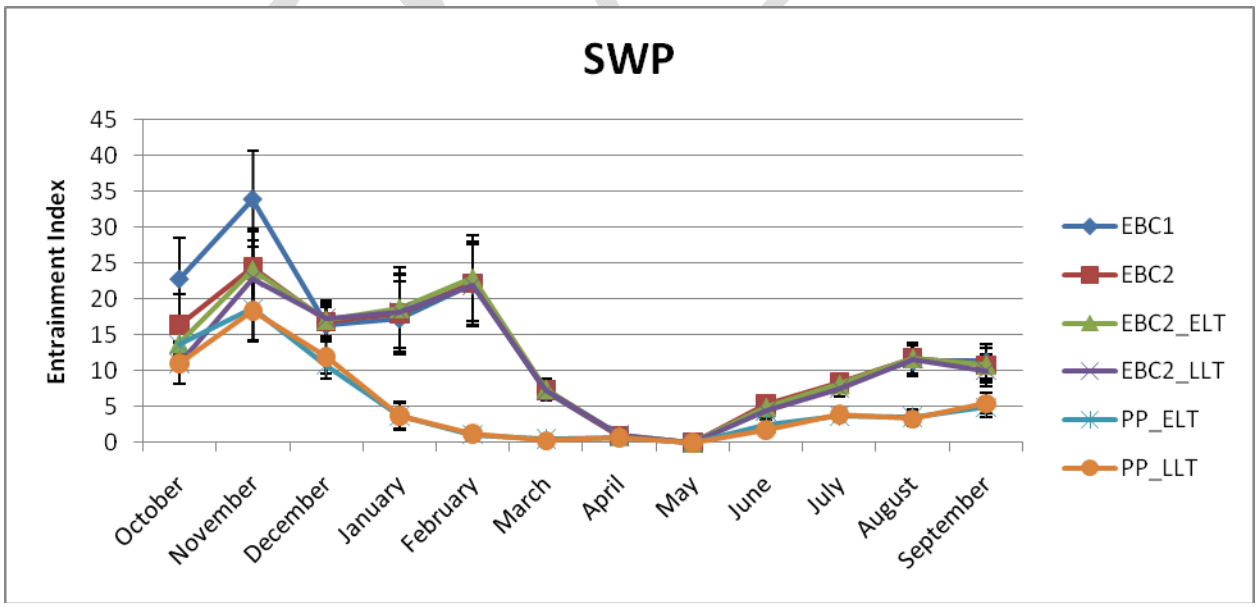

Figure B-70. Estimated Juvenile White Sturgeon Entrainment Index (Number of Fish as Expanded Salvage ± 95% Confidence Intervals) at the SWP Facility during Wet and Above Normal Years (Sacramento Valley Water Year–Type Classification)

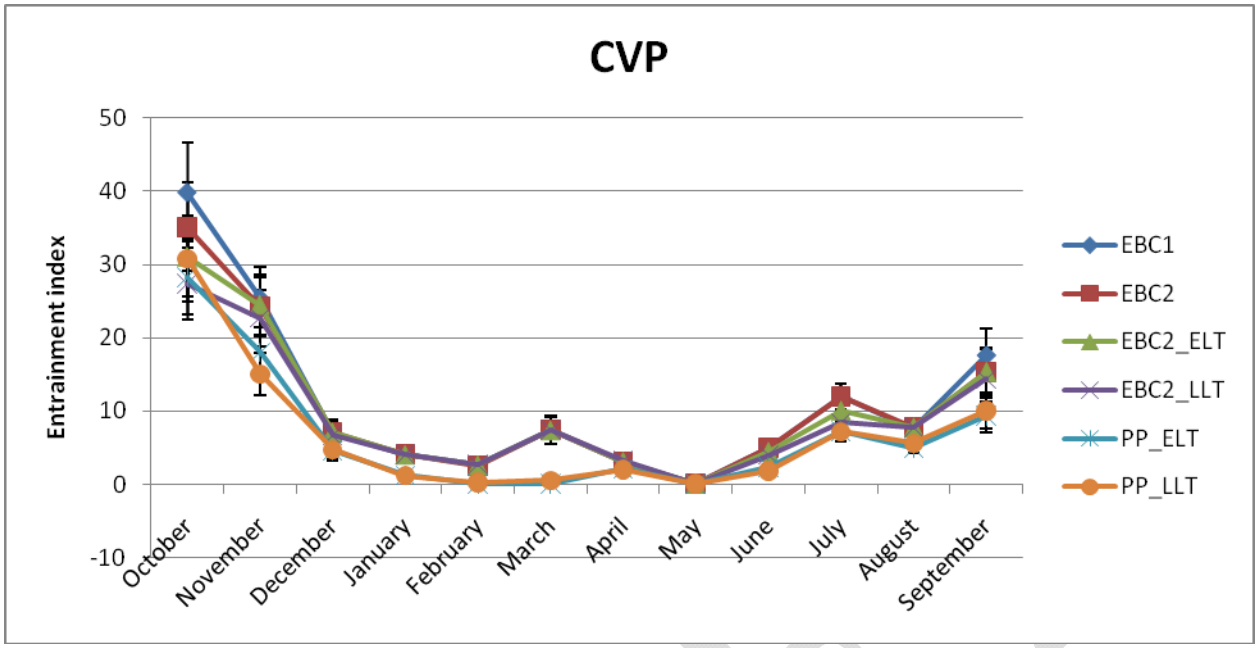

Figure B-71. Estimated Juvenile White Sturgeon Entrainment Index (Number of Fish as Expanded Salvage ± 95% Confidence Intervals) at the CVP Facility during Wet and Above Normal Years (Sacramento Valley Water Year–Type Classification)

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Table B-224. Estimated Juvenile White Sturgeon Entrainment Index (Number of Fish as Expanded Salvage ± 95% Confidence Intervals [CI]) at the SWP and CVP Salvage Facilities during Wet and Above Normal Years (Sacramento Valley Water Year–Type Classification)

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	23	±	6	16	±	4	14	±	4	11	±	3	14	±	3	11	±	3
November	34	±	7	24	±	5	24	±	5	23	±	5	19	±	4	18	±	4
December	16	±	2	17	±	2	17	±	2	17	±	3	11	±	2	12	±	2
January	17	±	5	18	±	5	19	±	6	18	±	5	4	±	2	4	±	2
February	22	±	6	22	±	6	23	±	6	22	±	6	1	±	1	1	±	1
March	7	±	1	7	±	1	7	±	1	7	±	1	1	±	0	0	±	0
April	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	5	±	1	5	±	1	5	±	1	4	±	1	3	±	1	2	±	0
July	8	±	1	8	±	1	8	±	1	8	±	1	4	±	1	4	±	1
August	11	±	2	12	±	2	12	±	2	12	±	2	4	±	1	3	±	1
September	11	±	2	11	±	2	11	±	2	10	±	2	5	±	1	5	±	1
Annual Average	157	±	18	142	±	17	141	±	16	133	±	15	64	±	8	62	±	8
(b) CVP																		
October	40	±	7	35	±	6	31	±	5	27	±	5	28	±	5	31	±	6
November	25	±	4	24	±	4	24	±	4	23	±	4	18	±	3	15	±	3
December	7	±	2	7	±	2	7	±	2	7	±	2	5	±	1	5	±	1
January	4	±	1	4	±	1	4	±	1	4	±	1	1	±	0	1	±	0
February	3	±	1	3	±	1	3	±	1	3	±	1	0	±	0	0	±	0
March	7	±	2	7	±	2	7	±	2	7	±	2	0	±	0	1	±	0
April	3	±	1	3	±	1	3	±	1	3	±	1	2	±	1	2	±	1
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	5	±	1	5	±	1	5	±	1	4	±	1	2	±	0	2	±	0
July	12	±	2	12	±	2	10	±	2	8	±	1	7	±	1	7	±	1
August	8	±	1	8	±	1	8	±	1	8	±	1	5	±	1	6	±	1
September	18	±	4	15	±	3	15	±	3	14	±	3	9	±	2	10	±	2
Annual Average	132	±	16	124	±	16	118	±	15	109	±	14	79	±	11	79	±	11

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Table B-225. Estimated Absolute and Percent Differences between Model Scenarios in Juvenile White Sturgeon Entrainment Index (Number of Fish as Expanded Salvage) at the SWP and CVP Salvage Facilities during Wet and Above Normal Years (Sacramento Valley Water Year–Type Classification)

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
October	-21 (-33%)	-21 (-33%)	-10 (-19%)	-10 (-19%)	-3 (-7%)	3 (9%)
November	-23 (-38%)	-26 (-44%)	-12 (-25%)	-15 (-31%)	-12 (-25%)	-12 (-27%)
December	-8 (-34%)	-7 (-29%)	-9 (-36%)	-7 (-31%)	-9 (-36%)	-7 (-31%)
January	-16 (-77%)	-16 (-77%)	-17 (-78%)	-17 (-78%)	-18 (-78%)	-17 (-78%)
February	-23 (-95%)	-23 (-94%)	-24 (-95%)	-23 (-94%)	-24 (-95%)	-23 (-94%)
March	-14 (-96%)	-14 (-94%)	-14 (-96%)	-14 (-95%)	-14 (-96%)	-14 (-95%)
April	-1 (-27%)	-1 (-32%)	-1 (-28%)	-1 (-33%)	-1 (-29%)	-2 (-36%)
May	0 (-30%)	0 (-24%)	0 (-30%)	0 (-24%)	0 (-33%)	0 (-25%)
June	-5 (-52%)	-7 (-65%)	-5 (-53%)	-7 (-65%)	-5 (-48%)	-5 (-58%)
July	-9 (-46%)	-9 (-45%)	-9 (-46%)	-9 (-45%)	-7 (-40%)	-5 (-30%)
August	-10 (-55%)	-10 (-53%)	-11 (-56%)	-11 (-55%)	-11 (-56%)	-10 (-54%)
September	-15 (-51%)	-13 (-46%)	-12 (-45%)	-11 (-40%)	-12 (-45%)	-9 (-36%)
Annual Average	-146 (-51%)	-148 (-51%)	-124 (-46%)	-125 (-47%)	-116 (-45%)	-101 (-42%)
Note: Negative values indicate decrease under PP relative to EBC.						

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Drier Year Analysis

Overall salvage of white sturgeon juveniles is estimated to be considerably lower in drier years than wetter years. The SWP salvage estimates suggest peaks in December, April–May, and August under all model scenarios (Figure B-72), with similar values between scenarios for most months except April–May, when PP scenarios had higher values. Salvage is estimated to peak in February–April and July–August at the CVP facility under all model scenarios (Figure B-73). Total annual average salvage of juvenile white sturgeon at SWP was estimated to be similar among all scenarios at 21–27 fish per year (Table B-226). At the CVP, EBC scenario total annual salvage ranged from 12 to 14 white sturgeon, and PP scenario salvage was 8–9 white sturgeon.

Reductions in salvage at both facilities combined under PP scenarios compared to EBC scenarios were low throughout the year (fewer than 4 white sturgeon per month, with many months of no change) (Table B-227). The overall annual average decrease in salvage under PP scenarios compared to EBC scenarios ranged from 4 to 11 white sturgeon (approximately 10–30% reductions).

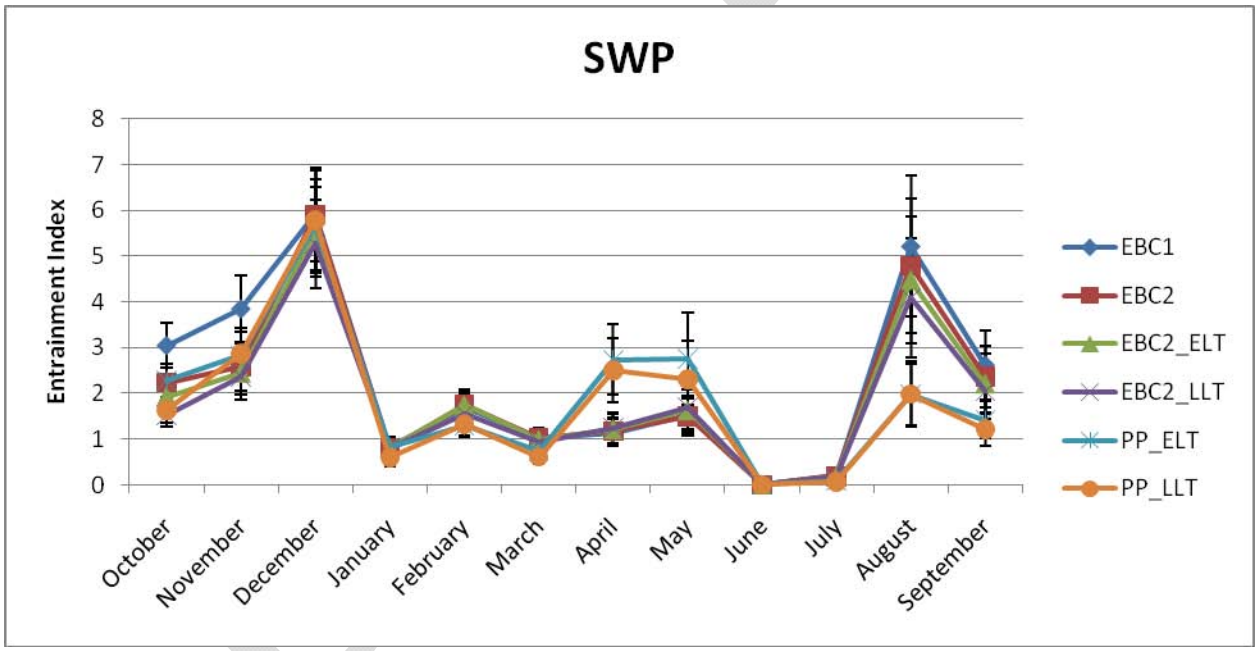

Figure B-72. Estimated Juvenile White Sturgeon Entrainment Index (Number of Fish as Expanded Salvage ± 95% Confidence Intervals) at the SWP Facility during Below Normal, Dry, and Critical Years (Sacramento Valley Water Year–Type Classification)

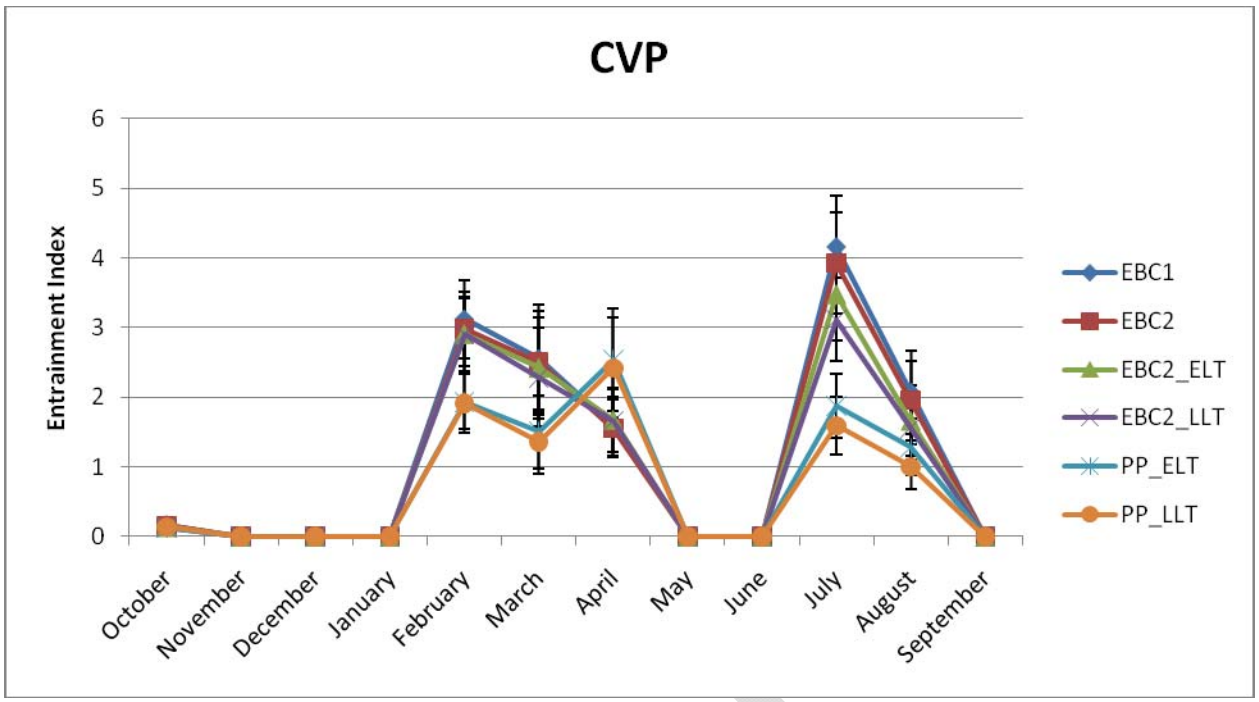

Figure B-73. Estimated Juvenile White Sturgeon Entrainment Index (Number of Fish as Expanded Salvage ± 95% Confidence Intervals) at the CVP Facility during Below Normal, Dry, and Critical Years (Sacramento Valley Water Year–Type Classification)

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Table B-226. Estimated Juvenile White Sturgeon Entrainment Index (Number of Fish as Expanded Salvage ± 95% Confidence Intervals [CI]) at the SWP and CVP Salvage Facilities during Below Normal, Dry, and Critical Water Years (Sacramento Valley Water Year–Type Classification)

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	3	±	0	2	±	0	2	±	0	2	±	0	2	±	0	2	±	0
November	4	±	1	3	±	1	2	±	0	2	±	0	3	±	1	3	±	1
December	6	±	1	6	±	1	6	±	1	5	±	1	6	±	1	6	±	1
January	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
February	2	±	0	2	±	0	2	±	0	2	±	0	1	±	0	1	±	0
March	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
April	1	±	0	1	±	0	1	±	0	1	±	0	3	±	1	2	±	1
May	2	±	0	1	±	0	2	±	0	2	±	0	3	±	1	2	±	1
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	5	±	2	5	±	1	4	±	1	4	±	1	2	±	1	2	±	1
September	3	±	1	2	±	1	2	±	1	2	±	1	1	±	0	1	±	0
Annual Average	27	±	3	24	±	3	23	±	3	22	±	2	23	±	3	21	±	2
(b) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	3	±	1	3	±	1	3	±	1	3	±	1	2	±	0	2	±	0
March	3	±	1	2	±	1	2	±	1	2	±	1	2	±	1	1	±	0
April	2	±	0	2	±	0	2	±	0	2	±	0	3	±	1	2	±	1
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	4	±	1	4	±	1	3	±	1	3	±	1	2	±	0	2	±	0
August	2	±	1	2	±	1	2	±	1	2	±	0	1	±	0	1	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	14	±	2	13	±	2	12	±	2	12	±	2	9	±	2	8	±	2

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Table B-227. Estimated Absolute and Percent Differences between Model Scenarios in Juvenile White Sturgeon Entrainment Index (Number of Fish as Expanded Salvage) at the SWP and CVP Salvage Facilities during Below Normal, Dry, and Critical Water Years (Sacramento Valley Water Year–Type Classification)

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
October	-1 (-25%)	-1 (-45%)	0 (1%)	-1 (-26%)	0 (16%)	0 (8%)
November	-1 (-27%)	-1 (-26%)	0 (10%)	0 (11%)	0 (16%)	1 (21%)
December	0 (-4%)	0 (-2%)	0 (-4%)	0 (-2%)	0 (2%)	1 (10%)
January	0 (1%)	0 (-26%)	0 (2%)	0 (-25%)	0 (3%)	0 (-25%)
February	-2 (-33%)	-2 (-33%)	-1 (-32%)	-1 (-31%)	-1 (-30%)	-1 (-27%)
March	-1 (-37%)	-2 (-45%)	-1 (-36%)	-2 (-44%)	-1 (-34%)	-1 (-39%)
April	3 (94%)	2 (81%)	3 (93%)	2 (80%)	2 (82%)	2 (69%)
May	1 (80%)	1 (50%)	1 (85%)	1 (55%)	1 (70%)	1 (35%)
June	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
July	-2 (-55%)	-3 (-62%)	-2 (-52%)	-2 (-60%)	-2 (-46%)	-2 (-49%)
August	-4 (-55%)	-4 (-59%)	-3 (-52%)	-4 (-56%)	-3 (-47%)	-3 (-47%)
September	-1 (-46%)	-1 (-54%)	-1 (-40%)	-1 (-49%)	-1 (-36%)	-1 (-41%)
Annual Average	-9 (-22%)	-11 (-28%)	-6 (-15%)	-8 (-22%)	-4 (-10%)	-4 (-12%)
Note: Negative values indicate decrease under PP relative to EBC.						

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Analysis Based on San Joaquin Valley Water Year–Type Classification

WETTER YEAR ANALYSIS

The mean entrainment indices for white sturgeon at the SWP and CVP export facilities based on San Joaquin Valley wet and above normal water-year types are estimated to be variable throughout the year (Figure B-74, Figure B-75, and Table B-228). The SWP salvage estimates suggest peaks in November (all model scenarios) and February (EBC scenarios) and lows in April and May (all scenarios). Salvage is estimated to peak in October and November at the CVP facility under all model scenarios. Total annual average salvage of juvenile white sturgeon at SWP was estimated to be around 150–175 fish under EBC scenarios and 70–75 fish under the two PP scenarios. At the CVP, EBC scenario average annual salvage ranged from 120 to 145 white sturgeon, and PP scenario salvage was just under 90 white sturgeon.

Reductions in salvage under PP scenarios compared to EBC scenarios ranged from very little change in April–May (0–1 fewer fish per month) to considerable changes in January–March (15–30 fewer fish, or >90% reduction) (Table B-229). The overall annual average reduction in salvage of juvenile white sturgeon from EBC scenarios to PP scenarios is estimated to be around 115–160 fish (42–50% reduction).

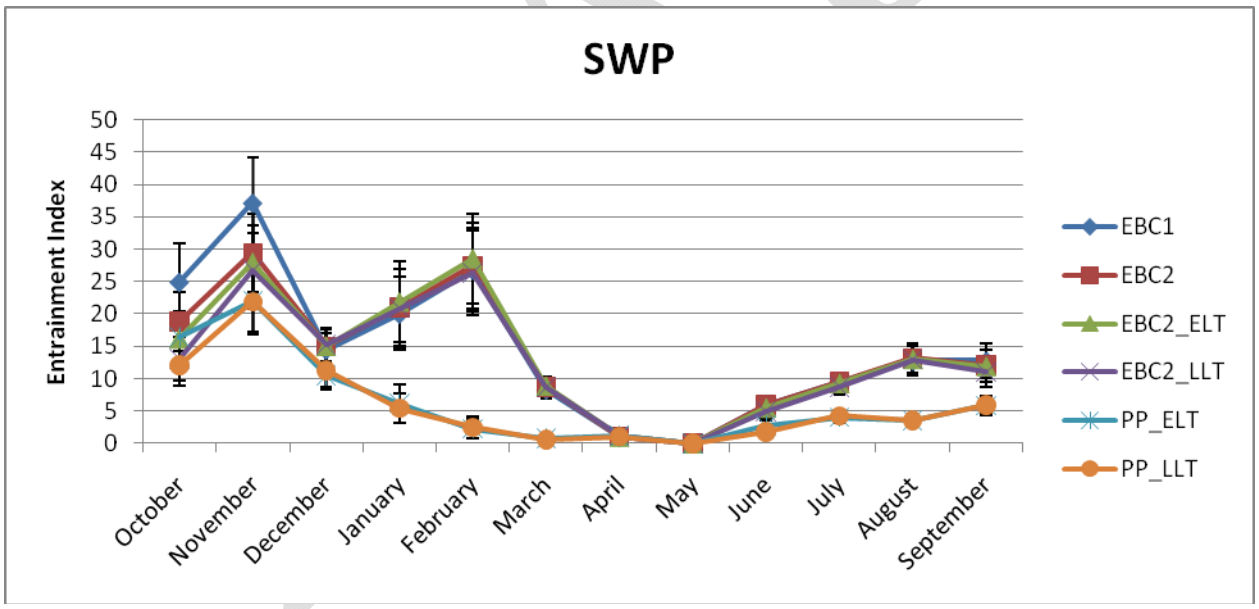

Figure B-74. Estimated Juvenile White Sturgeon Entrainment Index (Number of Fish as Expanded Salvage ± 95% Confidence Intervals) at the SWP Facility during Wet and Above Normal Years (San Joaquin Valley Water Year–Type Classification)

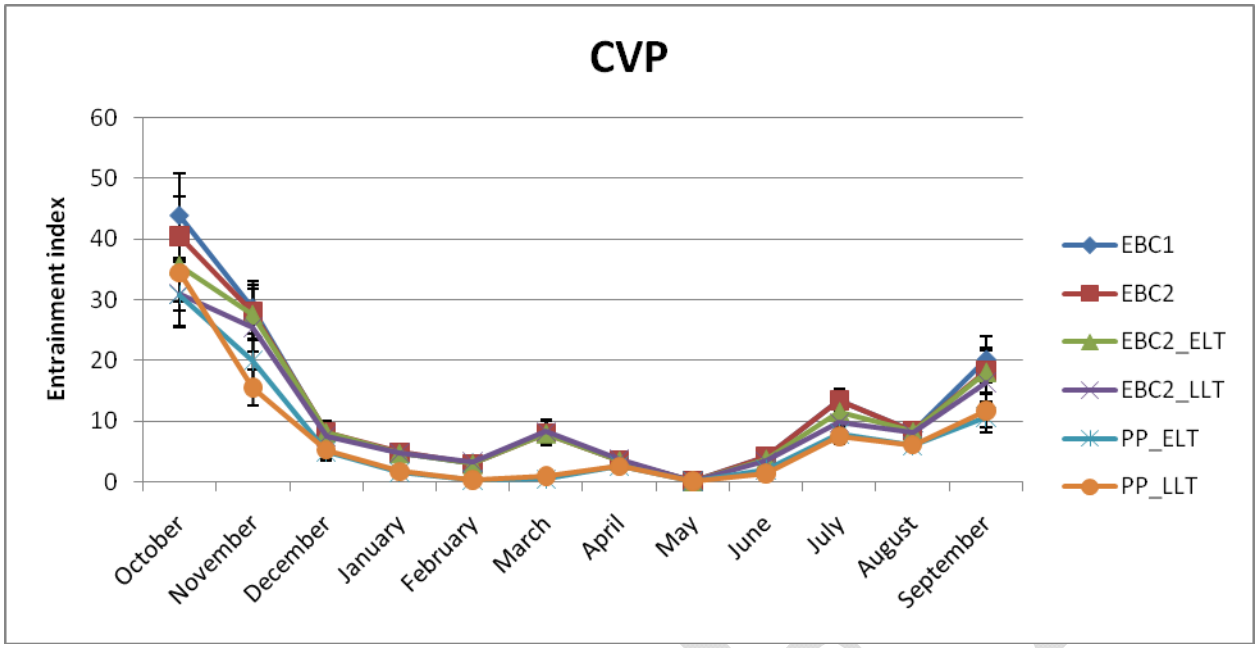

Figure B-75. Estimated Juvenile White Sturgeon Entrainment Index (Number of Fish as Expanded Salvage ± 95% Confidence Intervals) at the CVP Facility during Wet and Above Normal Years (San Joaquin Valley Water Year–Type Classification)

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Table B-228. Estimated Juvenile White Sturgeon Entrainment Index (Number of Fish as Expanded Salvage ± 95% Confidence Intervals [CI]) at the SWP and CVP Salvage Facilities during Wet and Above Normal Years (San Joaquin Water Year–Type Classification)

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	25	±	6	19	±	5	16	±	4	13	±	3	16	±	4	12	±	3
November	37	±	7	29	±	6	28	±	6	27	±	6	22	±	5	22	±	5
December	15	±	3	15	±	3	15	±	3	15	±	3	10	±	2	11	±	3
January	20	±	6	21	±	6	22	±	6	21	±	6	6	±	3	5	±	2
February	27	±	7	27	±	7	29	±	7	26	±	7	2	±	1	2	±	2
March	8	±	1	9	±	1	9	±	1	9	±	1	1	±	0	1	±	0
April	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	6	±	1	6	±	1	6	±	1	5	±	1	3	±	1	2	±	1
July	9	±	1	10	±	1	9	±	1	9	±	1	4	±	1	4	±	1
August	13	±	2	13	±	2	13	±	2	13	±	2	4	±	1	4	±	1
September	13	±	3	12	±	2	12	±	2	11	±	2	6	±	1	6	±	1
Annual Average	174	±	19	162	±	18	159	±	18	150	±	17	75	±	10	70	±	9
(b) CVP																		
October	44	±	7	40	±	7	36	±	6	31	±	5	31	±	5	34	±	6
November	29	±	4	28	±	4	28	±	4	25	±	4	20	±	4	16	±	3
December	8	±	2	8	±	2	8	±	2	8	±	2	5	±	1	5	±	1
January	5	±	1	5	±	1	5	±	1	5	±	1	2	±	1	2	±	1
February	3	±	1	3	±	1	3	±	1	3	±	1	0	±	0	0	±	0
March	8	±	2	8	±	2	8	±	2	8	±	2	0	±	0	1	±	1
April	3	±	1	3	±	1	4	±	1	4	±	1	3	±	1	3	±	1
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	4	±	1	4	±	1	4	±	1	3	±	1	2	±	0	1	±	0
July	13	±	2	13	±	2	12	±	2	10	±	2	8	±	1	8	±	1
August	8	±	1	8	±	1	8	±	1	8	±	1	6	±	1	6	±	1
September	20	±	4	18	±	4	18	±	4	16	±	3	11	±	3	12	±	3
Annual Average	146	±	17	140	±	17	132	±	15	121	±	14	87	±	12	88	±	12

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Table B-229. Estimated Absolute and Percent Differences between Model Scenarios in Juvenile White Sturgeon Entrainment Index (Number of Fish as Expanded Salvage) at the SWP and CVP Salvage Facilities during Wet and Above Normal Years (San Joaquin Valley Water Year–Type Classification)

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
October	-22 (-31%)	-22 (-32%)	-12 (-20%)	-13 (-22%)	-5 (-9%)	2 (5%)
November	-24 (-36%)	-28 (-43%)	-15 (-27%)	-20 (-35%)	-14 (-24%)	-15 (-28%)
December	-7 (-31%)	-6 (-26%)	-8 (-33%)	-7 (-28%)	-8 (-34%)	-6 (-27%)
January	-17 (-69%)	-18 (-71%)	-18 (-70%)	-19 (-73%)	-19 (-71%)	-18 (-72%)
February	-27 (-92%)	-27 (-91%)	-28 (-92%)	-28 (-91%)	-29 (-92%)	-27 (-91%)
March	-15 (-92%)	-15 (-91%)	-15 (-93%)	-15 (-91%)	-16 (-93%)	-15 (-91%)
April	-1 (-15%)	-1 (-19%)	-1 (-16%)	-1 (-20%)	-1 (-17%)	-1 (-24%)
May	0 (-17%)	0 (-19%)	0 (-17%)	0 (-19%)	0 (-20%)	0 (-19%)
June	-5 (-54%)	-7 (-69%)	-5 (-54%)	-7 (-70%)	-5 (-50%)	-5 (-63%)
July	-11 (-48%)	-11 (-49%)	-11 (-48%)	-11 (-49%)	-9 (-43%)	-7 (-36%)
August	-12 (-55%)	-11 (-54%)	-12 (-56%)	-12 (-55%)	-12 (-56%)	-11 (-54%)
September	-16 (-50%)	-15 (-46%)	-14 (-46%)	-13 (-42%)	-14 (-45%)	-10 (-36%)
Annual Average	-157 (-49%)	-162 (-51%)	-140 (-46%)	-145 (-48%)	-129 (-44%)	-113 (-42%)
Note: Negative values indicate decrease under PP relative to EBC.						

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Drier Year Analysis

Overall salvage of white sturgeon juveniles is estimated to be considerably lower in drier years than wetter years. The SWP salvage estimates suggest peaks in December, April–May, and August under all model scenarios (Figure B-76), with similar values between scenarios for most months. Salvage is estimated to peak in February–April and July–August at the CVP facility under all model scenarios (Figure B-77). Total annual average salvage of juvenile white sturgeon at SWP was estimated to be 22–27 fish per year under EBC scenarios and 21–22 fish per year under PP scenarios (Table B-230). At CVP, EBC scenario total annual salvage ranged from 10 to 12 white sturgeon, and PP scenario salvage was 7–8 white sturgeon.

Reductions in salvage at both facilities combined under PP scenarios compared to EBC scenarios were low throughout the year (fewer than 4 white sturgeon per month, with many months of no change) (Table B-231). The overall annual average decrease in salvage under PP scenarios compared to EBC scenarios ranged from 4 to 11 white sturgeon (12–28% reductions).

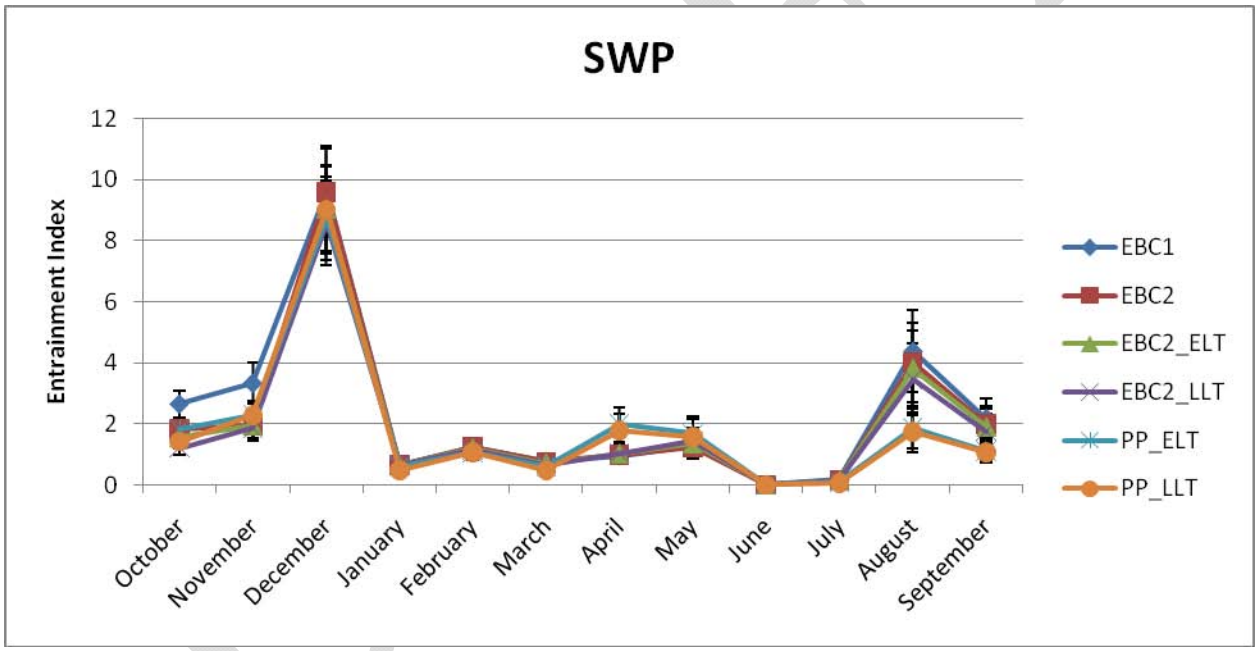

Figure B-76. Estimated Juvenile White Sturgeon Entrainment Index (Number of Fish as Expanded Salvage ± 95% Confidence Intervals) at the SWP Facility during Below Normal, Dry, and Critical Years (San Joaquin Valley Water Year–Type Classification)

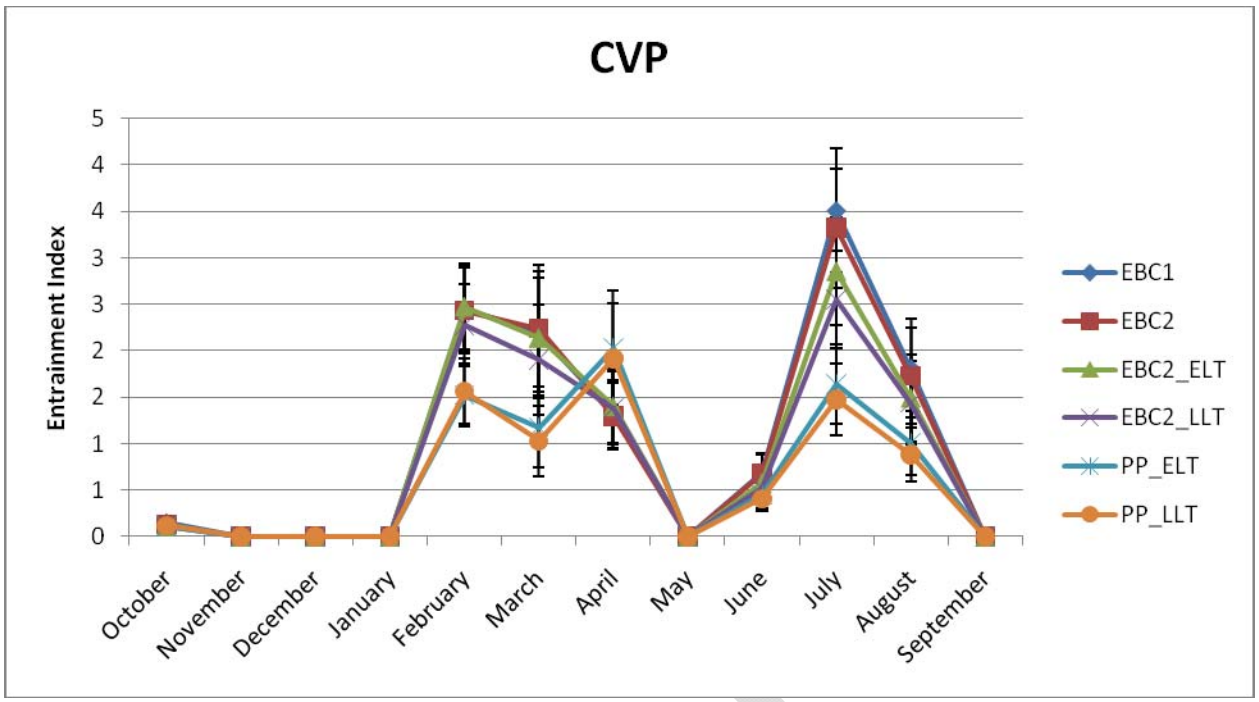

Figure B-77. Estimated Juvenile White Sturgeon Entrainment Index (Number of Fish as Expanded Salvage ± 95% Confidence Intervals) at the CVP Facility during Below Normal, Dry, and Critical Years (San Joaquin Valley Water Year–Type Classification)

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Table B-230. Estimated Juvenile White Sturgeon Entrainment Index (Number of Fish as Expanded Salvage ± 95% Confidence Intervals [CI]) at the SWP and CVP Salvage Facilities during Below Normal, Dry, and Critical Water Years (San Joaquin Valley Water Year–Type Classification)

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(b) SWP																		
October	3	±	0	2	±	0	2	±	0	1	±	0	2	±	0	1	±	0
November	3	±	1	2	±	0	2	±	0	2	±	0	2	±	0	2	±	0
December	10	±	1	10	±	1	9	±	1	9	±	1	9	±	1	9	±	1
January	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	0	±	0
February	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
March	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	0	±	0
April	1	±	0	1	±	0	1	±	0	1	±	0	2	±	1	2	±	1
May	1	±	0	1	±	0	1	±	0	1	±	0	2	±	1	2	±	1
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	4	±	1	4	±	1	4	±	1	3	±	1	2	±	1	2	±	1
September	2	±	1	2	±	1	2	±	1	2	±	1	1	±	0	1	±	0
Annual Average	27	±	3	24	±	2	23	±	2	22	±	2	22	±	2	21	±	2
(c) CVP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	2	±	0	2	±	0	2	±	0	2	±	0	2	±	0	2	±	0
March	2	±	1	2	±	1	2	±	1	2	±	1	1	±	0	1	±	0
April	1	±	0	1	±	0	1	±	0	1	±	0	2	±	1	2	±	1
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	1	±	0	1	±	0	1	±	0	1	±	0	0	±	0	0	±	0
July	4	±	1	3	±	1	3	±	1	3	±	1	2	±	0	1	±	0
August	2	±	1	2	±	1	1	±	0	1	±	0	1	±	0	1	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	12	±	2	12	±	2	11	±	2	10	±	2	8	±	1	7	±	1

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Table B-231. Estimated Absolute and Percent Differences between Model Scenarios in Juvenile White Sturgeon Entrainment Index (Number of Fish as Expanded Salvage) at the SWP and CVP Salvage Facilities during Below Normal, Dry, and Critical Water Years (San Joaquin Valley Water Year–Type Classification)

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
October	-1 (-31%)	-1 (-45%)	0 (-3%)	0 (-22%)	0 (15%)	0 (18%)
November	-1 (-32%)	-1 (-31%)	0 (18%)	0 (19%)	0 (17%)	0 (23%)
December	-1 (-9%)	-1 (-6%)	-1 (-9%)	-1 (-6%)	0 (-3%)	0 (5%)
January	0 (-5%)	0 (-29%)	0 (-3%)	0 (-27%)	0 (-1%)	0 (-28%)
February	-1 (-30%)	-1 (-29%)	-1 (-30%)	-1 (-28%)	-1 (-30%)	-1 (-23%)
March	-1 (-40%)	-1 (-49%)	-1 (-41%)	-1 (-50%)	-1 (-38%)	-1 (-41%)
April	2 (77%)	1 (63%)	2 (76%)	1 (62%)	2 (65%)	1 (52%)
May	0 (33%)	0 (25%)	0 (37%)	0 (29%)	0 (24%)	0 (11%)
June	0 (-34%)	0 (-40%)	0 (-33%)	0 (-40%)	0 (-22%)	0 (-23%)
July	-2 (-53%)	-2 (-58%)	-2 (-51%)	-2 (-56%)	-1 (-43%)	-1 (-43%)
August	-3 (-54%)	-4 (-58%)	-3 (-50%)	-3 (-54%)	-2 (-46%)	-2 (-47%)
September	-1 (-49%)	-1 (-52%)	-1 (-44%)	-1 (-47%)	-1 (-41%)	-1 (-40%)
Annual Average	-10 (-24%)	-11 (-28%)	-6 (-18%)	-8 (-22%)	-5 (-13%)	-4 (-12%)
Note: Negative values indicate decrease under PP relative to EBC.						

