Longfin Smelt Analyses

Marin Greenwood
ICF

Longfin Smelt Analyses

Overview of *4.2 Take of Longfin Smelt*

- Construction Effects
- Maintenance Effects
- Operations Effects
- Mitigation Measure Effects
- Monitoring Effects
- Take Analysis
- Analysis of Potential for Jeopardy

Longfin Smelt Analyses

4.2.3 Operations Effects

- *4.2.3.1 Delta Outflow/X2 Effects*
  - X2-Relative Abundance GLM (App. 4.A, Section 4.A.1)
  - Update of Mount et al. (2013), including 1967-2014

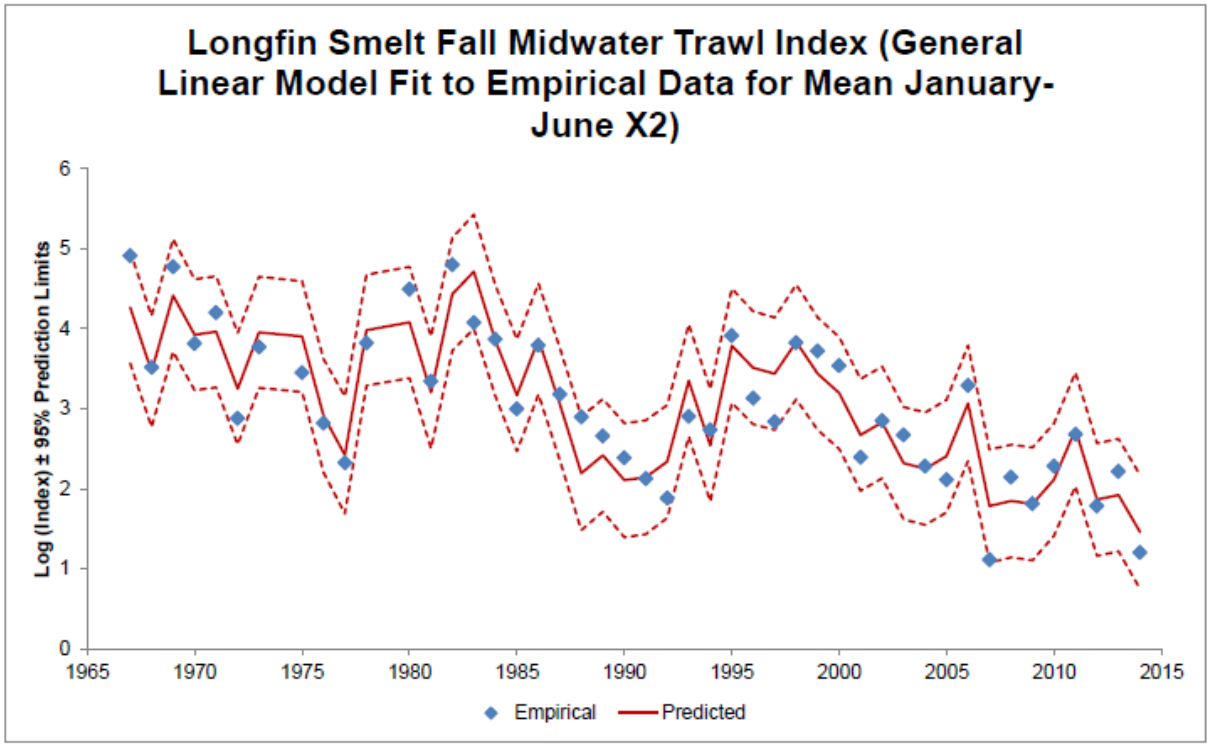
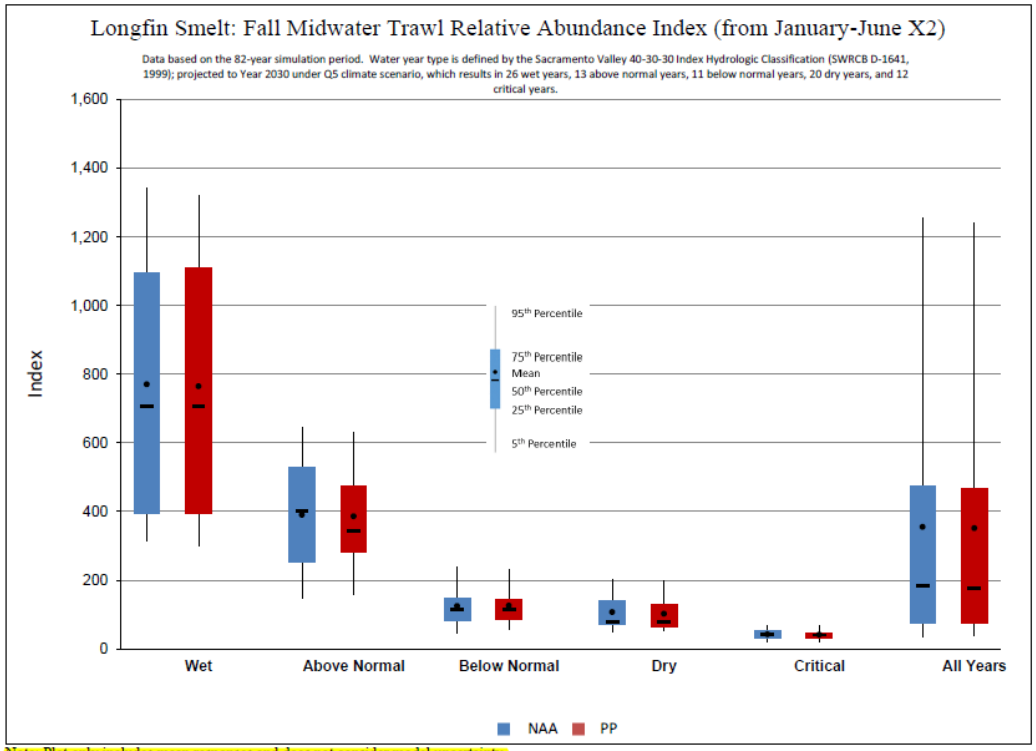


