Appendix 12G
Smelt Analysis

Line items and numbers identified or noted as “No Action Alternative” represent the “Existing Conditions/No Project/No Action Condition” (described in Chapter 2 Alternatives Analysis). Table numbering may not be consecutive for all appendixes.

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APPENDIX 12G
Smelt Analysis

12G.1 Overview

This appendix describes the approach used to compute Delta Smelt Entrainment in Banks and Jones pumping plants, Delta Smelt Habitat and Longfin Smelt Abundance in the Delta, for analysis of the Sites Reservoir Project (Project) action alternatives (alternatives) for the Draft Environmental Impact Report/Environmental Impact Statement (DEIR/EIS). It includes a summary of the methodology and results used in the detailed evaluation of the alternatives. Results were used or referenced in Chapter 12 Aquatic Biological Resources. The fisheries impact assessment and methodology is described in Chapter 12 Aquatic Biological Resources and in Appendix 12B Fisheries Impact Assessment Methodology and Appendix 12C Fisheries Impact Summary.

12G.1.1 Introduction

The analytical framework used to evaluate the alternatives is summarized in Chapter 5 Guide to the Resource Analyses and Appendix 6B Water Resources System Modeling. Assumptions used in modeling the alternatives are summarized in Appendix 6A Modeling of Alternatives. The methodologies described provide an approach to quantify the entrainment of Migrating and Spawning Adult Delta Smelt and Juvenile Delta Smelt in Banks and Jones pumping plants, Delta Smelt Habitat and Longfin Smelt abundance in the Delta. In evaluating the alternatives, entrainment of Juvenile and Adult Delta Smelt is presented as a percentage of the annual population that is entrained in the pumps, Delta Smelt Habitat is presented as the location of Fall X2, and Longfin Smelt Abundance is presented as an index value described below.

12G.1.2 Delta Smelt Entrainment

12G.1.2.1 Methodology for Migrating and Spawning Adults (December-March)

The entrainment of migrating and spawning adult Delta Smelt is primarily affected by the combined OMR flow in December through March. Water exported at the Banks and Jones pumping plants typically flows through the Old and Middle River channels. A positive OMR flow indicates a northward flow in the natural direction, toward the San Francisco Bay, and contributing to the Delta outflow. A negative OMR flow indicates a southward flow induced by pumping, and away from the Delta outflow.

In order to simulate Delta Smelt entrainment as influenced by OMR flow, the U.S. Fish and Wildlife Service (2008) developed a regression model based on Kimmerer (2008) which is subject to uncertainty and scientific dispute (Kimmerer 2011; Miller 2011) and are being revisited in the Collaborative Science and Adaptive Management Program (CSAMP) process. The equation developed by Kimmerer (2008) is based on the average December through March OMR flow (in units of cubic feet per second [cfs]) and yields the percentage of adult Delta Smelt that may become entrained in the pumps. The equation is:

*Adult entrainment loss [percentage] = 6.243 - 0.000957 * OMR Flow*
(average OMR from December through March)

Kimmerer's (2008) original estimates of entrainment loss had large confidence limits, which Kimmerer (2008) noted could be reduced by additional sampling. Miller (2011) assessed the explicit and implicit assumptions of Kimmerer's estimation methods and found that of eight assumptions, there were three that may have biased the estimates of adult proportional entrainment upward and one that may have biased the estimates downward. Miller (2011) suggested methodological adjustments for three of the four assumptions that could have resulted in biased estimates of adult proportional entrainment. In response, Kimmerer (2011) determined that the above equation has an upward bias due to one assumption, but rejected the other adjustments suggested by Miller (2011). To correct this bias, the result from the above equation for adult proportional entrainment was reduced by 24 percent. In the event that a negative entrainment percentage was calculated, the result was changed to zero.