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B.4.1.9 *Green Sturgeon (Juvenile)*

B.4.1.9.1 Salvage-Density Method

Analysis Based on Sacramento Valley Water Year–Type Classification

WETTER YEAR ANALYSIS

The mean entrainment indices for green sturgeon at the SWP and CVP export facilities based on Sacramento Valley wet and above normal water-year types are estimated to be variable throughout the year (Figure B-78, Figure B-79, and Table B-232). The SWP salvage estimates suggest a peak in August under all model scenarios (although more pronounced under EBC scenarios) and a second peak under all EBC scenarios in February. Salvage is estimated to peak in late summer at the CVP facility under all model scenarios. Total annual average salvage of juvenile green sturgeon at SWP was estimated around 70 fish under all EBC scenarios and 18 fish under the two PP scenarios. Differences between EBC and PP were less at the CVP, where EBC scenario salvage ranged from 37 to 45 green sturgeon and PP scenario salvage was around 18 green sturgeon.

Reductions in salvage under PP scenarios compared to EBC scenarios ranged from very little change in March–June (0–3 fewer fish per month) to considerable changes in February (around 25 fewer green sturgeon, or a 95% reduction) and August–September (7–15 fewer fish, or a 33–65% reduction) (Table B-233). The overall annual average reduction in salvage of juvenile green sturgeon from EBC scenarios to PP scenarios is around 60–70 fish (56–60% reduction).

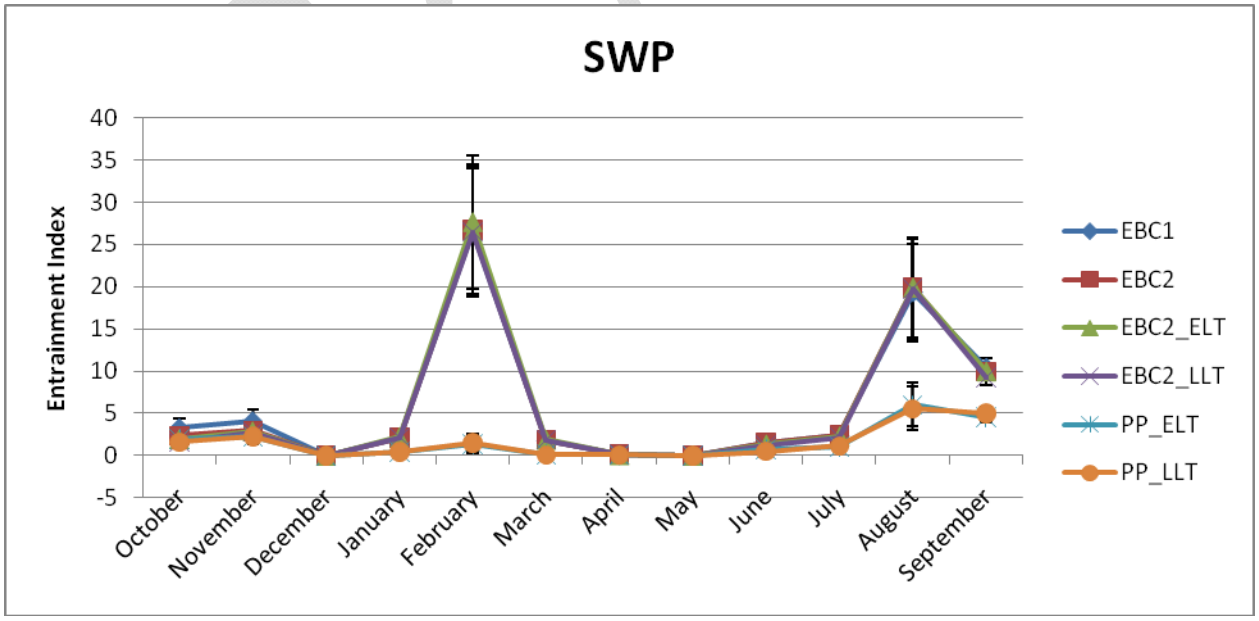

Figure B-78. Estimated Juvenile Green Sturgeon Entrainment Index (Number of Fish as Expanded Salvage ± 95% Confidence Intervals) at the SWP Facility during Wet and Above Normal Years (Sacramento Valley Water Year–Type Classification)

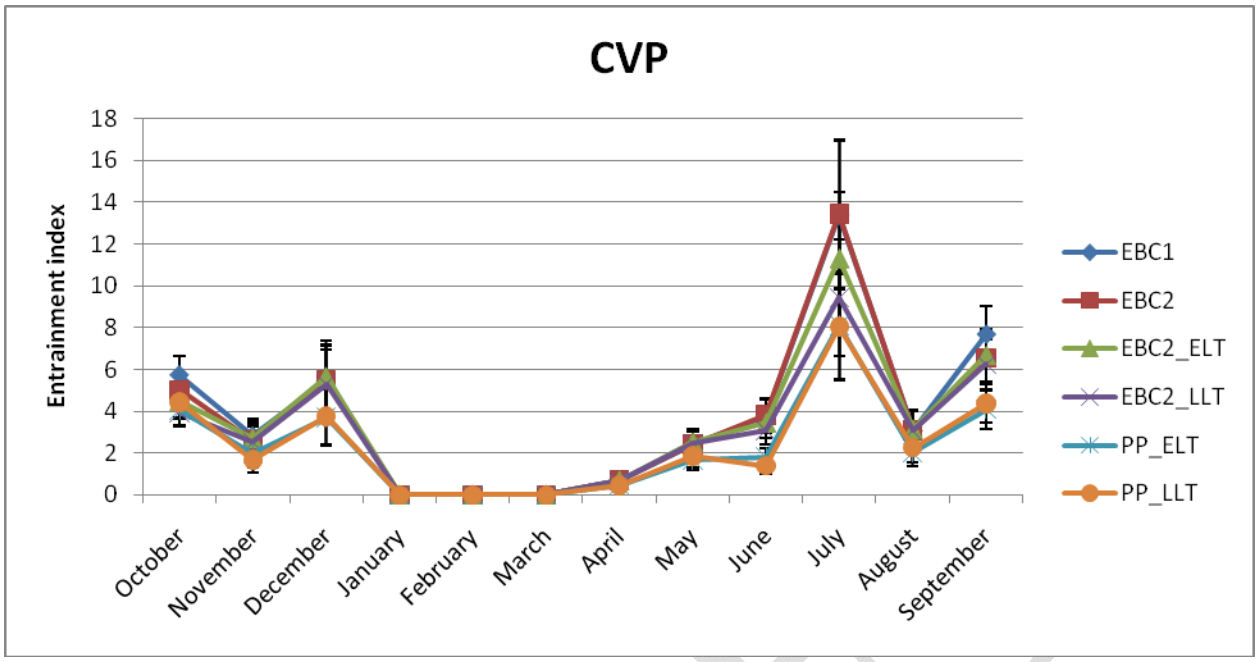

Figure B-79. Estimated Juvenile Green Sturgeon Entrainment Index (Number of Fish as Expanded Salvage ± 95% Confidence Intervals) at the CVP Facility during Wet and Above Normal Years (Sacramento Valley Water Year–Type Classification)

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Table B-232. Estimated Juvenile Green Sturgeon Entrainment Index (Number of Fish as Expanded Salvage ± 95% Confidence Intervals [CI]) at the SWP and CVP Salvage Facilities during Wet and Above Normal Years (Sacramento Valley Water Year–Type Classification)

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	3	±	1	2	±	1	2	±	1	2	±	1	2	±	1	2	±	1
November	4	±	1	3	±	1	3	±	1	3	±	1	2	±	1	2	±	1
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	2	±	0	2	±	0	2	±	0	2	±	0	0	±	0	0	±	0
February	27	±	8	27	±	8	28	±	8	26	±	8	1	±	1	2	±	1
March	2	±	1	2	±	1	2	±	1	2	±	1	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	0	±	0
July	2	±	0	2	±	0	2	±	0	2	±	0	1	±	0	1	±	0
August	19	±	6	20	±	6	20	±	6	20	±	6	6	±	3	6	±	3
September	10	±	1	10	±	1	10	±	1	9	±	1	5	±	1	5	±	1
Annual Average	71	±	9	70	±	9	70	±	9	67	±	9	18	±	3	18	±	3
(b) CVP																		
October	6	±	1	5	±	1	4	±	1	4	±	1	4	±	1	4	±	1
November	3	±	1	3	±	1	3	±	1	3	±	1	2	±	1	2	±	1
December	5	±	2	6	±	2	6	±	2	5	±	2	4	±	1	4	±	1
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	1	±	0	1	±	0	1	±	0	1	±	0	0	±	0	0	±	0
May	2	±	1	2	±	1	3	±	1	2	±	1	2	±	1	2	±	1
June	4	±	1	4	±	1	3	±	1	3	±	1	2	±	0	1	±	0
July	13	±	4	13	±	4	11	±	3	9	±	3	8	±	3	8	±	3
August	3	±	1	3	±	1	3	±	1	3	±	1	2	±	1	2	±	1
September	8	±	1	7	±	1	7	±	1	6	±	1	4	±	1	4	±	1
Annual Average	45	±	7	43	±	6	41	±	6	37	±	5	28	±	4	28	±	4

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Table B-233. Estimated Absolute and Percent Differences between Model Scenarios in Juvenile Green Sturgeon Entrainment Index (Number of Fish as Expanded Salvage) at the SWP and CVP Salvage Facilities during Wet and Above Normal Years (Sacramento Valley Water Year–Type Classification)

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
October	-3 (-33%)	-3 (-33%)	-1 (-18%)	-1 (-18%)	0 (-7%)	0 (9%)
November	-3 (-39%)	-3 (-44%)	-1 (-24%)	-2 (-30%)	-1 (-24%)	-1 (-26%)
December	-2 (-32%)	-2 (-31%)	-2 (-33%)	-2 (-32%)	-2 (-34%)	-2 (-29%)
January	-2 (-79%)	-2 (-78%)	-2 (-79%)	-2 (-79%)	-2 (-80%)	-2 (-79%)
February	-25 (-95%)	-25 (-94%)	-25 (-95%)	-25 (-94%)	-26 (-95%)	-25 (-94%)
March	-2 (-92%)	-2 (-96%)	-2 (-93%)	-2 (-96%)	-2 (-93%)	-2 (-96%)
April	0 (-29%)	0 (-34%)	0 (-29%)	0 (-34%)	0 (-30%)	0 (-37%)
May	-1 (-30%)	-1 (-24%)	-1 (-30%)	-1 (-24%)	-1 (-33%)	-1 (-25%)
June	-3 (-52%)	-3 (-64%)	-3 (-53%)	-3 (-65%)	-2 (-48%)	-2 (-56%)
July	-7 (-42%)	-7 (-42%)	-7 (-42%)	-7 (-42%)	-4 (-33%)	-2 (-21%)
August	-14 (-64%)	-15 (-65%)	-15 (-65%)	-15 (-66%)	-15 (-65%)	-15 (-66%)
September	-10 (-53%)	-9 (-48%)	-8 (-48%)	-7 (-43%)	-8 (-48%)	-6 (-39%)
Annual Average	-70 (-60%)	-70 (-60%)	-67 (-59%)	-67 (-59%)	-65 (-58%)	-58 (-56%)
Note: Negative values indicate decrease under PP relative to EBC.						

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Drier Year Analysis

Overall salvage of green sturgeon juveniles is estimated to be considerably lower in drier years than wetter years. The SWP salvage estimates suggest peaks in December and March under all model scenarios (Figure B-80). Salvage is estimated to peak in October and November at the CVP facility under all model scenarios (Figure B-81). Total annual average salvage of juvenile green sturgeon at SWP was estimated to be around 12–14 fish under all EBC scenarios and 13 fish under the two PP scenarios (Table B-234). At CVP, EBC scenario total annual salvage ranged from 29 to 36 green sturgeon and PP scenario salvage was 25–30 green sturgeon.

Reductions in salvage at both facilities combined under PP scenarios compared to EBC scenarios were low throughout the year (fewer than 10 green sturgeon per month, with many months of no change) (Table B-235). The overall annual average decrease in salvage under PP scenarios compared to EBC scenarios ranged from three to 12 green sturgeon (7–25% reductions).

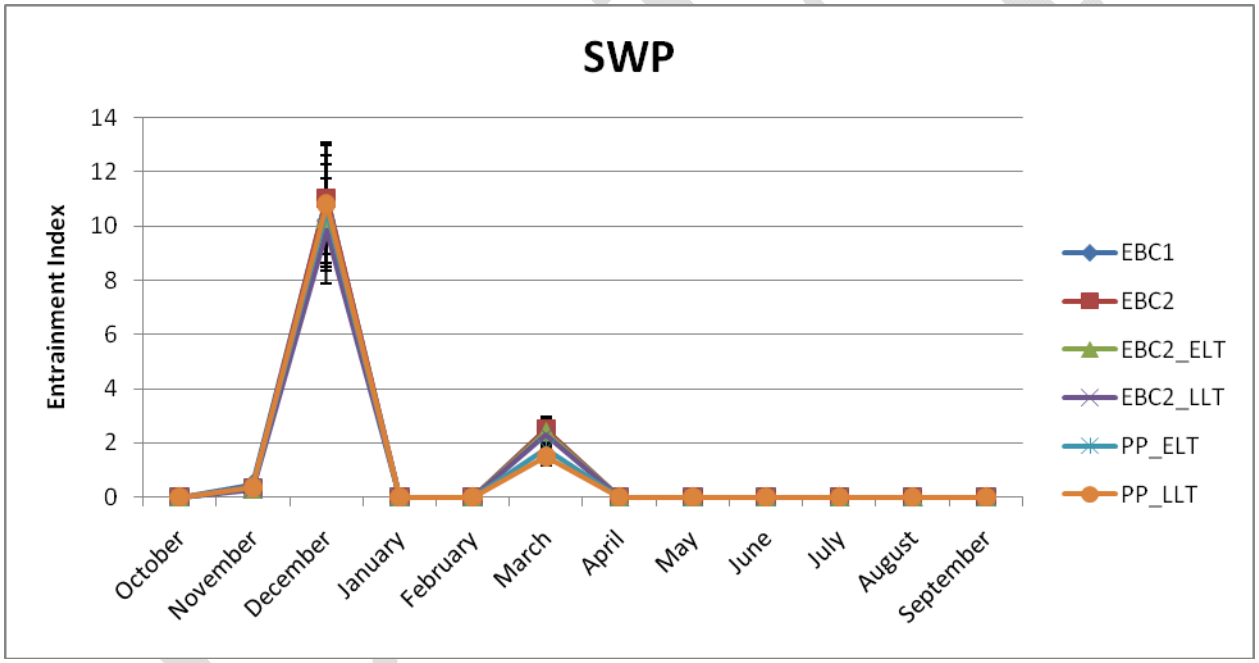

Figure B-80. Estimated Juvenile Green Sturgeon Entrainment Index (Number of Fish as Expanded Salvage ± 95% Confidence Intervals) at the SWP Facility during Below Normal, Dry, and Critical Years (Sacramento Valley Water Year–Type Classification)

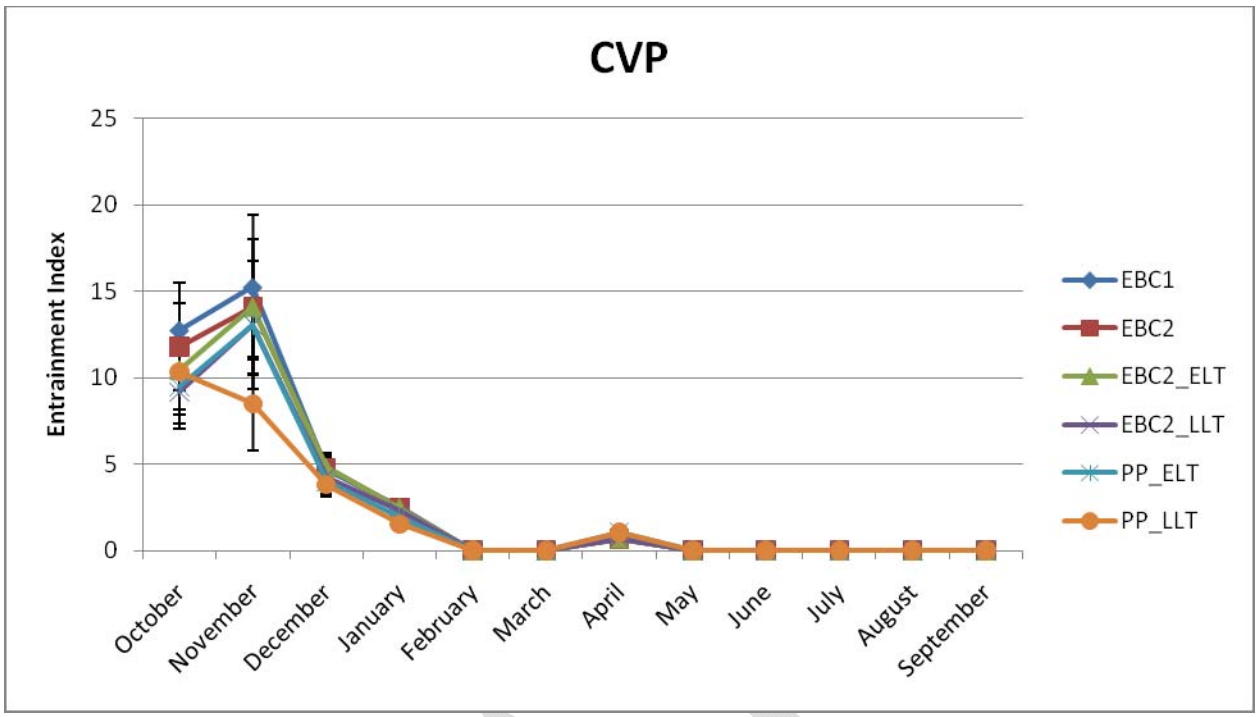

Figure B-81. Estimated Juvenile Green Sturgeon Entrainment Index (Number of Fish as Expanded Salvage ± 95% Confidence Intervals) at the CVP Facility during Below Normal, Dry, and Critical Years (Sacramento Valley Water Year–Type Classification)

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Table B-234. Estimated Juvenile Green Sturgeon Entrainment Index (Number of Fish as Expanded Salvage ± 95% Confidence Intervals [CI]) at the SWP and CVP Salvage Facilities during Below Normal, Dry, and Critical Water Years (Sacramento Valley Water Year–Type Classification)

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0
November	0.5	±	0.1	0.3	±	0.1	0.3	±	0.1	0.3	±	0.1	0.3	±	0.1	0.3	±	0.1
December	11.0	±	2.1	11.0	±	2.1	10.3	±	2.0	9.8	±	2.0	10.6	±	2.0	10.8	±	2.2
January	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0
February	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0
March	2.5	±	0.5	2.5	±	0.5	2.4	±	0.5	2.3	±	0.5	1.8	±	0.4	1.5	±	0.3
April	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0
May	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0
June	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0
July	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0
August	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0
September	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0
Annual Average	14.0	±	2.4	13.8	±	2.5	13.0	±	2.3	12.4	±	2.3	12.7	±	2.3	12.7	±	2.4
(b) CVP																		
October	12.8	±	2.7	11.8	±	2.5	10.5	±	2.3	9.2	±	2.1	9.5	±	2.2	10.3	±	2.5
November	15.2	±	4.2	14.1	±	3.9	14.1	±	3.9	13.0	±	3.7	13.1	±	3.7	8.5	±	2.7
December	4.6	±	0.8	4.8	±	0.8	4.8	±	0.8	4.2	±	0.8	4.0	±	0.7	3.8	±	0.7
January	2.5	±	0.5	2.5	±	0.5	2.5	±	0.5	2.3	±	0.4	2.0	±	0.4	1.5	±	0.3
February	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0
March	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0
April	0.7	±	0.2	0.7	±	0.2	0.7	±	0.2	0.7	±	0.2	1.1	±	0.3	1.0	±	0.3
May	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0
June	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0
July	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0
August	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0
September	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0	0.0	±	0.0
Annual Average	35.8	±	7.7	33.8	±	7.2	32.5	±	6.9	29.4	±	6.4	29.6	±	6.3	25.2	±	5.4

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Table B-235. Estimated Absolute and Percent Differences between Model Scenarios in Juvenile Green Sturgeon Entrainment Index (Number of Fish as Expanded Salvage) at the SWP and CVP Salvage Facilities during Below Normal, Dry, and Critical Water Years (Sacramento Valley Water Year–Type Classification)

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
October	-3 (-26%)	-2 (-19%)	-2 (-20%)	-1 (-12%)	-1 (-9%)	1 (13%)
November	-2 (-15%)	-7 (-44%)	-1 (-7%)	-6 (-39%)	-1 (-7%)	-4 (-34%)
December	-1 (-7%)	-1 (-7%)	-1 (-8%)	-1 (-8%)	-1 (-4%)	1 (4%)
January	-1 (-21%)	-1 (-39%)	-1 (-21%)	-1 (-38%)	-1 (-21%)	-1 (-33%)
February	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
March	-1 (-28%)	-1 (-40%)	-1 (-28%)	-1 (-40%)	-1 (-25%)	-1 (-35%)
April	0 (61%)	0 (54%)	0 (63%)	0 (55%)	0 (52%)	0 (45%)
May	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
June	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
July	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
August	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Annual Average	-8 (-15%)	-12 (-24%)	-5 (-11%)	-10 (-21%)	-3 (-7%)	-4 (-10%)
Note: Negative values indicate decrease under PP relative to EBC.						

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Analysis Based on San Joaquin Valley Water Year–Type Classification

WETTER YEAR ANALYSIS

The mean entrainment indices for green sturgeon at the SWP and CVP export facilities based on San Joaquin Valley wet and above normal water-year types are identical to those for the Sacramento Valley and are estimated to be variable throughout the year (Figure B-82, Figure B-83, and Table B-236). The SWP salvage estimates suggest a peak in August under all model scenarios (although more pronounced under EBC scenarios) and a second peak under all EBC scenarios in February. Salvage is estimated to peak in late summer at the CVP facility under all model scenarios. Total annual average salvage of juvenile green sturgeon at SWP was estimated around 75–80 fish under all EBC scenarios and 21 fish under the two PP scenarios. Differences between EBC and PP were less at the CVP, where EBC scenario salvage ranged from around 40–50 green sturgeon and PP scenario salvage was around 30 green sturgeon.

Reductions in salvage under PP scenarios compared to EBC scenarios ranged from very little change in March–June (0–4 fish per month) to considerable changes in February (around 30 fewer green sturgeon, or a >90% reduction) and August–September (7–17 fewer fish, or a 40–67% reduction) (Table B-237). The overall annual average reduction in salvage of juvenile green sturgeon from EBC scenarios to PP scenarios is around 65–80 fish (56–61%).

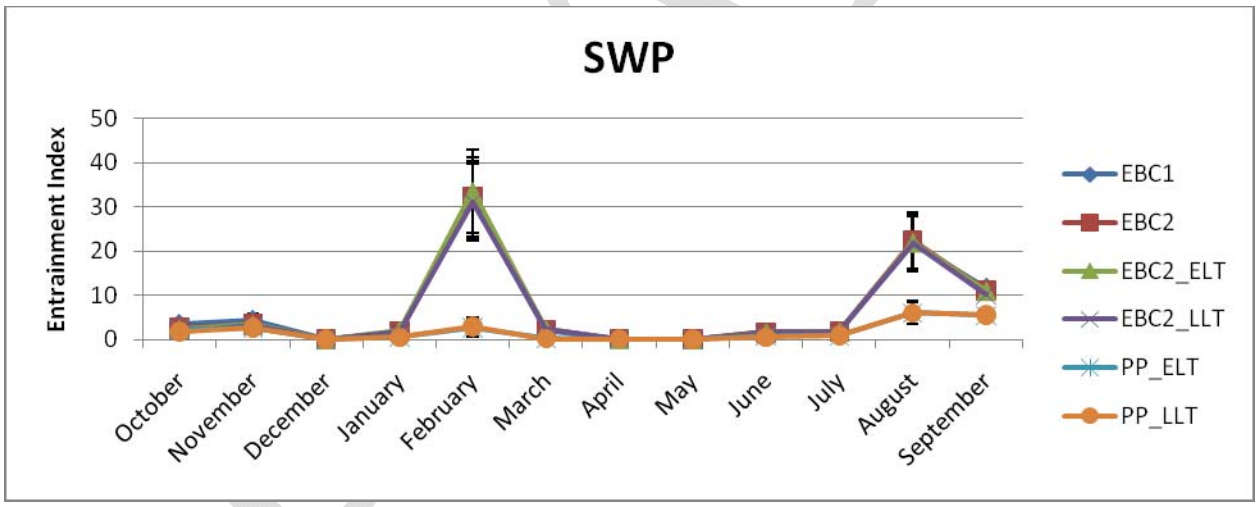

Figure B-82. Estimated Juvenile Green Sturgeon Entrainment Index (Number of Fish as Expanded Salvage ± 95% Confidence Intervals) at the SWP Facility during Wet and Above Normal Years (San Joaquin Valley Water Year–Type Classification)

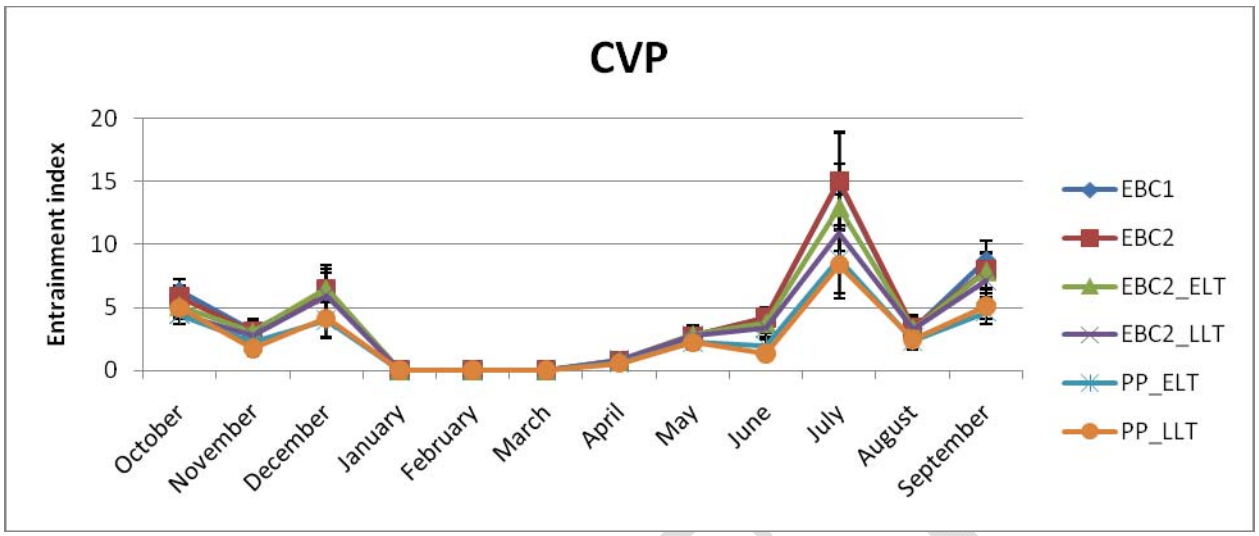

Figure B-83. Estimated Juvenile Green Sturgeon Entrainment Index (Number of Fish as Expanded Salvage ± 95% Confidence Intervals) at the CVP Facility during Wet and Above Normal Years (San Joaquin Valley Water Year–Type Classification)

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Table B-236. Estimated Juvenile Green Sturgeon Entrainment Index (Number of Fish as Expanded Salvage ± 95% Confidence Intervals [CI]) at the SWP and CVP Salvage Facilities during Wet and Above Normal Years (San Joaquin Water Year–Type Classification)

Month	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
	Avg.	±	95% CI	Avg.	±	95% CI	Avg.	±	95% CI	Avg.	±	95% CI	Avg.	±	95% CI	Avg.	±	95% CI
(a) SWP																		
October	4	±	1	3	±	1	2	±	1	2	±	1	2	±	1	2	±	1
November	5	±	1	4	±	1	3	±	1	3	±	1	3	±	1	3	±	1
December	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
January	2	±	0	2	±	0	2	±	0	2	±	0	1	±	0	0	±	0
February	32	±	9	32	±	9	34	±	9	31	±	9	3	±	2	3	±	2
March	2	±	1	2	±	1	2	±	1	2	±	1	0	±	0	0	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	2	±	1	2	±	1	2	±	0	1	±	0	1	±	0	0	±	0
July	2	±	0	2	±	0	2	±	0	2	±	0	1	±	0	1	±	0
August	22	±	6	22	±	6	22	±	6	22	±	6	6	±	3	6	±	3
September	12	±	1	11	±	1	11	±	1	10	±	1	5	±	1	5	±	1
Annual Average	81	±	10	80	±	10	80	±	11	75	±	10	21	±	3	21	±	4
(b) CVP																		
October	6	±	1	6	±	1	5	±	1	4	±	1	4	±	1	5	±	1
November	3	±	1	3	±	1	3	±	1	3	±	1	2	±	1	2	±	1
December	6	±	2	6	±	2	6	±	2	6	±	2	4	±	1	4	±	1
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
May	3	±	1	3	±	1	3	±	1	3	±	1	2	±	1	2	±	1
June	4	±	1	4	±	1	4	±	1	3	±	1	2	±	0	1	±	0
July	15	±	4	15	±	4	13	±	3	11	±	3	9	±	3	8	±	3
August	3	±	1	3	±	1	3	±	1	3	±	1	2	±	1	2	±	1
September	9	±	1	8	±	1	8	±	1	7	±	1	5	±	1	5	±	1
Annual Average	51	±	7	49	±	7	46	±	6	41	±	6	31	±	5	31	±	5

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Table B-237. Estimated Absolute and Percent Differences between Model Scenarios in Juvenile Green Sturgeon Entrainment Index (Number of Fish as Expanded Salvage) at the SWP and CVP Salvage Facilities during Wet and Above Normal Years (San Joaquin Valley Water Year–Type Classification)

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
October	-3 (-31%)	-3 (-32%)	-2 (-20%)	-2 (-22%)	-1 (-9%)	0 (5%)
November	-3 (-36%)	-3 (-43%)	-2 (-27%)	-2 (-34%)	-2 (-24%)	-2 (-28%)
December	-2 (-37%)	-2 (-34%)	-3 (-39%)	-2 (-36%)	-3 (-39%)	-2 (-30%)
January	-1 (-69%)	-1 (-73%)	-1 (-71%)	-1 (-74%)	-1 (-72%)	-1 (-74%)
February	-29 (-92%)	-29 (-91%)	-30 (-92%)	-29 (-91%)	-31 (-92%)	-28 (-91%)
March	-2 (-90%)	-2 (-93%)	-2 (-91%)	-2 (-93%)	-2 (-91%)	-2 (-93%)
April	0 (-19%)	0 (-22%)	0 (-19%)	0 (-23%)	0 (-20%)	0 (-27%)
May	0 (-17%)	-1 (-19%)	0 (-17%)	-1 (-19%)	-1 (-20%)	-1 (-19%)
June	-3 (-54%)	-4 (-69%)	-3 (-54%)	-4 (-69%)	-3 (-49%)	-3 (-61%)
July	-7 (-43%)	-8 (-45%)	-7 (-43%)	-8 (-45%)	-5 (-35%)	-3 (-27%)
August	-17 (-67%)	-17 (-66%)	-17 (-67%)	-17 (-67%)	-17 (-67%)	-17 (-66%)
September	-11 (-51%)	-10 (-49%)	-9 (-47%)	-8 (-45%)	-9 (-47%)	-7 (-39%)
Annual Average	-78 (-60%)	-79 (-61%)	-76 (-59%)	-77 (-60%)	-73 (-58%)	-65 (-56%)
Note: Negative values indicate decrease under PP relative to EBC.						

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Drier Year Analysis

Overall salvage of green sturgeon juveniles is estimated to be considerably lower in drier years than wetter years. The SWP salvage estimates suggest peaks in December and March under all model scenarios (Figure B-84). Salvage is estimated to peak in October and November at the CVP facility under all model scenarios (Figure B-85). Total annual average salvage of juvenile green sturgeon at SWP was estimated to be around 12–13 fish under all EBC scenarios and 11 fish under the two PP scenarios (Table B-238). At CVP, EBC scenario total annual salvage ranged from 25 to 30 green sturgeon and PP scenario salvage was 22–25 green sturgeon.

Reductions in salvage at both facilities combined under PP scenarios compared to EBC scenarios were low throughout the year (five or fewer green sturgeon per month, with many months of no change) (Table B-239). The overall annual average decrease in salvage under PP scenarios compared to EBC scenarios ranged from three to 11 green sturgeon (7–24% reductions).

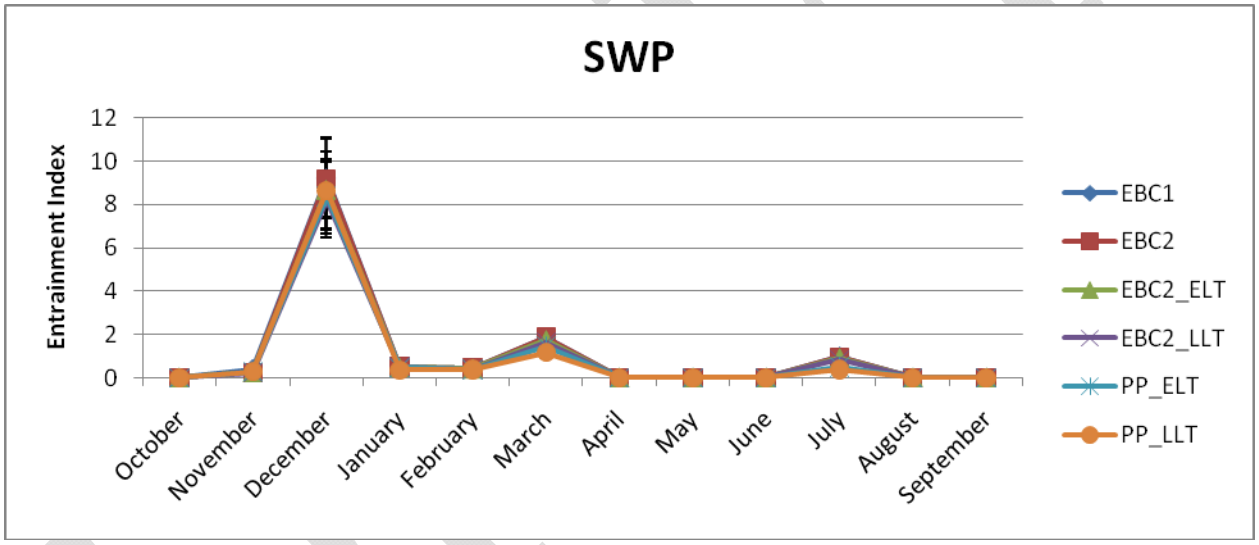

Figure B-84. Estimated Juvenile Green Sturgeon Entrainment Index (Number of Fish as Expanded Salvage ± 95% Confidence Intervals) at the SWP Facility during Below Normal, Dry, and Critical Years (San Joaquin Valley Water Year–Type Classification)

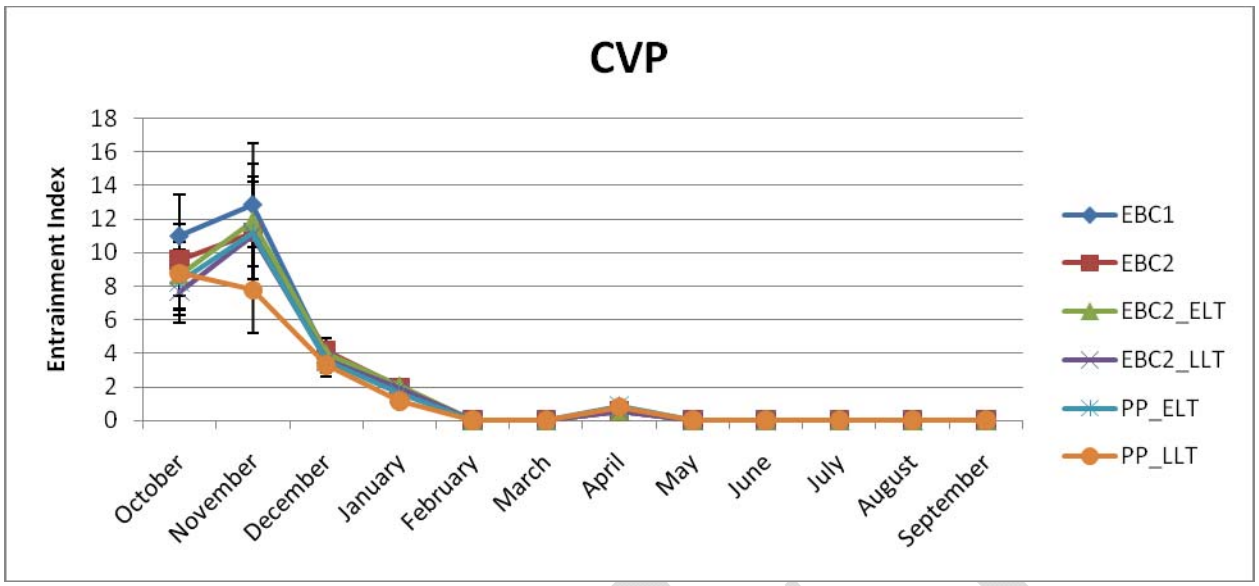

Figure B-85. Estimated Juvenile Green Sturgeon Entrainment Index (Number of Fish as Expanded Salvage ± 95% Confidence Intervals) at the CVP Facility during Below Normal, Dry, and Critical Years (San Joaquin Valley Water Year–Type Classification)

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Table B-238. Estimated Juvenile Green Sturgeon Entrainment Index (Number of Fish as Expanded Salvage ± 95% Confidence Intervals [CI]) at the SWP and CVP Salvage Facilities during Below Normal, Dry, and Critical Water Years (San Joaquin Valley Water Year–Type Classification)

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
November	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
December	9	±	2	9	±	2	9	±	2	8	±	2	8	±	2	9	±	2
January	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	2	±	0	2	±	0	2	±	0	2	±	0	1	±	0	1	±	0
April	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	1	±	0	1	±	0	1	±	0	1	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	13	±	2	13	±	2	12	±	2	12	±	2	11	±	2	11	±	2
(b) CVP																		
October	11	±	2	10	±	2	9	±	2	8	±	2	8	±	2	9	±	2
November	13	±	4	11	±	3	12	±	3	11	±	3	11	±	3	8	±	3
December	4	±	1	4	±	1	4	±	1	4	±	1	4	±	1	3	±	1
January	2	±	0	2	±	0	2	±	0	2	±	0	2	±	0	1	±	0
February	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
March	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
April	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
May	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
June	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
July	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
August	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	30	±	7	27	±	6	27	±	6	25	±	6	25	±	6	22	±	5

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Table B-239. Estimated Absolute and Percent Differences between Model Scenarios in Juvenile Green Sturgeon Entrainment Index (Number of Fish as Expanded Salvage) at the SWP and CVP Salvage Facilities during Below Normal, Dry, and Critical Water Years (San Joaquin Valley Water Year–Type Classification)

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
October	-3 (-25%)	-2 (-20%)	-1 (-14%)	-1 (-8%)	0 (-5%)	1 (14%)
November	-2 (-13%)	-5 (-39%)	0 (0%)	-3 (-30%)	-1 (-5%)	-3 (-28%)
December	-1 (-9%)	-1 (-9%)	-1 (-11%)	-1 (-11%)	-1 (-6%)	0 (1%)
January	0 (-17%)	-1 (-39%)	0 (-15%)	-1 (-38%)	0 (-17%)	-1 (-36%)
February	0 (-14%)	0 (-13%)	0 (-15%)	0 (-14%)	0 (-12%)	0 (-6%)
March	0 (-22%)	-1 (-38%)	0 (-20%)	-1 (-37%)	0 (-15%)	0 (-28%)
April	0 (54%)	0 (45%)	0 (57%)	0 (48%)	0 (45%)	0 (38%)
May	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
June	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
July	0 (-50%)	-1 (-63%)	0 (-48%)	-1 (-61%)	0 (-46%)	0 (-55%)
August	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
September	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Annual Average	-7 (-16%)	-11 (-24%)	-4 (-9%)	-8 (-19%)	-3 (-7%)	-4 (-10%)
Note: Negative values indicate decrease under PP relative to EBC.						

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B.4.1.10 *Pacific Lamprey and River Lamprey (Macropthalmia and Adult)*

B.4.1.10.1 Salvage-Density Method

As described in Section B.5.3, the analysis for Pacific and river lamprey was combined because the CVP and SWP fish salvage facilities do not distinguish between the two species. Salvage density estimates indicate that lamprey are most vulnerable to south Delta entrainment in January through May, particularly during January and February (Table B-240). CVP salvage is generally much higher than SWP salvage, particularly during peak salvage months. The large majority (approximately 85%) of salvaged lamprey are less than 200 mm fork length (DFG unpubl. data), indicating that they are macropthalmia, with the rest adults.

Estimated mean expanded salvage densities of lamprey for each month as reported by the facilities during water years 1996–2009 used in this analysis are reported in Table B-241. Reflecting historical expanded salvage density data (Table B-240), CVP lamprey salvage levels are estimated to be greater than SWP salvage levels. Salvage is estimated to occur primarily during January and February at the CVP, and December to February with a minor second peak in May at the SWP.