Figure 4.A-1. Fit to Empirical Data of General Linear Model Predicting Longfin Smelt Fall Midwater Trawl Relative Abundance Index as a Function of Mean January–June X2 and Step Changes for *Potamocorbula* and Pelagic Organism Decline.

Longfin Smelt Analyses

4.2.3 Operations Effects

- *4.2.3.1 Delta Outflow/X2 Effects*
  - Phase 1 recommendation: "That boxplot and exceedance plot figure legends state that the plots exclude model uncertainty, unless that uncertainty can be incorporated."



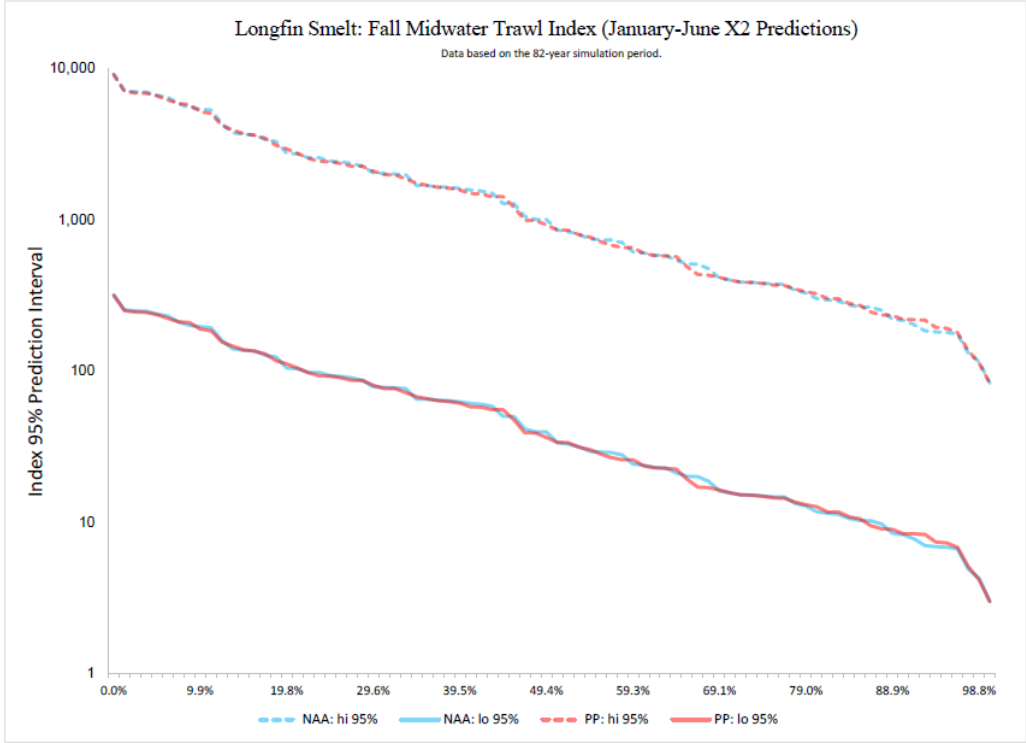
Note: Plot only includes mean responses and does not consider model uncertainty.

Figure 4.A-2. Box Plot of Longfin Smelt Fall Midwater Trawl Relative Abundance Index, Estimated from the General Linear Model Including Mean January–June X2, Grouped by Water Year Type.

Longfin Smelt Analyses

4.2.3 Operations Effects

- *4.2.3.1 Delta Outflow/X2 Effects*
  - Phase 1 recommendation: "That boxplot and exceedance plot figure legends state that the plots exclude model uncertainty, unless that uncertainty can be incorporated."



Note: Data are sorted by mean estimate, with only 95% prediction intervals shown.

Figure 4.A-3. Exceedance Plot of Longfin Smelt Fall Midwater Trawl Relative Abundance Index, Estimated from the General Linear Model Including Mean January–June X2.

Longfin Smelt Analyses

4.2.3 Operations Effects

- *4.2.3.1 Delta Outflow/X2 Effects*
  - Phase 1 recommendation: "That time series plots…omit the solid lines depicting the point predictions from the fish response model, because the point predictions are unlikely to be the actual future outcomes."