12G.1.2.2 Methodology for Larvae and Early Juveniles (March-June)

Larvae and early juvenile smelt are most prevalent in the Delta in the spring months of March through June. The U.S. Fish and Wildlife Service (2008) developed a regression model based on Kimmerer (2008) to calculate the percentage entrainment of larval and early juvenile Delta Smelt in South Delta pumping facilities. This regression is dependent on two variables: March through June average OMR flow, and March through June average X2:

*Larvae and early juvenile entrainment loss [percentage] = [0.00933 * X2 (March through June) - 0.0000207 * OMR Flow (March through June) - 0.556] * 100*

Similar to described above for adult entrainment, Miller (2011) suggested that of 10 assumptions made by Kimmerer (2008), eight would have resulted in upward bias and two would not have resulted in bias, but could provide a quantitative adjustment for only one of the assumptions resulting in bias. Subsequent review by Kimmerer (2011) rejected this adjustment such that the above equation for larval and early juvenile entrainment was used without adjustment. In the event that a negative entrainment percentage was calculated, the result was changed to zero. OMR and X2 values simulated in the CalSim II model for each alternative were used in estimating the entrainment loss. The X2 variable used in the calculation and the calculation below was specific to the Project CalSim II models.

12G.1.3 Delta Smelt Fall Abiotic Habitat Index

Feyrer et al. (2010) demonstrated that Delta Smelt abiotic habitat availability in the fall in the West Delta, Suisun Bay, and Suisun Marsh subregions, as well as smaller portions of the Cache Slough, South Delta, and North Delta subregions, is correlated with X2 location. Feyrer et al. (2010) used X2 as an indicator of the suitable salinity and water transparency for rearing older juvenile Delta Smelt. Feyrer et al. (2010) concluded that when X2 is located downstream (west) of the confluence of the Sacramento and San Joaquin Rivers, at a distance of 70 to 80 km from the Golden Gate Bridge, there is a larger area of suitable habitat. The overlap of the low salinity zone (or X2) with the Suisun Bay/Marsh results in a dramatic increase in the habitat index (Feyrer et al., 2010); however, others (see Manly et al., 2015) have questioned the use of outflow and X2 location as an indicator of Delta Smelt habitat because other factors may be influencing survival.

In evaluating the fall abiotic habitat availability for Delta Smelt under the alternatives, average September through December X2 position in kilometers was used. X2 values simulated in the CalSim II model for each alternative were averaged over September through December, and compared for the expected changes.

12G.1.4 Longfin Smelt Abundance

Kimmerer et al. (2009) correlated log-transformed Longfin Smelt abundance based on the Fall Midwater Trawl (FMWT) data with the winter and spring location of X2. The correlation is based on the following regression equation:

*Longfin Smelt abundance index value = 10 ^ [-0.05 * (January through June X2 average position) + 7]*

The equation is based on the assumption that a lower X2 value indicates higher flows transporting longfin farther downstream, which would lead to greater longfin smelt survival. The index value indicates the relative abundance of the Longfin Smelt and not the calculated population.

12G.2 Results

This section includes the results of the Smelt Analysis for the alternatives evaluated in the DEIR/EIS. The fisheries impact assessment and methodology is described in Chapter 12 Aquatic Biological Resources and in Appendix 12B Fisheries Impact Assessment Methodology and Appendix 12C Fisheries Impact Summary.

12G.2.1 Introduction

Modeling results are presented in tabular format for delta smelt entrainment, September – December X2, and longfin smelt abundance. The delta smelt results show the percent entrainment for long-term average and for each water year type (SWRCB D-1641 40-30-30 Index). Results are provided together for the migrating and spawning adults, and for the larvae and early juveniles. Long-term average fall X2 (average Sep – Dec) and average for each water year type, in KM are presented separately. The longfin smelt abundance tables provide the abundance index value for long-term average and for each water year type for the different alternatives.

12G.2.2 Comparisons

Summary tables of the different Smelt Analyses are provided for the following comparisons:

- Alternative A compared to No Action Alternative
- Alternative B compared to No Action Alternative
- Alternative C compared to No Action Alternative
- Alternative D compared to No Action Alternative

12G.3 References

Feyrer, F., K. Newman, M. Nobriga, and T. Sommer. 2010. "Modeling the Effects of Future Outflow on the Abiotic Habitat of an Imperiled Estuarine Fish." *Estuaries and Coasts* 34:120–128.

Kimmerer, W. J. 2008. "Losses of Sacramento River Chinook Salmon and Delta Smelt to Entrainment in Water Diversions in the Sacramento-San Joaquin Delta." *San Francisco Estuary and Watershed Science* 6(2), 29.

Kimmerer, W. J., E. S. Gross, and M. L. MacWilliams. 2009. "Is the Response of Estuarine Nekton to Freshwater Flow in the San Francisco Estuary Explained by Variation in Habitat Volume?" *Coastal and Estuarine Research Federation, 2009*.