Estimated average expanded salvage under EBC (all time periods) ranged from zero in September at SWP to more than 1,300 at CVP in January, for average annual totals of around 720–740 lamprey at SWP and 2,600 lamprey at CVP. The total annual estimated expanded salvage under the project was around 50% less (1,700–1,800 lamprey), and this was quite consistent across all time periods (Table B-242).

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Table B-240. Historical Mean Monthly Lamprey Salvage (Fish per Thousand Acre-Feet with 95% Confidence Interval [CI]) at CVP and SWP Salvage Facilities during Water Years 1996–2009

Month	Statistic	SWP	CVP
October	Mean	0.0059	0.0230
	95% CI	0.0116	0.0323
November	Mean	0.0055	0.0637
	95% CI	0.0082	0.1070
December	Mean	0.3235	0.7040
	95% CI	0.4407	1.0845
January	Mean	1.7655	6.8667
	95% CI	1.4971	5.8455
February	Mean	0.3925	4.5775
	95% CI	0.3472	3.4801
March	Mean	0.3144	1.5220
	95% CI	0.2915	1.1108
April	Mean	0.1634	0.2693
	95% CI	0.1068	0.1366
May	Mean	0.4696	0.5540
	95% CI	0.3024	0.3163
June	Mean	0.1259	0.1798
	95% CI	0.1027	0.2128
July	Mean	0.0468	0.0416
	95% CI	0.0381	0.0467
August	Mean	0.0069	0.0129
	95% CI	0.0073	0.0144
September	Mean	0.0005	0.0138
	95% CI	0.0010	0.0154

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Table B-241. Estimated Mean Monthly and Annual Entrainment Index (Number of Fish as Expanded Salvage with 95% Confidence Interval [CI]) of Lamprey for Six Model Scenarios at the SWP and CVP Salvage Facilities for All Water Years

	EBC1			EBC2			EBC2_ELT			EBC2_LLT			PP_ELT			PP_LLT		
Month	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**	**Avg.**	**±**	**95% CI**
(a) SWP																		
October	2	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
November	2	±	0	1	±	0	1	±	0	1	±	0	1	±	0	1	±	0
December	98	±	15	99	±	15	97	±	15	95	±	15	80	±	13	84	±	15
January	377	±	38	384	±	39	390	±	41	385	±	40	219	±	28	173	±	23
February	88	±	10	90	±	10	91	±	10	85	±	9	31	±	5	31	±	5
March	73	±	8	75	±	9	75	±	9	72	±	9	23	±	4	18	±	3
April	10	±	1	10	±	1	11	±	1	11	±	1	15	±	1	14	±	1
May	31	±	3	32	±	4	34	±	4	34	±	4	39	±	4	33	±	4
June	19	±	2	19	±	2	18	±	2	15	±	2	9	±	1	7	±	1
July	19	±	2	19	±	2	18	±	2	17	±	2	9	±	1	8	±	1
August	3	±	0	3	±	0	2	±	0	2	±	0	1	±	0	1	±	0
September	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0	0	±	0
Annual Average	721	±	52	732	±	54	737	±	55	719	±	54	427	±	40	371	±	36
(b) CVP																		
October	5	±	1	5	±	1	4	±	1	4	±	1	4	±	1	4	±	1
November	14	±	3	13	±	3	14	±	3	13	±	2	11	±	2	8	±	2
December	165	±	28	175	±	29	171	±	29	155	±	27	128	±	24	125	±	24
January	1331	±	125	1316	±	126	1320	±	127	1274	±	124	739	±	92	613	±	80
February	791	±	69	760	±	68	768	±	69	778	±	70	254	±	36	264	±	38
March	261	±	23	260	±	23	255	±	23	249	±	23	65	±	10	68	±	10
April	17	±	1	17	±	1	17	±	1	18	±	1	19	±	1	18	±	1
May	38	±	3	38	±	3	38	±	3	38	±	3	40	±	3	38	±	3
June	25	±	4	25	±	4	22	±	3	20	±	3	13	±	2	10	±	2
July	10	±	1	10	±	1	9	±	1	7	±	1	5	±	1	5	±	1
August	3	±	0	3	±	0	3	±	0	3	±	0	2	±	0	2	±	0
September	3	±	0	3	±	0	3	±	0	3	±	0	2	±	0	2	±	0
Annual Average	2664	±	173	2626	±	173	2625	±	175	2561	±	173	1283	±	118	1158	±	105

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Table B-242. Mean Difference in Estimated Average Monthly Lamprey Entrainment Index (Number of Fish and Percent Difference) between Model Scenarios at CVP and SWP Salvage Facilities Combined

Month	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs PP_LLT	EBC2_ELT vs PP_ELT	EBC2_LLT vs. PP_LLT
October	-2 (-29%)	-2 (-27%)	-1 (-17%)	-1 (-15%)	0 (-6%)	1 (11%)
November	-4 (-23%)	-7 (-42%)	-2 (-15%)	-5 (-36%)	-2 (-16%)	-4 (-32%)
December	-56 (-21%)	-54 (-20%)	-67 (-24%)	-65 (-24%)	-60 (-22%)	-41 (-16%)
January	-750 (-44%)	-922 (-54%)	-742 (-44%)	-913 (-54%)	-753 (-44%)	-873 (-53%)
February	-594 (-68%)	-584 (-66%)	-565 (-67%)	-555 (-65%)	-575 (-67%)	-567 (-66%)
March	-246 (-74%)	-247 (-74%)	-247 (-74%)	-249 (-74%)	-242 (-73%)	-235 (-73%)
April	7 (25%)	5 (17%)	7 (24%)	4 (16%)	6 (20%)	3 (10%)
May	10 (15%)	2 (2%)	9 (13%)	1 (1%)	7 (9%)	-2 (-3%)
June	-21 (-49%)	-26 (-60%)	-21 (-48%)	-26 (-60%)	-17 (-43%)	-18 (-51%)
July	-15 (-52%)	-16 (-56%)	-15 (-51%)	-16 (-55%)	-12 (-47%)	-11 (-47%)
August	-3 (-49%)	-3 (-51%)	-3 (-48%)	-3 (-50%)	-2 (-46%)	-2 (-45%)
September	-1 (-41%)	-2 (-44%)	-1 (-36%)	-1 (-39%)	-1 (-32%)	-1 (-31%)
Annual Average	-1676 (-49%)	-1856 (-55%)	-1648 (-49%)	-1829 (-54%)	-1653 (-49%)	-1751 (-53%)
Note: Negative values indicate decrease under PP relative to EBC.						

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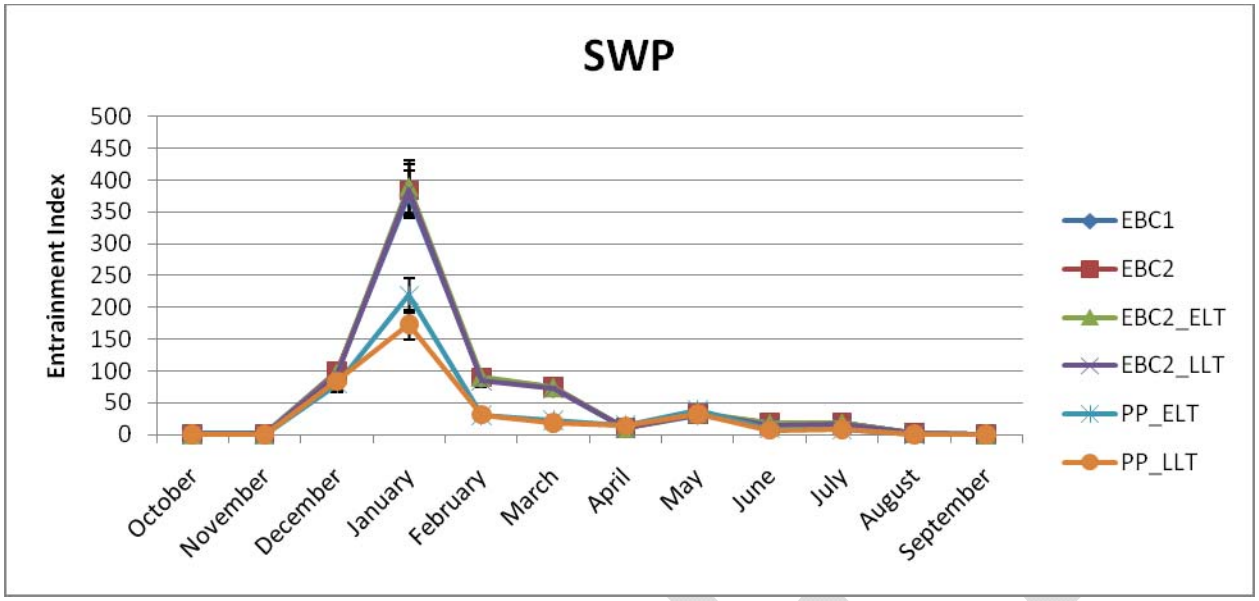

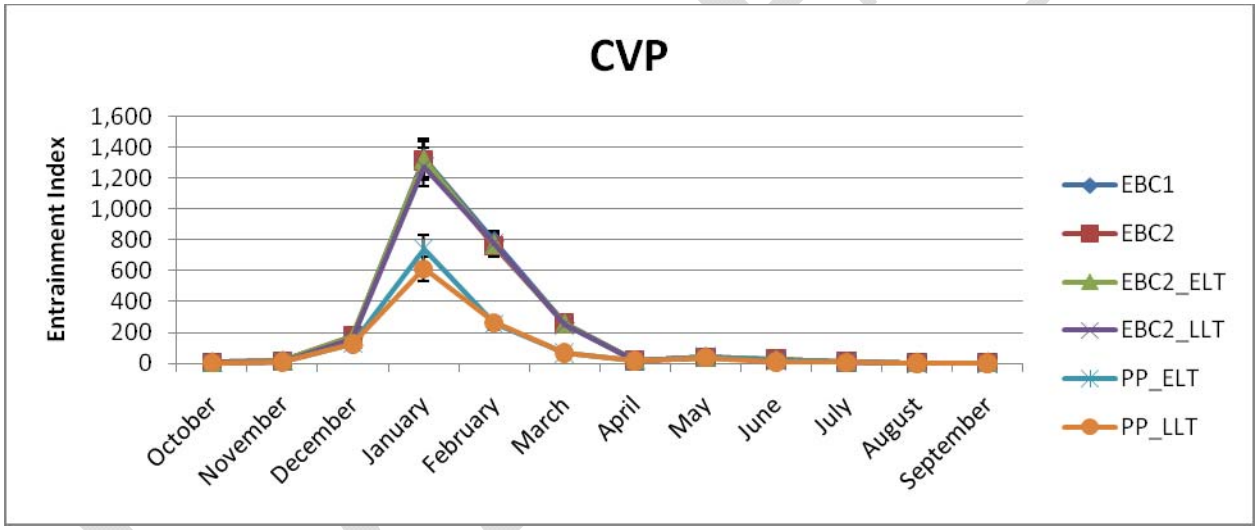

Figure B-86. Estimated Average Monthly Lamprey Entrainment Index (Number of Fish as Expanded Salvage) at SWP and CVP Salvage Facilities under Model Scenarios

B.4.1.11 *All Covered Fish Species*

B.4.1.11.1 Effectiveness of Nonphysical Barriers

Water Column Position

Assuming that nonphysical barriers at the entrances to CCF and the DMC are situated close to the river bed, as seems appropriate based on the relatively shallow water, all covered fish species except for white and green sturgeon would be expected to encounter the barrier based on typical water column positions (Table B-243). The sturgeons tend to be close to the bottom (Moyle 2002) and may pass beneath the barrier.

Hearing Ability

Most of the covered fish species, such as the salmonids and the smelts, have moderate hearing ability that laboratory and field studies have shown to be sensitive to the types of stimuli generated by the barriers (Bowen et al. 2008; Bowen et al. 2009; Bowen and Bark 2010) (Table B-243). Sacramento splittail are cyprinids, a family of fish that is regarded as hearing specialists and therefore would be expected to be very sensitive to the acoustic stimuli of the nonphysical barriers (Nedwell et al. 2004). The sturgeons and lampreys have relatively low hearing ability and may not respond to the acoustic stimuli from the nonphysical barriers (Lovell et al. 2004; Turnpenny pers. comm.).

Escape Ability

Covered fish species may encounter nonphysical barriers and, if hearing ability is sufficient, may respond to the acoustic stimuli. The ability to be deterred then rests upon escape ability, which is a function of swimming ability in relation to velocities through and past the barriers. Velocities at the CCF radial gates are very high (up to 20 ft/sec) when the gates are opened, whereas the velocities in the intake channel leading to the radial gates are less but still appreciable (up to ~3 ft/sec) (Clark et al. 2009). Velocities at the likely location of a nonphysical barrier at the divergence between the intake channel and Old River probably would be lower but would vary depending on the position of the radial gates, tidal flows, and river flows. Velocities at the entrance to the DMC in the vicinity of its divergence from Old River may not fluctuate as much because of the relatively constant pumping rate. Regardless of the actual velocities at the nonphysical barriers, some general conclusions about escape ability can be made. Larval smelts and larval Sacramento splittail would be the weakest of the covered fish species encountering the nonphysical barriers and would be unlikely to be deterred. Juvenile and adult smelts and Sacramento splittail would have better swimming ability (Table B-244) but deterrence would vary depending on flow. Migrating juvenile Chinook salmon would be expected to have good swimming ability but still would be subject to prevailing flows as far as barrier effectiveness. Adult Sacramento splittail and juvenile steelhead would be expected to have higher escape ability (Table B-244). The escape ability of sturgeons and lampreys may not be relevant given the probable lack of response to the acoustic stimuli.

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Table B-243. Qualitative Assessment of Potential Effectiveness of Nonphysical Barriers on Covered Fish Species

Species	Life Stage	Water Column Position	Hearing Ability	Escape Ability	Overall Potential Barrier Effectiveness
Chinook salmon (all races)	Juvenile	Upper	Moderate	High	High
Steelhead	Juvenile	Upper	Moderate	High	High
Delta smelt	Larva	Upper	Moderate	Low	Low
	Juvenile	Upper	Moderate	Low–Moderate	Moderate
	Adult	Upper	Moderate	Moderate	Moderate
Longfin smelt	Larva	Upper	Moderate	Low	Low
	Juvenile	Upper	Moderate	Low–Moderate	Moderate
	Adult	Upper	Moderate	Moderate	High
Sacramento splittail	Larva	Upper	High	Low	Low
	Juvenile	Middle	High	Moderate	High
	Adult	Middle	High	High	High
White sturgeon	Larva	Upper	Low	Low	Low
	Juvenile	Lower	Low	High	Low
Green sturgeon	Juvenile	Lower	Low	High	Low
Pacific lamprey	Macropthalmia	Upper	Low	Low	Low
	Adult	Upper	Low	Low	Low
River lamprey	Macropthalmia	Upper	Low	Low	Low
	Adult	Upper	Low	Low	Low

Table B-244. Swimming Ability of Covered Fish Species That May Respond to Acoustic Stimuli from Nonphysical Barriers

Species	Velocity
Longfin smelt	No information found
Delta smelt	Juveniles/adults 0.7–1.1 ft/s critical swimming speed (Swanson et al. 1998)
Chinook salmon	Underyearlings ~1.6 ft/s and yearlings ~2.1 ft/s at time of exhaustion, at ~8 mg/l dissolved oxygen (Davis et al. 1963)
Steelhead	Juvenile 2.2 ft/s critical swimming speed (Beamish 1978)
Sacramento splittail	Juvenile 0.66–1.31 ft/s critical swimming speed (Young and Cech 1996) Adult 1.31–2.07 ft/s critical swimming speed (Young and Cech 1996)

Predation

Predation in the south Delta and in particular in the vicinity of the fish salvage facilities is a notable issue for covered fish survival (Vogel 2011). Studies are ongoing to determine the influence of nonphysical barriers on predation characteristics at the head of Old River and Georgiana Slough. It is uncertain whether the potential benefits of deterrence of fish by

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nonphysical barriers at the entrances to CCF and the DMC may be offset by aggregations of predatory fish such as striped bass.

Overall Potential Effectiveness of Nonphysical Barriers

Considering species-specific factors such as water column position, hearing ability, and escape ability, nonphysical barriers at the entrances to CCF and the DMC have the most potential to considerably reduce entrainment of juvenile salmonids and juvenile and adult Sacramento splittail. There is somewhat less potential to reduce entrainment of juvenile and adult smelts, primarily because of lower escape ability. Insensitivity of sturgeons and lampreys makes them unlikely to benefit from nonphysical barriers. The potential importance of nonphysical barriers is that fish would not be subject to the salvage process, which generally is quite inefficient. Prescreen predation in CCF in particular results in the majority of fish not being salvaged. However the uncertainties associated with fish response to the barrier (particularly with respect to velocities) and the potential for predation associated with the barrier structure make it challenging to come to firm conclusions regarding the effectiveness of the measure. Targeted studies on nonphysical barrier effectiveness at these locations would allow determination of the benefits of the technology for enhancing survival of covered fish species.

B.4.2 SWP/CVP North Delta Intake (North Delta Subregion)

B.4.2.1 *Salmonids (Juvenile)*

B.4.2.1.1 Screening Effectiveness Analysis

Juvenile Chinook salmon at sizes of 30 mm or greater may occur in the vicinity of the north Delta intake structures (NMFS 1997). Juvenile steelhead migrating downstream in the Sacramento River that would be exposed to the north Delta intakes typically range in length from approximately 150 to 250 mm. Based on the results of Weisberg et al. (1987), a fish screen equipped with a 1.75 mm screen slot opening would be 100% effective in excluding this size of juvenile Chinook salmon, as well as juvenile steelhead, which are generally larger than Chinook salmon during their Delta residence (McEwan 2001). Results of fishery monitoring at the Contra Costa Water District positive-barrier fish screen at the Old River intake show that the screen mesh is effective at excluding juvenile fish from entrainment into the water diversion (Morinaka 1998, 2000, 2003; Tenera 2005, 2006). Therefore, no entrainment of salmonids is expected at the proposed north Delta diversions.

Fish that are excluded from entrainment by a mesh screen potentially would be vulnerable to impingement on the screen surface. However, laboratory experiments and swimming performance studies have shown that a fish screen with an approach velocity of 0.2 ft/sec or less is not expected to result in impingement of juvenile Chinook salmon (NMFS 2008; DFG 2011), and similar results are expected for steelhead because of their greater swimming capabilities. This approach velocity is lower than criteria established by NMFS (2008) for salmonids because it is designed to meet delta smelt fish screen approach velocity requirements (DFG 2011). In

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addition, the use of a smooth screen surface (e.g., wedge-wire screen material) and routine (e.g., continuous) screen cleaning would be additionally protective to exclude juvenile Chinook salmon and steelhead from screen surface impingement. The smooth surface also would serve to reduce the risk of abrasion and scale loss for any fish that does come into contact with the screen (Swanson et al. 2004).

Based on these considerations, the direct loss of juvenile Chinook salmon and steelhead to entrainment and impingement at the proposed north Delta intakes is expected to be negligible.

B.4.2.2 *Delta Smelt*

B.4.2.2.1 Larva, Juvenile, and Adult

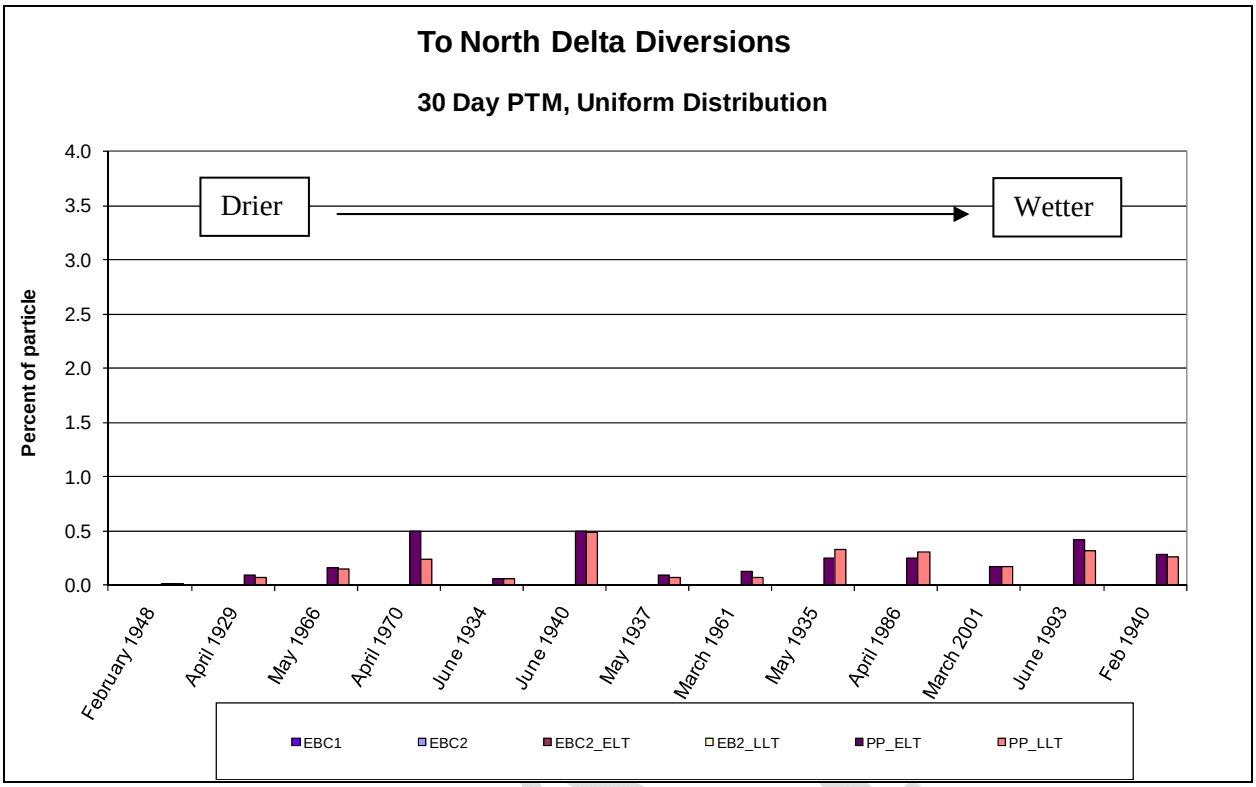
Screening Effectiveness Analysis

Potential entrainment of delta smelt at the north Delta diversions was evaluated through a review of the literature and abundance and distribution data from the DFG SKT surveys (http://www.dfg.ca.gov/delta/data/). The SKT focuses primarily on sampling of adults, and likely provides a worst-case scenario regarding how close juveniles might get to the north Delta diversions. Although the 20-mm survey would provide more accurate information regarding the distribution of the juvenile life stage, these surveys were not evaluated because they do not include monitoring in the vicinity of the new diversions. The survey data and literature review indicate that delta smelt occur infrequently in the vicinity of the proposed north Delta diversions sites (http://www.dfg.ca.gov/delta/data/) (Moyle 2002). However, delta smelt have been observed in this area historically and may occur in this area under future climate conditions if sea level rise induces movement of the spawning population farther upstream than is currently typical. Juvenile and adult delta smelt potentially occurring in the vicinity of the north Delta diversions in the future as a result of changes in climate conditions are not expected to be vulnerable to entrainment, as these facilities will be screened to preclude entrainment of juvenile and adult delta smelt, as described above for salmonids. Larval delta smelt would become increasingly susceptible to entrainment at sizes below 15 mm, whereas larger larvae would be less likely to be entrained but could be impinged on the screens.

B.4.2.2.2 Larva

Particle-Tracking Modeling

Entrainment of delta smelt larvae at the north Delta intakes occurred only under PP scenarios because there are no north Delta intakes operational under EBC scenarios. Entrainment ranged from 0–3.5% based on PTM results and the results were virtually identical between 30-day and 60-day particle tracking durations (Figure B-87 through Figure B-93). Average entrainment across hydrologic scenarios and particle tracking durations was lowest under the Uniform Distribution (around 0.2%) and greatest under the Wet April Ripe Female distribution (1.4–1.6%) (Table B-245).



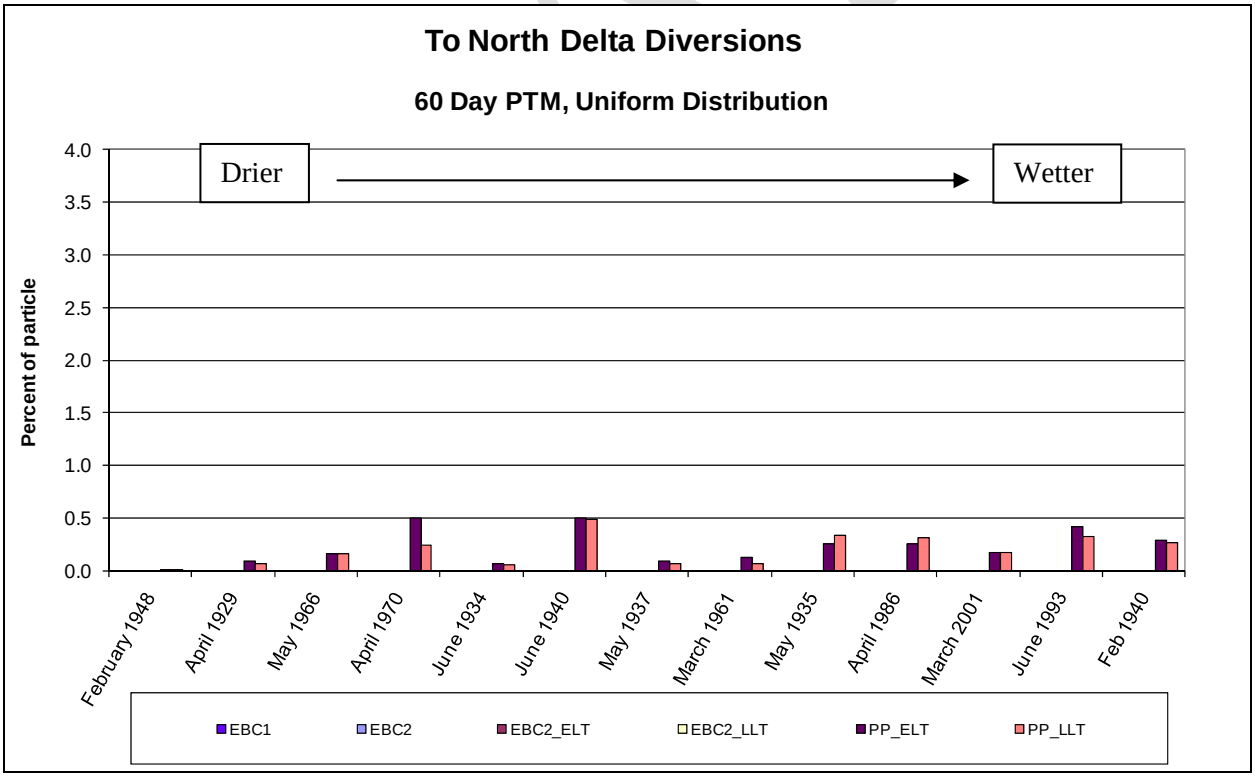
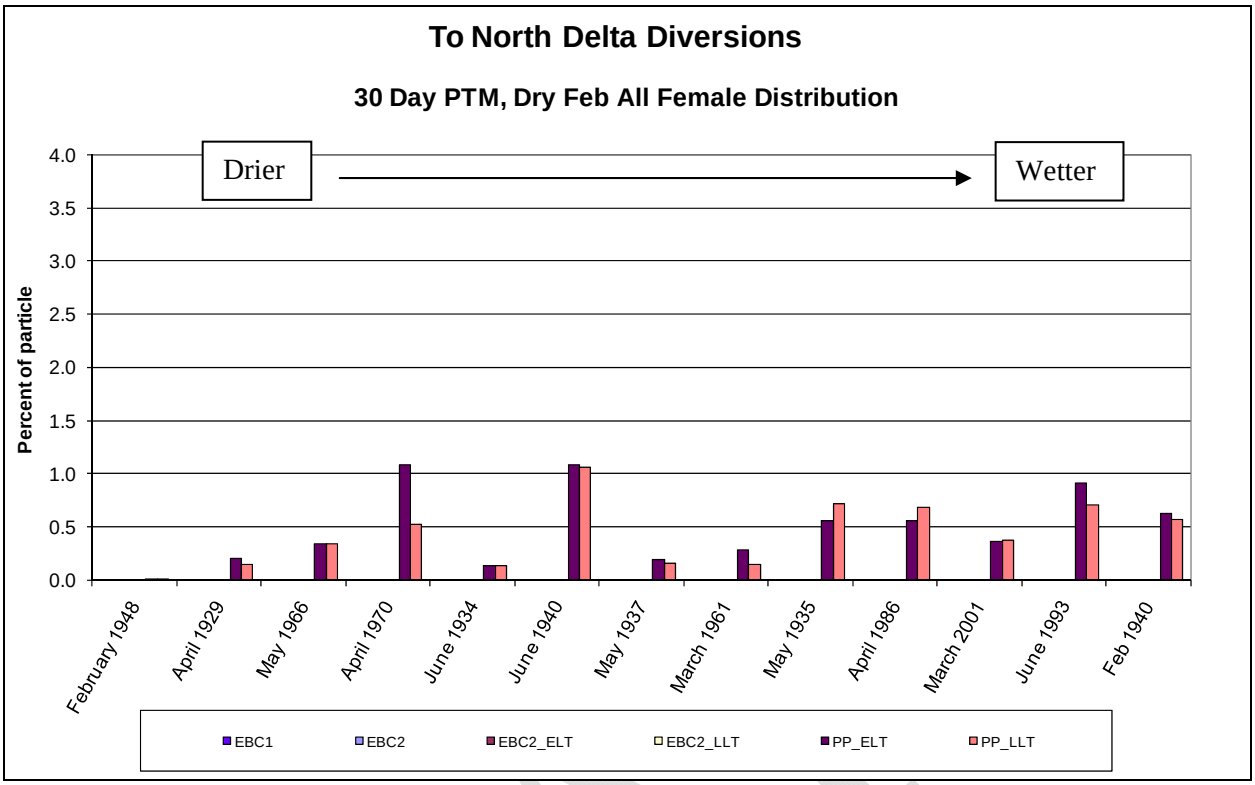


Figure B-87. Percentage of Particles Entrained at North Delta Diversions; Uniform Distribution



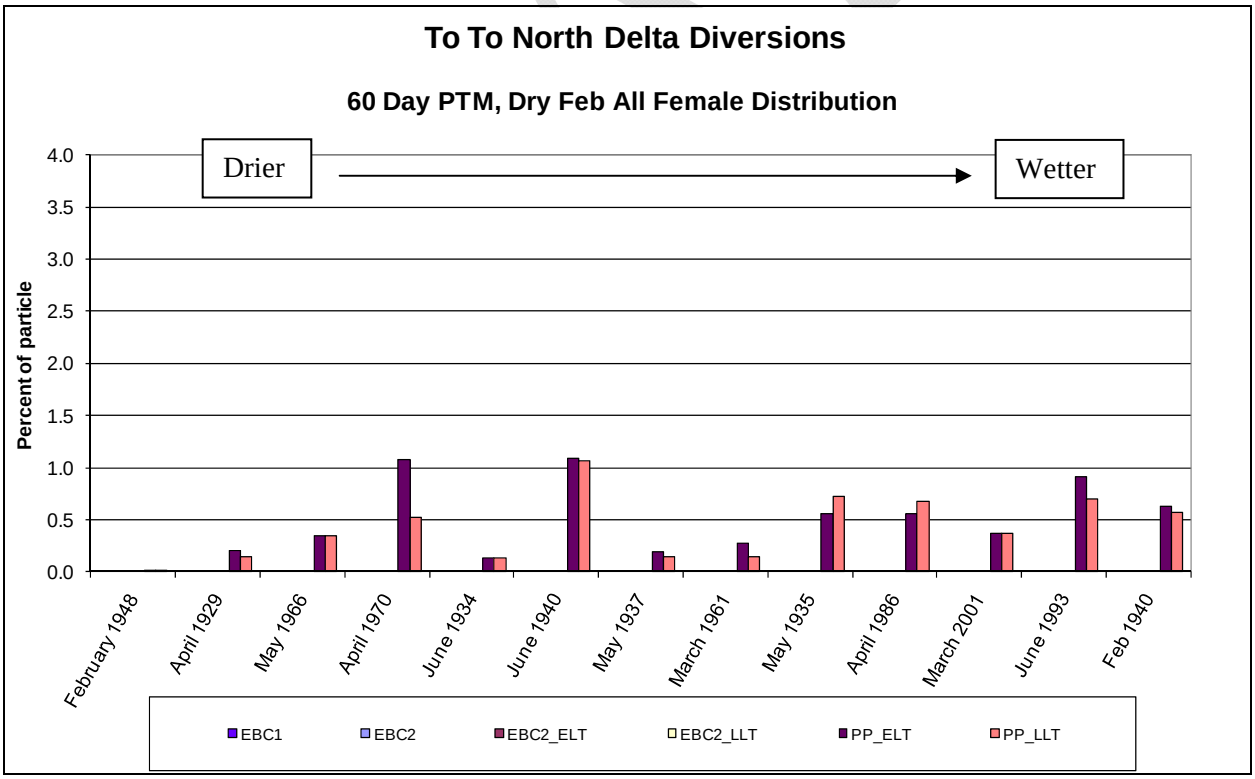
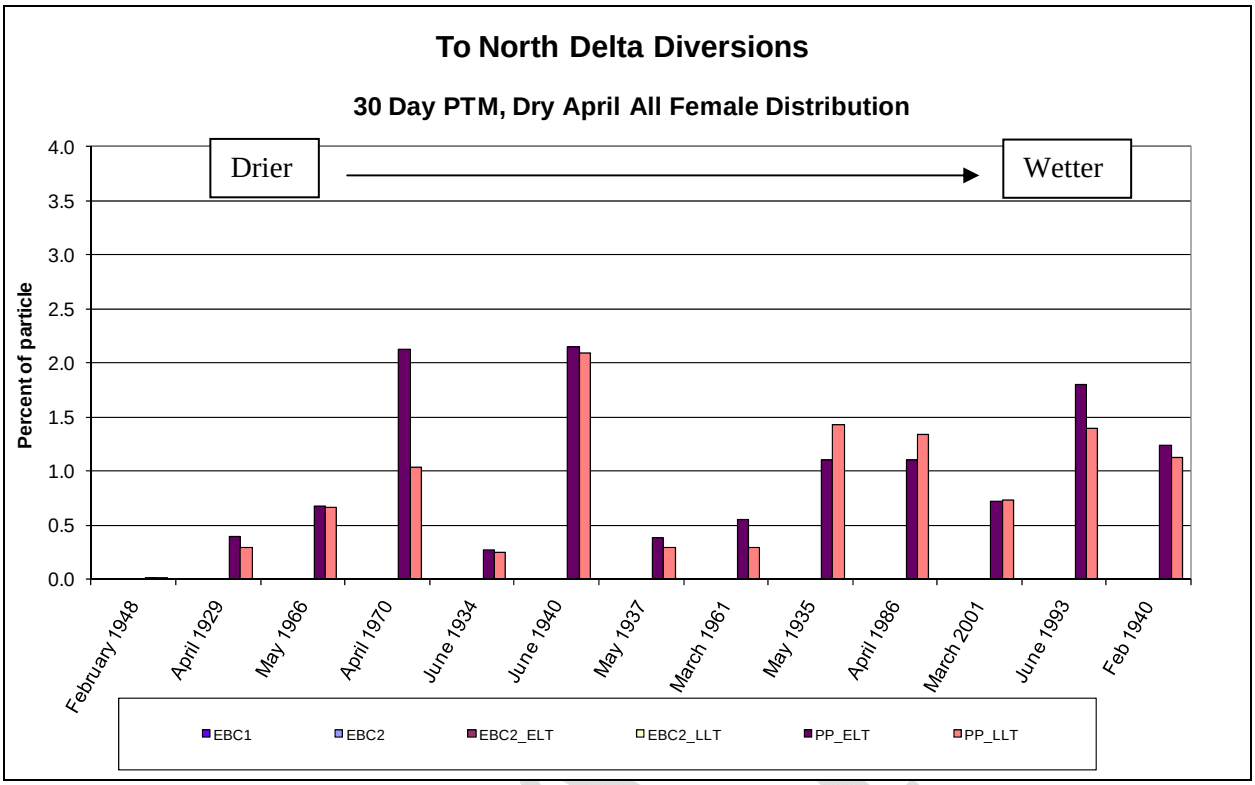


Figure B-88. Percentage of Particles Entrained at North Delta Diversions; Dry February All Female Distribution



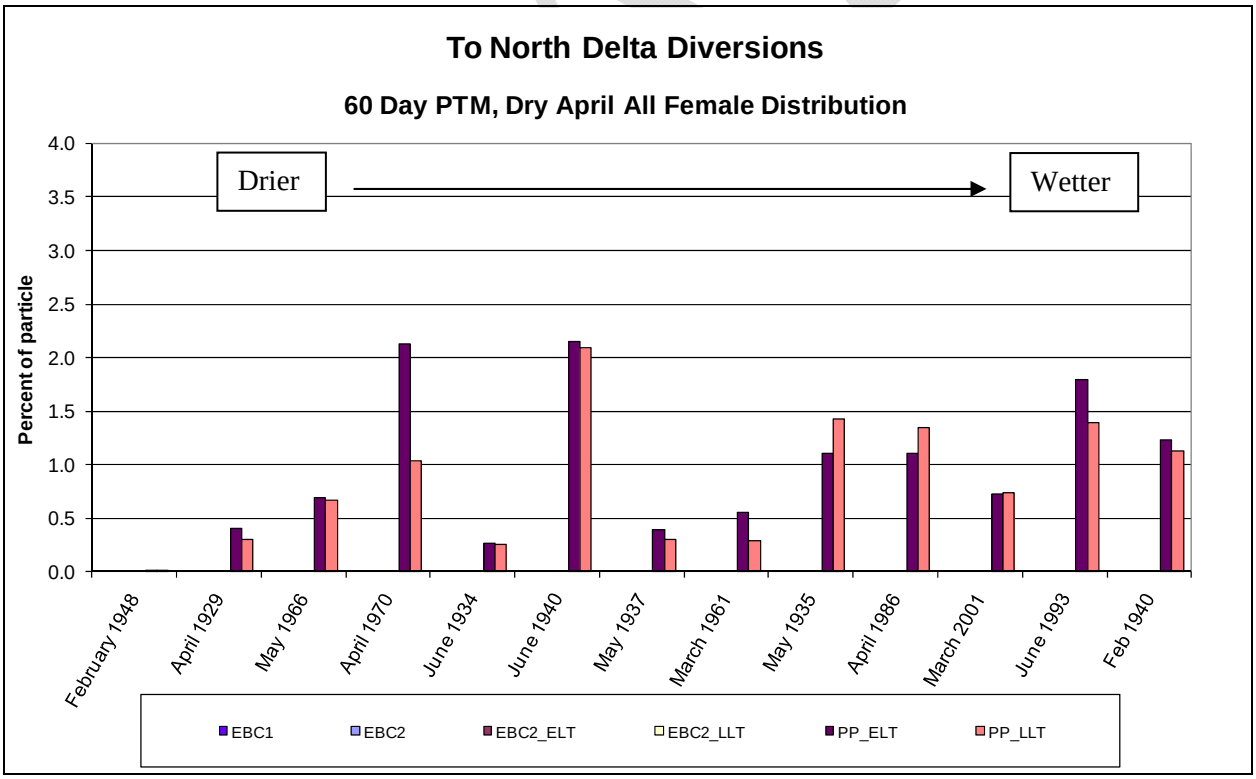
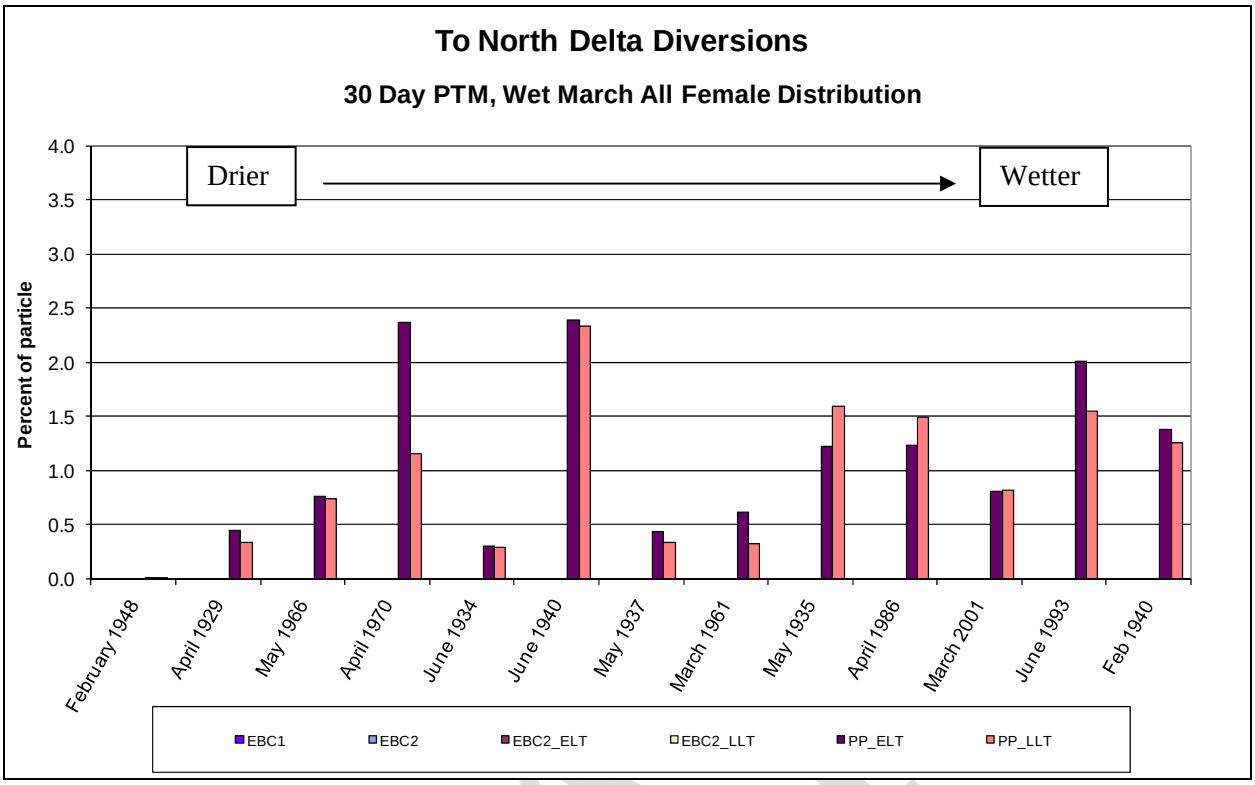