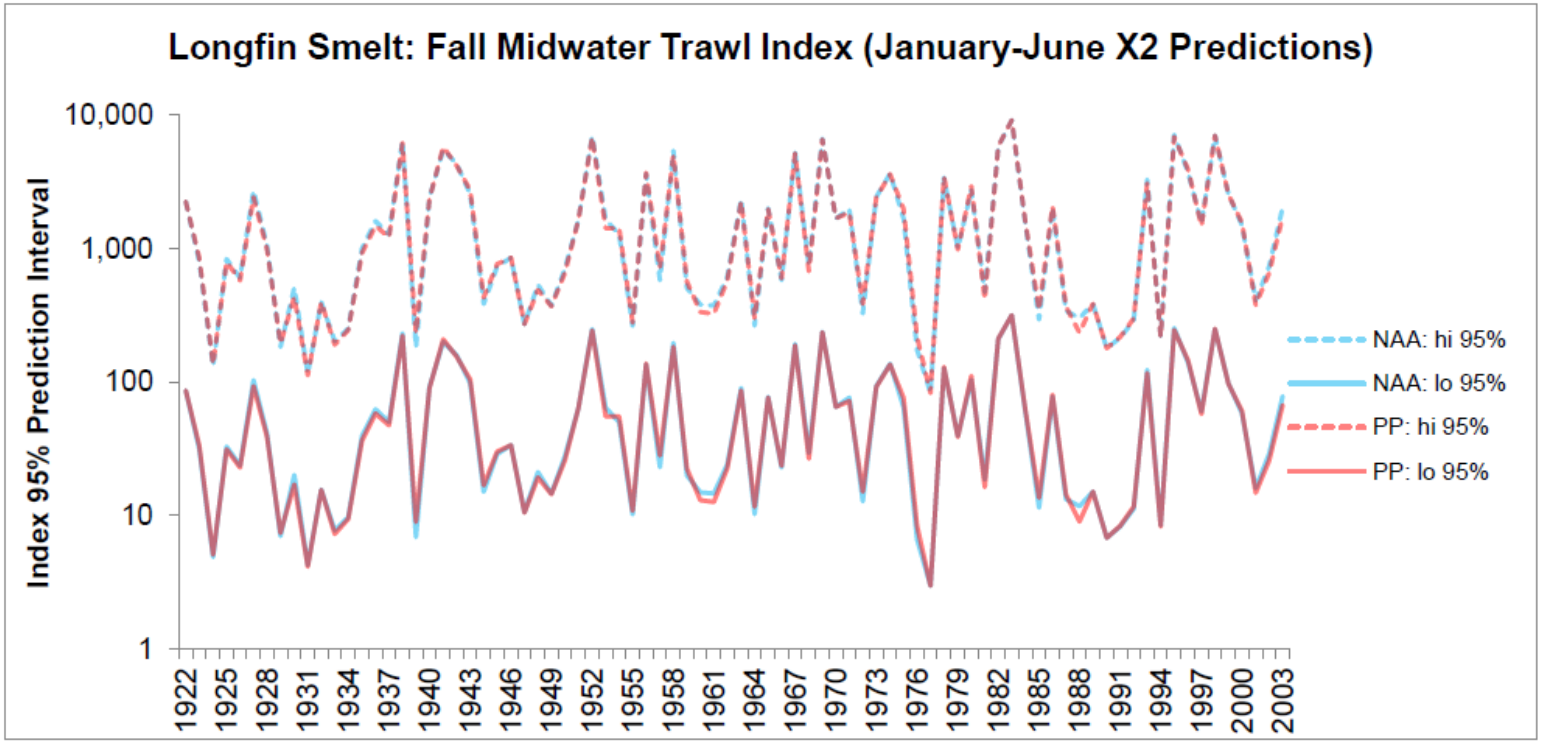
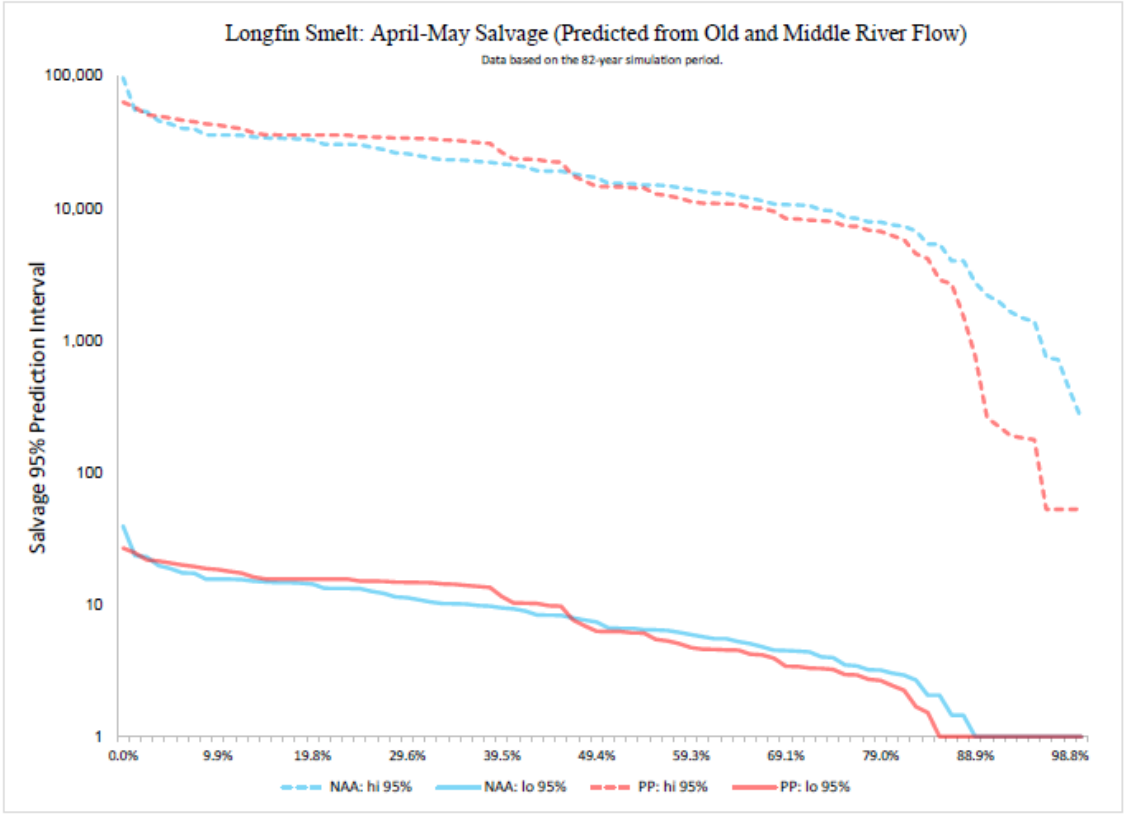