Kimmerer, W. J. 2011. "Modeling Delta Smelt Losses at the South Delta Export Facilities." *San Francisco Estuary and Watershed Science* 9(1).

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Miller, W. J. 2011. "Revisiting Assumptions that Underlie Estimates of Proportional Entrainment of Delta Smelt by State and Federal Water Diversions from the Sacramento-San Joaquin Delta." *San Francisco Estuary and Watershed Science* 9(1).

U.S. Fish and Wildlife Service (USFWS). 2008. Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the Central Valley Project (CVP) and State Water Project (SWP). Sacramento, CA.

Appendix 12G
Delta Smelt and Longfin Smelt Analyses Results

Line items and numbers identified or noted as “No Action Alternative” represent the “Existing Conditions/No Project/No Action Condition” (described in Chapter 2 Alternatives Analysis). Table numbering may not be consecutive for all appendixes.

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Alternative A Compared to No Action Alternative

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Table AQ-12-3a

Delta Smelt Entrainment

Long-term Average and Average by Water Year Type

Analysis Period	Percent Entrainment by Lifestage: Juvenile	Percent Entrainment by Lifestage: Adult
Long-term		
Full Simulation Period[1]		
No Action Alternative	10.8	7.7
Alternative A	11.0	7.8
Difference	0.2	0.0
Water Year Types[2]		
Wet (32%)		
No Action Alternative	3.2	7.1
Alternative A	3.2	8.1
Difference	0.0	1.0
Above Normal (15%)		
No Action Alternative	6.3	8.1
Alternative A	6.4	8.1
Difference	0.1	0.0
Below Normal (17%)		
No Action Alternative	11.7	8.2
Alternative A	12.1	8.3
Difference	0.3	0.0
Dry (22%)		
No Action Alternative	16.4	8.2
Alternative A	16.7	8.3
Difference	0.4	0.1
Critical (15%)		
No Action Alternative	22.7	7.5
Alternative A	22.9	7.6
Difference	0.2	0.1

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

Table AQ-12-3b

Fall Abiotic Habitat Availability

Long-term Average and Average by Water Year Type

	Sep-Dec Average X2 (KM)
	Long-term
Full Simulation Period[1]	
No Action Alternative	81.6
Alternative A	81.2
Difference	-0.4
Water Year Types[2]	
Wet (32%)	
No Action Alternative	72.8
Alternative A	73.0
Difference	0.2
Above Normal (15%)	
No Action Alternative	78.5
Alternative A	78.5
Difference	0.0
Below Normal (17%)	
No Action Alternative	84.9
Alternative A	83.6
Difference	-1.3
Dry (22%)	
No Action Alternative	87.1
Alternative A	86.5
Difference	-0.6
Critical (15%)	
No Action Alternative	91.2
Alternative A	91.0
Difference	-0.3

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

Table AQ-12-3c

Longfin Smelt Abundance in the Delta

Long-term Average and Average by Water Year Type

	Long-fin Smelt Abundance Index
	Long-term
Full Simulation Period[1]	
No Action Alternative	8,749.1
Alternative A	8,539.1
Difference	-210.1
Percent Difference	0.0
Water Year Types[2]	
Wet (32%)	
No Action Alternative	18,613.5
Alternative A	18,437.6
Difference	-175.9
Percent Difference	0.0
Above Normal (15%)	
No Action Alternative	9,856.1
Alternative A	9,497.1
Difference	-359.1
Percent Difference	0.0
Below Normal (17%)	
No Action Alternative	4,341.1
Alternative A	4,052.4
Difference	-288.6
Percent Difference	-0.1
Dry (22%)	
No Action Alternative	2,303.2
Alternative A	2,124.0
Difference	-179.2
Percent Difference	-0.1
Critical (15%)	
No Action Alternative	1,081.2
Alternative A	991.3
Difference	-89.9
Percent Difference	-0.1

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

3 Relative difference of the annual average

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Alternative B Compared to No Action Alternative