Figure B-89. Percentage of Particles Entrained at North Delta Diversions; Dry April All Female Distribution



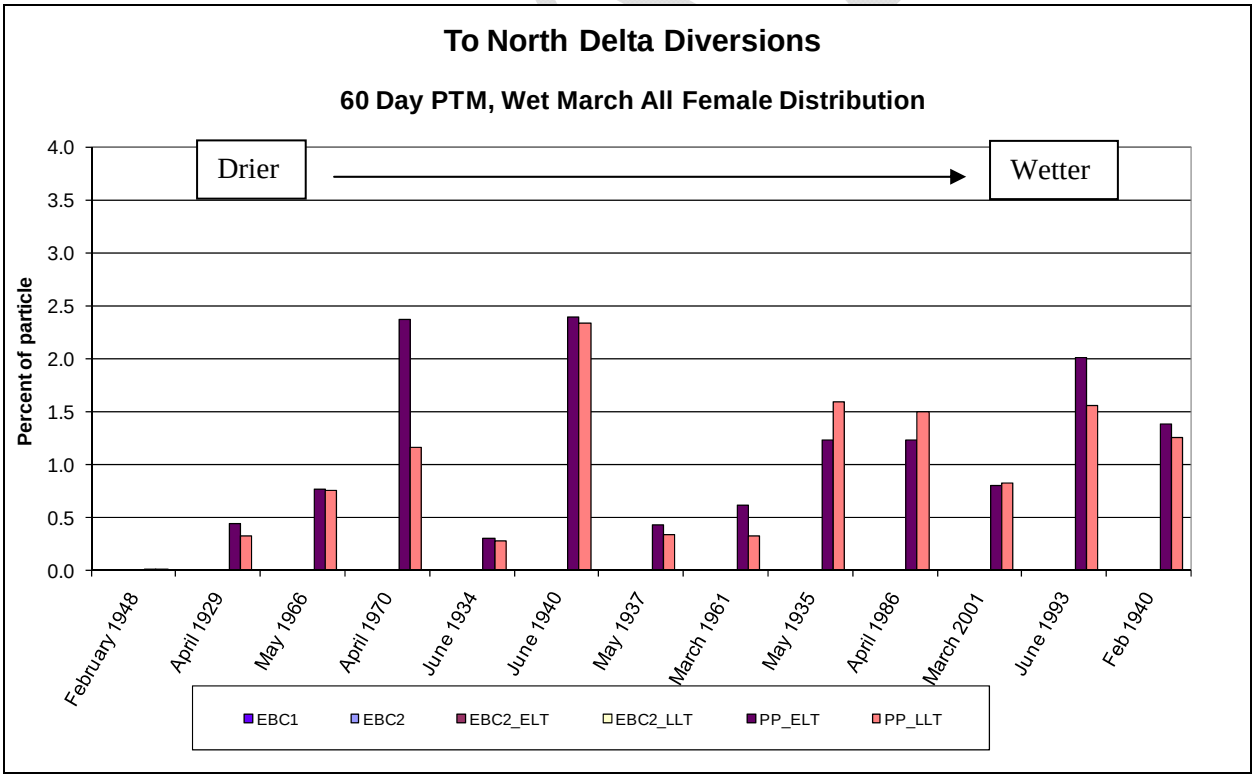
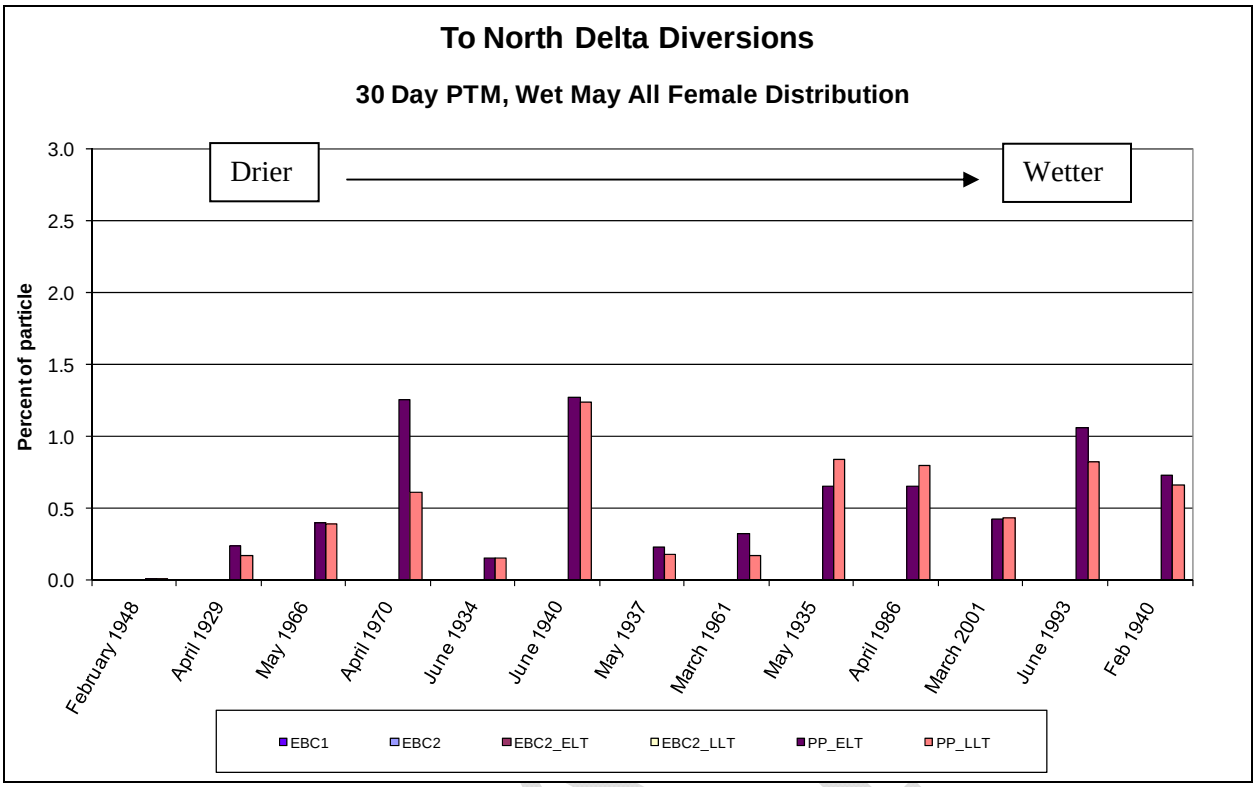


Figure B-90. Percentage of Particles Entrained at North Delta Diversions; Wet March All Female Distribution



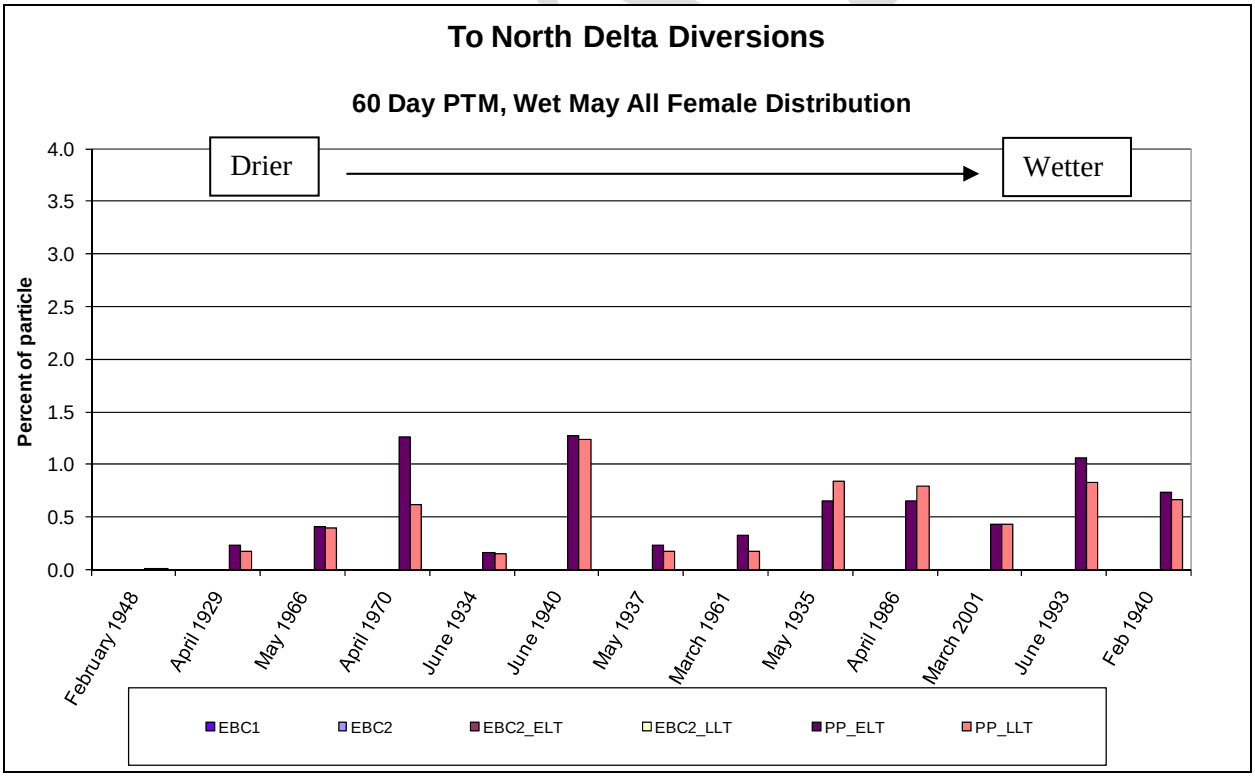
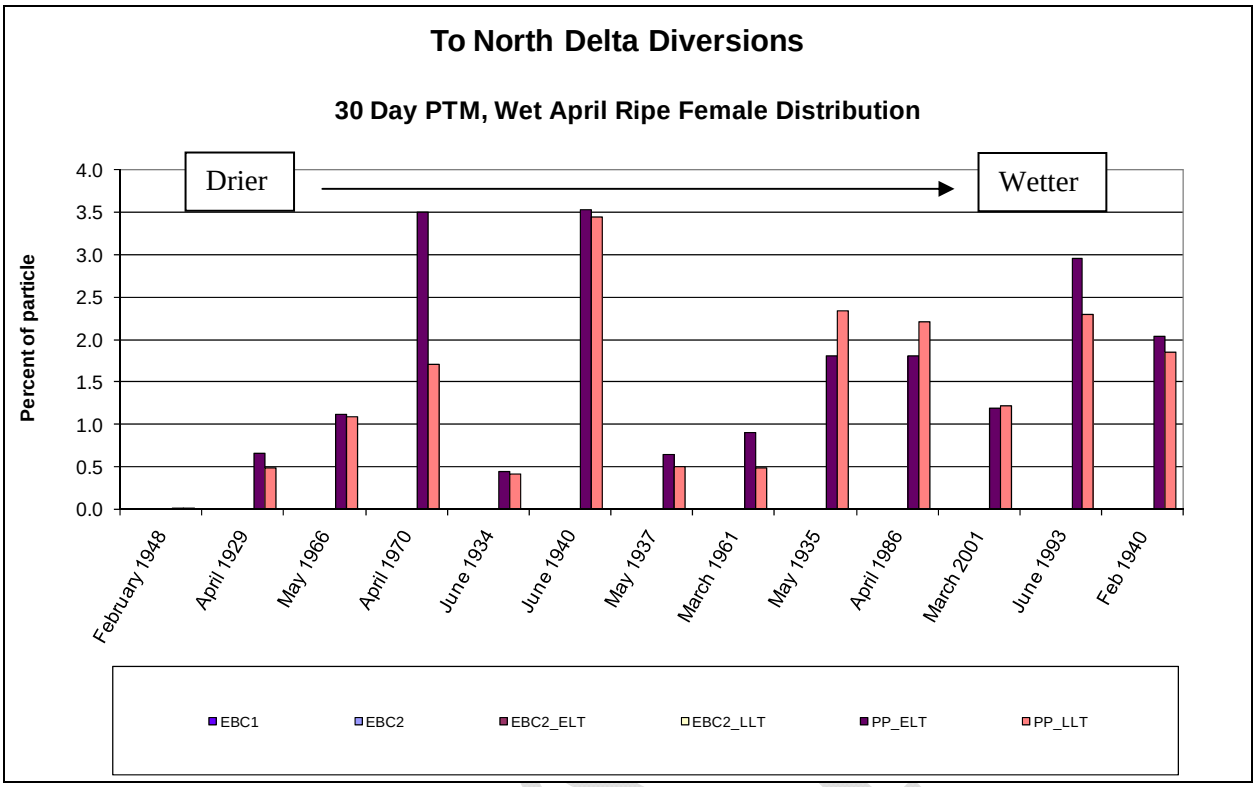


Figure B-91. Percentage of Particles Entrained at North Delta Diversions; Wet May All Female Distribution



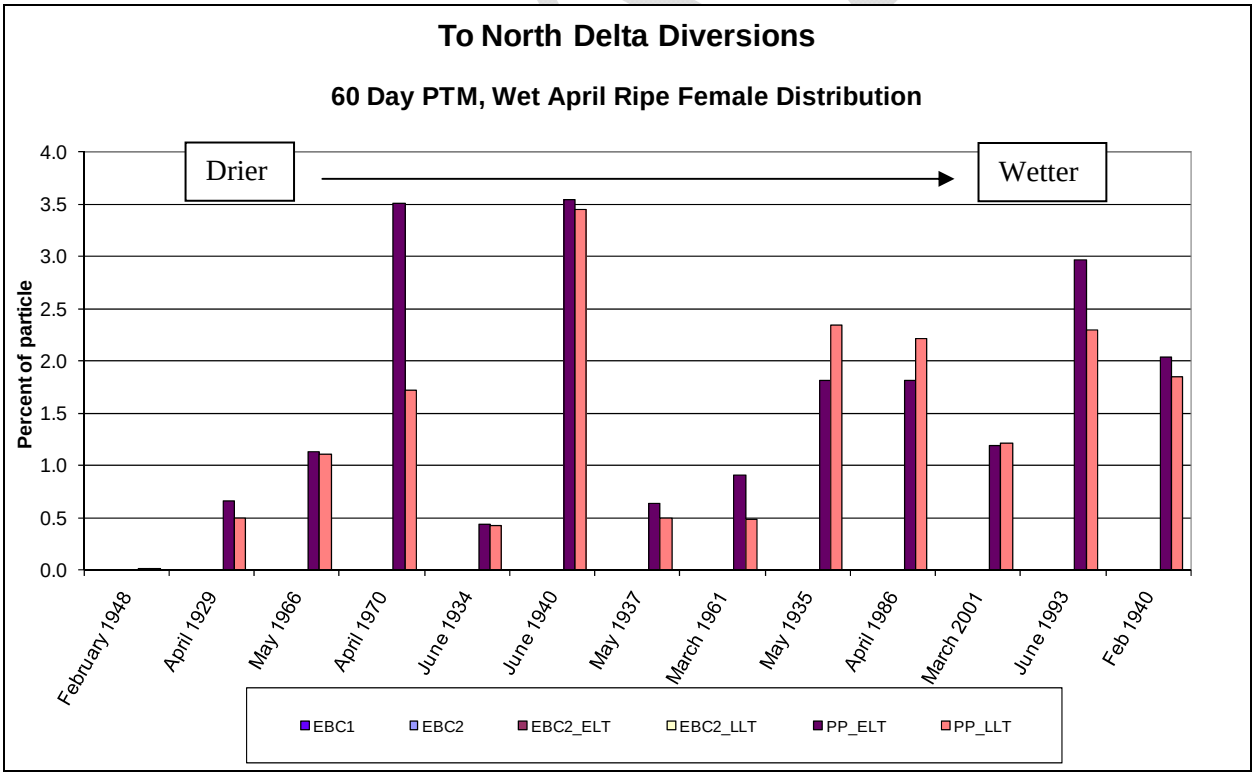
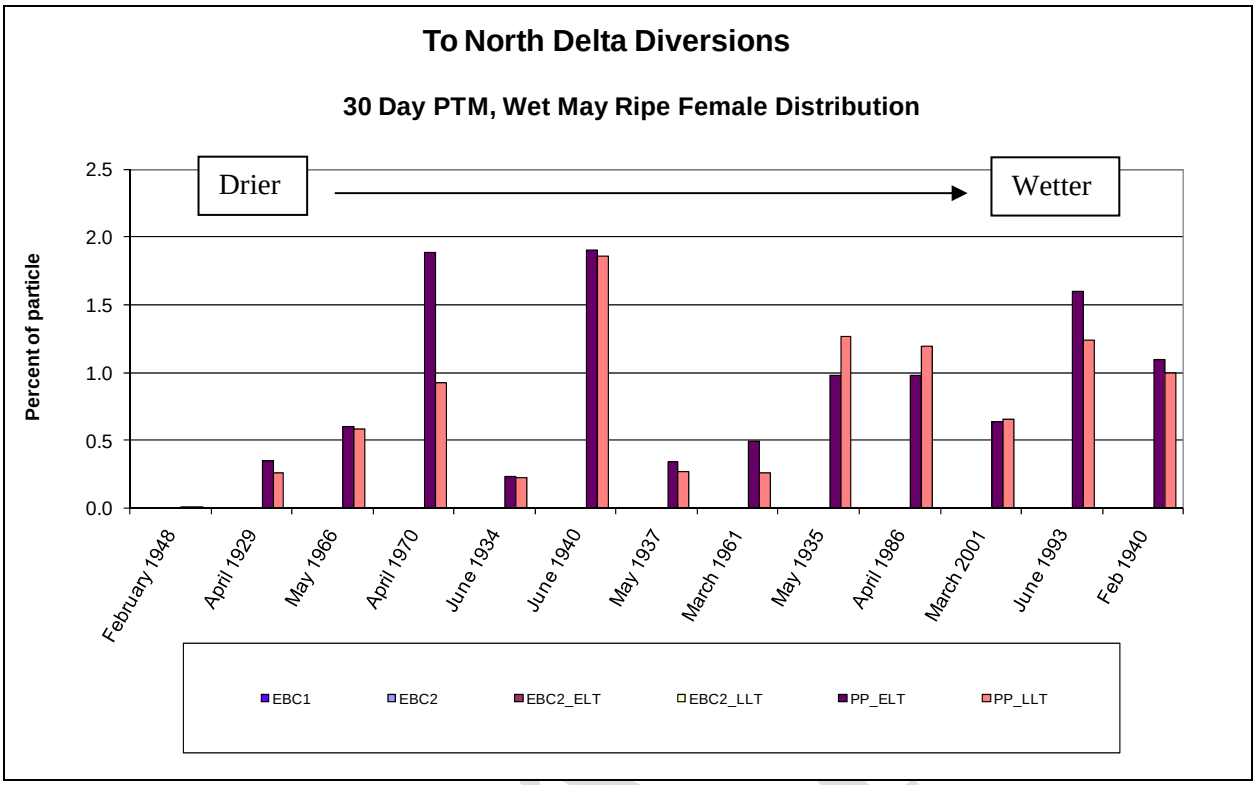


Figure B-92. Percentage of Particles Entrained at North Delta Diversions; Wet April Ripe Female Distribution



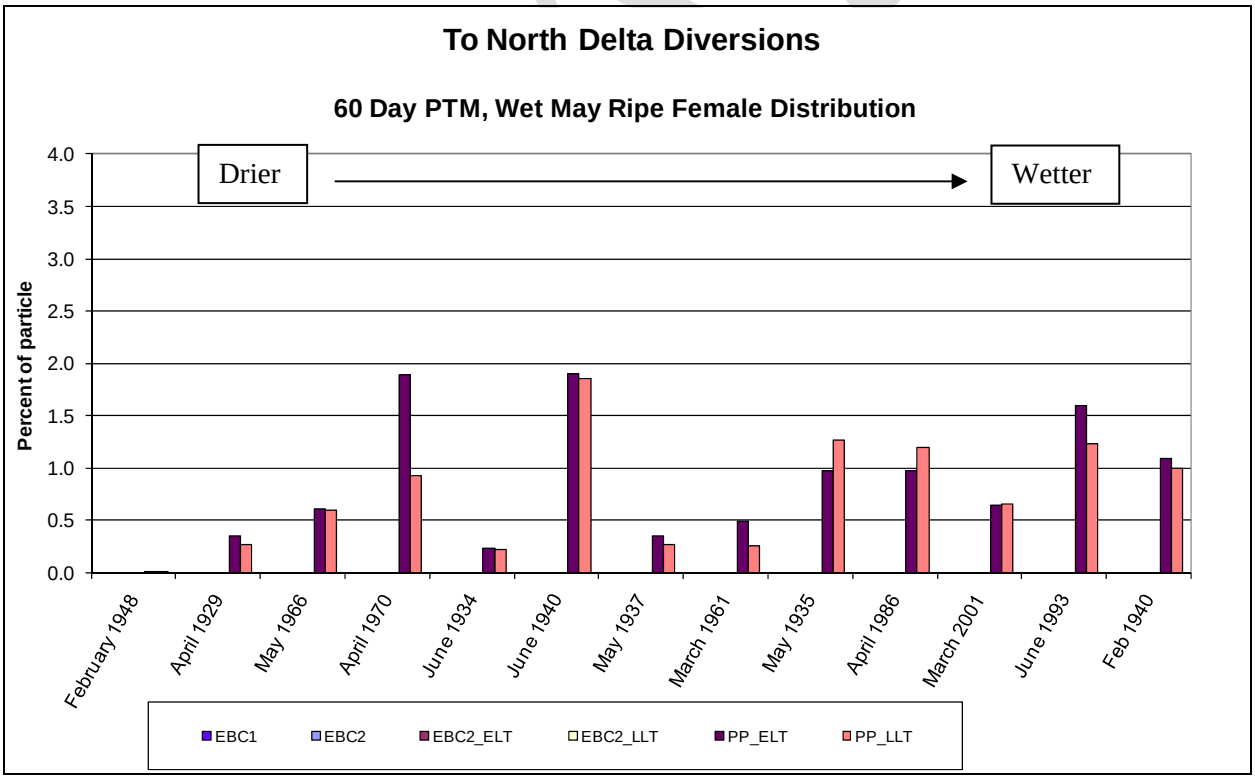


Figure B-93. Percentage of Particles Entrained at North Delta Diversions; Wet May Ripe Female Distribution

Table B-245. Average Difference[1] (Number of Runs) between Model Scenarios for Entrainment at North Delta Diversions for Particle-Tracking Runs after (A) 30 Days and (B) 60 Days

	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs. PP_LLT	EBC2_ELT vs. PP_ELT	EBC2_LLT vs. PP_LLT
(A) 30 Days, Starting Distribution						
Uniform Distribution						
Higher Entrainment	0.2 (13)	0.2 (13)	0.2 (13)	0.2 (13)	0.2 (13)	0.2 (13)
Lower Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Dry February All Female Distribution						
Higher Entrainment	0.5 (13)	0.4 (13)	0.5 (13)	0.4 (13)	0.5 (13)	0.4 (13)
Lower Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Dry April All Female Distribution						
Higher Entrainment	1.0 (13)	0.8 (13)	1.0 (13)	0.8 (13)	1.0 (13)	0.8 (13)
Lower Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Wet March All Female Distribution						
Higher Entrainment	1.1 (13)	0.9 (13)	1.1 (13)	0.9 (13)	1.1 (13)	0.9 (13)
Lower Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Wet May All Female Distribution						
Higher Entrainment	0.6 (13)	0.5 (13)	0.6 (13)	0.5 (13)	0.6 (13)	0.5 (13)
Lower Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Wet April Ripe Female Distribution						
Higher Entrainment	1.6 (13)	1.4 (13)	1.6 (13)	1.4 (13)	1.6 (13)	1.4 (13)
Lower Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Wet May Ripe Female Distribution						
Higher Entrainment	0.9 (13)	0.7 (13)	0.9 (13)	0.7 (13)	0.9 (13)	0.7 (13)
Lower Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
(B) 60 Days, Starting Distribution						
Uniform Distribution						
Higher Entrainment	0.2 (13)	0.2 (13)	0.2 (13)	0.2 (13)	0.2 (13)	0.2 (13)
Lower Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Dry February All Female Distribution						
Higher Entrainment	0.5 (13)	0.4 (13)	0.5 (13)	0.4 (13)	0.5 (13)	0.4 (13)
Lower Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Dry April All Female Distribution						
Higher Entrainment	1.0 (13)	0.8 (13)	1.0 (13)	0.8 (13)	1.0 (13)	0.8 (13)
Lower Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Wet March All Female Distribution						
Higher Entrainment	1.1 (13)	0.9 (13)	1.1 (13)	0.9 (13)	1.1 (13)	0.9 (13)
Lower Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Wet May All Female Distribution						
Higher Entrainment	0.6 (13)	0.5 (13)	0.6 (13)	0.5 (13)	0.6 (13)	0.5 (13)
Lower Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)

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	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs. PP_LLT	EBC2_ELT vs. PP_ELT	EBC2_LLT vs. PP_LLT
Wet April Ripe Female Distribution						
Higher Entrainment	1.6 (13)	1.4 (13)	1.6 (13)	1.4 (13)	1.6 (13)	1.4 (13)
Lower Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Wet May Ripe Female Distribution						
Higher Entrainment	0.9 (13)	0.7 (13)	0.9 (13)	0.7 (13)	0.9 (13)	0.7 (13)
Lower Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)

[1] Values represent the difference in the percentage of particles reaching this destination. Negative values indicate lower entrainment under the preliminary proposal compared to the EBC.

B.4.2.3 *Longfin Smelt*

B.4.2.3.1 Larva, Juvenile, and Adult

Screening Effectiveness Analysis

Recent abundance and distribution survey data are not available for the North Delta Subregion for longfin smelt, but previous studies indicate that this species rarely is distributed upstream of Rio Vista on the Sacramento River (Moyle 2002). However, similar to delta smelt, they may occur in this area under future climate conditions if sea level rise induces migration farther upstream for spawning. As with delta smelt, longfin smelt susceptibility to entrainment and impingement at the SWP/CVP north Delta intakes would be minimal for juveniles and adults because of the delta smelt screening criteria, whereas smaller larvae (<15 mm) would be increasingly susceptible to entrainment through the screen mesh.

B.4.2.3.2 Larva

Particle-Tracking Modeling

The results of the PTM analyses did not result in any particles being entrained at the north Delta intakes for any of the starting distribution/hydrological scenario/particle tracking duration combinations that were run, suggesting that longfin smelt larvae would not be entrained at these locations.

B.4.2.4 *Sacramento Splittail (Larva, Juvenile, and Adult)*

B.4.2.4.1 Screening Effectiveness Analysis

Juvenile splittail emigrating from spawning habitats in the Sacramento River and its tributaries upstream of the intakes potentially would be vulnerable to entrainment by the proposed north Delta diversions. These spawning areas include the important floodplain habitat of the Sutter Bypass but do not include the Yolo Bypass because splittail enter and exit the Yolo Bypass by way of Cache Slough (downstream of the proposed north Delta intakes). The Yolo Bypass has almost four times as much floodplain habitat as the Sutter Bypass. However, habitat upstream of

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the north Delta diversions likely is especially important in dry years, when spawning is limited to channel margin habitat (Feyrer et al. 2005). Juvenile splittail emigrating from habitat along the Cosumnes and San Joaquin Rivers would have little to no entrainment risk at the intakes because flow from these habitats joins flow from the Sacramento River well downstream of the proposed intake locations.

Similar to other species, splittail larvae less than 15 mm in length would be vulnerable to entrainment by the north Delta diversions, whereas individuals greater than 15 mm in length are likely to be effectively excluded by the proposed screen design. Three USFWS seine survey stations are the closest, upstream and downstream, to the proposed intake locations on the Sacramento River: Garcia Bend (RM49), Clarksburg (RM43), and Koket (RM24). In these samples, less than 0.1% of the splittail in the samples were equal to or less than 15 mm in length, and about 1% were less than 20 mm in length. However, very small fish/larvae are not measured, so the samples are not representative of the abundance of larval splittail that could be entrained at the north Delta intakes. Splittail are strong swimmers (Young and Cech 1996; Young et al. 1999; Danley et al. 2002), and juvenile splittail are larger than delta smelt larvae. Therefore, screens are expected to be protective of emigrating juvenile splittail. Given these factors, a negligible number of juvenile or adult splittail is expected to be entrained at the north Delta diversions, but considerable numbers of larvae could be entrained.

Juvenile splittail are potentially vulnerable to impingement on the surface of the intake fish screens. However, the use of a smooth screen surface (e.g., wedge-wire screen material) and low approach velocity maintained by routine screen cleaning is expected to minimize impingement of juvenile splittail on the screen surface. The smooth surface also would serve to reduce the risk of abrasion and scale loss for any fish that comes into contact with the screen surface.

Based on these considerations, the direct loss of juvenile splittail to entrainment and impingement at the north Delta intakes is expected to be negligible.

B.4.2.5 *White Sturgeon (Egg/Embryo, Larva, and Juvenile)*

B.4.2.5.1 Screening Effectiveness Analysis

White sturgeon eggs and embryos can occur from the lower mainstem of the Sacramento River downstream to the north Delta (Israel et al. 2009), including in the vicinity of the north Delta diversion facilities. Israel et al. (2009) indicate an April–May occurrence of these life stages in this region, although eggs and embryos may occur as early as February. This February–May period overlaps periods of increased north Delta pumping. However, there are currently no quantitative modeling estimates of egg/embryo entrainment for these proposed facilities, and documentation of agricultural entrainment of sturgeon of any age in the north Delta is extremely limited. Because of the sticky nature of sturgeon eggs, which allows them to adhere to substrates within the first few hours of being laid (Parsley et al. 1989) and minimize their drift, the north Delta diversions are expected to entrain very few eggs; therefore, they would have a minimal

effect on white sturgeon. The certainty of this effect is low because of the lack of sufficient data and an inability to model entrainment.

The entrainment risk of north Delta diversions to white sturgeon larvae would be similar to that described for eggs and embryos. More than egg/embryo stages, larvae would occur within the water column and likely would be subject to a greater entrainment risk than eggs and embryos. As described for other species such juvenile salmonids and smelts, the mesh size of the intake screens would be increasingly effective at reducing entrainment of white sturgeon larvae >15 mm long. However, as entrainment risk for these life stages is uncertain, the evaluation of this biological effect has a low degree of certainty.

Juvenile white sturgeon that would occur in the vicinity of the north Delta diversion facilities are greater than 30 mm in length, their large size minimizing the potential for them to become entrained at the north Delta intake based on the screening studies of Weisberg et al. (1987). In addition, white sturgeon are demersal and would not likely be near the vertical fish screens, but rather on the bottom of the channel. Although Hallock and Van Woert (1959) detected agricultural entrainment of three white sturgeon, all in the spring of 1954 at one diversion, it was unknown whether these fish were larvae or juveniles. However, the spring timing of their capture indicates they were likely young of the year. Although agricultural entrainment studies have been don e, no other sturgeon entrainment data records exist for the north Delta. Therefore, either sturgeon entrainment is extremely rare, or studies are not designed to detect it. Regardless, because of the absence of reliable baseline data, estimating larval or juvenile sturgeon entrainment in this portion of the system is not quantitatively possible. However, it is possible that increased CVP/SWP pumping during spring months in lower reaches of the Sacramento River could increase larval or juvenile white sturgeon entrainment relative to existing conditions. However, in the absence of baseline entrainment estimates, the evaluation of this effect has a low degree of certainty.

B.4.2.6 *Green Sturgeon (Juvenile)*

B.4.2.6.1 Screening Effectiveness Analysis

Green sturgeon eggs, embryos, and larvae occur farther upstream in the Sacramento River than the proposed location of the north Delta diversions (Israel and Klimley 2008). As a result, it is concluded with high certainty that the egg and embryo life stages of green sturgeon would not be entrained by the north Delta diversion facilities.

Juvenile green sturgeon that may occur in the vicinity of the north Delta diversion facilities are greater than 30 mm in length; therefore, juvenile green sturgeon would not be expected to be entrained at north Delta intake facilities, given their swimming abilities and the proposed screen design. As is the case for white sturgeon, green sturgeon are demersal (i.e., prefer the bottom of the channel), and hence are less likely to occur near vertical, on-bank fish screens. Thus, the BDCP would have little or no effect on juvenile green sturgeon entrainment at the north Delta intake facilities. There is high certainty of this conclusion based on existing literature of screen

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efficiency for a given fish size (Tomljanovich et al. 1978; Schneeberger and Jude 1981; Zeitoun et al. 1981; Weisberg et al. 1987).

B.4.2.7 *Pacific Lamprey and River Lamprey (Macropthalmia and Adults)*

B.4.2.7.1 Screening Effectiveness Analysis

The analysis of north Delta diversion entrainment applies to Pacific and river lamprey macropthalmia (migrating juveniles) from the Sacramento River watershed only. Lamprey from the San Joaquin River watershed would not be exposed to the north Delta diversions. Lamprey spend 3 to 7 years upstream as ammocoetes before outmigrating to the ocean (Moyle 2002) and are 35 to 195 mm in length (average length = 127 mm) when they reach the approximate location of the north Delta diversion structures (1976–2010 USFWS Sacramento trawl unpublished data). As described above, positive-barrier fish screens of 1.75 mm mesh size are expected to be 99.5 to 99.9% effective for bay anchovies greater than 15 mm in length (Weisberg et al. 1987). Although lamprey have a leaner body depth (Pacific lamprey: 7.7% TL; river lamprey: unknown although as lean or leaner than Pacific lamprey [G. Lasko unpublished data; FishBase 2010a]) than anchovies (18.6% TL [FishBase 2010b]), only a very small fraction of lamprey are expected to be vulnerable to entrainment through this mesh size because of their larger size when near the diversions and effectiveness of the positive barrier screens.

The approach velocity criterion of less than 0.2 ft/sec and sweeping velocity criterion of greater than 0.4 ft/sec are designed to be protective of delta smelt larvae, which have weak swimming ability. Lamprey are among the weaker swimming fishes in the Delta; however, given their average size when near the intake structures, it is reasonable to assume that their burst speeds will exceed those of delta smelt larvae. As with winter-run Chinook salmon, the most common occurrence of lamprey in the Delta is during or just after the first pulse flow (1976–2010 USFWS Sacramento trawl unpublished data) which, according to BDCP operating criteria, is when operations of the north Delta diversion will be minimized for winter-run protection. Given these factors, a negligible number of lamprey are expected to be entrained at the north Delta diversions.

Lamprey macropthalmia are vulnerable to impingement on the fish screen surface. The combined use of a smooth screen surface (e.g., wedge-wire screen material) and low approach velocity maintained by routine (e.g., continuous) screen cleaning would be expected to minimize impingement of lamprey on the screen surface. The smooth surface also would serve to reduce the risk of abrasion for any fish that comes into contact with the screen surface. It is unlikely that lamprey macropthalmia will attempt to attach to the screens for holding, as their primary purpose for passing through the north Delta Subregion where the intakes would be located is outmigration.

Based on these considerations, the direct loss of lamprey macropthalmia to entrainment and impingement at the north Delta intakes is expected to be negligible.

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B.4.3 SWP North Bay Aqueduct Barker Slough Pumping Plant and Alternative Intake (Cache Slough and North Delta Subregions)

B.4.3.1 *Delta Smelt (Larva)*

B.4.3.1.1 Particle-Tracking Modeling

The results of the PTM suggested that entrainment at the North Bay Aqueduct Barker Slough Pumping Plant would be lower under PP scenarios in all comparisons with EBC scenarios (Figure B-94 through Figure B-100; Table B-246). Entrainment ranged from just over 0% (both PP scenarios in February 1948 for several starting distributions) to over 9% (EBC scenarios in several years with Wet April Ripe Female and Wet May Ripe Female distributions). Entrainment differences between PP and EBC scenarios were lowest under the uniform distribution (average reductions of 0.4–0.8% from PP to EBC scenarios) (Table B-246). Entrainment reductions under PP scenarios compared to EBC scenarios were greatest for the Wet April Ripe Female distribution (average reductions of 2.6–5.3%).

Entrainment would be lower under PP scenarios compared to EBC scenarios mainly because of the tidal marsh restoration assumed under PP in the Cache Slough region and the overall changes in the hydrodynamics caused by modified operations. The establishment of a dual diversion system for the NBA, with combined operations of a new intake on the Sacramento River (operated in conjunction with proposed BDCP north Delta facilities) and the existing intake at Barker Slough, would reduce the level of entrainment of delta smelt further by removing most of the export pumping from the Barker Slough facility to the new Sacramento River facility.