Figure 4.A-4. Time Series of 95% Prediction Interval Longfin Smelt Bay Midwater Trawl Index, from the General Linear Model Including Mean January–June X2.

Longfin Smelt Analyses

4.2.3 Operations Effects

- *4.2.3.2 Entrainment and South Delta Entry*
  - Added Salvage-Old & Middle River Flow Regression for juvenile entrainment (recreating Grimaldo et al. 2009)



Note: Data are sorted by mean estimate, with only 95% prediction intervals shown. Zero estimates are converted to 1 in this plot to allow plotting on a log scale.

Figure 4.A-32. Exceedance Plot of Longfin Smelt April–May Salvage, from the Regression Including Mean Old and Middle River Flows.

Longfin Smelt Analyses

4.2.3 Operations Effects

- *4.2.3.2 Entrainment and South Delta Entry*
  - Added exploration of reasons for less OMR flow in Apr/May– almost entirely because of assumed HOR gate operations (addressed with real-time ops)

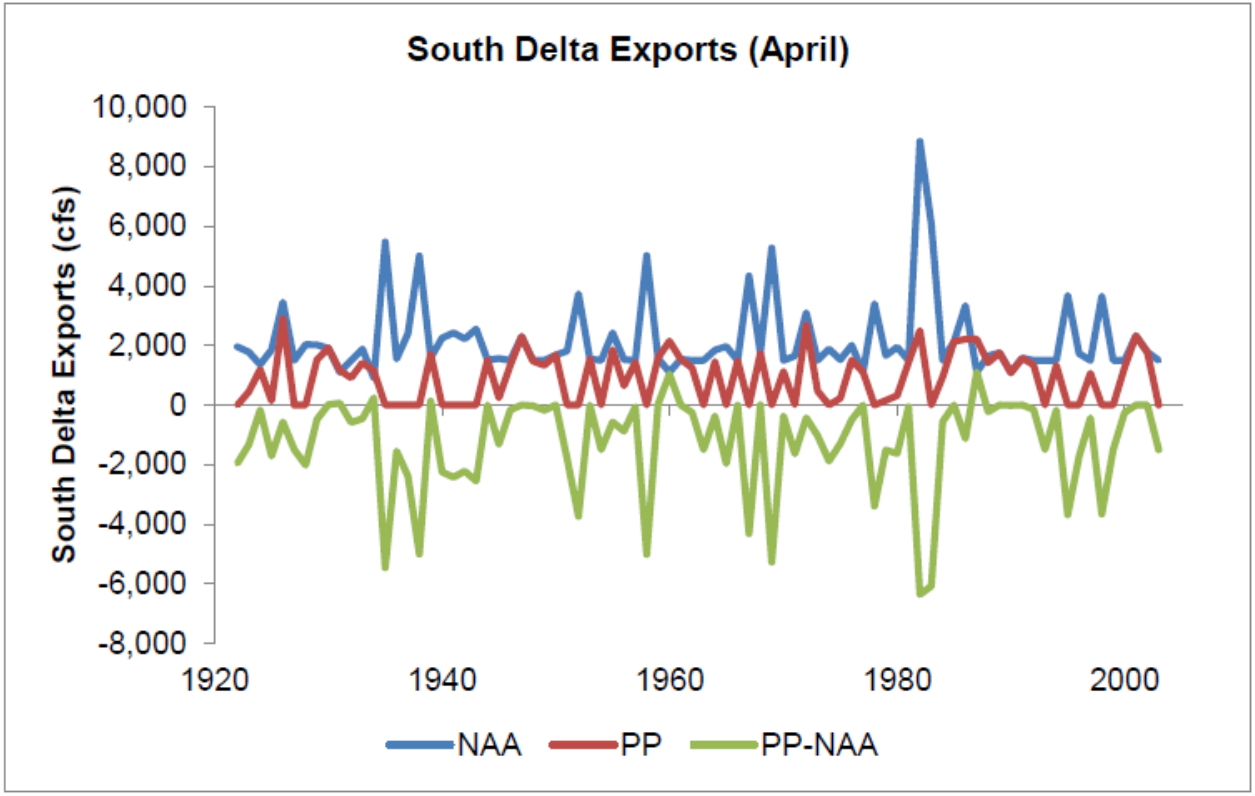


Figure 4.A-34. CalSim-II Modeling Results for South Delta Exports under No Action Alternative (NAA) and Proposed Project (PP) and Difference Between NAA and PP, April.