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Table AQ-12-5a

Delta Smelt Entrainment

Long-term Average and Average by Water Year Type

Analysis Period	Percent Entrainment by Lifestage Juvenile	Adult
Long-term		
Full Simulation Period[1]		
No Action Alternative	10.8	7.7
Alternative B	11.0	7.8
Difference	0.2	0.0
Water Year Types[2]		
Wet (32%)		
No Action Alternative	3.2	7.1
Alternative B	3.2	7.1
Difference	0.1	0.0
Above Normal (15%)		
No Action Alternative	6.3	8.1
Alternative B	6.5	8.1
Difference	0.2	0.0
Below Normal (17%)		
No Action Alternative	11.7	8.2
Alternative B	12.2	8.2
Difference	0.5	-0.1
Dry (22%)		
No Action Alternative	16.4	8.2
Alternative B	16.7	8.3
Difference	0.3	0.1
Critical (15%)		
No Action Alternative	22.7	7.5
Alternative B	22.7	7.7
Difference	0.0	0.2

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

Table AQ-12-5b

Fall Abiotic Habitat Availability

Long-term Average and Average by Water Year Type

	Sep-Dec Average X2 (KM)
Long-term	
Full Simulation Period[1]	
No Action Alternative	81.6
Alternative B	81.1
Difference	-0.5
Water Year Types[2]	
Wet (32%)	
No Action Alternative	72.8
Alternative B	72.9
Difference	0.1
Above Normal (15%)	
No Action Alternative	78.5
Alternative B	78.3
Difference	-0.1
Below Normal (17%)	
No Action Alternative	84.9
Alternative B	83.6
Difference	-1.3
Dry (22%)	
No Action Alternative	87.1
Alternative B	86.4
Difference	-0.8
Critical (15%)	
No Action Alternative	91.2
Alternative B	90.7
Difference	-0.5

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

Table AQ-12-5c

Longfin Smelt Abundance in the Delta

Long-term Average and Average by Water Year Type

Long-fin Smelt Abundance Index	
	Long-term
Full Simulation Period[1]	
No Action Alternative	8,749.1
Alternative B	8,504.4
Difference	-244.8
Percent Difference	0.0
Water Year Types[2]	
Wet (32%)	
No Action Alternative	18,613.5
Alternative B	18,278.3
Difference	-335.2
Percent Difference	0.0
Above Normal (15%)	
No Action Alternative	9,856.1
Alternative B	9,429.1
Difference	-427.0
Percent Difference	0.0
Below Normal (17%)	
No Action Alternative	4,341.1
Alternative B	4,101.8
Difference	-239.3
Percent Difference	-0.1
Dry (22%)	
No Action Alternative	2,303.2
Alternative B	2,179.9
Difference	-123.3
Percent Difference	-0.1
Critical (15%)	
No Action Alternative	1,081.2
Alternative B	1,026.0
Difference	-55.2
Percent Difference	-0.1

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

3 Relative difference of the annual average

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Alternative C Compared to No Action Alternative

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Table AQ-12-7a

Delta Smelt Entrainment

Long-term Average and Average by Water Year Type

Analysis Period	Percent Entrainment by Lifestage: Juvenile	Adult
Long-term		
Full Simulation Period[1]		
No Action Alternative	10.8	7.7
Alternative C	11.1	7.8
Difference	0.2	0.0
Water Year Types[2]		
Wet (32%)		
No Action Alternative	3.2	7.1
Alternative C	3.2	7.1
Difference	0.0	0.0
Above Normal (15%)		
No Action Alternative	6.3	8.1
Alternative C	6.4	8.1
Difference	0.1	0.0
Below Normal (17%)		
No Action Alternative	11.7	8.2
Alternative C	12.1	8.2
Difference	0.4	0.0
Dry (22%)		
No Action Alternative	16.4	8.2
Alternative C	16.8	8.3
Difference	0.5	0.1
Critical (15%)		
No Action Alternative	22.7	7.5
Alternative C	23.0	7.7
Difference	0.3	0.2

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

Table AQ-12-7b

Fall Abiotic Habitat Availability

Long-term Average and Average by Water Year Type

	Sep-Dec Average X2 (KM)
	Long-term
Full Simulation Period[1]	
No Action Alternative	81.6
Alternative C	81.0
Difference	-0.6
Water Year Types[2]	
Wet (32%)	
No Action Alternative	72.8
Alternative C	73.0
Difference	0.2
Above Normal (15%)	
No Action Alternative	78.5
Alternative C	78.5
Difference	0.0
Below Normal (17%)	
No Action Alternative	84.9
Alternative C	83.3
Difference	-1.6
Dry (22%)	
No Action Alternative	87.1
Alternative C	86.0
Difference	-1.1
Critical (15%)	
No Action Alternative	91.2
Alternative C	90.7
Difference	-0.5