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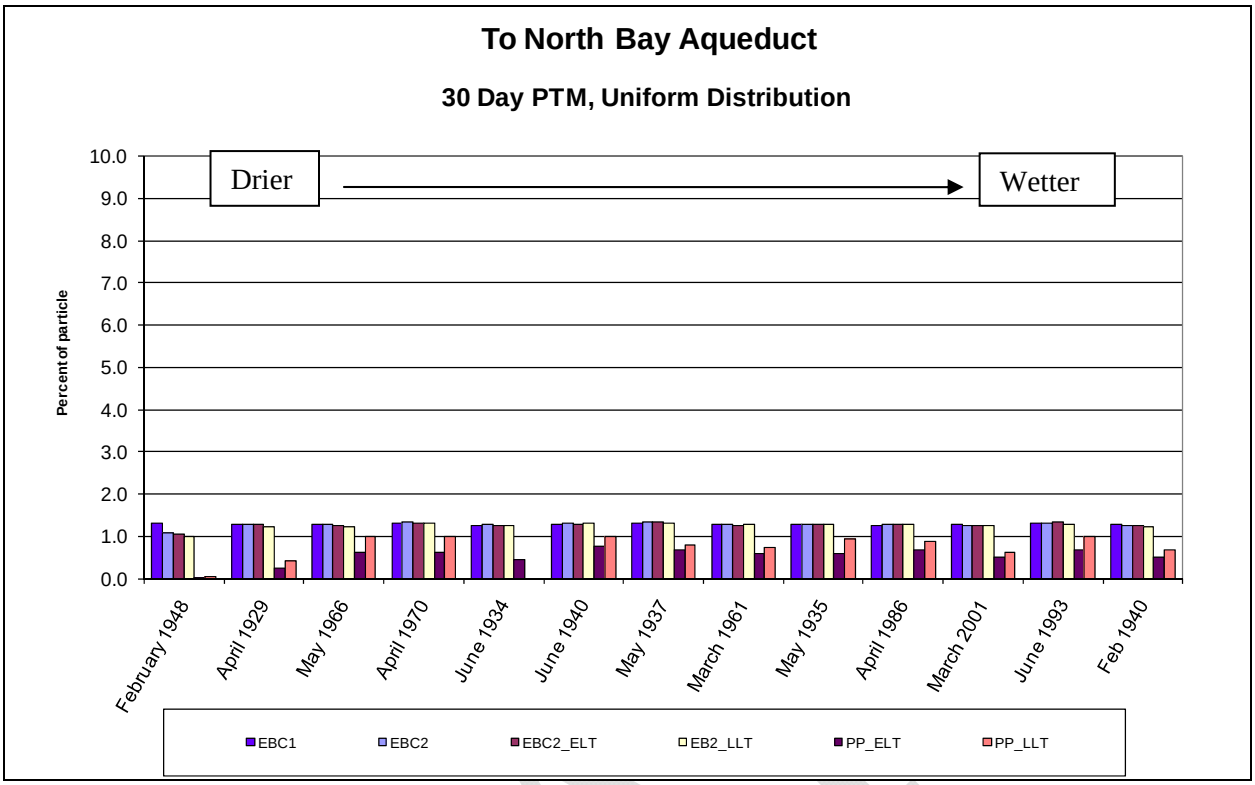


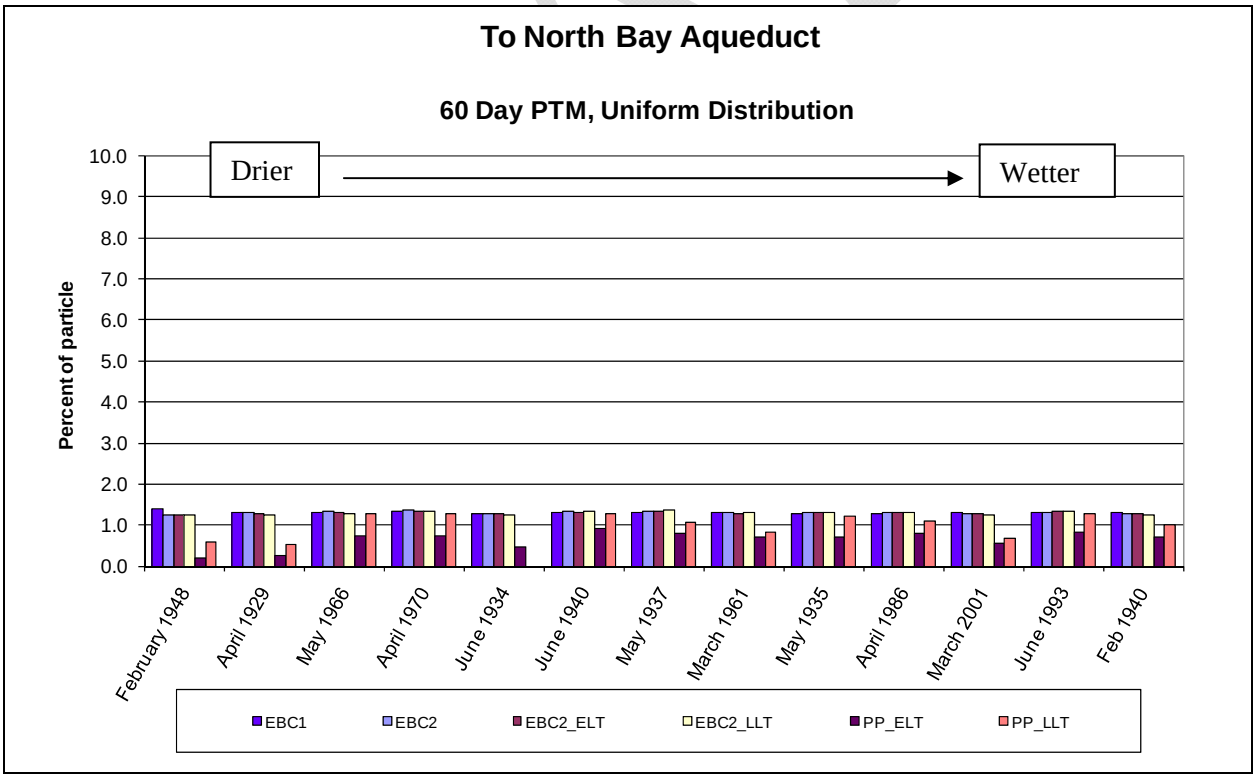
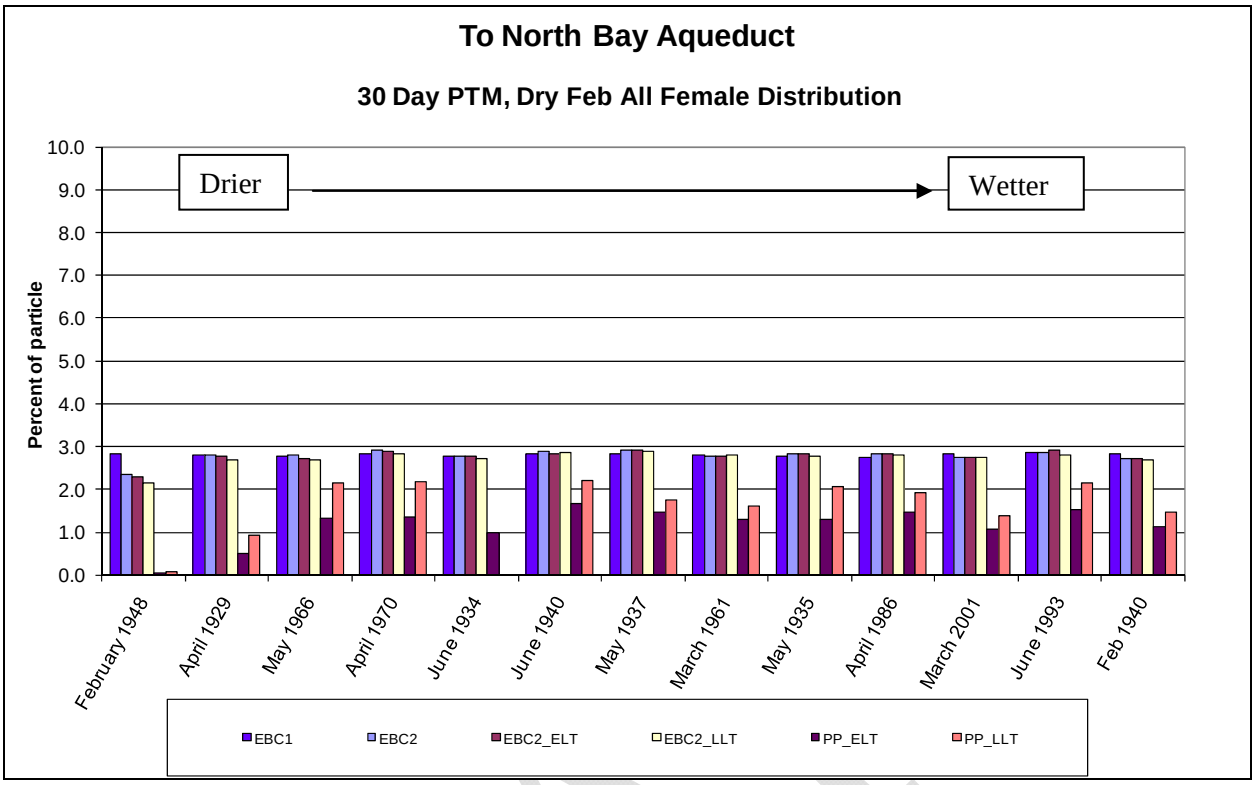


Figure B-94. Percentage of Particles Entrained at North Bay Aqueduct Barker Slough Facility; Uniform Distribution



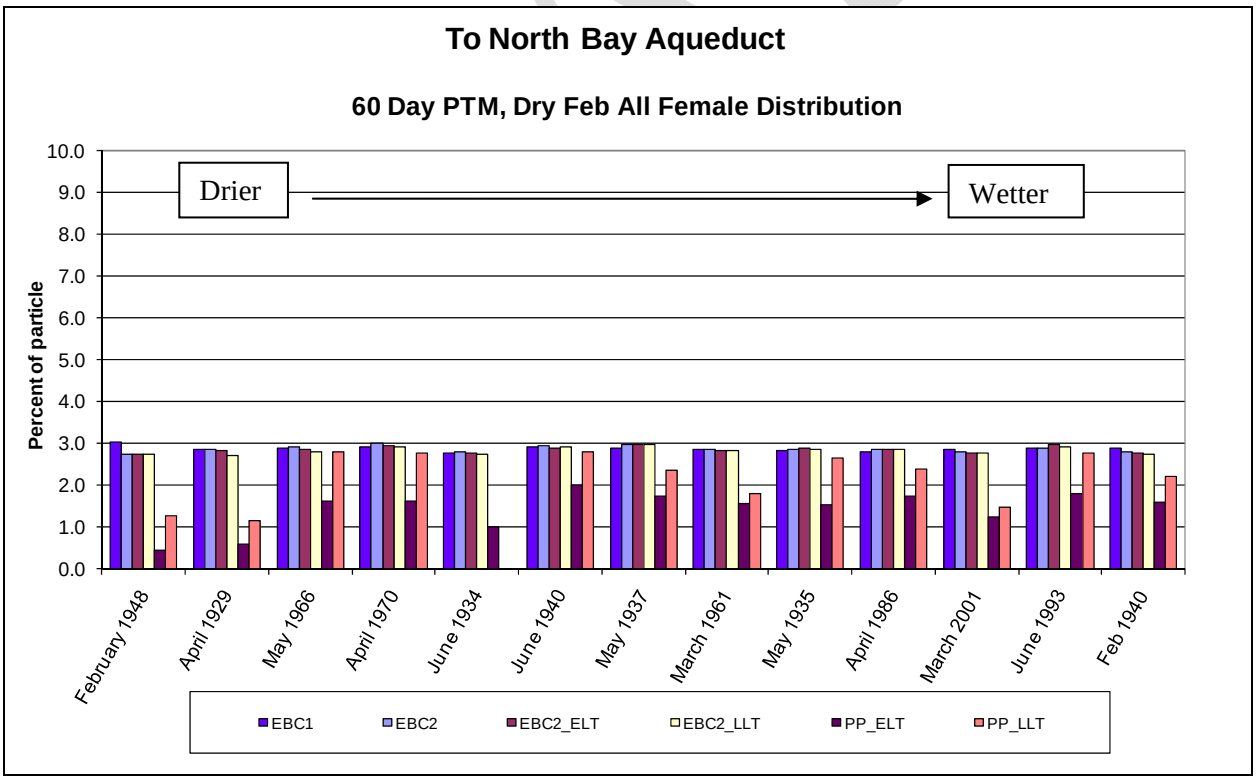
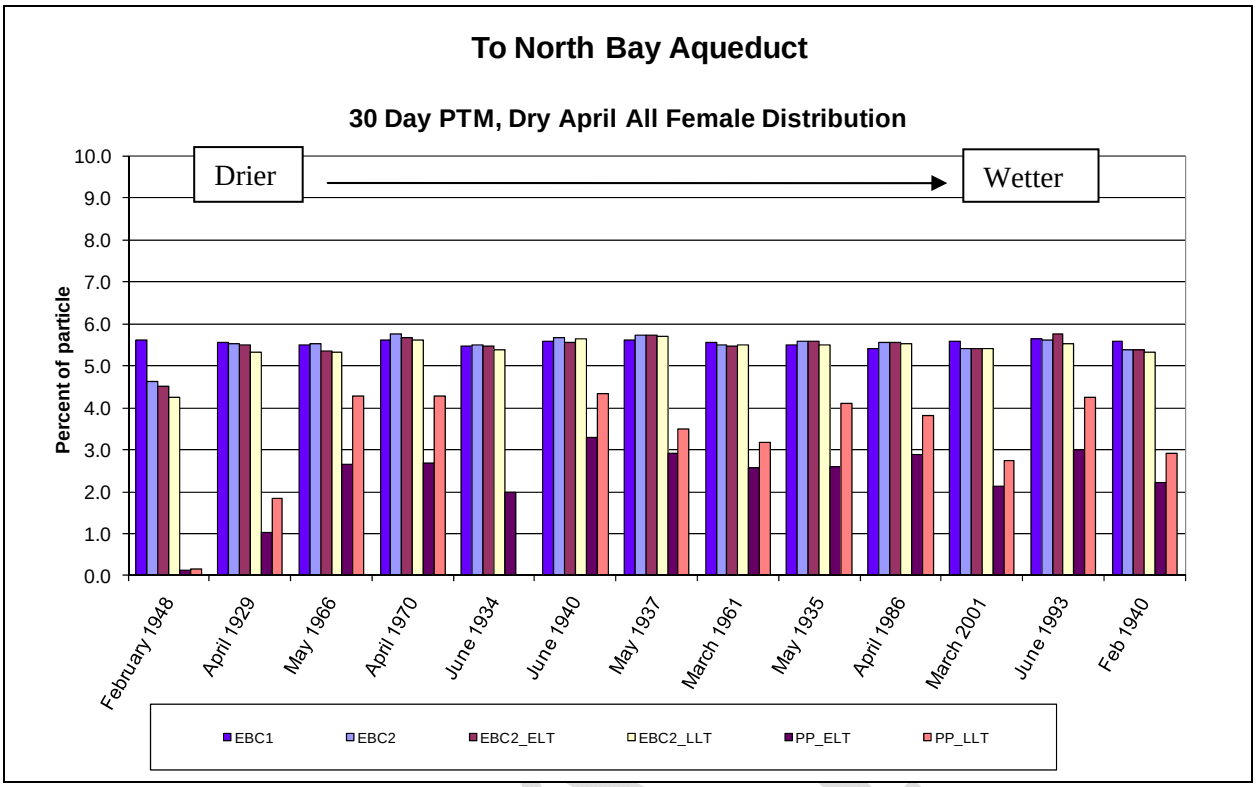


Figure B-95. Percentage of Particles Entrained at North Bay Aqueduct Barker Slough Facility; Dry February All Female Distribution



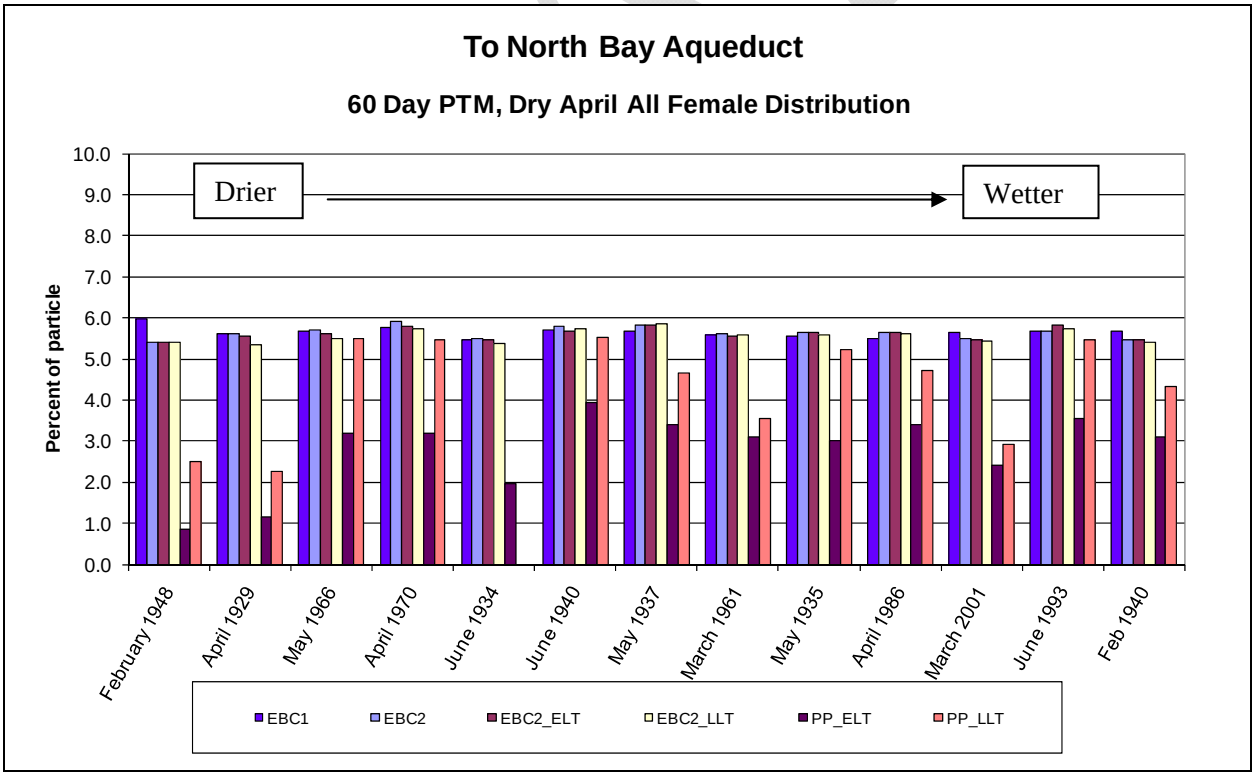
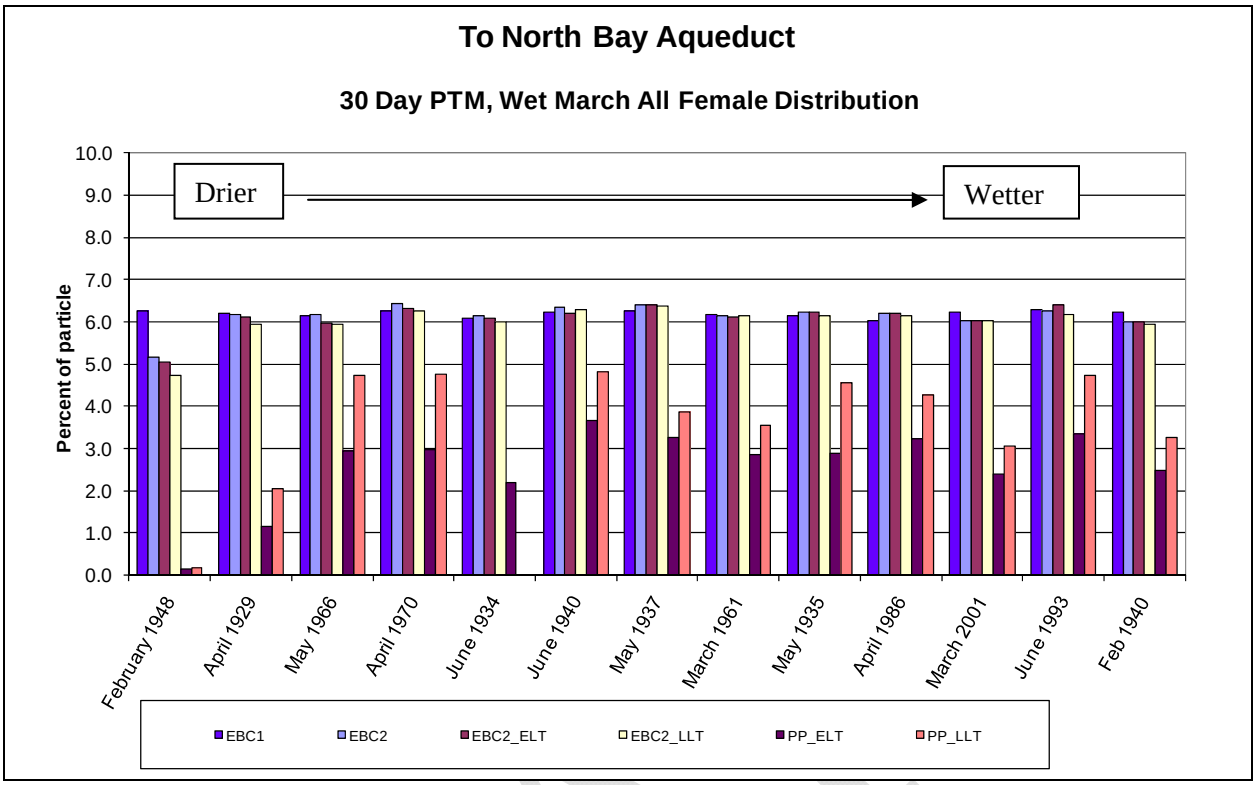


Figure B-96. Percentage of Particles Entrained at North Bay Aqueduct Barker Slough Facility; Dry April All Female Distribution



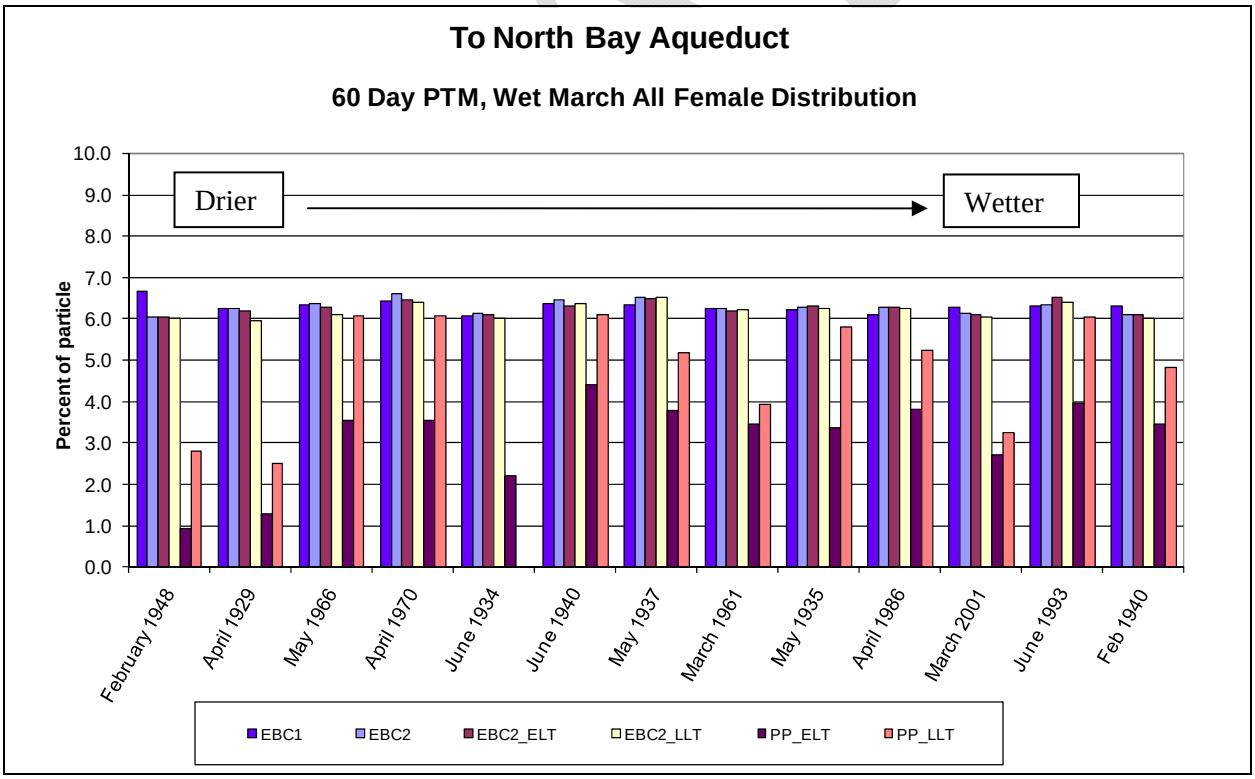
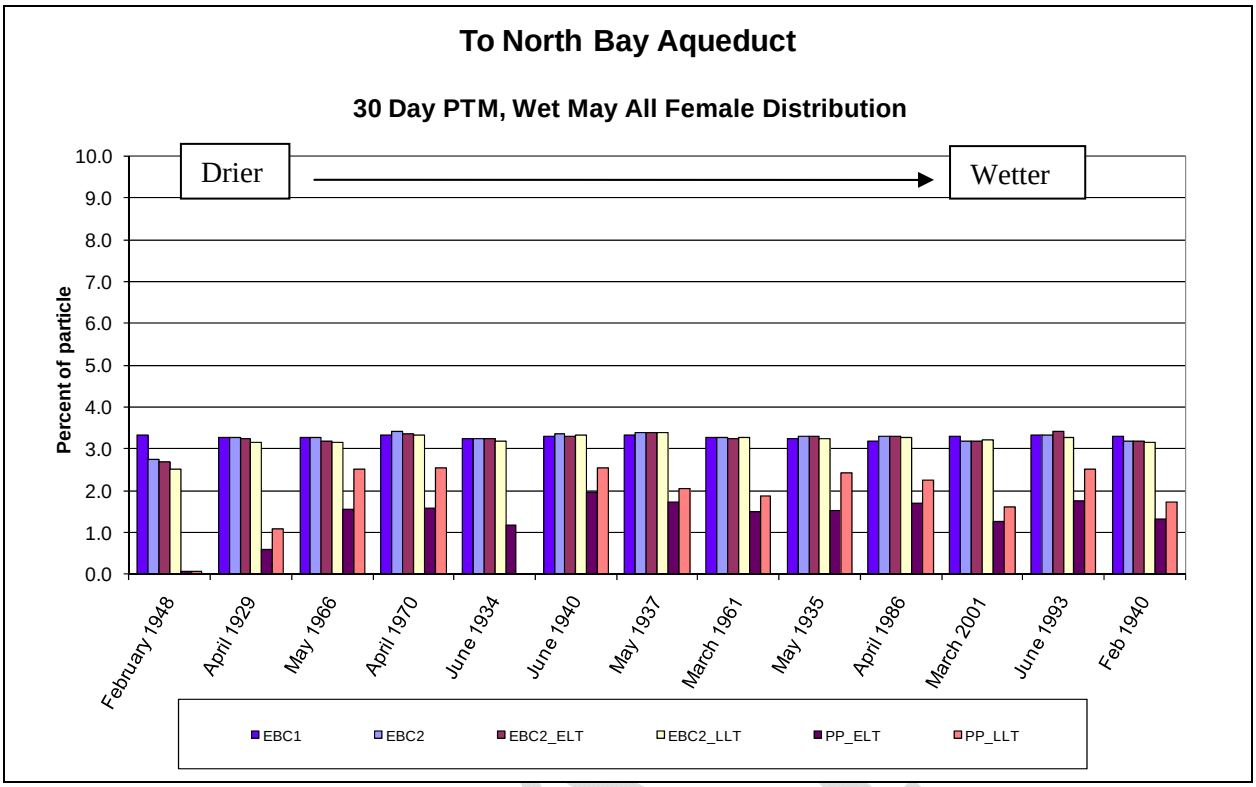


Figure B-97. Percentage of particles entrained at North Bay Aqueduct Barker Slough Facility; Wet March All Female Distribution



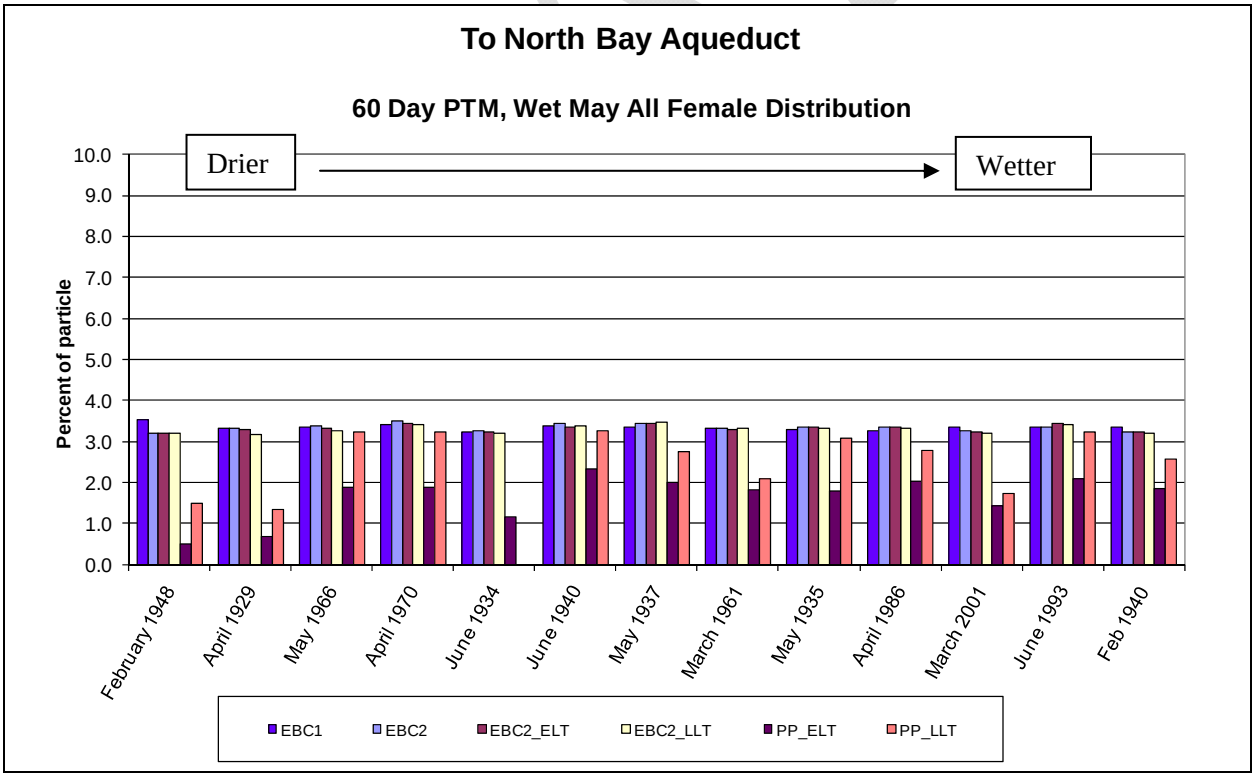
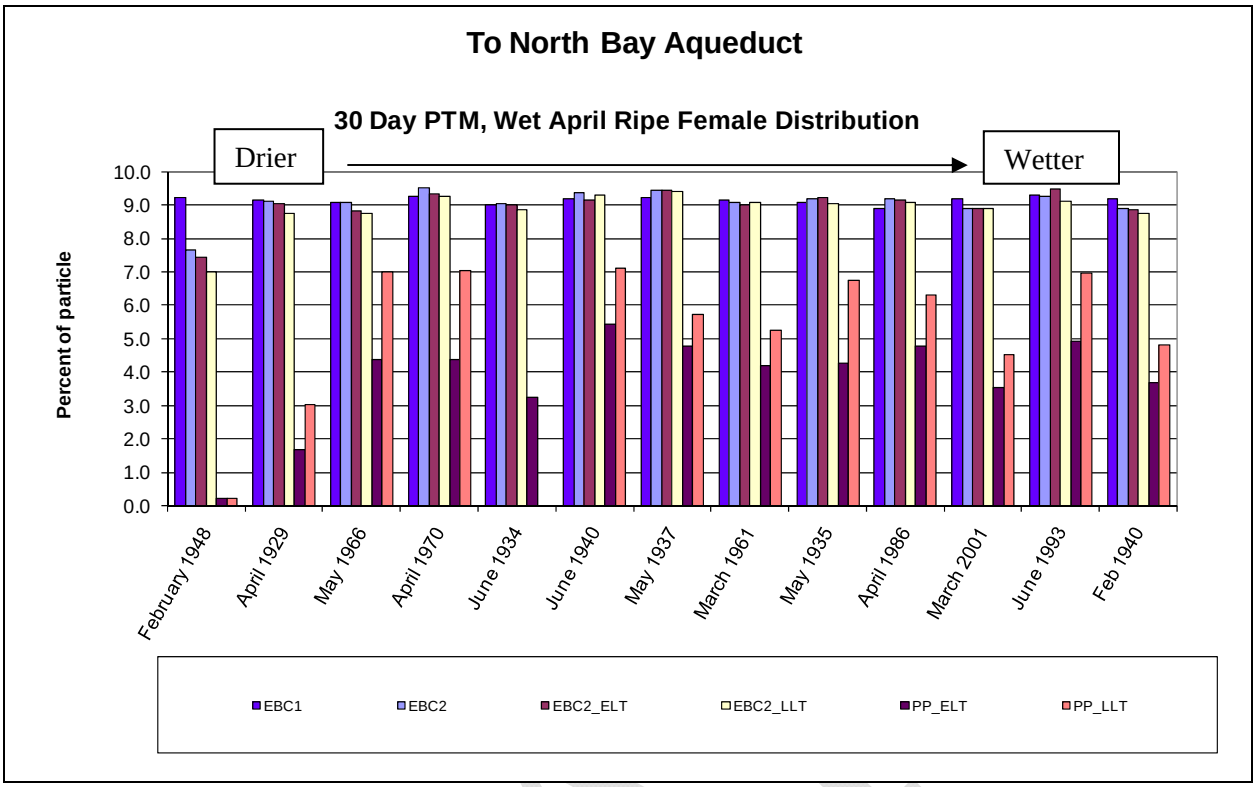


Figure B-98. Percentage of particles entrained at North Bay Aqueduct Barker Slough Facility; Wet May All Female Distribution



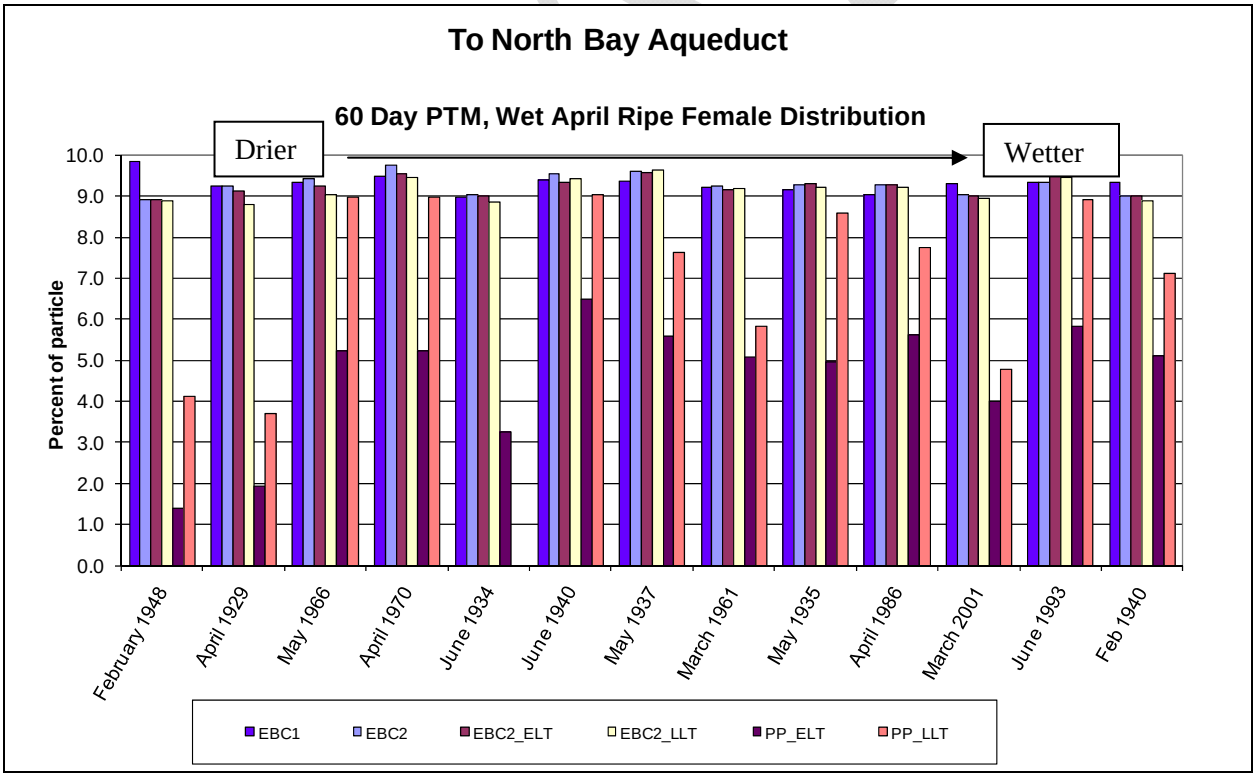
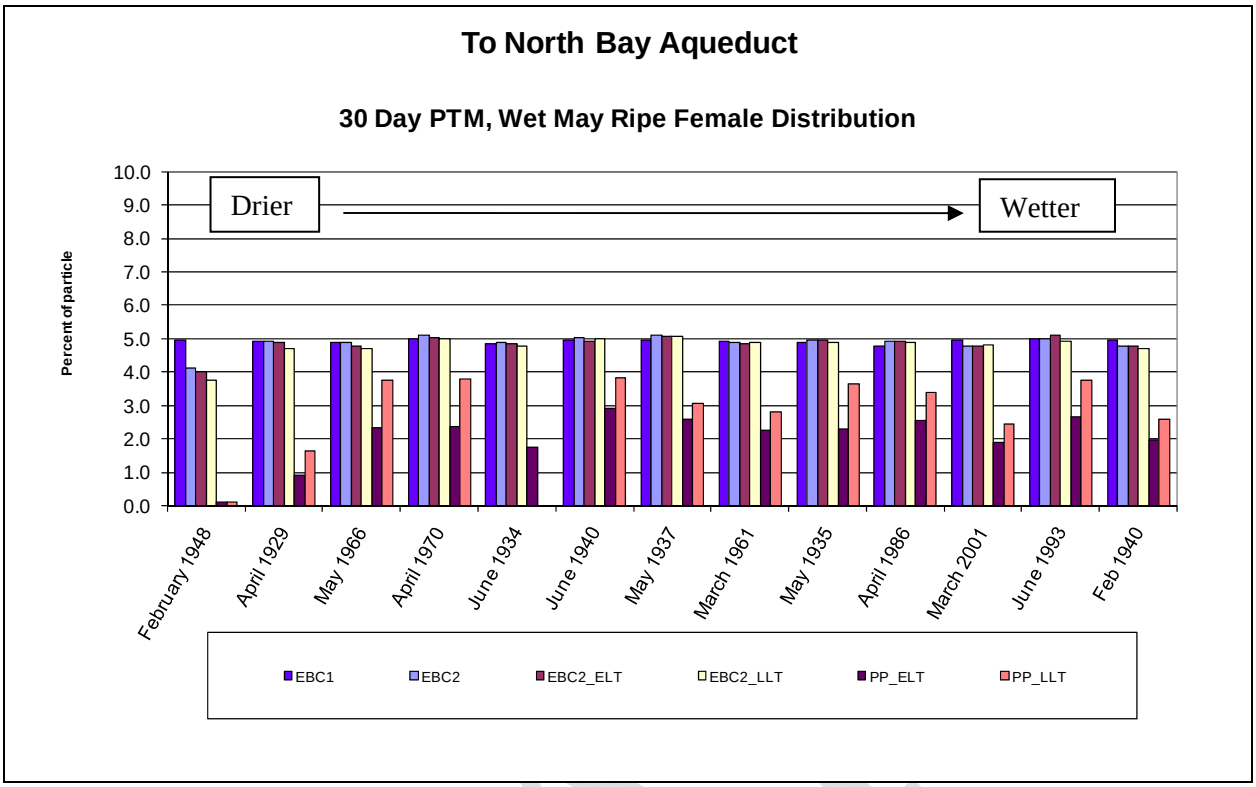


Figure B-99. Percentage of Particles Entrained at North Bay Aqueduct Barker Slough Facility; Wet April Ripe Female Distribution



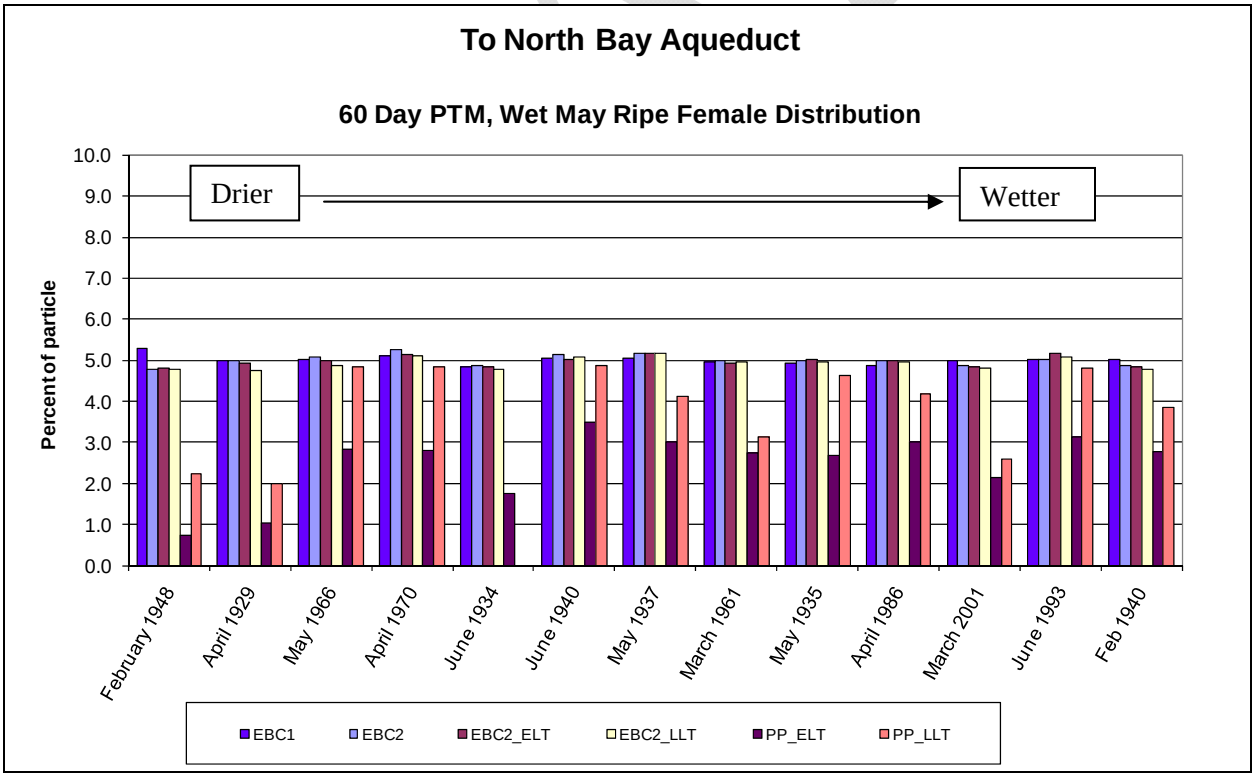


Figure B-100. Percentage of Particles Entrained at North Bay Aqueduct Barker Slough Facility; Wet May Ripe Female Distribution

Table B-246. Average Difference[1] (Number of Runs) between Model Scenarios for Entrainment at the North Bay Aqueduct Barker Slough Facility for Particle-Tracking Runs after (A) 30 Days and (B) 60 Days

(A) 30 Days Starting Distribution	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs. PP_LLT	EBC2_ELT vs. PP_ELT	EBC2_LLT vs. PP_LLT
Uniform Distribution						
Higher Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Lower Entrainment	-0.8 (13)	-0.6 (13)	-0.7 (13)	-0.6 (13)	-0.7 (13)	-0.5 (13)
Dry February All Female Distribution						
Higher Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Lower Entrainment	-1.6 (13)	-1.3 (13)	-1.6 (13)	-1.3 (13)	-1.6 (13)	-1.2 (13)
Dry April All Female Distribution						
Higher Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Lower Entrainment	-3.2 (13)	-2.5 (13)	-3.2 (13)	-2.5 (13)	-3.1 (13)	-2.4 (13)
Wet March All Female Distribution						
Higher Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Lower Entrainment	-3.6 (13)	-2.8 (13)	-3.6 (13)	-2.8 (13)	-3.5 (13)	-2.6 (13)
Wet May All Female Distribution						
Higher Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Lower Entrainment	-1.9 (13)	-1.5 (13)	-1.9 (13)	-1.5 (13)	-1.9 (13)	-1.4 (13)
Wet April Ripe Female Distribution						
Higher Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Lower Entrainment	-5.3 (13)	-4.2 (13)	-5.2 (13)	-4.1 (13)	-5.2 (13)	-3.9 (13)
Wet May Ripe Female Distribution						
Higher Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Lower Entrainment	-2.9 (13)	-2.2 (13)	-2.8 (13)	-2.2 (13)	-2.8 (13)	-2.1 (13)
(B) 60 Days Starting Distribution	**EBC1 vs. PP_ELT**	**EBC1 vs. PP_LLT**	**EBC2 vs. PP_ELT**	**EBC2 vs. PP_LLT**	**EBC2_ELT vs. PP_ELT**	**EBC2_LLT vs. PP_LLT**
Uniform Distribution						
Higher Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Lower Entrainment	-0.7 (13)	-0.4 (13)	-0.7 (13)	-0.4 (13)	-0.7 (13)	-0.4 (13)
Dry February All Female Distribution						
Higher Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Lower Entrainment	-1.5 (13)	-0.8 (13)	-1.4 (13)	-0.8 (13)	-1.4 (13)	-0.8 (13)
Dry April All Female Distribution						
Higher Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Lower Entrainment	-2.9 (13)	-1.6 (13)	-2.8 (13)	-1.6 (13)	-2.8 (13)	-1.6 (13)
Wet March All Female Distribution						
Higher Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Lower Entrainment	-3.2 (13)	-1.9 (13)	-3.2 (13)	-1.8 (13)	-3.1 (13)	-1.7 (13)
Wet May All Female Distribution						
Higher Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Lower Entrainment	-1.7 (13)	-1.0 (13)	-1.7 (13)	-1.0 (13)	-1.7 (13)	-0.9 (13)

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Wet April Ripe Female Distribution						
Higher Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Lower Entrainment	-4.7 (13)	-2.7 (13)	-4.7 (13)	-2.7 (13)	-4.6 (13)	-2.6 (13)
Wet May Ripe Female Distribution						
Higher Entrainment	- (0)	- (0)	- (0)	- (0)	- (0)	- (0)
Lower Entrainment	-2.5 (13)	-1.5 (13)	-2.5 (13)	-1.5 (13)	-2.5 (13)	-1.4 (13)
[1] Values represent the difference in the percentage of particles reaching this destination. Negative values indicate lower entrainment under the preliminary proposal compared to the EBC.						