Longfin Smelt Analyses

4.2.3 Operations Effects

- *4.2.3.2 Entrainment and South Delta Entry*
  - Added exploration of reasons for less OMR flow in Apr/May– almost entirely because of assumed HOR gate operations (addressed with real-time ops)

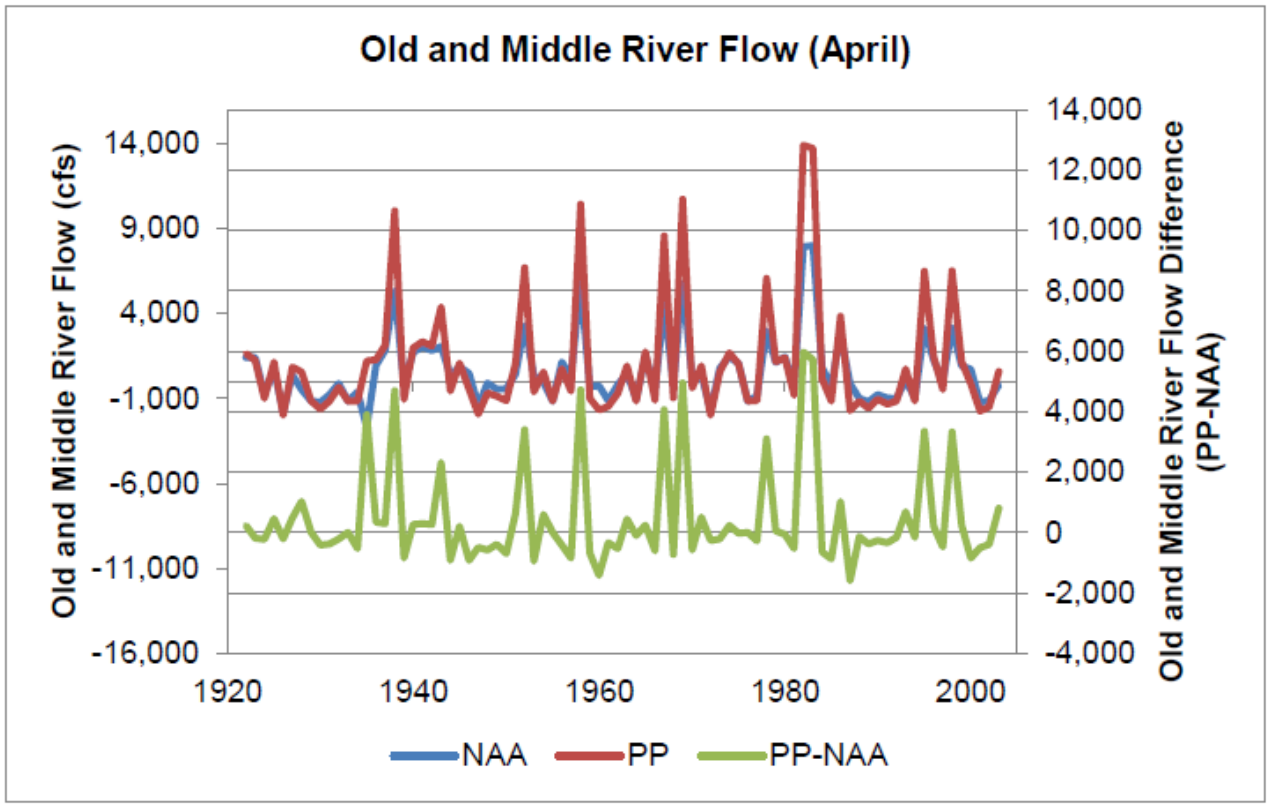


Figure 4.A-35. CalSim-II Modeling Results for Old and Middle River Flows under No Action Alternative (NAA) and Proposed Project (PP) and Difference Between NAA and PP, April.

Longfin Smelt Analyses

4.2.3 Operations Effects

- *4.2.3.2 Entrainment and South Delta Entry*
  - Added exploration of reasons for less OMR flow in Apr/May– almost entirely because of assumed HOR gate operations (addressed with real-time ops)