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

Table AQ-12-7c

Longfin Smelt Abundance in the Delta

Long-term Average and Average by Water Year Type

	Long-fin Smelt Abundance Index
	Long-term
Full Simulation Period[1]	
No Action Alternative	8,749.1
Alternative C	8,468.3
Difference	-280.9
Percent Difference	0.0
Water Year Types[2]	
Wet (32%)	
No Action Alternative	18,613.5
Alternative C	18,328.8
Difference	-284.6
Percent Difference	0.0
Above Normal (15%)	
No Action Alternative	9,856.1
Alternative C	9,335.8
Difference	-520.3
Percent Difference	-0.1
Below Normal (17%)	
No Action Alternative	4,341.1
Alternative C	4,012.3
Difference	-328.8
Percent Difference	-0.1
Dry (22%)	
No Action Alternative	2,303.2
Alternative C	2,097.3
Difference	-205.9
Percent Difference	-0.1
Critical (15%)	
No Action Alternative	1,081.2
Alternative C	991.5
Difference	-89.7
Percent Difference	-0.1

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

3 Relative difference of the annual average

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Alternative D Compared to No Action Alternative

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Table AQ-12-9a

Delta Smelt Entrainment

Long-term Average and Average by Water Year Type

Analysis Period	Percent Entrainment by Lifestage Juvenile	Adult
Long-term		
Full Simulation Period[1]		
No Action Alternative	10.8	7.7
Alternative D	11.0	7.8
Difference	0.2	0.0
Water Year Types[2]		
Wet (32%)		
No Action Alternative	3.2	7.1
Alternative D	3.2	7.1
Difference	0.0	0.0
Above Normal (15%)		
No Action Alternative	6.3	8.1
Alternative D	6.4	8.1
Difference	0.1	0.0
Below Normal (17%)		
No Action Alternative	11.7	8.2
Alternative D	12.1	8.2
Difference	0.4	0.0
Dry (22%)		
No Action Alternative	16.4	8.2
Alternative D	16.8	8.3
Difference	0.4	0.0
Critical (15%)		
No Action Alternative	22.7	7.5
Alternative D	22.9	7.6
Difference	0.2	0.1

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

Table AQ-12-9b

Fall Abiotic Habitat Availability

Long-term Average and Average by Water Year Type

	Sep-Dec Average X2 (KM)
Long-term	
Full Simulation Period[1]	
No Action Alternative	81.6
Alternative D	81.4
Difference	-0.2
Water Year Types[2]	
Wet (32%)	
No Action Alternative	72.8
Alternative D	73.0
Difference	0.2
Above Normal (15%)	
No Action Alternative	78.5
Alternative D	78.5
Difference	0.0
Below Normal (17%)	
No Action Alternative	84.9
Alternative D	84.1
Difference	-0.8
Dry (22%)	
No Action Alternative	87.1
Alternative D	86.7
Difference	-0.4
Critical (15%)	
No Action Alternative	91.2
Alternative D	91.2
Difference	0.0

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

Table AQ-12-9c

Longfin Smelt Abundance in the Delta

Long-term Average and Average by Water Year Type

Long-fin Smelt Abundance Index	
Long-term	
Full Simulation Period[1]	
No Action Alternative	8,749.1
Alternative D	8,484.1
Difference	-265.0
Percent Difference	0.0
Water Year Types[2]	
Wet (32%)	
No Action Alternative	18,613.5
Alternative D	18,344.0
Difference	-269.4
Percent Difference	0.0
Above Normal (15%)	
No Action Alternative	9,856.1
Alternative D	9,379.2
Difference	-476.9
Percent Difference	0.0
Below Normal (17%)	
No Action Alternative	4,341.1
Alternative D	4,026.2
Difference	-314.8
Percent Difference	-0.1
Dry (22%)	
No Action Alternative	2,303.2
Alternative D	2,111.8
Difference	-191.3
Percent Difference	-0.1
Critical (15%)	
No Action Alternative	1,081.2
Alternative D	985.1
Difference	-96.1
Percent Difference	-0.1

1 Based on the 82-year simulation period

2 As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999)

3 Relative difference of the annual average

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