B.4.3.2 *Longfin Smelt (Larva)*

B.4.3.2.1 Particle-Tracking Modeling

Entrainment of longfin smelt larvae at the NBA Barker Slough pumping plant as simulated by PTM generally suggested that relatively low levels of entrainment (always less than 0.8%) would occur (Figure B-101 and Figure B-102). The most common result of PTM runs was increased entrainment under PP scenarios compared to EBC scenarios; however, the average increases were always very small (typically 0.1%) and similar in magnitude to the decreases under PP scenarios that also occurred (Table B-247).

As described above for delta smelt larvae in Section B.6.3.1.1, entrainment would be lower under PP scenarios compared to EBC scenarios mainly because of the tidal marsh restoration assumed under PP in the Cache Slough region and the overall changes in the hydrodynamics caused by modified operations. The establishment of a dual diversion system for the NBA, with combined operations of a new intake on the Sacramento River (operated in conjunction with proposed BDCP north Delta facilities) and the existing intake at Barker Slough, would reduce the level of entrainment of delta smelt further by removing most of the export pumping from the Barker Slough facility to the new Sacramento River facility.

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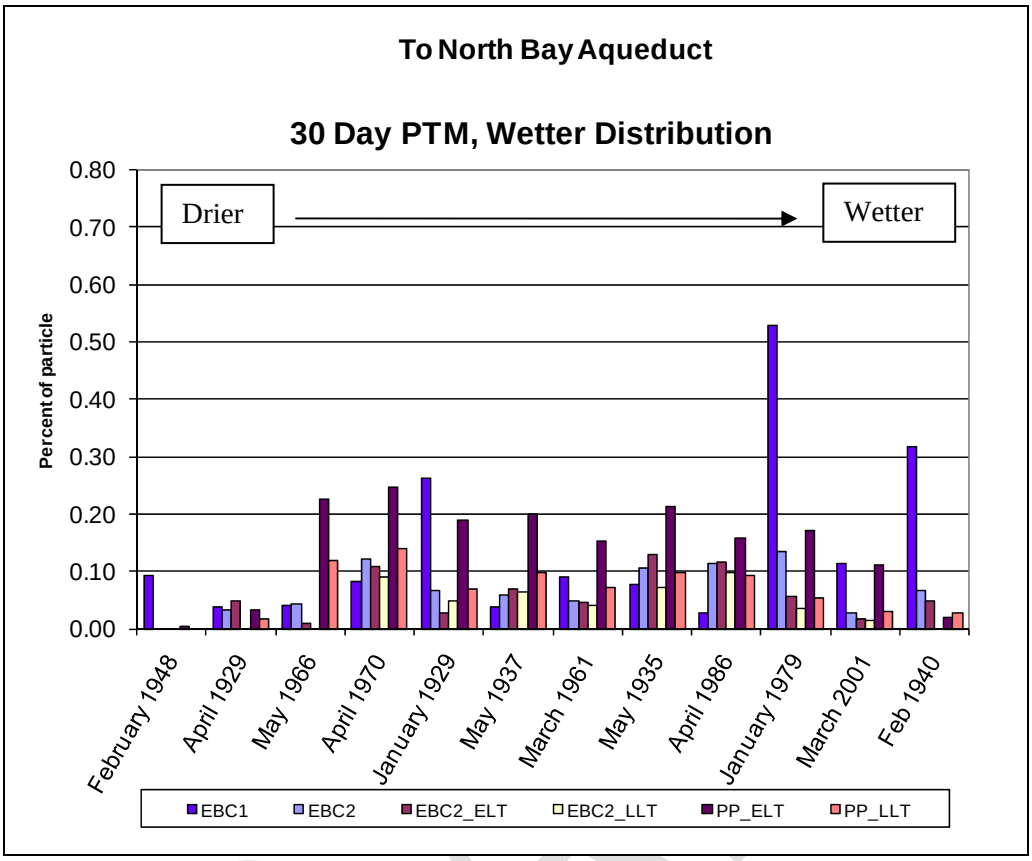


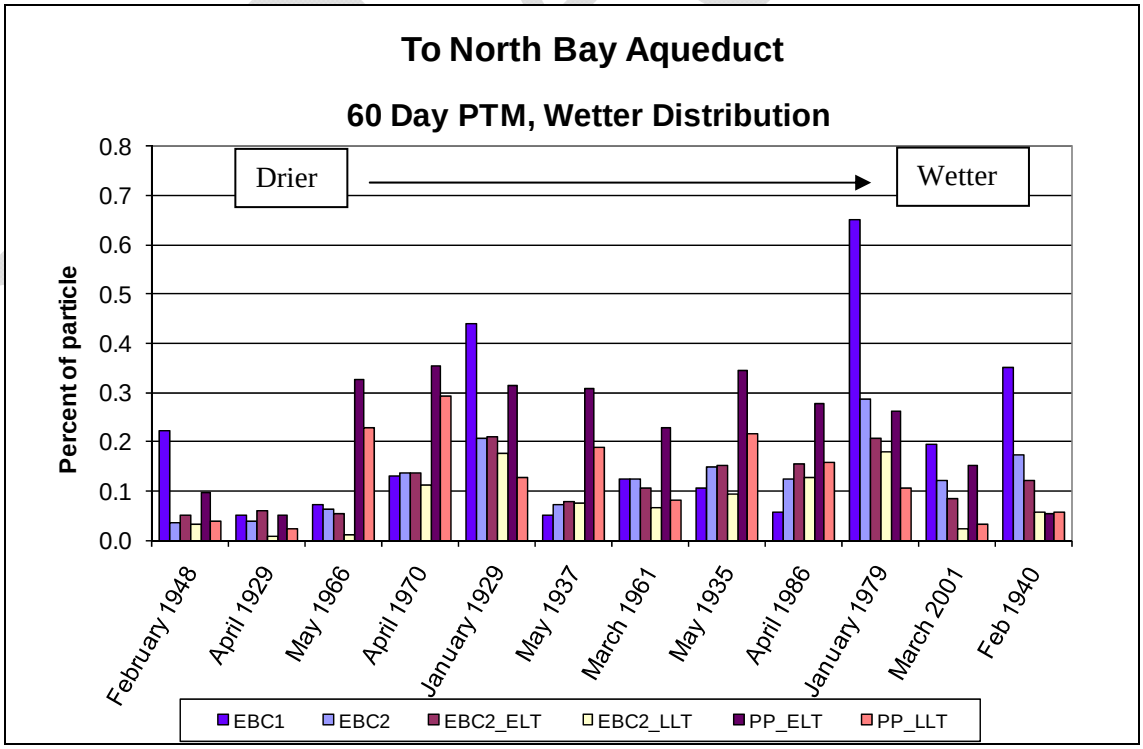
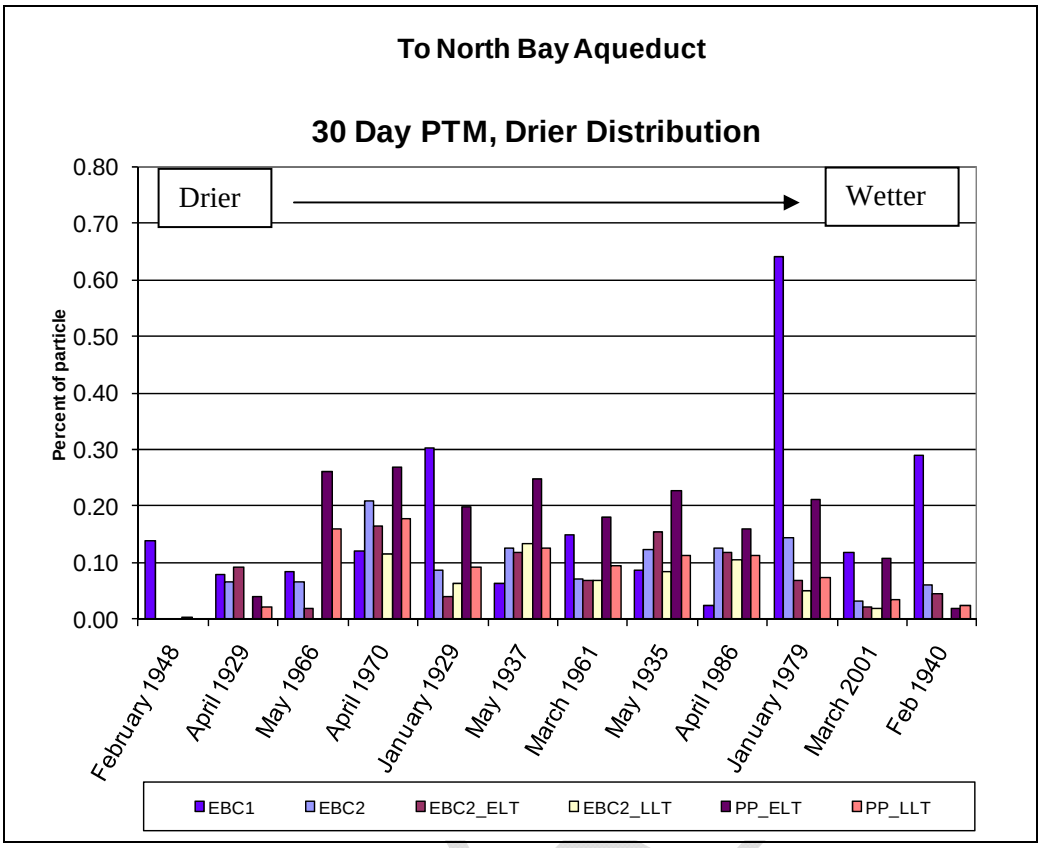


Figure B-101. Percentage of Particles Entrained at North Bay Aqueduct, Wetter Distribution



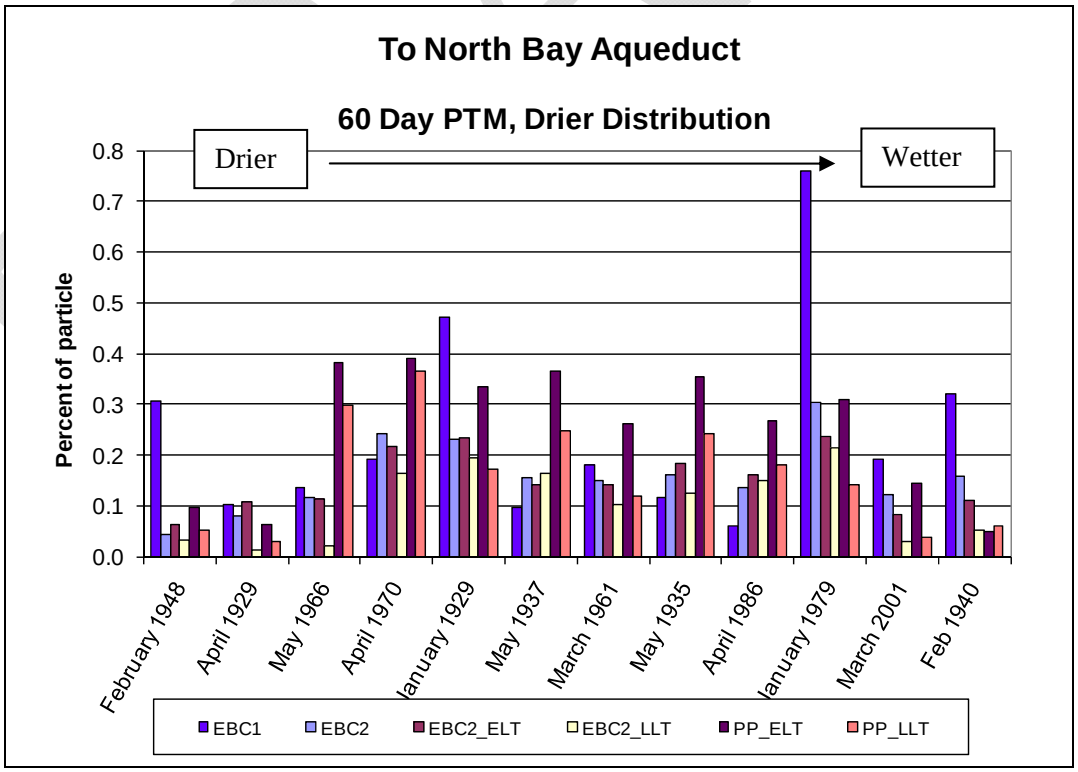


Figure B-102. Percentage of Particles Entrained at North Bay Aqueduct, Drier Distribution

Table B-247. Average Difference[1] (Number of Runs) between Model Scenarios in Entrainment Risk at North Bay Aqueduct Diversions for Particle-Tracking Runs after (A) 30 Days and (B) 60 Days (%)

(A) 30 Days Starting Distribution	**EBC1 vs. PP_ELT**	**EBC1 vs. PP_LLT**	**EBC2 vs. PP_ELT**	**EBC2 vs. PP_LLT**	**EBC2_ELT vs. PP_ELT**	**EBC2_LLT vs. PP_LLT**
Wetter Distribution						
Higher Entrainment	0.1 (6)	0.1 (5)	0.1 (11)	0.0 (6)	0.1 (10)	0.0 (10)
Lower Entrainment	-0.1 (6)	-0.2 (7)	0.0 (1)	0.0 (5)	0.0 (2)	0.0 (1)
Drier Distribution						
Higher Entrainment	0.1 (6)	0.1 (5)	0.1 (10)	0.0 (5)	0.1 (10)	0.0 (10)
Lower Entrainment	-0.2 (6)	-0.2 (7)	0.0 (2)	0.0 (6)	0.0 (2)	0.0 (1)
(B) 60 Days Starting Distribution	**EBC1 vs. PP_ELT**	**EBC1 vs. PP_LLT**	**EBC2 vs. PP_ELT**	**EBC2 vs. PP_LLT**	**EBC2_ELT vs. PP_ELT**	**EBC2_LLT vs. PP_LLT**
Wetter Distribution						
Higher Entrainment	0.2 (6)	0.1 (5)	0.1 (10)	0.1 (6)	0.1 (10)	0.1 (10)
Lower Entrainment	-0.2 (6)	-0.2 (7)	-0.1 (2)	-0.1 (6)	0.0 (2)	-0.1 (2)
Drier Distribution						
Higher Entrainment	0.2 (6)	0.1 (5)	0.1 (10)	0.1 (6)	0.1 (10)	0.1 (10)
Lower Entrainment	-0.2 (6)	-0.2 (7)	-0.1 (2)	-0.1 (6)	-0.1 (2)	0.0 (2)

[1] Values represent the difference in the percentage of particles reaching this destination. Negative values indicate lower entrainment under the preliminary proposal compared to the EBC.

Sensitivity analyses that placed 2%, 10%, and 15% of particles in the south Delta produced similar results to those described above for the wetter and drier distributions, i.e., little absolute entrainment and therefore little difference between scenarios (Figure B-103, Figure B-104, and Figure B-105; Table B-248).

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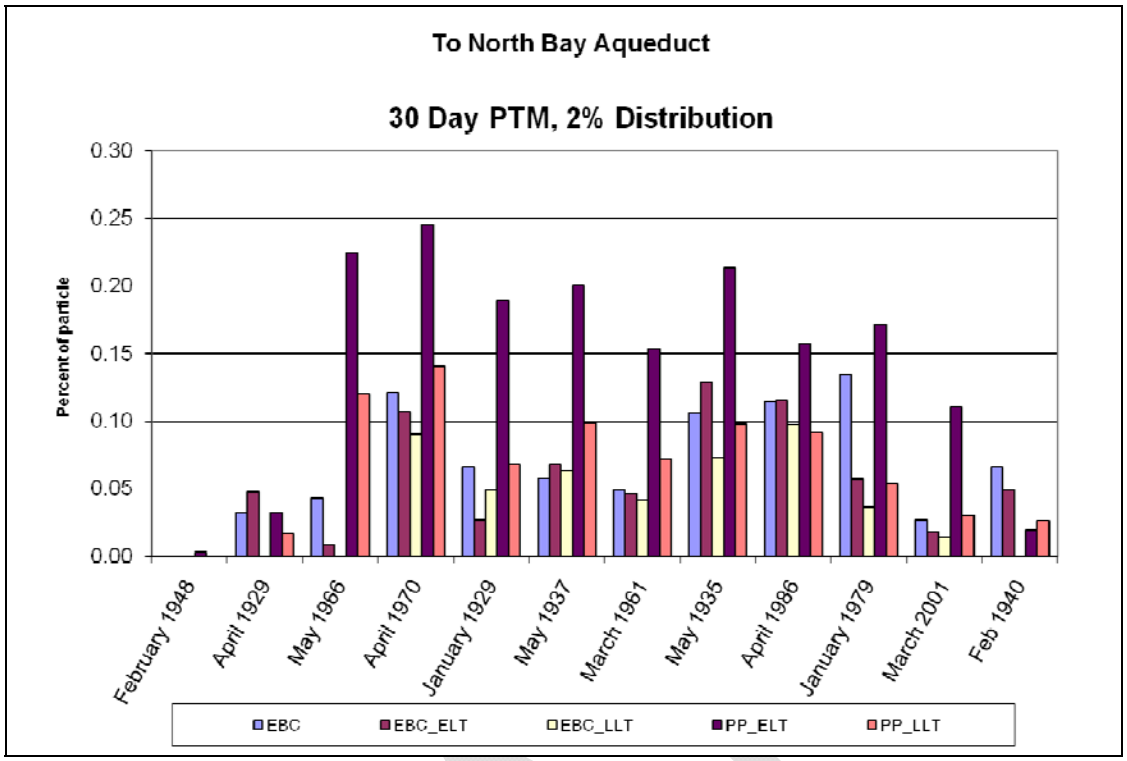

Figure B-103. Percentage of Particles Entrained at North Bay Aqueduct Diversions, 2% Sensitivity Distribution (Note: EBC = EBC2)

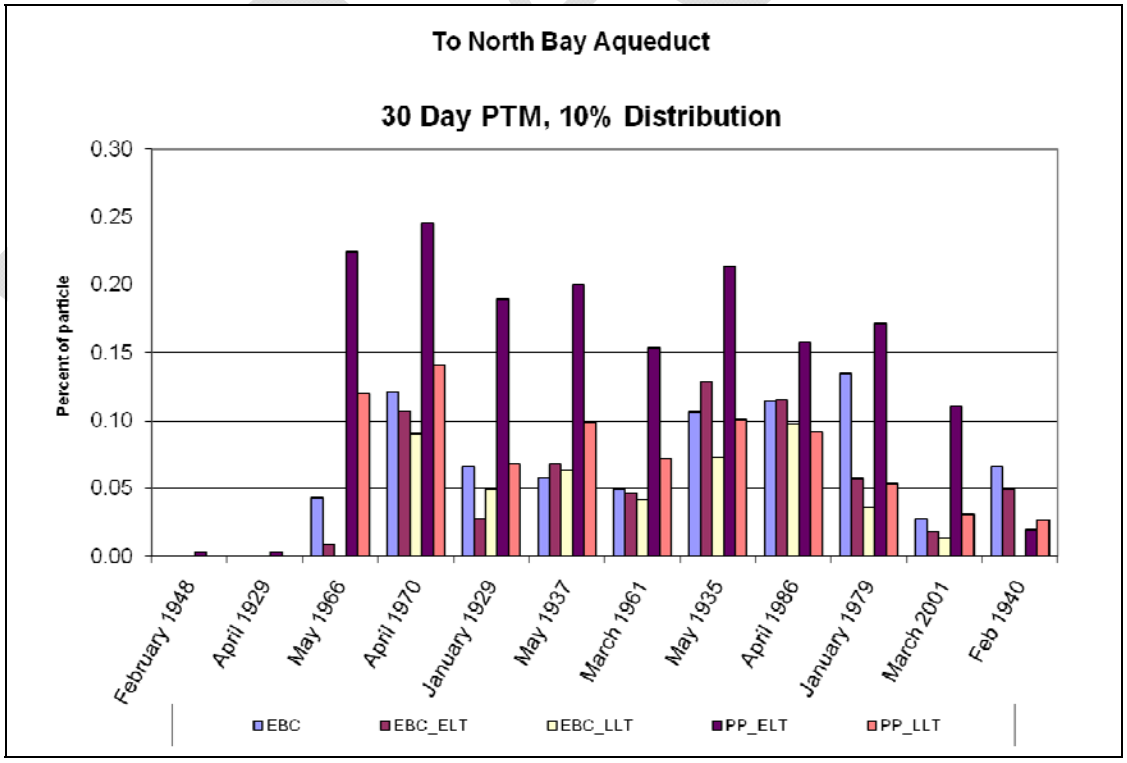

Figure B-104. Percentage of Particles Entrained at North Bay Aqueduct Diversions, 10% Sensitivity Distribution (Note: EBC = EBC2)

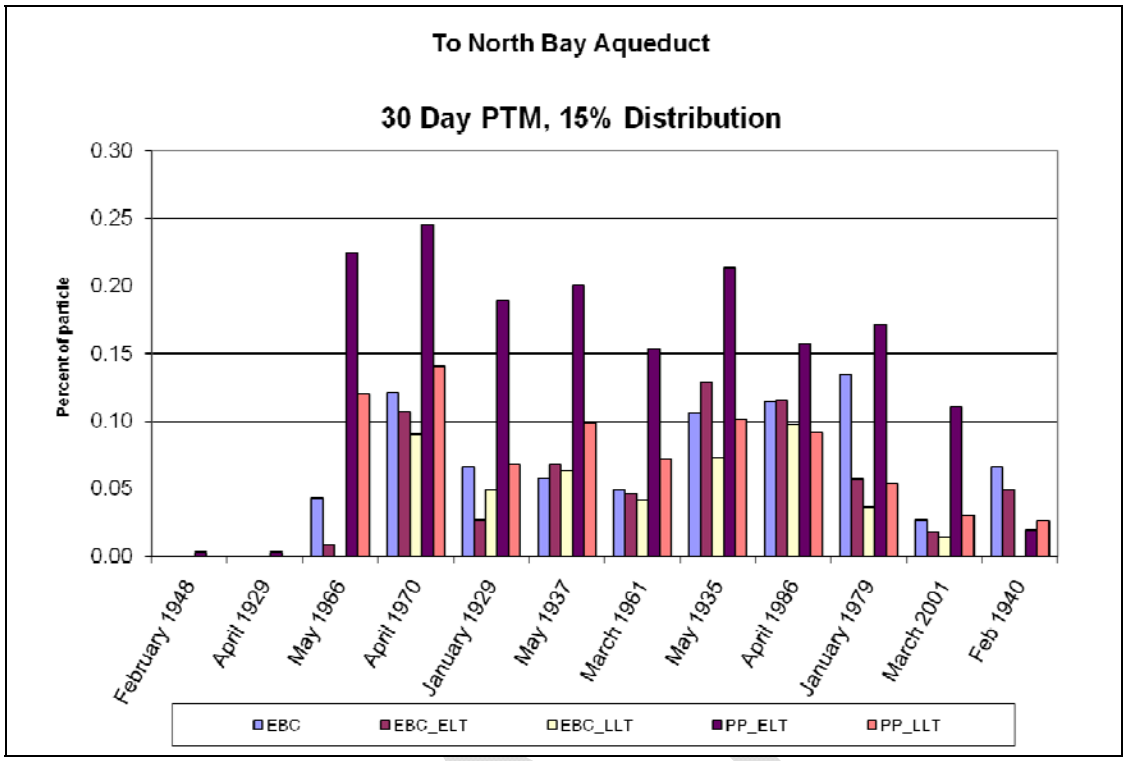

Figure B-105. Percentage of Particles Entrained at North Bay Aqueduct Diversions, 15% Sensitivity Distribution (Note: EBC = EBC2)

Table B-248. Average Difference between Model Scenarios in Entrainment at North Bay Aqueduct Diversions for Particle-Tracking Runs after 30 Days (%)

Starting Distribution	PP_ELT v. EBC2	PP_LLT v. EBC2	PP_ELT v. EBC2_ELT	PP_LLT v. EBC2_LLT
2% Distribution				
Higher Entrainment	0.1	0.0	0.1	0.0
Lower Entrainment	0.0	0.0	0.0	0.0
10% Distribution				
Higher Entrainment	0.1	0.0	0.1	0.0
Lower Entrainment	0.0	0.0	0.0	0.0
15% Distribution				
Higher Entrainment	0.1	0.0	0.0	0.1
Lower Entrainment	0.0	0.0	0.0	0.0
Values represent the difference in the percentage of particles reaching this destination. Negative values indicate lower entrainment under the preliminary proposal compared to the EBC.				

B.4.4 Agricultural Diversions (Cache Slough, North Delta, West Delta, East Delta, South Delta, and Suisun Marsh Subregions)

B.4.4.1 *Delta Smelt (Larva)*

In addition to the analysis using PTM (see below), an analysis of delta smelt entrainment at agricultural diversions is presented in the section entitled All Covered Species (below).

B.4.4.1.1 Particle-Tracking Modeling

Based on the PTM runs, larval delta smelt entrainment at Delta agricultural diversions differed by particle starting distribution, hydrologic scenario, and tracking duration, and was estimated to range from a maximum of over 15–20% of the population under the Wet April Ripe Female and Wet May Ripe Female Distributions to less than 1% in a number of runs (Figure B-106 through Figure B-112). Entrainment generally was estimated to be lower under PP scenarios than EBC scenarios, with average reductions under PP scenarios (0.3–8.1%) generally being greater than the average increases in the less common instances where there PP scenarios gave greater entrainment than EBC scenarios (0.0–0.2%) (Table B-249).

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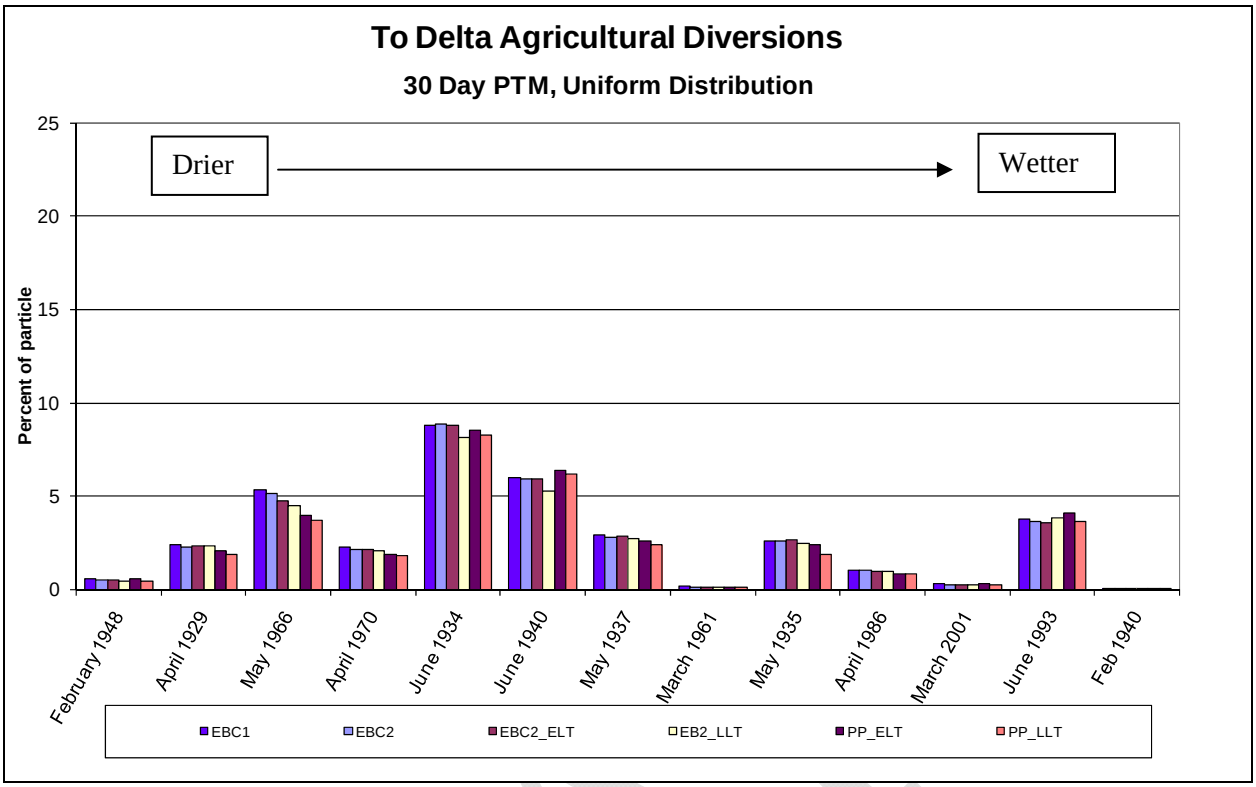


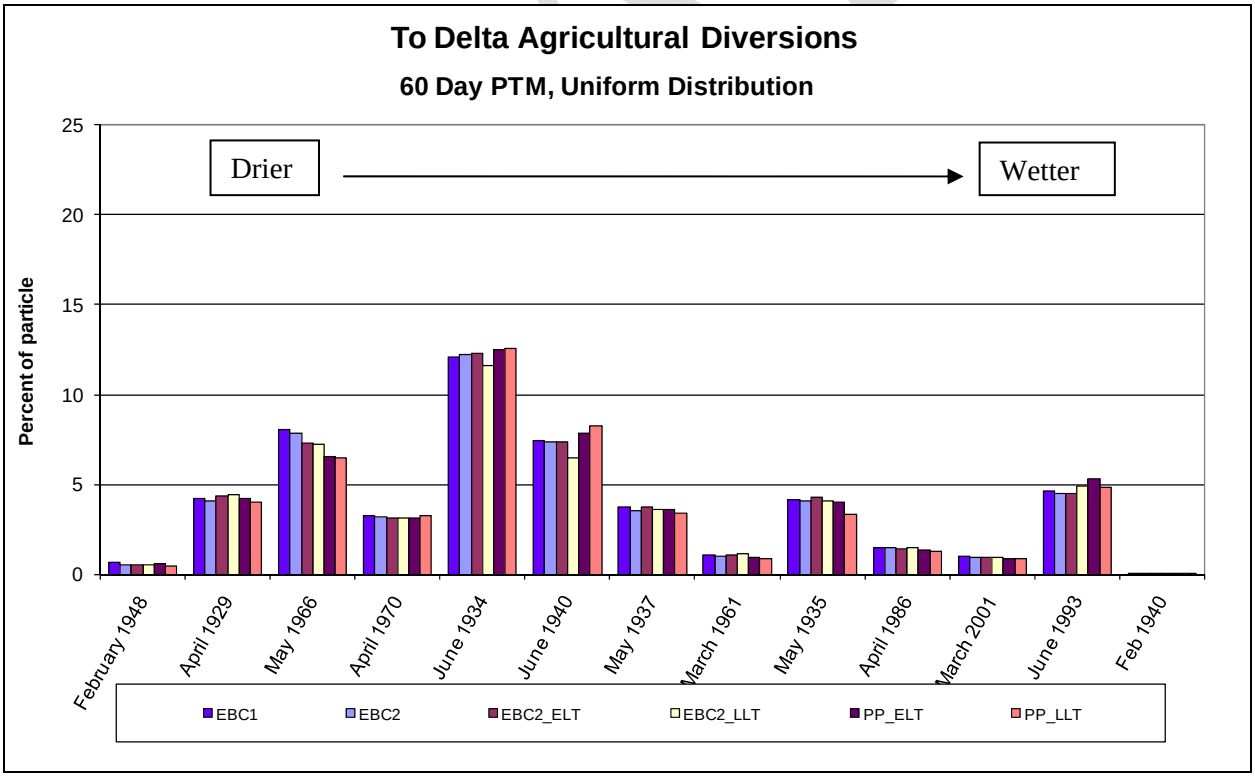
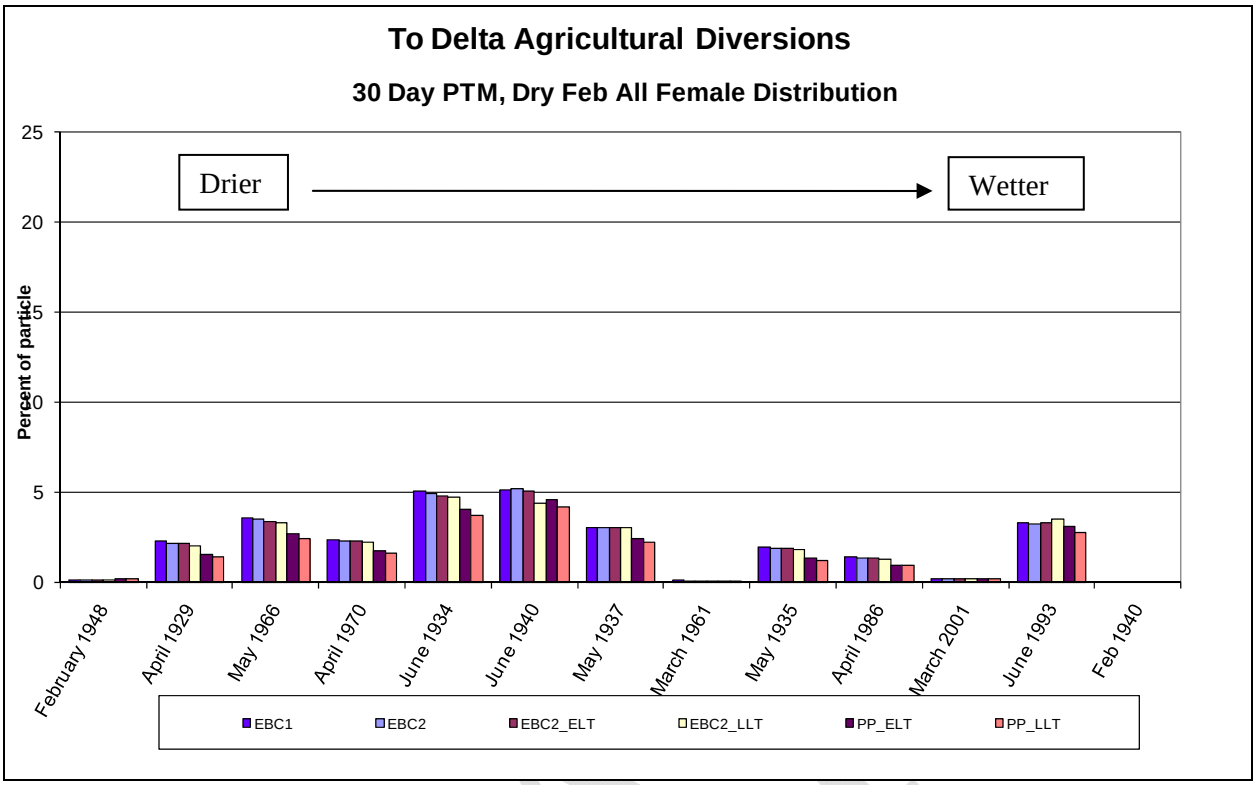


Figure B-106. Percentage of Particles Entrained at Delta Agricultural Diversions; Uniform Distribution



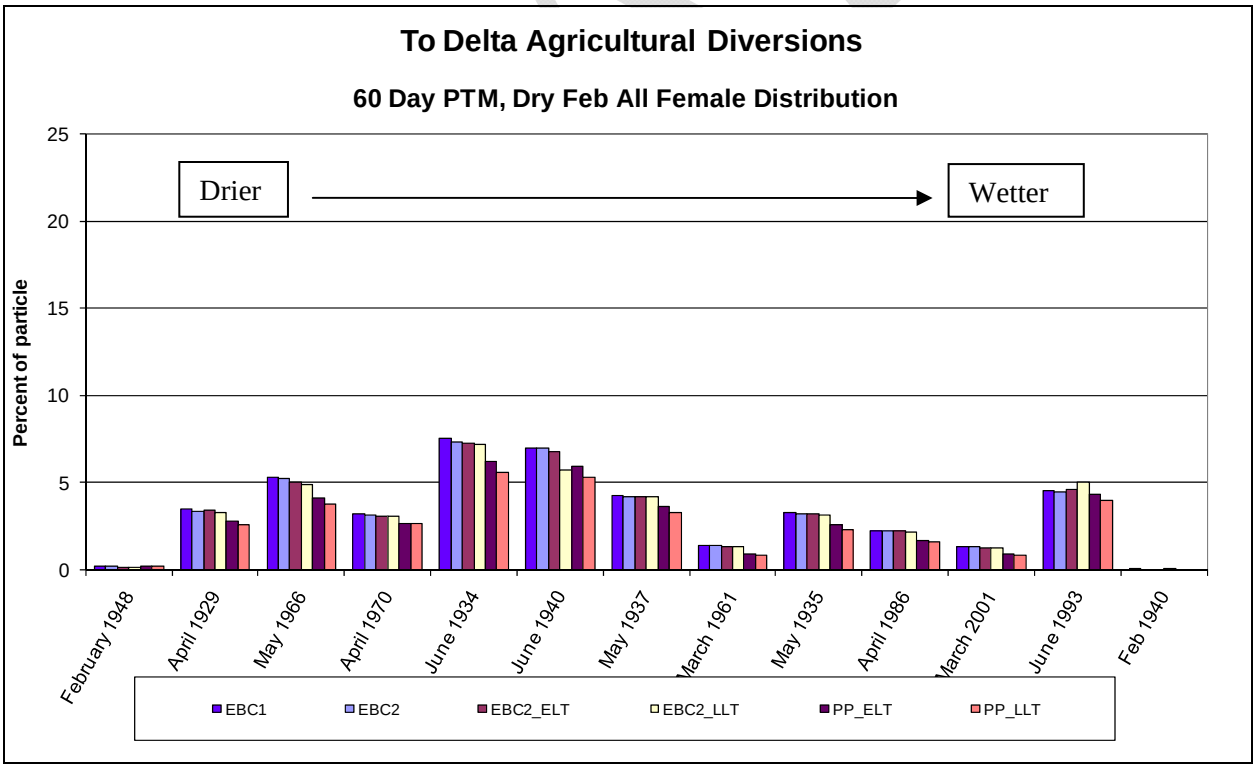
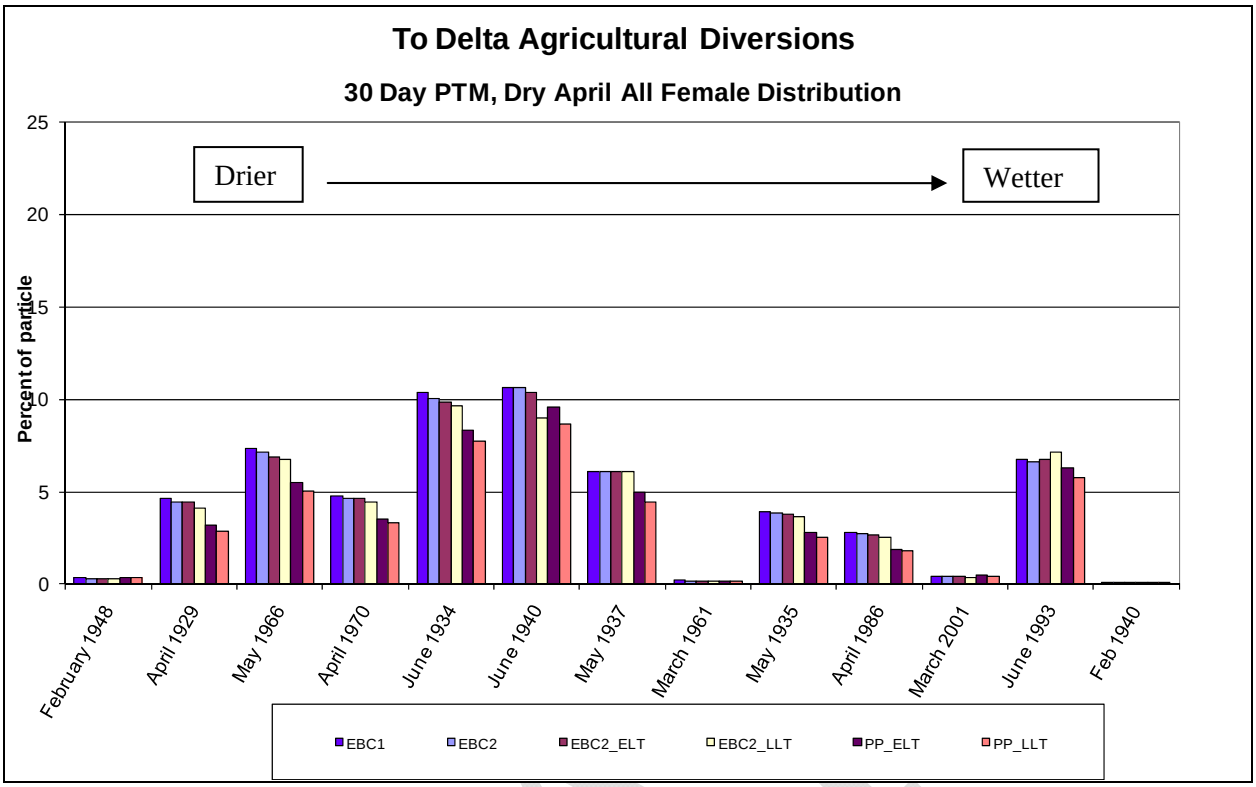