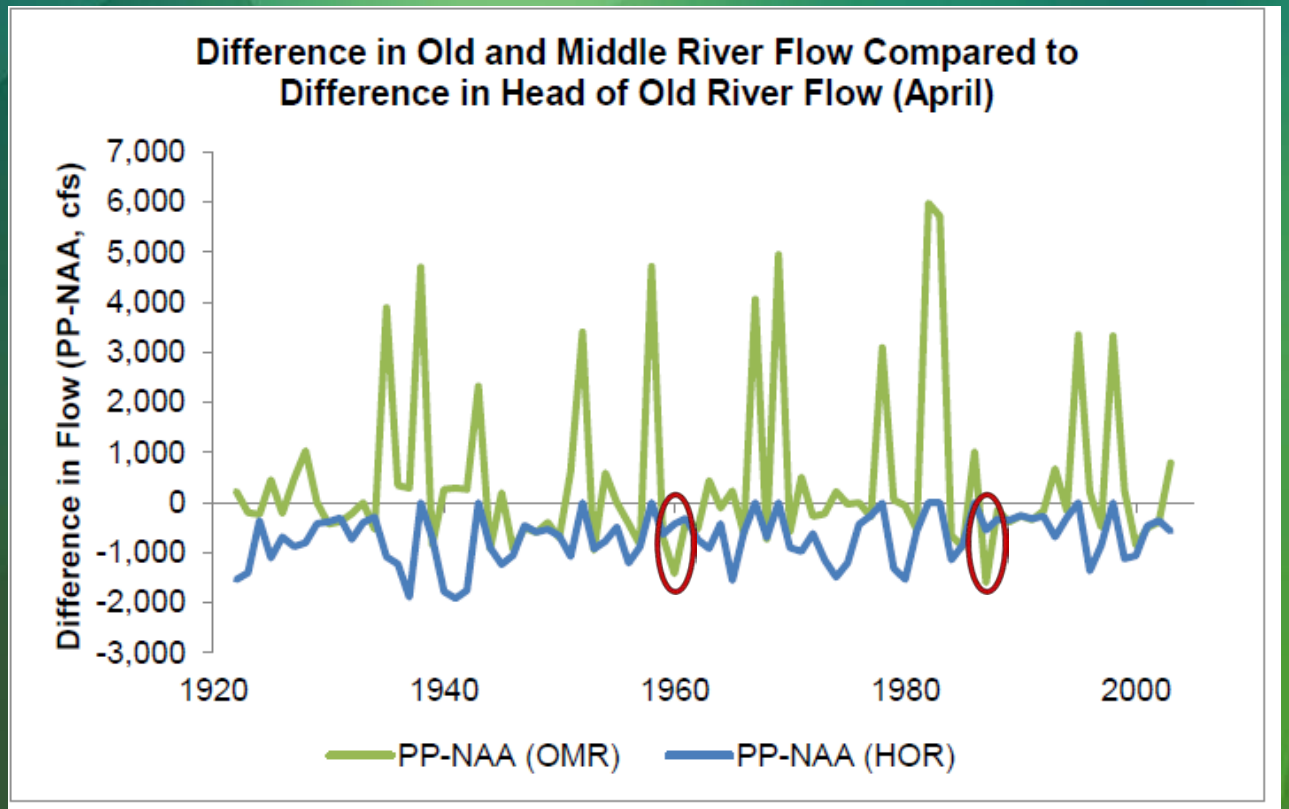


Figure 4.A-36. CalSim-II Modeling Results for Difference Between No Action Alternative (NAA) and Proposed Project (PP) for Head of Old River (HOR) Flows and Old and Middle River (OMR) Flows, April.

Longfin Smelt Analyses

4.2.3 Operations Effects

- *4.2.3.2 Entrainment and South Delta Entry*
  - Added % of particles reaching Chipps Island

Table 4.A-9. Mean Annual Percentage of Particles Reaching Chipps Island By Water Year Type, from DSM2-PTM Analysis of January-March 1922-2003.

Water Year Type	January			February			March		
	NAA	PP	PP vs. NAA[1]	NAA	PP	PP vs. NAA[1]	NAA	PP	PP vs. NAA[1]
Wet	44.74	45.78	1.04 (2%)	44.70	45.63	0.93 (2%)	43.50	44.46	0.96 (2%)
Above Normal	42.16	43.51	1.36 (3%)	43.48	44.48	1.01 (2%)	42.67	44.19	1.52 (4%)
Below Normal	34.86	38.65	3.79 (11%)	40.24	41.29	1.05 (3%)	40.45	41.38	0.93 (2%)
Dry	33.42	36.09	2.67 (8%)	39.19	40.17	0.99 (3%)	40.85	41.03	0.18 (0%)
Critical	30.51	32.44	1.93 (6%)	36.46	36.46	0.00 (0%)	38.24	37.74	-0.50 (-1%)

Note:
[1] Negative values indicate lower percentage of particles reaching Chipps Island under the proposed project (PP) than under the no action alternative (NAA).

Longfin Smelt Analyses

4.2.3 Operations Effects

- *4.2.3.2 Entrainment and South Delta Entry*
  - Phase 1 comment with respect to DSM2 particles remaining in modeling domain summary: "Because…DSM2 is…one-dimensional…, open water regions [Franks Tract and Mildred Island are…represented as…continuously stirred tank reactor[s]. … DSM2…was not intended to represent the actual circulation patterns in these open water regions. …if particles are getting "stuck"…, this is likely a limitation of the model representation of circulation…"
  - Response: DSM2 attempts to mimic the observed flow exchange between the surrounding channel and the open water body, with the probability of particle exit through any one outlet being determined by the ratio of flow through the outlet and the volume of the reservoir.

Longfin Smelt Analyses

4.2.3 Operations Effects

- *4.2.3.2 Entrainment and South Delta Entry*
  - Added summary of QWEST (San Joaquin R. at Jersey Point) flows

Table 4.2-7. Monthly Water-year-type Mean of Flows in the San Joaquin River at Jersey Point (Cubic Feet per Second), from the 1922–2003 DSM2-HYDRO Simulation.

Month	WYT	NAA	PP	PP vs. NAA[1]
Jan	W	19,054	21,307	2,253 (12%)
	AN	9,626	10,766	1,140 (12%)
	BN	2,794	5,217	2,423 (87%)
	D	2,334	3,480	1,146 (49%)
	C	1,377	2,115	738 (54%)
Feb	W	22,177	26,089	3,912 (18%)
	AN	13,152	14,441	1,289 (10%)
	BN	7,901	8,759	858 (11%)
	D	4,992	5,544	553 (11%)
	C	3,393	3,518	124 (4%)
Mar	W	18,919	23,238	4,319 (23%)
	AN	10,351	14,160	3,809 (37%)
	BN	3,673	4,755	1,082 (29%)
	D	4,901	5,051	150 (3%)
	C	3,218	3,333	115 (4%)
Apr	W	16,363	17,757	1,394 (9%)
	AN	9,353	10,056	704 (8%)
	BN	5,790	5,789	-1 (0%)
	D	5,111	5,240	129 (3%)
	C	2,936	2,790	-146 (-5%)
May	W	13,740	15,214	1,474 (11%)
	AN	7,023	7,465	443 (6%)
	BN	4,532	4,660	127 (3%)
	D	3,680	3,885	206 (6%)
	C	2,224	2,210	-14 (-1%)
Dec	W	8,104	8,514	410 (5%)
	AN	2,971	3,805	834 (28%)
	BN	-433	342	775 (179%)
	D	-199	180	380 (190%)
	C	612	671	59 (10%)

[1]Positive values indicate greater flow under the proposed project (PP) than under the no action alternative (NAA).
Green shading indicates differences that are > +5%.

Longfin Smelt Analyses

4.2.6 Take Analysis

- Where possible, provided estimates of % of population taken
  - *4.2.6.3.1 North Delta Exports*
    - << 1% of larvae, based on density in NDD reach relative to downstream areas and entrainment

Longfin Smelt Analyses

4.2.6 Take Analysis

- Where possible, provided estimates of % of population taken
  - *4.2.6.3.2 South Delta Exports*
    - Adults and juveniles: historic estimates for context
    - Larvae: DSM2-PTM

Table 4.2-10. Entrainment Loss of Adult Longfin Smelt In Relation to December Population Abundance.

Water Year	Entrainment Loss	Population Abundance			Entrainment Loss as % of Population Abundance		
		Mean	Lower 95% Confidence Limit	Upper 95% Confidence Limit	Mean	Lower 95% Confidence Limit	Upper 95% Confidence Limit
1994	515	2,121,299	1,539,453	2,923,767	0.02%	0.02%	0.03%
1995	1,256	762,931	492,457	1,185,366	0.16%	0.11%	0.26%
1996	794	1,897,507	1,280,158	2,626,755	0.04%	0.03%	0.06%
1997	43	2,505,703	1,707,191	3,556,312	0.00%	0.00%	0.00%
1998	86	356,804	169,092	623,598	0.02%	0.01%	0.05%
1999	43	There were insufficient trawl samples for an estimate.					
2000	333	893,531	548,077	1,371,856	0.04%	0.02%	0.06%
2001	601	6,261,994	4,538,034	8,417,526	0.01%	0.01%	0.01%
2002	1,648	252,942	142,355	422,206	0.65%	0.39%	1.16%
2003	3,429	1,627,699	1,038,290	2,369,905	0.21%	0.14%	0.33%
2004	2,102	1,145,721	801,008	1,605,858	0.18%	0.13%	0.26%
2005	183	475,231	271,314	756,977	0.04%	0.02%	0.07%
2006	0	159,244	90,862	257,436	0.00%	0.00%	0.00%
2007	0	83,311	26,826	159,348	0.00%	0.00%	0.00%
2008	570	21,376	6,255	43,048	2.67%	1.32%	9.11%

Sources:
Entrainment loss: Fujimura (2009).
Population abundance: DFG (2009a: Appendix C, Attachment 2, Table 2).

Table 4.2-11. Entrainment Loss of Juvenile Longfin Smelt (20-79 mm) In Relation to Population Abundance (Extrapolated from 20-mm Survey Data).

Water Year	Entrainment Loss	Population Abundance			Entrainment Loss as % of Population Abundance		
		Mean	Lower 95% Confidence Limit	Upper 95% Confidence Limit	Mean	Lower 95% Confidence Limit	Upper 95% Confidence Limit
1995	690	28,533,241	646,582	83,446,706	0.00%	0.00%	0.11%
1996	2,329	55,551,678	2,952,507	160,930,326	0.00%	0.00%	0.08%
1997	16,224	53,124,330	27,786,879	81,514,564	0.03%	0.02%	0.06%
1998	13,151	67,816,816	430,480	201,955,221	0.02%	0.01%	3.05%
2000	14,061	105,680,968	23,624,089	227,525,445	0.01%	0.01%	0.06%
2001	29,779	155,878,920	29,659,827	397,513,090	0.02%	0.01%	0.10%
2002	59,250	14,788,919	6,268,759	27,156,527	0.40%	0.22%	0.95%
2003	1,250,100	34,788,791	16,739,707	57,544,906	3.59%	2.17%	7.47%
2004	25,609	12,690,736	2,456,744	31,824,070	0.20%	0.08%	1.04%
2005	6,274	11,953,747	3,049,485	25,527,635	0.05%	0.02%	0.21%
2006	3,633	20,103,627	3,154,146	53,010,040	0.02%	0.01%	0.12%
2007	0	95,376,388	835,562	280,036,933	0.00%	0.00%	0.00%
2008	1,338	3,401,228	1,296,730	6,933,677	0.04%	0.02%	0.10%

Sources:
Entrainment loss: Fujimura (2009).
20-mm Survey data: ftp://ftp.dfg.ca.gov/Delta%20Smelt/20-mm.mdb

Longfin Smelt Analyses

4.2.6 Take Analysis

- Where possible, provided estimates of % of population taken
  - *4.2.6.3.4 Delta Outflow/X2 Effects*
    - Relative comparison of PP to NAA, as opposed to absolute
  - *4.2.6.3.7 North Bay Aqueduct*

Table 4.2-12. Estimated Entrainment of Longfin Smelt < 25 mm at the North Bay Aqueduct Barker Slough Pumping Plant In Relation to Estimates of Longfin Smelt < 25 mm Population Abundance (Extrapolated from 20-mm Survey Data), Water Years 1995-2004.