Figure B-107. Percentage of Particles Entrained at Delta Agricultural Diversions; Dry February All Female Distribution



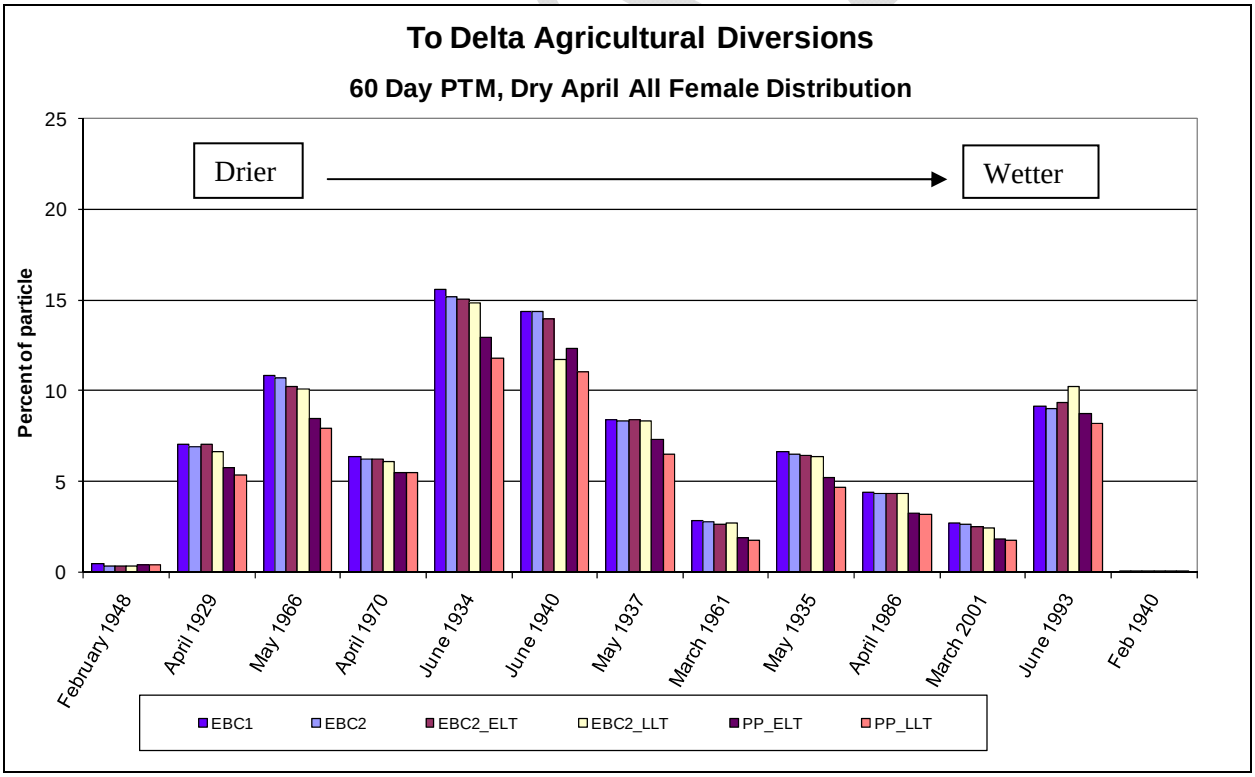
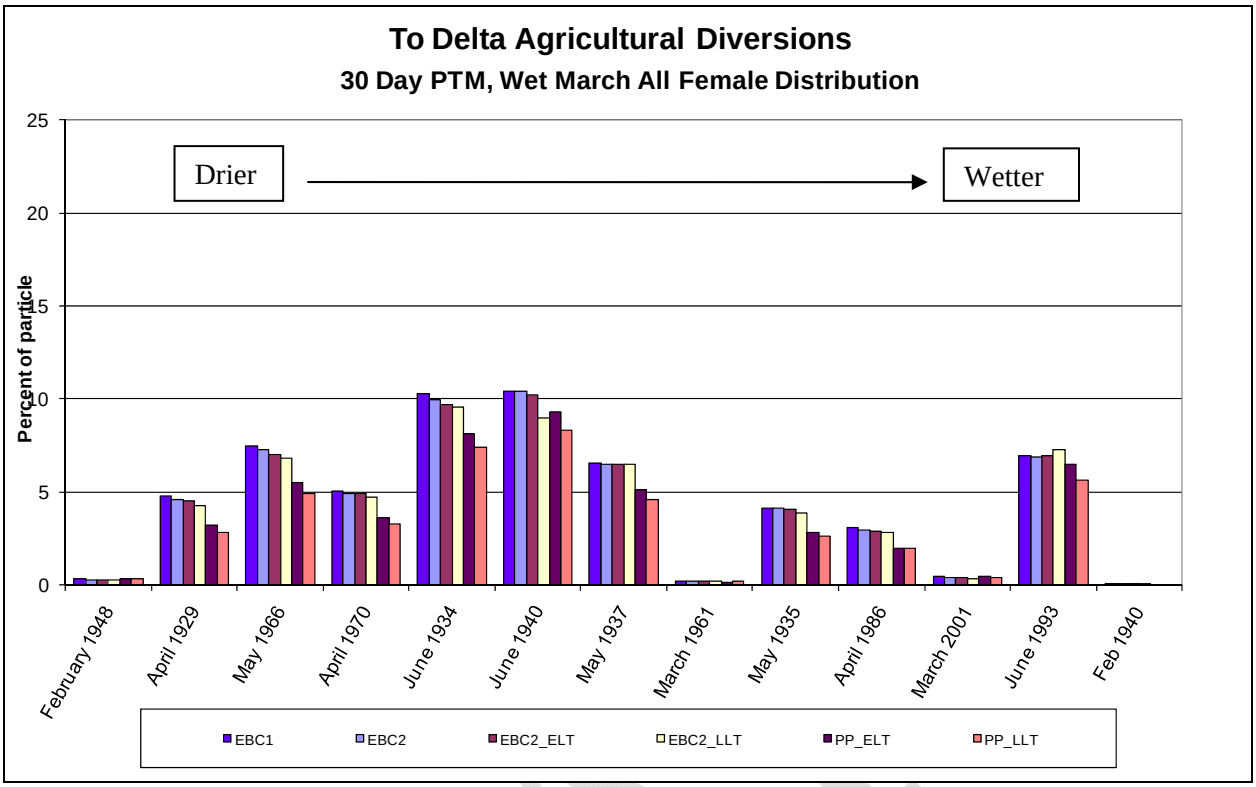


Figure B-108. Percentage of Particles Entrained at Delta Agricultural Diversions; Dry April All Female Distribution



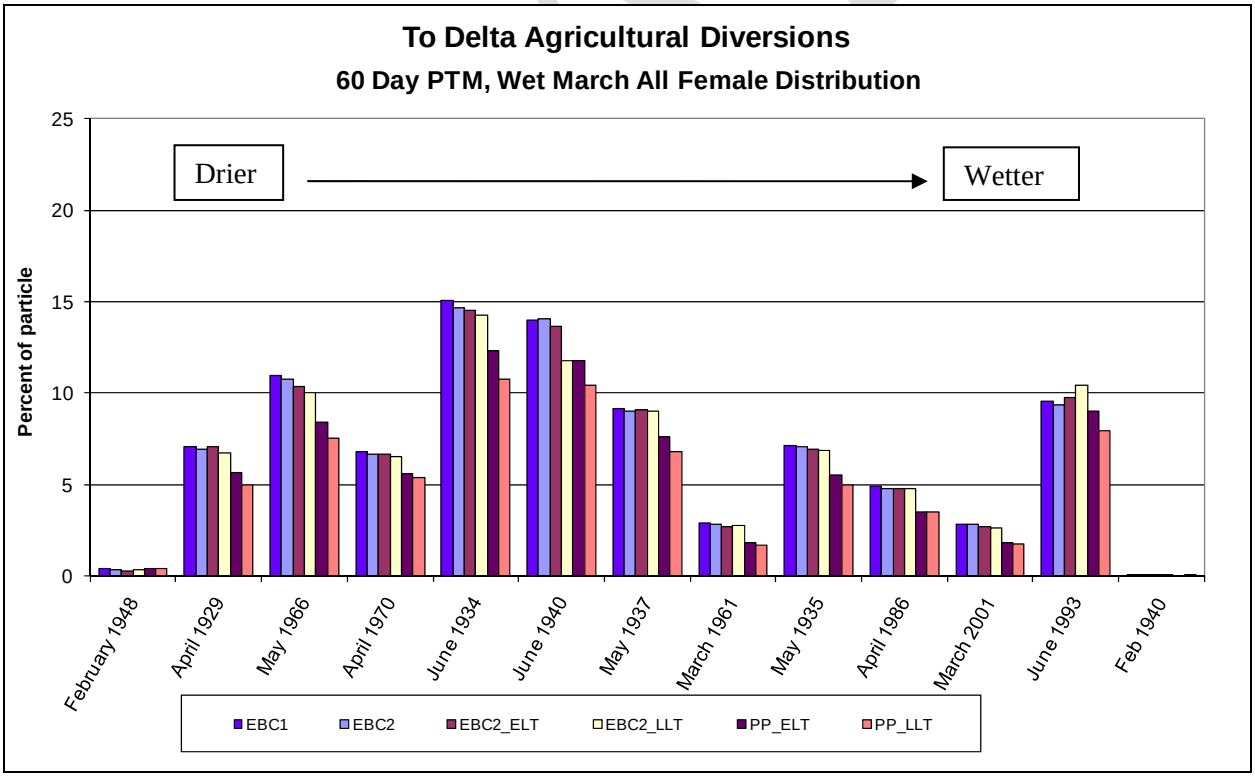
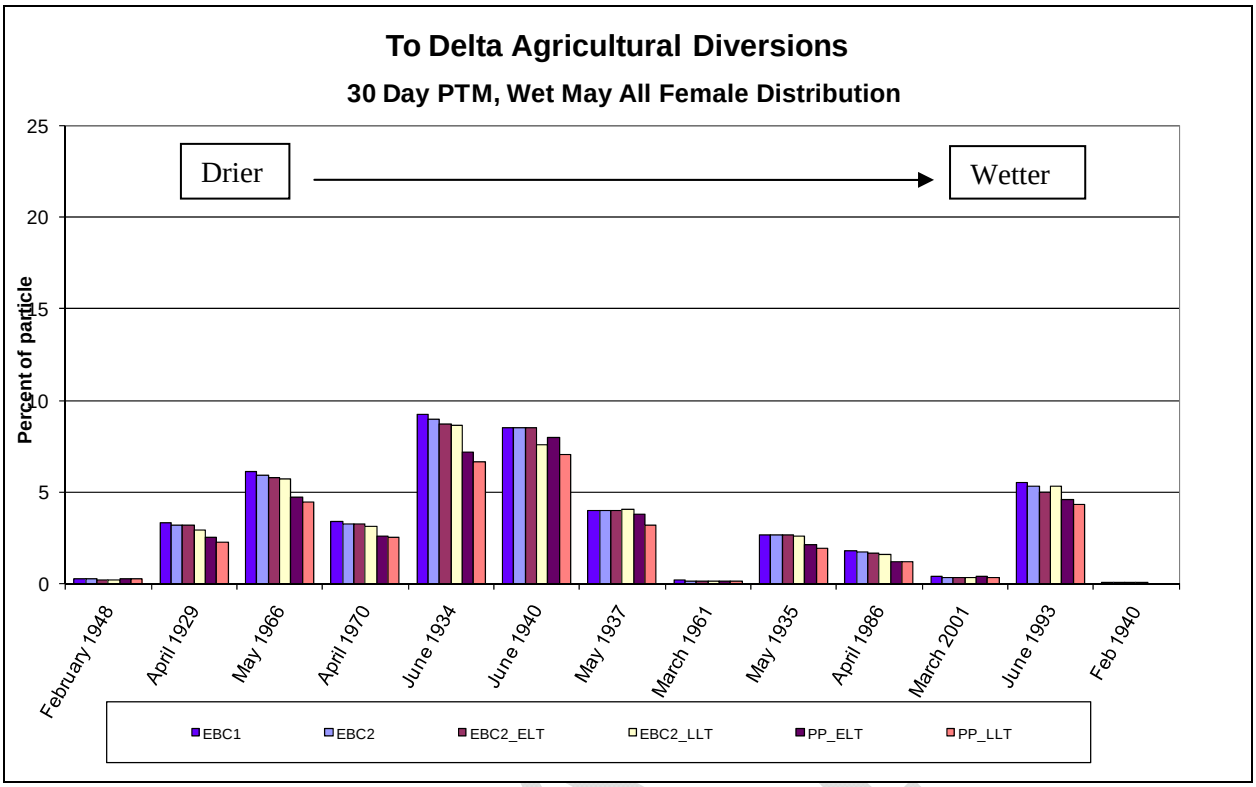


Figure B-109. Percentage of particles entrained at Delta Agricultural Diversions; Wet March All Female Distribution



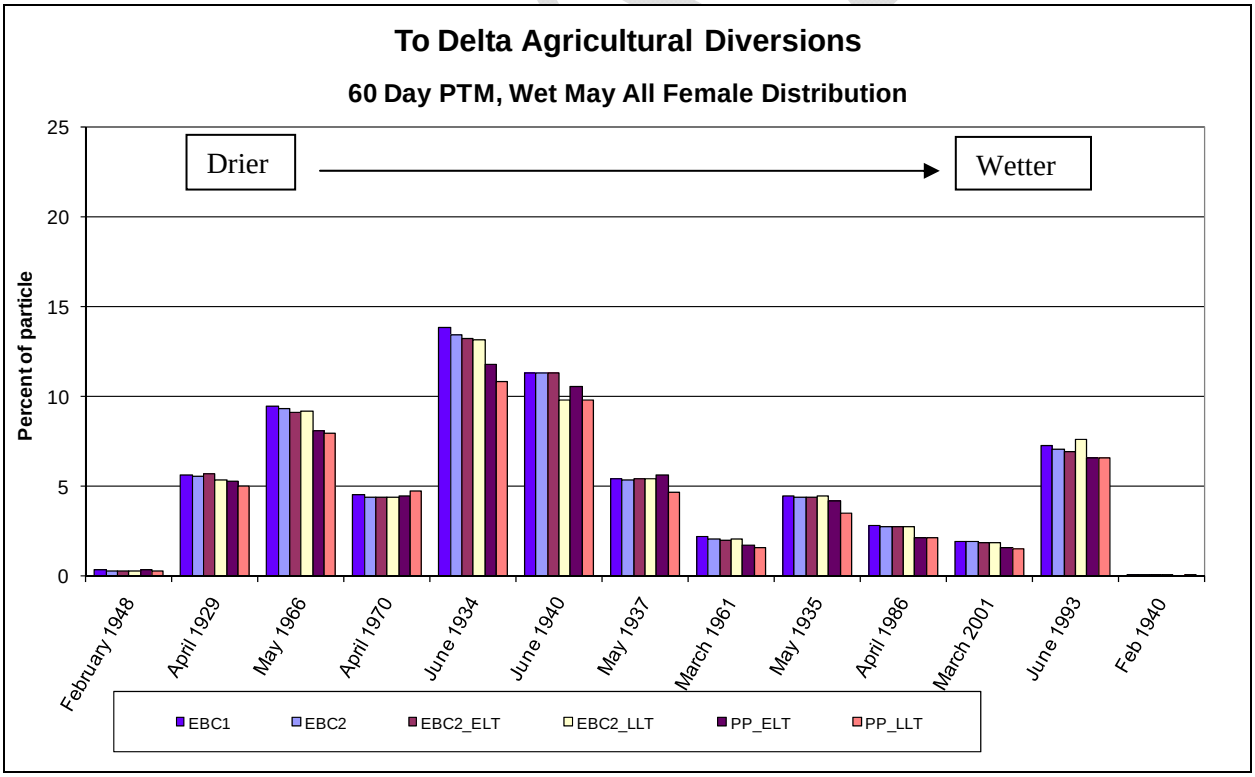
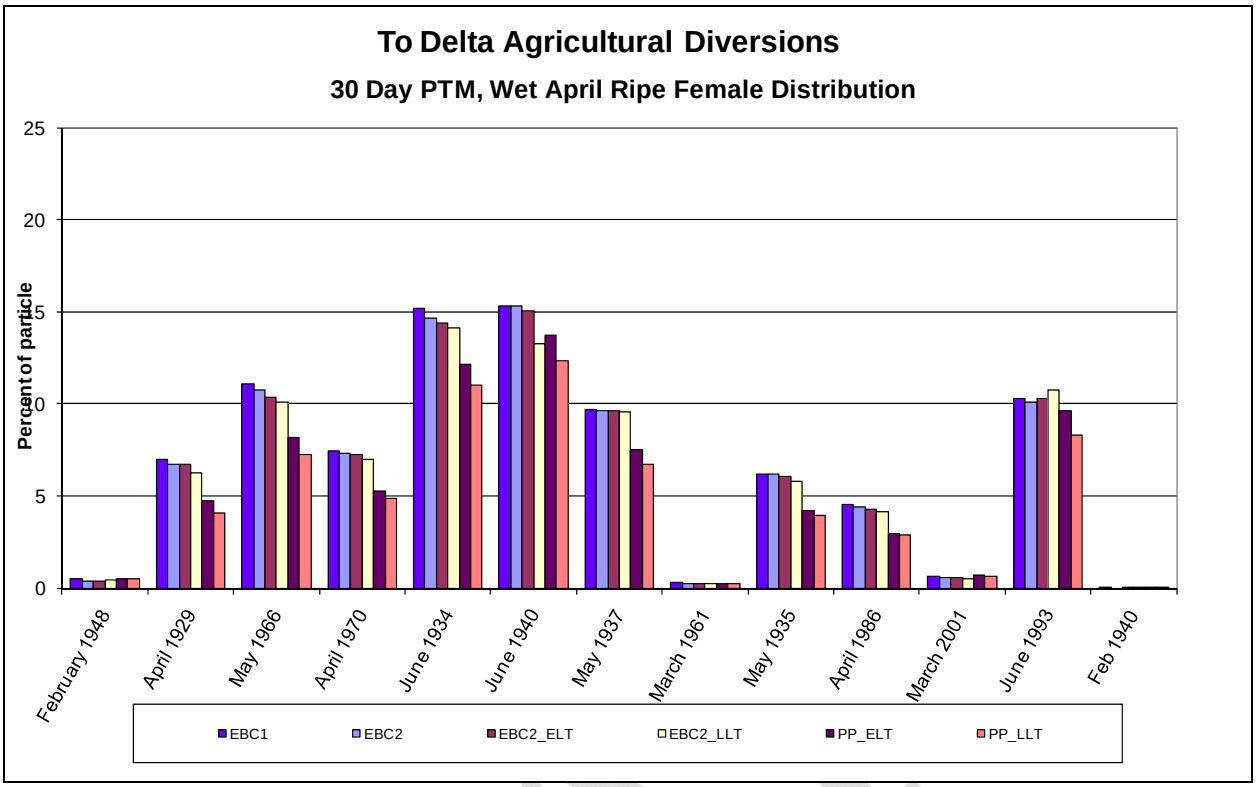


Figure B-110. Percentage of particles entrained at Delta Agricultural Diversions; Wet May All Female Distribution



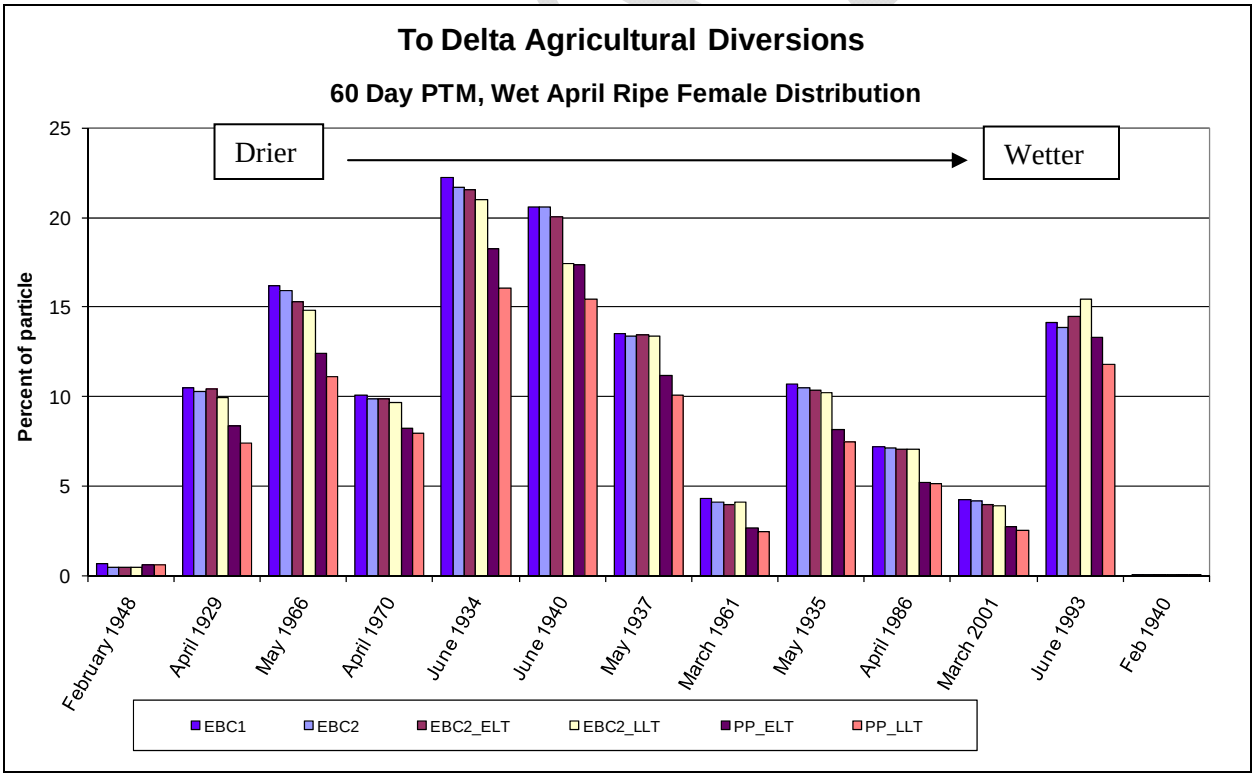
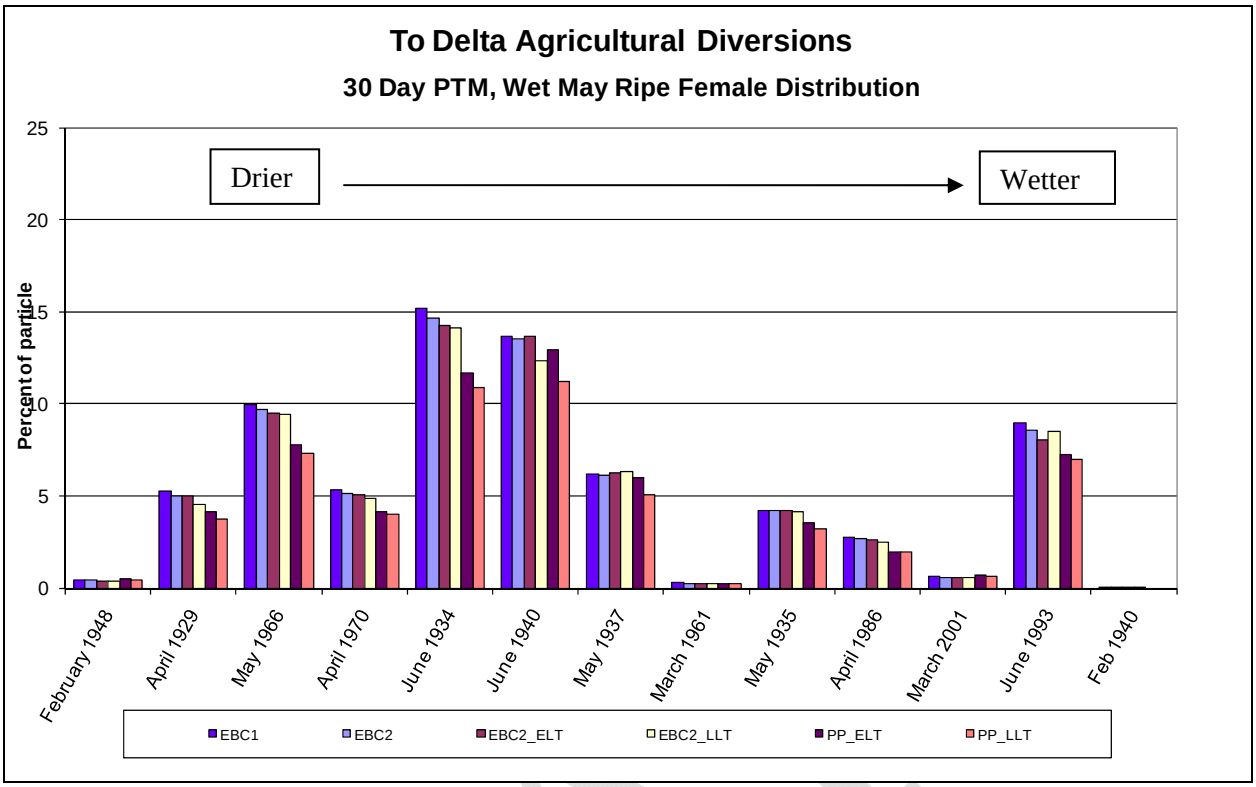


Figure B-111. Percentage of Particles Entrained at Delta Agricultural Diversions; Wet April Ripe Female Distribution



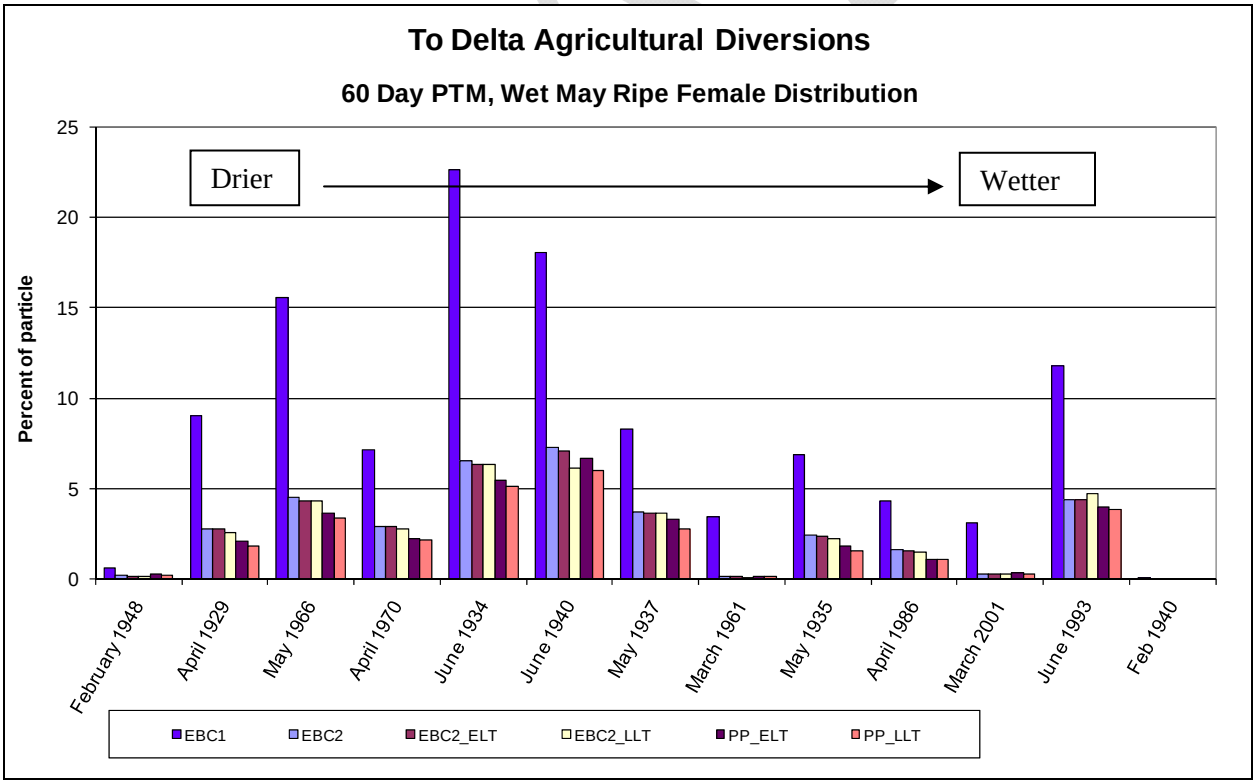


Figure B-112. Percentage of Particles Entrained at Delta Agricultural Diversions; Wet May Ripe Female Distribution

Table B-249. Average Difference[1] (Number of Runs) between Model Scenarios in Entrainment at Delta Agricultural Diversions for Particle-Tracking Runs after (A) 30 Days and (B) 60 Days

	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs. PP_LLT	EBC2_ELT vs. PP_ELT	EBC2_LLT vs. PP_LLT
(A) 30 Days, Starting Distribution						
Uniform Distribution						
Higher Entrainment	0.2 (4)	0.1 (2)	0.2 (6)	0.1 (4)	0.2 (6)	0.2 (5)
Lower Entrainment	-0.3 (9)	-0.4 (11)	-0.4 (7)	-0.5 (9)	-0.3 (7)	-0.4 (8)
Dry February All Female Distribution						
Higher Entrainment	0.0 (2)	0.0 (1)	0.0 (2)	0.0 (3)	0.0 (2)	0.0 (3)
Lower Entrainment	-0.6 (10)	-0.7 (11)	-0.5 (10)	-0.8 (9)	-0.5 (10)	-0.6 (9)
Dry April All Female Distribution						
Higher Entrainment	0.0 (3)	0.0 (1)	0.0 (3)	0.0 (4)	0.0 (4)	0.0 (4)
Lower Entrainment	-1.1 (10)	-1.3 (12)	-1.0 (10)	-1.6 (9)	-1.0 (9)	-1.2 (9)
Wet March All Female Distribution						
Higher Entrainment	0.0 (2)	0.0 (1)	0.1 (2)	0.0 (3)	0.1 (2)	0.0 (3)
Lower Entrainment	-1.1 (11)	-1.4 (12)	-1.0 (11)	-1.6 (10)	-1.0 (11)	-1.3 (10)
Wet May All Female Distribution						
Higher Entrainment	0.0 (2)	- (0)	0.0 (3)	0.0 (2)	0.0 (3)	0.0 (3)
Lower Entrainment	-0.7 (11)	-0.8 (13)	-0.7 (10)	-0.9 (11)	-0.6 (10)	-0.8 (10)
Wet April Ripe Female Distribution						
Higher Entrainment	0.0 (3)	0.0 (2)	0.1 (3)	0.0 (4)	0.1 (3)	0.1 (4)
Lower Entrainment	-1.8 (10)	-2.3 (11)	-1.7 (10)	-2.6 (9)	-1.6 (10)	-2.2 (9)
Wet May Ripe Female Distribution						
Higher Entrainment	0.0 (2)	- (0)	0.1 (3)	0.0 (2)	0.1 (3)	0.1 (3)
Lower Entrainment	-1.1 (11)	-1.3 (13)	-1.0 (10)	-1.4 (11)	-0.9 (10)	-1.2 (10)
(B) 60 Days, Starting Distribution						
Uniform Distribution						
Higher Entrainment	0.4 (4)	0.5 (3)	0.3 (6)	0.4 (4)	0.3 (5)	0.7 (4)
Lower Entrainment	-0.3 (9)	-0.4 (10)	-0.3 (7)	-0.3 (9)	-0.2 (8)	-0.3 (9)
Dry February All Female Distribution						
Higher Entrainment	- (0)	- (0)	0.0 (1)	0.0 (1)	0.0 (1)	0.0 (1)
Lower Entrainment	-0.6 (13)	-0.8 (13)	-0.7 (11)	-0.9 (11)	-0.6 (11)	-0.7 (12)
Dry April All Female Distribution						
Higher Entrainment	- (0)	- (0)	0.1 (1)	0.1 (1)	0.0 (2)	0.1 (1)
Lower Entrainment	-1.2 (13)	-1.6 (13)	-1.1 (12)	-1.6 (12)	-1.2 (11)	-1.3 (12)
Wet March All Female Distribution						
Higher Entrainment	- (0)	- (0)	0.1 (1)	0.1 (1)	0.1 (1)	0.1 (1)
Lower Entrainment	-1.3 (13)	-1.9 (13)	-1.3 (12)	-1.9 (12)	-1.3 (12)	-1.7 (12)
Wet May All Female Distribution						
Higher Entrainment	0.2 (1)	0.2 (1)	0.1 (3)	0.2 (2)	0.1 (3)	0.2 (3)
Lower Entrainment	-0.6 (12)	-0.9 (12)	-0.6 (10)	-0.9 (11)	-0.5 (10)	-0.8 (10)

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	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs. PP_LLT	EBC2_ELT vs. PP_ELT	EBC2_LLT vs. PP_LLT
Wet April Ripe Female Distribution						
Higher Entrainment	- (0)	- (0)	0.1 (1)	0.1 (1)	0.1 (2)	0.1 (2)
Lower Entrainment	-2.0 (13)	-2.8 (13)	-2.0 (12)	-2.8 (12)	-2.0 (11)	-2.7 (11)
Wet May Ripe Female Distribution						
Higher Entrainment	0.4 (2)	0.7 (1)	0.3 (4)	0.4 (2)	0.3 (3)	0.4 (3)
Lower Entrainment	-0.9 (11)	-1.3 (12)	-0.9 (9)	-1.2 (11)	-0.8 (10)	-1.2 (10)

[1] Values represent the difference in the percentage of particles reaching this destination. Negative values indicate lower entrainment under the preliminary proposal compared to the EBC.

The preliminary proposal also has the potential to reduce entrainment related to agricultural diversions through conversion of agricultural lands into tidal habitat. The preliminary proposal would restore 25,000 acres of tidal habitat in the project area in the early long-term and 65,000 acres in the late long-term. There are more than 2,600 agricultural diversions in the Plan Area (DFG Passage Assessment Database 2010). Information regarding the size and type of these diversions is spotty and inconsistent. Information regarding their operation is largely nonexistent. For the purposes of this analysis, it is assumed that all of these diversions are of similar size and operate in a similar manner, recognizing *a priori* that this assumption is an oversimplification. Based on a hypothetical restoration scenario, it is estimated that approximately 109 diversions would be removed by the early long-term and about 236 would be removed by the late long-term (Table B-250). This corresponds to 4.2 and 12.4% of the total number of diversions. Assuming that agricultural diversions cumulatively entrain about 2 to 8% of the total population (based on the PTM results presented previously), removal of these diversions as a result of the preliminary proposal would reduce overall entrainment by 0.08 to 0.34% of delta smelt larvae in the early long-term and by 0.25 to 0.99% in the late long-term.

Table B-250. Hypothetical Nonproject Diversions to Be Removed through Habitat Restoration Actions

Region	Existing Total	Number Removed	
		ELT	LLT
North	610	25	52
East	493	5	5
Central	733	23	23
South	364	0	64
Suisun	423	56	182
Total diversions	2623	109	326
Percent of diversions removed		4.2	12.4

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B.4.4.2 *Longfin Smelt (Larva)*

In addition to the analysis using PTM (see below), an analysis of delta smelt entrainment at agricultural diversions is presented in the section entitled All Covered Species (below).

B.4.4.2.1 Particle-Tracking Modeling

Entrainment of particles representing longfin smelt larvae at Delta agricultural diversions ranged from approximately 0% to over 10% (Figure B-113 and Figure B-114). In nearly all PTM runs, there was lower entrainment under PP scenarios than EBC scenarios (Table B-251; Figure B-113 and Figure B-114). The average decrease in entrainment under PP scenarios compared to EBC scenarios ranged from 2.3% to 3.5% whereas the average increase under PP scenarios was much less (0.0–0.1%).

Table B-251. Average Difference[1] (Number of Runs) in Entrainment for Model Scenarios at the Delta Agricultural Diversions for Particle-Tracking Runs after (A) 30 Days and (B) 60 Days (%)

	EBC1 vs. PP_ELT	EBC1 vs. PP_LLT	EBC2 vs. PP_ELT	EBC2 vs. PP_LLT	EBC2_ELT vs. PP_ELT	EBC2_LLT vs. PP_LLT
(A) 30 Days, Starting Distribution						
Wetter Distribution						
Higher Entrainment	0.0 (1)	0.0 (1)	0.0 (1)	0.0 (1)	0.1 (2)	0.0 (1)
Lower Entrainment	-2.3 (10)	-2.8 (10)	-2.3 (10)	-2.7 (10)	-2.8 (8)	-2.3 (10)
Drier Distribution						
Higher Entrainment	0.0 (2)	0.0 (1)	0.0 (2)	0.0 (1)	0.1 (2)	0.0 (2)
Lower Entrainment	-2.3 (9)	-2.5 (10)	-2.3 (9)	-2.4 (10)	-2.5 (8)	-2.3 (9)
(B) 60 Days, Starting Distribution						
Wetter Distribution						
Higher Entrainment	- (0)	0.0 (1)	0.0 (1)	0.0 (1)	0.1 (1)	0.0 (1)
Lower Entrainment	-3.1 (11)	-3.6 (11)	-3.4 (10)	-3.5 (11)	-3.3 (10)	-3.4 (11)
Drier Distribution						
Higher Entrainment	0.0 (1)	0.0 (1)	0.1 (1)	0.0 (1)	0.1 (1)	0.0 (2)
Lower Entrainment	-3.1 (10)	-3.2 (11)	-3.0 (10)	-3.1 (11)	-3.0 (10)	-3.3 (10)

[1] Values represent the difference in the percentage of particles reaching this destination. Negative values indicate lower entrainment under the preliminary proposal compared to the EBC.

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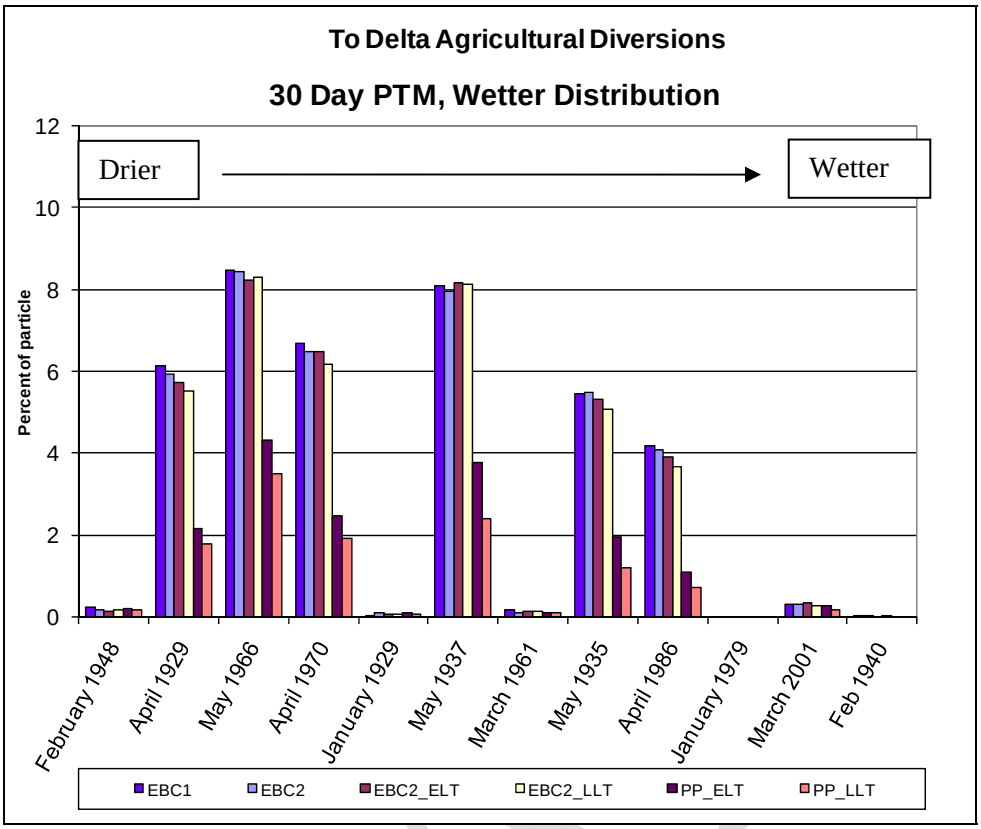


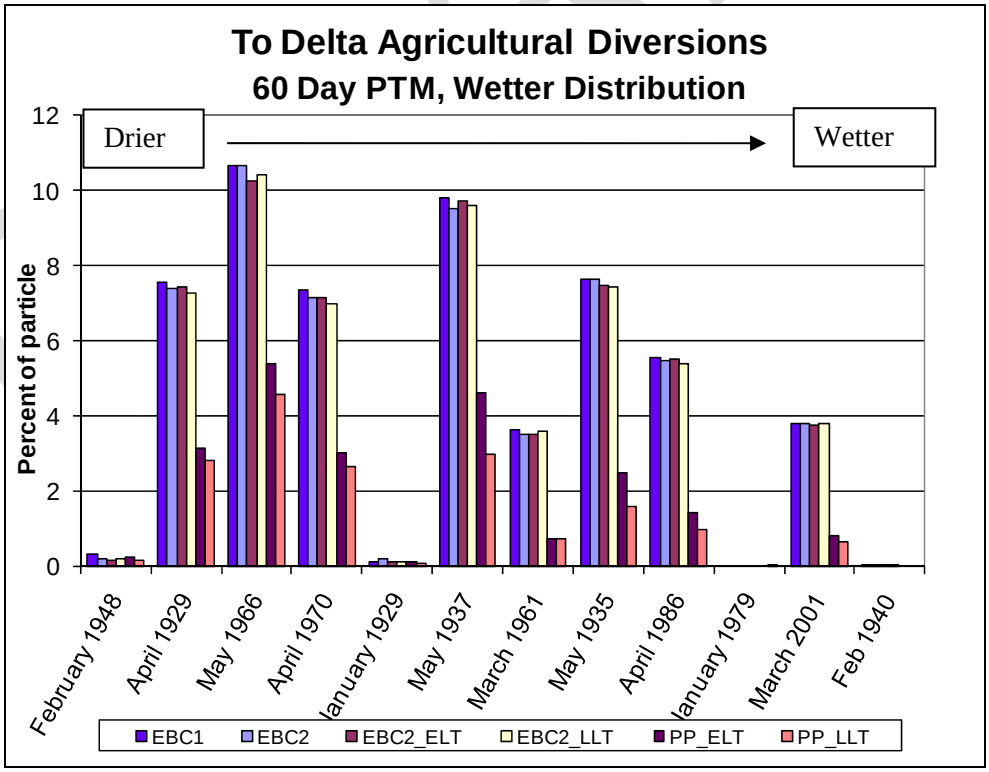
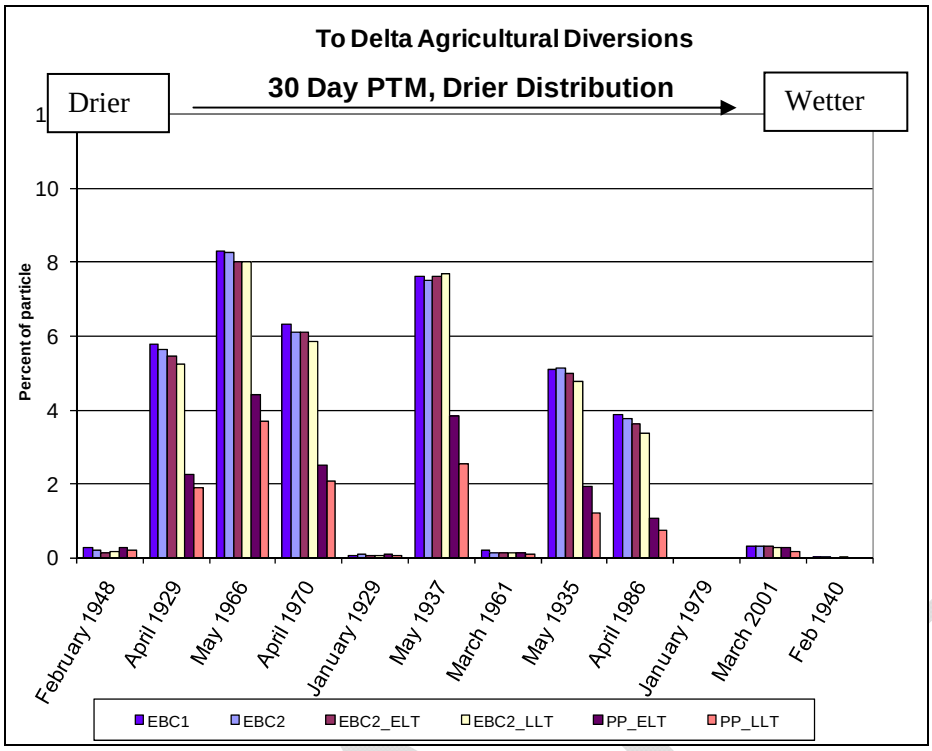


Figure B-113. Percentage of Particles Entrained at Delta Agricultural Diversions, Wetter Distribution



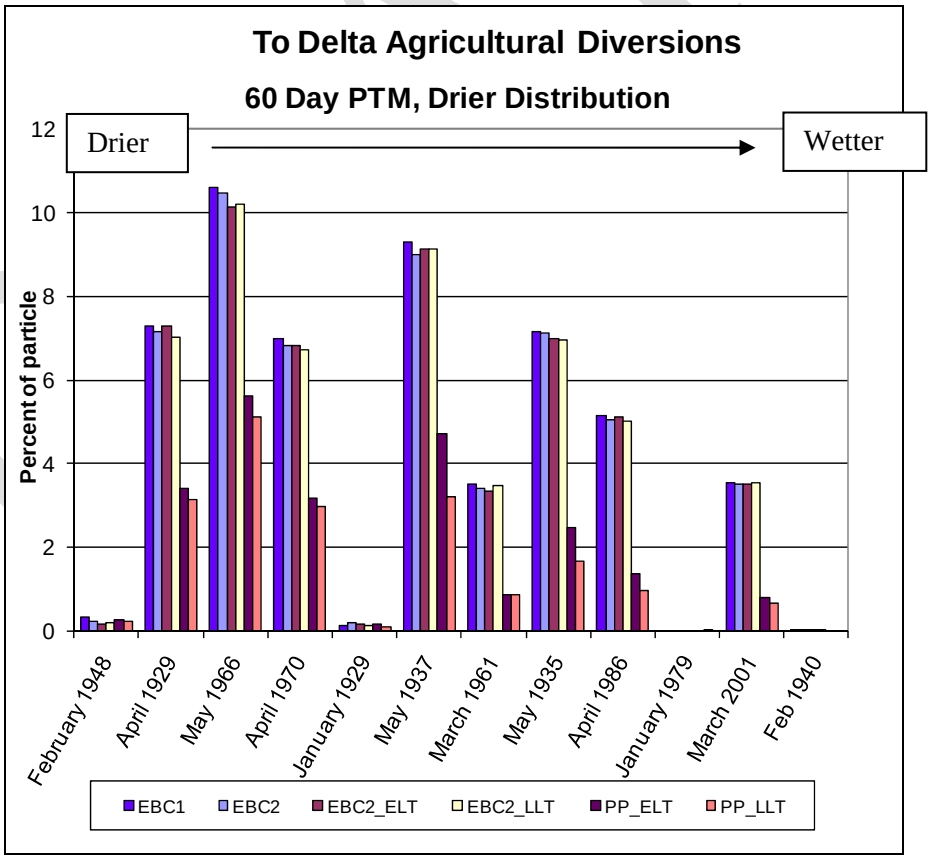


Figure B-114. Percentage of Particles Entrained at Delta Agricultural Diversions, Drier Distribution

Sensitivity analyses with 2%, 10%, and 15% of particles originating in the south Delta gave very similar results to those described above for the wetter and drier distributions (Figure B-115, Figure B-116, and Figure B-117; Table B-252).

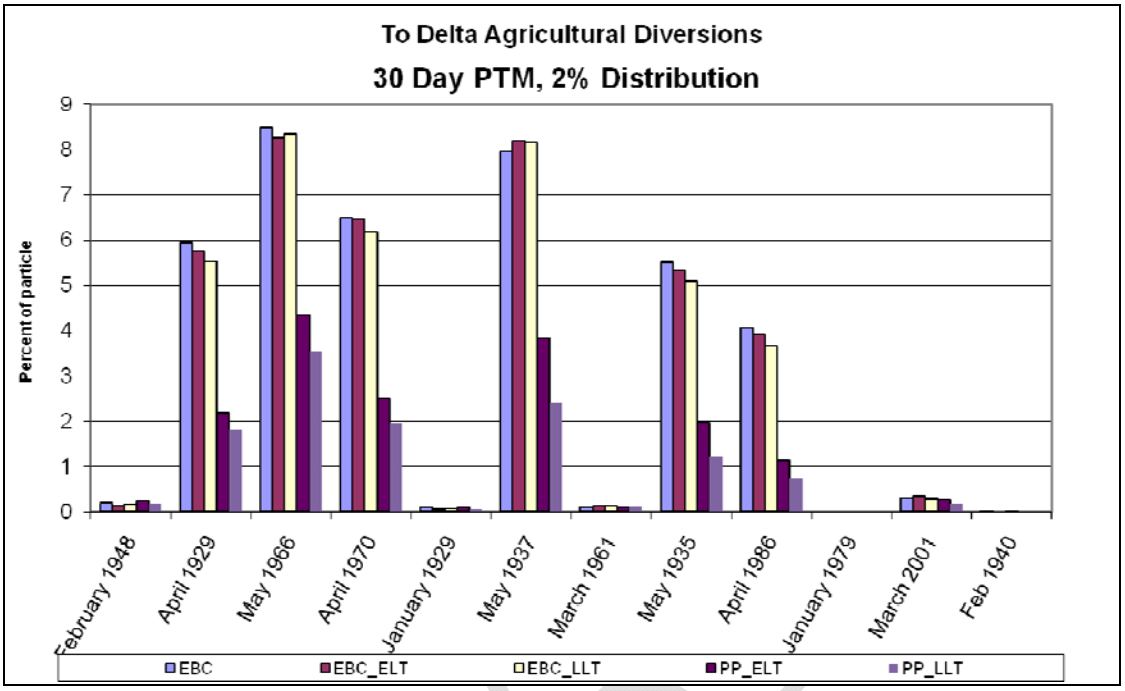


Figure B-115. Percentage of Particles Entrained at Delta Agricultural Diversions, 2% Sensitivity Distribution (Note: EBC = EBC2)

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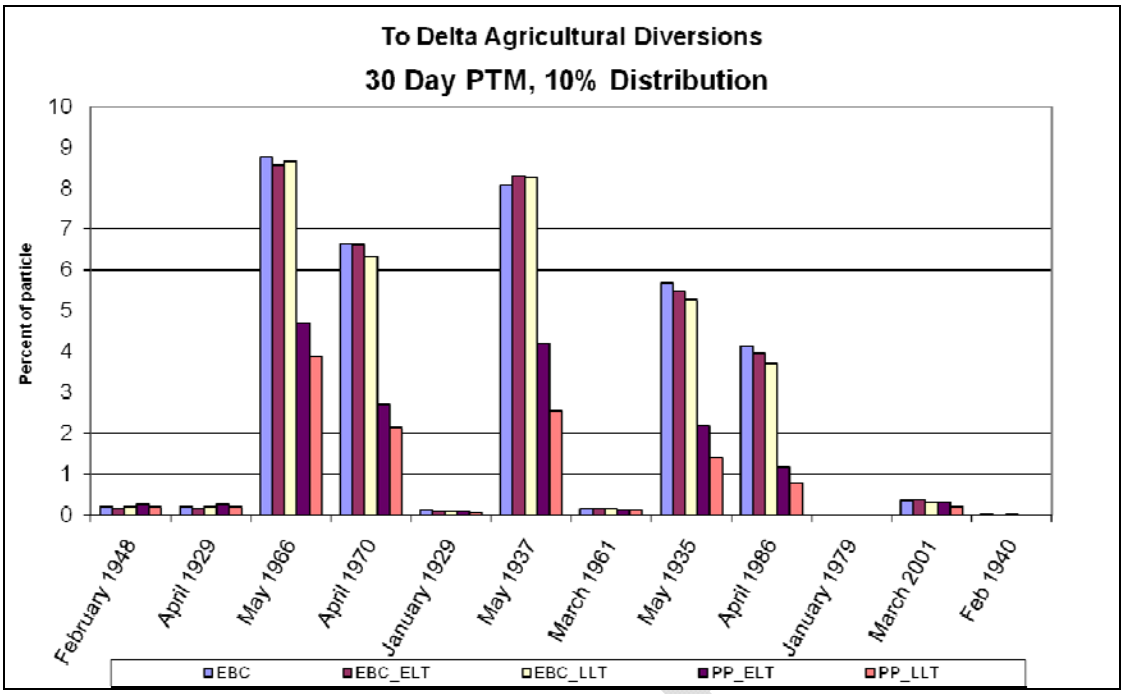

Figure B-116. Percentage of Particles Entrained at Delta Agricultural Diversions, 10% Sensitivity Distribution (Note: EBC = EBC2)

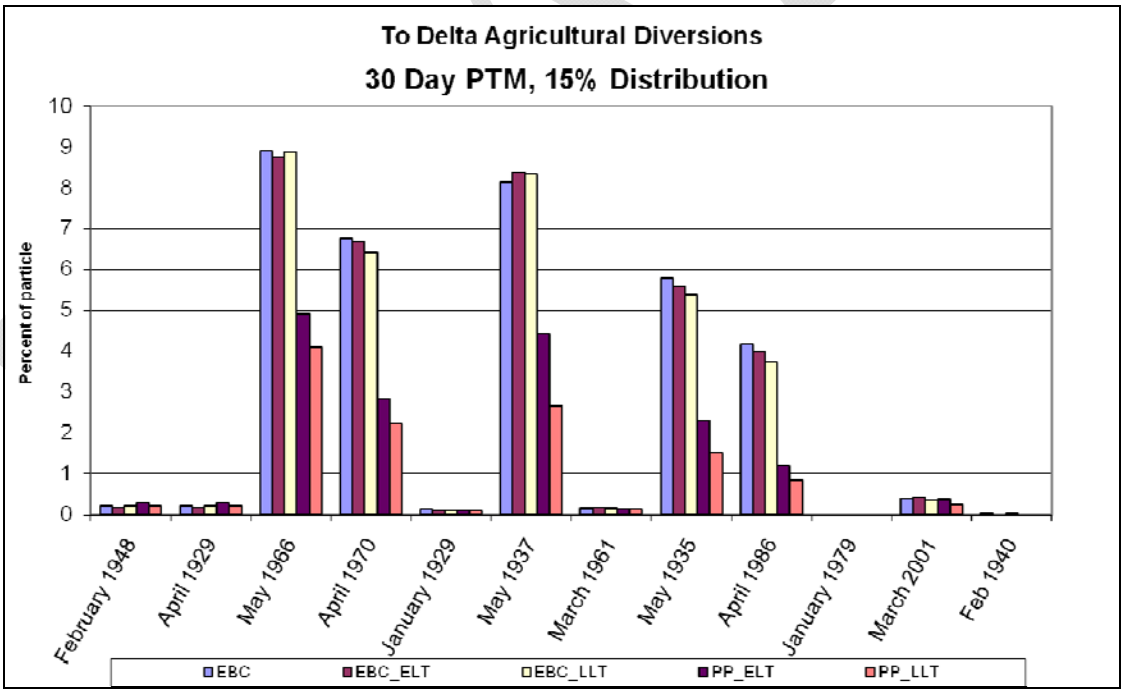

Figure B-117. Percentage of Particles Entrained at Delta Agricultural Diversions, 15% Sensitivity Distribution (Note: EBC = EBC2)

Table B-252. Average Difference between Model Scenarios in Entrainment at Delta Agricultural Diversions for Particle-Tracking Runs after 30 Days (%)

Starting Distribution	PP_ELT v. EBC2	PP_LLT v. EBC2	PP_ELT v. EBC2_ELT	PP_LLT v. EBC2_LLT
2% Distribution				
Higher Entrainment	0.0	-	0.1	-
Lower Entrainment	-2.3	-2.5	-2.8	-2.3
10% Distribution				
Higher Entrainment	0.1	-	0.1	-
Lower Entrainment	-2.0	-2.1	-2.6	-2.0
15% Distribution				
Higher Entrainment	0.1	-	0.1	-
Lower Entrainment	-2.0	-2.1	-2.6	-2.0
Values represent the difference in the percentage of particles reaching this destination. Negative values indicate lower entrainment under the preliminary proposal compared to the EBC.				

B.4.4.3 *All Covered Fish Species*

B.4.4.3.1 Delta Regional Ecosystem Restoration Implementation Plan Analysis of Nonproject Diversions

As described above in Section B.6.4.1.1 (Particle-Tracking Modeling results for larval delta smelt), it is estimated that 4.2% of agricultural diversions in the Delta could be removed by habitat restoration within ROAs in the ELT and 12.4% in the LLT. Assuming all agricultural diversions in the Delta have a similar rate of water intake, approximately 4.2%–12.4% less entrainment may occur for each covered species. It is not well known to what extent covered fish species are entrained in agricultural diversions but the available evidence suggests that it is not great (Cook and Buffaloe 1998; Nobriga et al. 2004). Therefore the 4.2–12.4% reduction in entrainment may be a reduction from an already small number. The 2009 DRERIP evaluation of the then-proposed BDCP conservation measure of modification (e.g., screening) or elimination of nonproject diversions concluded that the potential positive outcomes from this measure would be increased food availability and reduced entrainment mortality. The analysis concluded that the measure generally would be, from a fish population–level perspective, of the lowest magnitude (score = 1) and have the lowest certainty (score = 1) of achieving the outcomes (Table B-253) for all of the covered fish species (except Pacific and river lamprey, which were not analyzed but for which the results are assumed to be applicable). The only species/life stages for which this measure had a greater score than 1 were delta smelt larvae and juveniles (magnitude and certainty both equal to 2). Given that this measure was focused on selection of priority intakes (>50 cfs) that would not have been limited to ROAs, it is possible that the measure would have provided a greater decrease in entrainment than the decrease resulting from decommissioning of agricultural intakes in the ROAs. This suggests that the population-level effect attributable to decommissioning agricultural diversions in the ROAs will be minimal. However, as Vogel (2011) notes, the benefits to covered species associated with removing water diversion structures

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may be manifested more in terms of reduction in predator holding/ambush habitat (as opposed to entrainment loss), a topic treated in Appendix F.

Table B-253. Summary of 2009 DRERIP Evaluation of Positive Outcomes That Could Result from Modifying or Eliminating Nonproject Diversions in the Delta to Reduce the Entrainment of Covered Fish Species

Covered Species	Positive Outcomes Description	Magnitude*	Certainty*
Chinook salmon	Increased food availability	1	1
Chinook salmon—fry and juvenile	Reduced entrainment mortality by nonproject diversions	1	1
Delta smelt	Increased food availability	1	1
Delta smelt—larval and juvenile	Reduced entrainment mortality by nonproject diversions	2	2
Green sturgeon	Increased food availability	1	1
Green sturgeon—juvenile	Reduced entrainment mortality by nonproject diversions	1	1
Longfin smelt	Increased food availability	1	1
Longfin smelt—larval and juvenile	Reduced entrainment mortality by nonproject diversions	1	1
Splittail	Increased food availability	1	1
Splittail—juvenile	Reduced entrainment mortality by nonproject diversions	1	1
Steelhead	Increased food availability	1	1
Steelhead—fry and juvenile	Reduced entrainment mortality by nonproject diversions	1	1
White sturgeon	Increased food availability	1	1
White sturgeon—juvenile	Reduced entrainment mortality by nonproject diversions	1	1

Source: Cavallo et al. 2009b.
*Note: *Magnitude* assesses the size or level of the outcome, either positive or negative, in terms of population or habitat effects on a given species. *Certainty* describes the likelihood that a given restoration action will achieve a certain outcome. Both are ranked on a scale from 1 (lowest) to 4 (highest).

B.5 Summary and Conclusions for Effects on Entrainment

Table B-254 summarizes the results of the numerous analyses of the effects of BDCP on entrainment in the Plan Area by species and life stage. Effects are summarized for each of the five major sources of entrainment. Effects of the SWP/CVP are separated by each of five water-year types when possible (wet, above normal, below normal, dry, and critical). Estimated effects of entrainment at most of the other four sources are not differentiated by water-year type. For analyses based on limited water years (e.g., analyses using DSM2 modeled flows), summaries were calculated only for all water years. The table is based on consideration of the percentage change between baseline (EBC1, EBC2, EBC2_ELT, EBC2_LLT) and the preliminary proposal (PP_ELT and PP_LLT).

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Table B-254. Summary of Effects of BDCP on Entrainment of Covered Fish Species

Species	Life Stage	SWP/CVP South Delta Export Facilities by Water-Year Type						SWP/CVP North Delta Intakes	SWP North Bay Aqueduct Barker Slough Pumping Plant and Alternative Intake	Agricultural Diversions
		All	Wet	Above Normal	Below Normal	Dry	Critical			
Steelhead	Egg/Alevin	Occur upstream of Plan Area								
	Fry	Occur upstream of Plan Area								
	Juvenile	---	----	---	---	-/~	-/~/+	100% screened	100% screened	-/~
	Adult	Large body size/strong swimming ability make entrainment very unlikely								
Winter-run Chinook salmon	Egg/Alevin	Occur upstream of Plan Area								
	Fry	Occur upstream or otherwise included under analysis of juveniles								
	Juvenile	---/--/-/~/+	----	----/---	--	-/~	-/~	100% screened	100% screened	-/~
	Adult	Large body size/strong swimming ability make entrainment very unlikely								
Spring-run Chinook salmon	Egg/Alevin	Occur upstream of Plan Area								
	Fry	Occur upstream or otherwise included under analysis of juveniles								
	Juvenile	---/--/-/~	---	~/+	+++/++++	++/+++/++++	~/+	100% screened	100% screened	-/~
	Adult	Large body size/strong swimming ability make entrainment very unlikely								
Fall-/late fall–run Chinook salmon	Egg/Alevin	Occur upstream of Plan Area								
	Fry	Occur upstream or otherwise included under analysis of juveniles								
	Juvenile	--/-/~/+/++	---	--/-	--/-/~/+/++	-/~/+/++/+++	--/-/~/+/++	100% screened	100% screened	-/~
	Adult	Large body size/strong swimming ability make entrainment very unlikely								
Delta smelt	Egg/Embryo	Adhere to substrates and therefore minimally subject to entrainment								
	Larva[1]	--/-/~/+	----/---/--/-/~/+	--/-/~/+/++	--/-/~/+/++	---/--/-/~/+	---/--/-/~/+	Average PTM entrainment 0.2-1.6% but assumes larvae are passive particles	----/---/--/-	-/~
	Juvenile	--/-/~/+	----/---/--/-/~/+	--/-/~/+/++	--/-/~/+/++	---/--/-/~/+	---/--/-/~/+	100% screened	100% screened at >25 mm; vulnerable at < 25 mm	-/~
	Adult	----/---/--	----/---	---/--/-	--/-	-/~	-/~/+	100% screened	100% screened	-/~
Longfin smelt	Egg/Embryo	Adhere to substrates and therefore minimally subject to entrainment								
	Larva[2]	--/-	NA	---/--	-	-/~/+	-/~	No entrainment based on typical larval distribution	----/---/--/-/~/+/++/+++/++++	-/~
	Juvenile	~/+	--	++	+++/++++	+/++	-	100% screened	100% screened at >25 mm; vulnerable at < 25 mm	-/~
	Adult	---	----	---	--/-	--/-	--/-/~/+	100% screened	100% screened	-/~
Sacramento splittail	Egg/Embryo	Adhere to substrates and therefore minimally subject to entrainment								
	Larva	NA	NA	NA	NA	NA	NA	100% screened at >15 mm; vulnerable at < 15 mm	100% screened at >25 mm; vulnerable at < 25 mm	-/~
	Juvenile	----/---/--/-/~/+/++/+++/++++	----/---/--/-/~/+/++/+++/++++	-/~/+/++/+++/++++	--/-/~/+/++/+++/++++	---/--/-/~/+/++/+++/++++	---/--/-/~/+	100% screened	100% screened	-/~
	Adult	---	----	----	---/--	-/~	-/~/+	100% screened	100% screened	-/~
White sturgeon	Egg/Embryo	Adhere to substrates and therefore minimally subject to entrainment								
	Larva	Uncertain as to what extent entrainment occurs because most of the larval population is upstream of the south Delta export facilities						100% screened at >15 mm; vulnerable at < 15 mm	100% screened at >25 mm; vulnerable at < 25 mm	-/~
	Juvenile	NA	---/--		--/-			100% screened	100% screened	-/~
	Adult	Rarely entrained, presumably because of large size						100% screened	100% screened	-/~
Green sturgeon	Egg/Embryo	Occur upstream of Plan Area								
	Larva	Occur upstream of Plan Area								
	Juvenile	NA	---		-			100% screened	100% screened	-/~

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		SWP/CVP South Delta Export Facilities by Water-Year Type						SWP/CVP North Delta Intakes	SWP North Bay Aqueduct Barker Slough Pumping Plant and Alternative Intake	Agricultural Diversions
Species	**Life Stage**	**All**	**Wet**	**Above Normal**	**Below Normal**	**Dry**	**Critical**			
	Adult	Rarely entrained, presumably because of large size						100% screened	100% screened	-/~
Pacific lamprey	Egg/Embryo	Occur upstream of Plan Area								
	Ammocoete	Generally buried in the substrate upstream of the Plan Area but may be subject to entrainment if washed out of natal streams into the Plan Area (before burying into Plan Area substrates)								
	Macropthalmia	---/--	NA	NA	NA	NA	NA	100% screened	100% screened	-/~
	Adult	---/--	NA	NA	NA	NA	NA	100% screened	100% screened	-/~
River lamprey	Egg/Embryo	Occur upstream of Plan Area								
	Ammocoete	Generally buried in the substrate upstream of the Plan Area but may be subject to entrainment if washed out of natal streams into the Plan Area (before burying into Plan Area substrates)								
	Macropthalmia	---/--	NA	NA	NA	NA	NA	100% screened	100% screened	-/~
	Adult	---/--	NA	NA	NA	NA	NA	100% screened	100% screened	-/~

Note: Quantitative results generally are presented as effects because of preliminary proposal relative to baseline (existing biological conditions), with little change indicated as ~ (± ≤ 5%); reductions in entrainment indicated as - (5–25% reduction), -- (25–50% reduction), --- (50–75% reduction), and ---- (>75% reduction); and increases in entrainment indicated as + (5–25% increase), ++ (25–50% increase), +++ (50–75% increase), and ++++ (>75% increase). Results that span several categories are indicated by multiple values separated by forward slashes (/). For example different analysis techniques sometimes yielded different results. In other cases, different preliminary proposal vs. existing biological conditions comparisons gave differing estimates of entrainment.

CVP = Central Valley Project.

SWP = State Water Project.

NA = Not Analyzed.

[1]Summary for south Delta export facilities is based on proportional entrainment regressions (Kimmerer and Miller approaches; Section B.6.1.5.2) and OMR-particle entrainment regression derived from particle-tracking modeling (Section B.6.1.5.1).

[2]Summary for south Delta export facilities is based on OMR-particle entrainment regression derived from particle-tracking modeling (Section B.6.1.6.1).

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BDCP WILL SUBSTANTIALLY CHANGE THE AMOUNT AND PATTERN OF WATER EXPORTS FROM SWP/CVP FACILITIES, WHICH IS EXPECTED TO REDUCE THE NUMBER OF FISH OF ALL SPECIES ENTRAINED RELATIVE TO EXISTING BIOLOGICAL CONDITIONS

Across the five water-year types, exports from the south Delta decrease from 100% of total exports under the existing biological conditions to an average of about 58% under BDCP. The proportion of total exports that comes from the south Delta facilities under BDCP is lowest in wet water years (about 35%) and is highest in critical water years (about 84%). BDCP increases total exports over baselines during April, May, and June but does so largely by taking water from the north Delta intakes. Exports from the south Delta facilities during the spring months are generally similar or reduced relative to the existing biological conditions. With BDCP, total exports from combined north and south Delta intakes increase in the early and late long-term relative to the existing biological conditions in wet, above normal, and below normal water years. Under dry and critical water years, total exports decrease under BDCP relative to existing biological conditions. Nonetheless, overall BDCP will substantially reduce exports from the south Delta facilities in most months relative to the existing biological conditions. Entrainment is expected to be reduced most in wetter years because a greater percentage of flow will be diverted from the north Delta in wet years than in dry years.

Consistent with the general pattern of decreased south Delta exports under the preliminary proposal reducing entrainment relative to existing biological conditions, entrainment of juvenile salmonids at the south Delta export facilities also generally would be lower under BDCP compared to existing biological conditions, with differences according to species and water-year type.

Juvenile steelhead entrainment would decrease substantially overall (greater than 50% decrease across all water years), with decreases occurring mostly in wet (greater than 80%), above normal (around 60%), and below normal years (greater than 50%); entrainment of juvenile steelhead in dry and critical years generally would be similar under the preliminary proposal to existing biological conditions.

The relative decrease in juvenile winter-run Chinook salmon entrainment under the preliminary proposal compared to existing biological conditions was very similar to that for juvenile steelhead, with overall decreases of around 60% based on the salvage-density method. This reduction was attributable to considerable decreases in entrainment in wet, above normal, and below normal years but little change in dry and critical years. The Delta Passage Model suggested that there may be increases in entrainment (salvage) in some years when comparing the preliminary proposal with existing biological conditions in the late long term, but the estimated increased percentage of winter-run Chinook salmon juveniles to be salvaged under the preliminary proposal was quite low (0.01% of all individuals on average, a 12% increase relative to existing biological conditions). Estimates of the percentage of winter-run Chinook salmon salvaged at the south Delta export facilities from the Delta Passage Model were an order of magnitude lower than estimates of entrainment loss from the salvage-density method, even if a

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multiplier of 3 or 4 is applied to the Delta Passage Model results to account for entrainment losses during salvage. The results of the salvage-density method suggested entrainment losses of winter-run Chinook salmon are well below 1% in all water-year types under the preliminary proposal, albeit under a simplified assumption of a fixed number of individuals reaching the Delta each year.

Entrainment of juvenile spring-run Chinook salmon was estimated to be similar or somewhat lower under the preliminary proposal than under existing biological conditions across all water years (considering the all-year salvage-density results and the average results from the Delta Passage Model). The salvage-density results suggested that substantial decreases in entrainment in wet years under the preliminary proposal (around 60%, but with large numbers of fish) contrasted with appreciable increases in below normal (50–90%) and dry years (50–80%), albeit with lower numbers of fish estimated to be entrained in the latter year types. The estimates of the percentage of spring-run Chinook salmon juveniles entrained at the south Delta export facilities from the salvage-density method was up to 5% for the preliminary proposal and over 10% for existing biological conditions, but these percentages are probably an overestimate because the length-based classification method may classify fall-run Chinook salmon as spring-run. As with winter-run Chinook salmon, the estimates of salvage from the Delta Passage Model were considerably less than the entrainment loss estimates from the salvage-density method, even accounting for losses not included in the Delta Passage Model estimates.

The general similarity in emigration timing of juvenile fall-run Chinook salmon to spring-run Chinook salmon resulted in similar salvage-density results: overall modestly reduced entrainment losses (less than 30%) under the preliminary proposal compared to existing biological conditions that was driven largely by substantial decreases in entrainment in wet years when more export pumping shifts to the north Delta intakes. The results for late fall–run Chinook salmon suggested decreased entrainment under the preliminary proposal by 30–40% across all water years relative to existing biological conditions, with this pattern again being driven largely by considerable decreases in wet years, but the differing seasonality of emigration meant that increases in entrainment under the preliminary proposal were not generally evident in any of the water-year types. The results of the Delta Passage Model for fall-run Chinook salmon generally suggested modest differences (typically less than 30%) in entrainment between the preliminary proposal and existing biological conditions for fish originating in the Sacramento and San Joaquin watersheds. As with winter-run Chinook salmon, salvage under the preliminary proposal would be greater than under existing biological conditions (by 40%), but the overall percentage of fish lost to entrainment (0.01–0.02%) was very low. The percentage of fall-run and late fall–run Chinook salmon estimated to be lost to entrainment from the salvage density method was well below 1% for all scenarios, and the estimated salvage from the Delta Passage Model for Sacramento River–origin fish was also very low (below 0.1%). The estimated salvage of San Joaquin–origin fall-run Chinook salmon was above 1% for existing biological conditions and preliminary proposal scenarios, reflecting the greater likelihood of fish from the San Joaquin watershed reaching the south Delta export facilities than the Sacramento River–origin fish.

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ENTRAINMENT OF DELTA SMELT AT THE SOUTH DELTA EXPORT FACILITIES MAY GENERALLY DECREASE UNDER BDCP RELATIVE TO EXISTING BIOLOGICAL CONDITIONS, ALTHOUGH INSTANCES OF INCREASED ENTRAINMENT ARE ALSO POSSIBLE

In general, entrainment of delta smelt was reduced under the preliminary proposal relative to existing biological conditions, reflecting the reduced south Delta exports. Therefore the project generally maintains or enhances the low entrainment from south Delta pumping regulations assumed under the existing biological conditions. For adults, a number of different methods (salvage density, OMR regressions based on unadjusted and adjusted Kimmerer estimates of proportional entrainment, and the Manly salvage estimation technique) generally gave the same basic results: across all water years entrainment would be substantially reduced (25% to almost100%), with the magnitude of decrease being greatest in wet years (greater than 50%) ranging to little change from existing biological conditions in dry and critical years.

In addition to decreases in entrainment, results for larvae and juveniles suggested possible increases in entrainment. For juveniles, average decreases in entrainment under the preliminary proposal relative to existing biological conditions averaged around 25–40% across all water years using the salvage-density method. However, increased south Delta exports during the juvenile period in above normal years gave increased entrainment by 20–30%, for example. Application of the analyses based on Miller (2011) meant that in addition to OMR flows, the position of X2 also became important. Because X2 is positively related to proportional entrainment and can be greater (further upstream) under the preliminary proposal than existing biological conditions because of the north Delta diversions, estimates of proportional entrainment were occasionally relatively higher (e.g., by 10–30%) under the preliminary proposal than under the existing biological conditions. The estimated absolute differences were small, however, and constituted less than 0.01 (1% of the population) in most cases.

Adjustment of Kimmerer's estimates to account for potential biases described by Miller (2011) reduces the proportion of the population estimated to be entrained, in particular for adults. Thus unadjusted estimates of adult entrainment averaged up to 0.10 (10% of the population) in some water year types whereas adjusted estimates never averaged more than around 0.06 (6% of the population). The actual proportion of the population entrained may be within the range bounded by the adjusted and unadjusted estimates. Application of a different adjustment factor would change the absolute estimates of entrainment but would maintain the relative differences in entrainment between preliminary proposal and existing biological conditions.

ENTRAINMENT OF LARVAL AND ADULT LONGFIN SMELT AT THE SOUTH DELTA EXPORT FACILITIES MAY DECREASE UNDER BDCP RELATIVE TO EXISTING BIOLOGICAL CONDITIONS, WHEREAS JUVENILE ENTRAINMENT COULD REMAIN SIMILAR TO EXISTING BIOLOGICAL CONDITIONS OR SLIGHTLY INCREASE

Overall, entrainment of larval and adult longfin smelt at the south Delta export facilities may decrease under the preliminary proposal relative to existing biological conditions. Entrainment for these life stages follows a familiar pattern evident in a number of the covered species: decreases in entrainment under the preliminary proposal relative to existing biological conditions

in higher-flow years coupled with modest changes (increases or decreases) in lower-flow years. For juvenile longfin smelt, salvage has historically been higher in lower-flow years and the salvage-density approach for March–June entrainment suggested that overall entrainment loss would be similar or slightly increase (by up to 25%) under the preliminary proposal relative to existing biological conditions. Although there were considerable relative increases in entrainment (over 100% in some cases) under the preliminary proposal in below normal years, the actual numbers of fish involved were very low (single individuals). Higher numbers of entrained fish were estimated in dry water years and it was in these years that entrainment under the preliminary proposal was 14–44% higher than existing biological conditions. In critical years, there were modest decreases of 5–20% in entrainment under the preliminary proposal relative to existing biological conditions.

ENTRAINMENT OF SACRAMENTO SPLITTAIL AT THE SOUTH DELTA EXPORT FACILITIES MAY INCREASE BECAUSE IMPROVED REPRODUCTION FROM INCREASED ACCESSIBILITY TO FLOODPLAIN HABITAT WOULD INCREASE POPULATION SIZE

The two different modeling techniques for entrainment (represented by salvage) of Sacramento splittail gave opposite results. The Delta inflow method estimated substantially less salvage under the preliminary proposal compared to existing biological conditions because of reduced pumping in the south Delta under the preliminary proposal. In contrast, the Yolo Bypass days of inundation method estimated that there would be substantial increases (severalfold to an order of magnitude or more) in the number of Sacramento splittail entrained in most water-year types; this would occur because of increased accessibility to floodplain habitat for spawning and early rearing, leading to more juvenile splittail occupying the Plan Area. However, the general decrease in export pumping from the south Delta during the main May–July entrainment period for juvenile splittail would result in a lower overall proportion of the splittail population being entrained.

ENTRAINMENT OF WHITE STURGEON AND GREEN STURGEON AT THE SOUTH DELTA EXPORT FACILITIES MAY DECREASE BECAUSE OF REDUCED EXPORT PUMPING

Under the assumption that reduced export pumping in the south Delta is directly proportional to entrainment of juvenile white and green sturgeon, entrainment of these two species should decrease under the preliminary proposal relative to existing biological conditions. The decrease would be greater in wet and above normal years (40–60%) than in below normal, dry, and critical years (10–30% or less).

ENTRAINMENT OF PACIFIC LAMPREY AND RIVER LAMPREY AT THE SOUTH DELTA EXPORT FACILITIES MAY DECREASE BECAUSE OF REDUCED EXPORT PUMPING

As with white and green sturgeon, reductions in south Delta export pumping would be expected to decrease entrainment of Pacific and river lamprey macropthalmia and adults under the preliminary proposal relative to existing biological conditions. The estimated level of reduction (approximately 50%) is based solely on the assumption that proportional changes in flow lead to similar proportional changes in entrainment.

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NONPHYSICAL BARRIERS HAVE THE POTENTIAL TO REDUCE ENTRAINMENT OF SOME COVERED FISH SPECIES AT THE SWP/CVP SOUTH DELTA EXPORT FACILITIES, BUT THERE IS UNCERTAINTY BECAUSE OF HYDRODYNAMICS AND PREDATION

Nonphysical barriers at the entrances to Clifton Count Forebay (CCF) and the Delta-Mendota Canal (DMC) have the best potential to reduce entrainment of juvenile Chinook salmon and steelhead and juvenile and adult delta smelt, longfin smelt, and Sacramento splittail. There is little potential to reduce entrainment of white and green sturgeon or Pacific and river lamprey because these species have little sensitivity to the acoustic deterrence of the nonphysical barriers. The effectiveness of nonphysical barriers will depend on the water velocity characteristics in the vicinity of the barrier and on the extent to which predatory fish occur along the barrier.

SCREENING OF THE SWP/CVP NORTH DELTA INTAKES SHOULD PREVENT ENTRAINMENT AND IMPINGEMENT OF ALL BUT THE SMALLEST LIFE STAGES OF COVERED FISH SPECIES

The north Delta intakes will be screened to exclude juvenile delta smelt and are expected to be effective at excluding fish less than 15 mm long. Because this life stage of delta smelt is smaller than most life stages of all the covered fish, the screens are expected to be protective of nearly all life stages of all covered fish species. Exceptions could be smaller larvae of delta smelt, Sacramento splittail, and white sturgeon that may occur in the intake vicinity. Very little is known of the densities of these species in this area, so entrainment and impingement monitoring will determine the extent to which they occur there. The considerable along-bank length of each of the intakes necessitates monitoring (see below) that fish are indeed being excluded from entrainment and impingement in the manner that the design specifications suggest they should be.

IMPLEMENTATION OF A DUAL CONVEYANCE FOR THE SWP NORTH BAY AQUEDUCT SHOULD REDUCE ENTRAINMENT OF DELTA SMELT AND LONGFIN SMELT LARVAE

Construction of an alternative intake on the Sacramento River for the North Bay Aqueduct (NBA) will provide flexibility in operations and facilitate reduced pumping from the Barker Slough Pumping Plant in the Cache Slough Subregion, a particularly important portion of the delta smelt range. This should reduce entrainment of delta smelt larvae because delta smelt are not commonly found in the vicinity of the alternative intake. Particle-tracking modeling also showed that tidal restoration and changes in hydrodynamics could reduce larval delta smelt entrainment at the Barker Slough Pumping Plant even without implementation of a dual conveyance, as there were very few model runs with greater entrainment under preliminary proposal scenarios compared to existing biological conditions. In contrast to delta smelt, it was estimated that increased entrainment of longfin smelt larvae at the Barker Slough Pumping Plant under the preliminary proposal relative to existing biological conditions would occur as often as decreased entrainment under the preliminary proposal; however, the percentage of entrained particles was very low and would become even lower with the implementation of a dual conveyance.

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DECOMMISSIONING OF AGRICULTURAL DIVERSIONS IN BDCP RESTORATION OPPORTUNITY AREAS WILL REDUCE ENTRAINMENT OF COVERED SPECIES TO SOME SMALL DEGREE

There is no evidence of substantial entrainment of covered fish species at agricultural diversions in the Plan Area, but some entrainment likely is occurring. Whatever entrainment is occurring would be reduced by decommissioning agricultural diversions in the BDCP Restoration Opportunity Areas (ROAs). Particle-tracking modeling and extrapolations to a hypothetical number of diversions to be removed from the ROAs (i.e., around 4–12% of diversions) gave estimates of up to a 1% reduction in overall loss of delta smelt larvae because of such decommissioning. This reduction is uncertain because particle tracking is not necessarily an accurate representation of smelt larval behavior in relation to agricultural intakes. Greater benefits to smelt and other covered species associated with removing water diversion structures may occur from the reduction of predator holding habitat (see Appendix F) than from reductions in entrainment.

ESTIMATES OF ENTRAINMENT CHANGES UNDER BDCP ARE UNCERTAIN, BUT ENTRAINMENT IS READILY MONITORED

There is uncertainty when estimating the effects of pumping changes that may result under the preliminary proposal, beyond the general observation that entrainment should decrease as pumping decreases. An example is the uncertainty of whether the relationship between pumping and entrainment is linear or non-linear. However, fish losses at water diversions are readily monitored. Entrainment (and impingement) sampling programs already exist, and others will be developed as part of the BDCP implementation in order to allow monitoring of the preliminary proposal, with particular emphasis on:

- Continued salvage and entrainment monitoring at the SWP/CVP south Delta export facilities.
- Entrainment and impingement monitoring at the new SWP/CVP north Delta intakes.
- Entrainment and impingement monitoring at the SWP NBA Barker Slough Pumping Plant and Alternative Intake on the Sacramento River.

Continued entrainment monitoring into the future will be of particular importance, given the likely changes in species distribution caused by large-scale habitat changes. For example, species such as longfin smelt may spawn farther upstream as sea level rises.

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B.6.1 Personal Communications

Turnpenny, Andrew. Director. Turnpenny Horsfield Associates Ltd. Southampton, UK. July 20, 2011—email to Marin Greenwood, Aquatic Ecologist, ICF International, Sacramento, CA.

Greene, Sheila. TITLE. California Department of Fish and Game. DATE—TYPE OF COMMUNICATION to/with NAME, TITLE, SAIC, CITY, STATE. – pers comm from Sheila to SAIC (Rick Wilder to provide details).

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