Water Year	Entrainment Loss	Population Abundance			Entrainment Loss as % of Population Abundance		
		Mean	Lower 95% Confidence Limit	Upper 95% Confidence Limit	Mean	Lower 95% Confidence Limit	Upper 95% Confidence Limit
1995	391	12,694,770	2,880,472	27,724,889	0.00%	0.00%	0.01%
1996	0	436,840,112	222,421,096	683,703,946	0.00%	0.00%	0.00%
1997	4,949	122,818,910	67,832,966	190,921,902	0.00%	0.00%	0.01%
1998	0	73,198,295	7,379,642	174,115,762	0.00%	0.00%	0.00%
1999	0	288,110,345	127,000,833	497,663,601	0.00%	0.00%	0.00%
2000	0	541,835,049	234,627,632	942,389,187	0.00%	0.00%	0.00%
2001	95,775	212,642,712	119,226,105	324,895,736	0.05%	0.03%	0.08%
2002	970,315	243,004,460	118,956,495	430,398,147	0.40%	0.23%	0.82%
2003	41,695	98,766,407	49,567,072	160,579,034	0.04%	0.03%	0.08%
2004	0	105,412,110	40,827,244	192,603,970	0.00%	0.00%	0.00%
2005	0	87,853,433	29,271,032	194,338,958	0.00%	0.00%	0.00%

Sources:
North Bay Aqueduct Monitoring Data: ftp://ftp.dfg.ca.gov/Delta%20Smelt/NBA.mdb
20-mm Survey Data: ftp://ftp.dfg.ca.gov/Delta%20Smelt/20-mm.mdb

Longfin Smelt Analyses

4.2.7 Analysis of Potential for Jeopardy

- *4.2.7.2.2 Effect of Take Minimization Measures*
  - Phase 2A charge question: "How well does the…application justify…a (March through May) averaging window to provide outflow targets…?"

[8] Focus on spring was based on unpublished analyses suggesting that spring may be of greater importance than winter (discussed by Hanson [2014] in supporting material for Maunder et al. [2015]). However, the relative importance of flows during these seasons would remain a focus of research and adaptive management.

Results ***with*** additional spring outflow:

Table 4.2-13. Mean Annual Longfin Smelt Relative Abundance Index (Fall Midwater Trawl Survey), Estimated from General Linear Model Based on Mean January–June X2[1], Grouped by Water Year Type, Comparing PP with Longfin Smelt Spring Outflow Criteria to NAA.

Water Year Type	NAA	PP (With Longfin Smelt Spring Outflow Criteria)	PP (With Longfin Smelt Spring Outflow Criteria) vs. NAA[2]
Wet	770	759	-11 (-1%)
Above Normal	390	390	0 (0%)
Below Normal	125	132	7 (6%)
Dry	107	107	1 (0%)
Critical	42	42	0 (-1%)

[1]A step change for the Pelagic Organism Decline (POD) was also included in the General Linear Model.
[2]Negative values indicate lower abundance index under the proposed project (PP with Longfin Smelt spring outflow criteria) than under the no action alternative (NAA).

Results ***without*** additional spring outflow:

Table 4.A-2. Mean Annual Longfin Smelt Relative Abundance Index (Fall Midwater Trawl Survey), Estimated from General Linear Model Based on Mean January–June X2[1], Grouped by Water Year Type.

Water Year Type	NAA	PP	PP vs. NAA[2]
Wet	770	765	-5 (-1%)
Above Normal	390	386	-4 (-1%)
Below Normal	125	126	1 (1%)
Dry	107	102	-5 (-4%)
Critical	42	41	-1 (-3%)

1A step change for the Pelagic Organism Decline (POD) was also included in the General Linear Model.
2Negative values indicate lower abundance index under the proposed project (PP) than under the no action alternative (NAA).

Longfin Smelt Analyses

4.2.7 Analysis of Potential for Jeopardy

- *4.2.7.2.4 Conclusions*
  - Take minimization measures to be applied
    - Cross-references Section 5.3.2 in Chapter 5
    - Many avoidance and mitigation measures for construction and maintenance
    - Minimization/avoidance through operational criteria (e.g., OMR flow constraints)
    - Reduced sediment effects (reintroduction, operational protection of initia pulse flows)
    - Spring outflow criteria
  - Loss of habitat fully mitigated
    - Cross-references Section 5.4.2 in Chapter 5
    - ~348 acres to offset construction and habitat access loss
  - Conclusion: No jeopardy

Longfin Smelt Analyses

Addressing Uncertainty

- Phase 1 comment: "Given the persistent uncertainties about the risk and vulnerability of Longfin Smelt to the PA, the Panel reinforces the BA's emphasis on real-time management and monitoring to minimize entrainment effects under the PA."
- Response: All five agencies, as well as other stakeholders, are committed to the Adaptive Management Program [framework provided to the panel] and monitoring: reflected in July 2016 Final Biological Assessment Section 3.1.5, *Real-Time Operations Upstream of the Delta*, and Section 3.3.3, *Real-Time Operational (RTO) Decision-Making Process*, by bolstering descriptions of real-time operations and decisions-making.
- In addition, importance of outflow would be subject of scientific research program
  - Longfin smelt biology
  - Mechanisms behind the Delta outflow-longfin smelt abundance relationship
    - Evidence for critical time periods (e.g., winter vs. spring)
    - Annual variation in critical time periods
    - Evidence for the importance of retention in the low salinity zone and its variation with outflow
  - Longfin smelt's use of tidal wetlands and potential for benefit from food production exported from restoration sites
  - Longfin smelt occurrence in the Delta, Bay, and nearshore coastal ocean