Delta Smelt Summer-Fall Habitat Action

2022 Action Plan

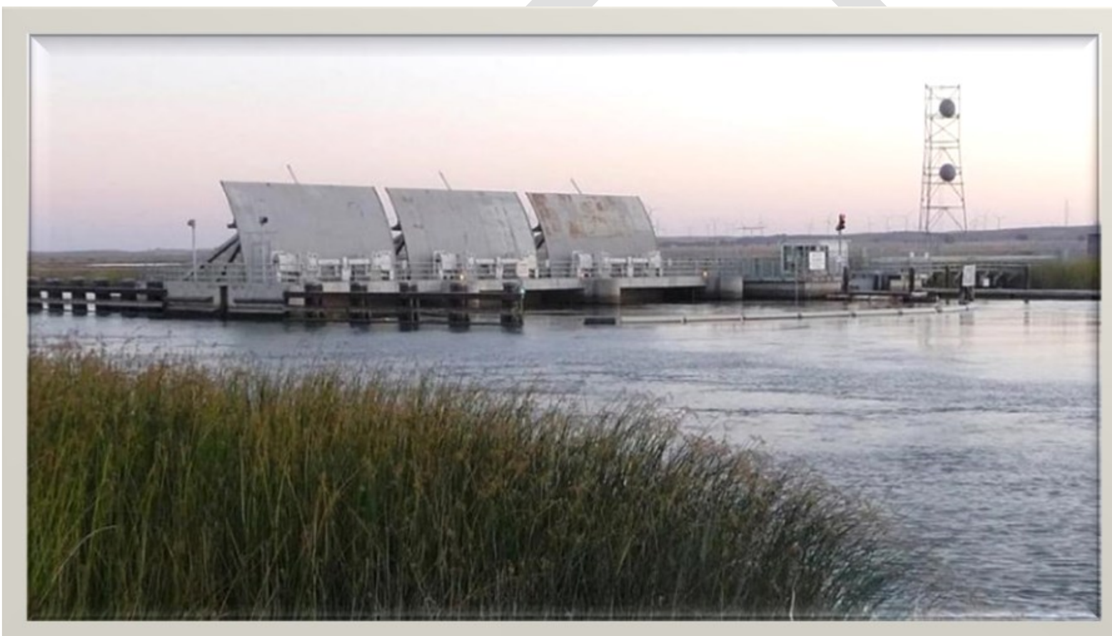

Photo: Sunrise over the Suisun Marsh Salinity Control gates. From California Department of Water Resources

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Summary

If the final Water Year (WY) 2022 Sacramento Valley water year designation (40-30-30 Index based on the May 1 50% exceedance forecast) is Dry or Critical, no Summer Fall Habitat Action will occur. If the final water year designation is Below Normal, the Suisun Marsh Salinity Control Gates will be operated to a target of 4 ppt starting as soon as the salinity at Belden's Landing reaches 4 ppt. No North Delta Food Subsidy Action will be conducted during 2022, for any water year designation, due to ESA coverage constraints. Monitoring and science to evaluate the effectiveness of these actions will accompany the actions. If the no action occurs, monitoring and science will still occur to establish an environmental baseline. This decision was reached by the Delta Coordination Group through the structured decision-making process as described below.

Background

The Delta Smelt Summer Fall Habitat Action (SFHA) is intended to improve growth, survival, and recruitment of critically endangered Delta Smelt (*Hypomesus transpacificus*) by enhancing habitat and food availability through coordinated management actions. The SFHA and investigation of summer-fall habitat conditions are included as condition of approval 9.1.3 of the California Department of Fish and Wildlife's (CDFW) Incidental Take Permit (ITP) issued to DWR for State Water Project operations (CDFW 2020) and are also components of U.S. Bureau of Reclamation and California Department of Water Resource's Proposed Action for coordinated long-term operation of the Central Valley Project and State Water Project, and corresponding Biological Opinions (NMFS 2019, USFWS 2019).

Planning, recommendations for implementation, and reporting of the SHFA are coordinated through the Delta Coordination Group (DCG), consisting of state and federal agencies and water contractors. Annually, during February, March, and April, the DCG assesses current water year hydrology forecasts and fish distributions, operations, and conducts qualitative and/or quantitative activities to inform structured decision making and develop a SFHA action plan (this document) which considers what specific actions to take in Dry, Below Normal, Above Normal, and Wet years (as established by the Sacramento Valley Hydrologic Classification Index)[1]. Implementation and monitoring of actions (or no-action baseline conditions) are conducted June through October after which the SFHA seasonal report is compiled with a draft completed by December of each year.

Current components of the SFHA are aimed to provide suitable environmental and biological conditions for Delta Smelt based on current conceptual models. For example, our current understanding is that Delta Smelt habitat should include low salinity (0-6 ppt), low temperature (<24°C), turbidity of approximately 12 NTU, and high food availability in littoral or open water habitats (FLaSH Synthesis; Brown et al. 2011). The SFHA is being undertaken recognizing that the highest quality habitat in Bay-Delta includes areas with complex bathymetry, in deep channels close to shoals and shallows, and in proximity to extensive tidal or freshwater marshlands and other wetlands (Bever et al. 2016; Hammock et al. 2019). The intent of the SFHA is to provide these habitat components in the same geographic area through a range of actions to improve water quality and food supplies. Current SFHA actions include the following; however, only 2 and 4 will be described in this plan, as others are not applicable in the 2022 water year:

1) *Management of X2 during September and October (applicable only in Above Normal and Wet years)*
2) Suisun Marsh Salinity Control Gates (SMSCG) reoperations
3) *Extra 100 TAF (applicable only in Above Normal and Wet years, or the following year)*
4) North Delta Food Subsidy (NDFS) – Colusa Basin Drain action (still undergoing ESA consultation, but applicable in Dry and Below Normal years)

[1] See: https://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST

5) *Sacramento Deep Water Shipping Channel Food study (still undergoing ESA consultation and feasibility studies)*

6) *Roaring River Distribution System (RRDS) Food subsidy study (still undergoing ESA consultation and feasibility studies)*

Additional information on each action can be found in supporting documents including the DCG Guidance Document, SFHA Science and Monitoring Plan (Appendix A), and past SFHA Seasonal Reports.

The purpose of this Action Plan is to describe DCG planning activities and recommendations for implementation for the 2022 SFHA (including a no-action option). This document also serves as a deliverable for ITP Condition of Approval (COA) 9.1.3.1 due to CDFW. Implementation of the SFHA has not occurred in the last two years due to drought conditions, including Dry (2020) and Critical (2021) water year designations. However, information has been gained from previous SFHA reporting of baseline conditions, special studies relative to actions, and development of structured decision making (SDM) prototypes. While it is likely that 2022 will be the third no-action year in a row, the DCG is engaged in learning and improving SDM processes for future years in which an SFHA action will be implemented. SFHA successive dry year planning (ITP COA 9.1.3.2) did not identify any alternative actions for implementation this year, but continued science and monitoring and DCG discussions of potential options during dry conditions will continue to occur. This 2022 Action Plan describes specifically SMSCG and NDFS actions in Below Normal and Dry water year types, development of quantitative and conceptual models to inform SDM, and evaluation of consequences.

2022 Hydrology and Temperature Forecast

WY 2022 will most likely be the third year in a row with dry hydrology, and a Critical or Dry water year designation. While early storms brought some relief, very little precipitation fell in January, February, and March (Figure *1*). As of April 1, 2022, the 50% exceedance forecast predicted that 2022 would be classified as Critical (Sacramento Valley Index, 4.2). Almost all reservoirs in California were below the historical average for this time of year, and snowpack was only 25% of average (Figure 2). The March 17, 2022 seasonal temperature outlook predicted that the summer of 2022 will be warmer than average (Figure 3). The combination of lower than average snowpack, low predicted runoff, and high temperatures will make it difficult to conduct any of the summer-fall habitat actions in 2022. Only if extremely high precipitation occurs in the second half of March and April will we reach a Below Normal water year classification.

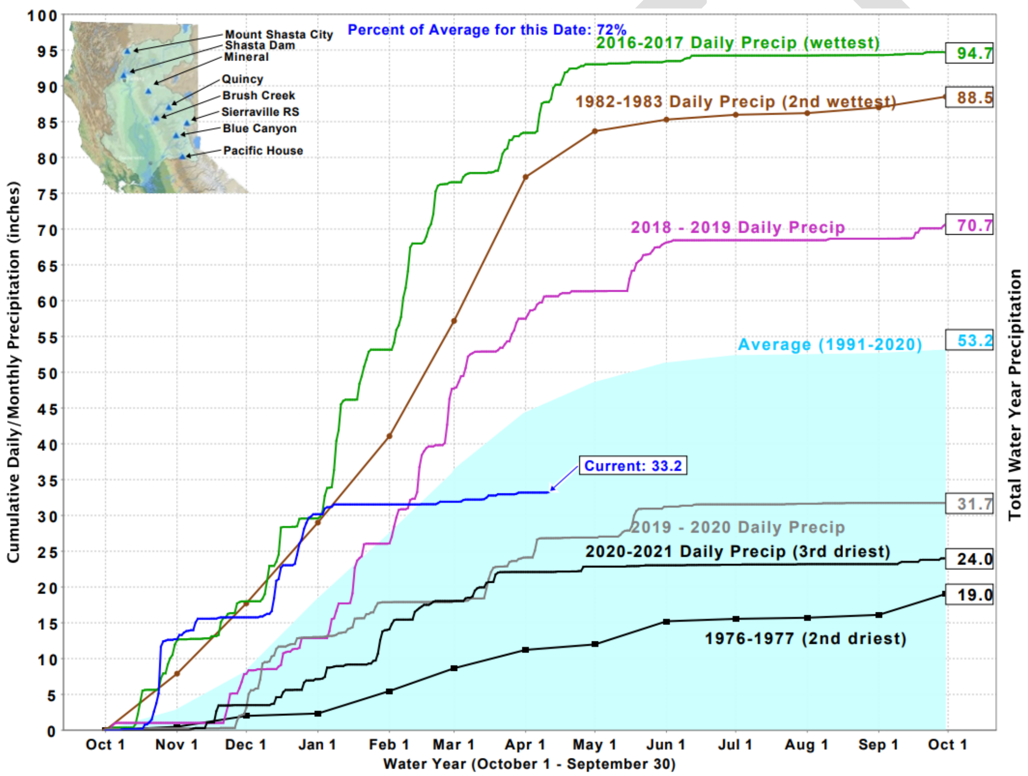

Figure 1. Northern Sierra Precipitation, 8-station index as April 11th, 2022. Graph from https://cdec.water.ca.gov/cgi-progs/products/PLOT_ESI.pdf

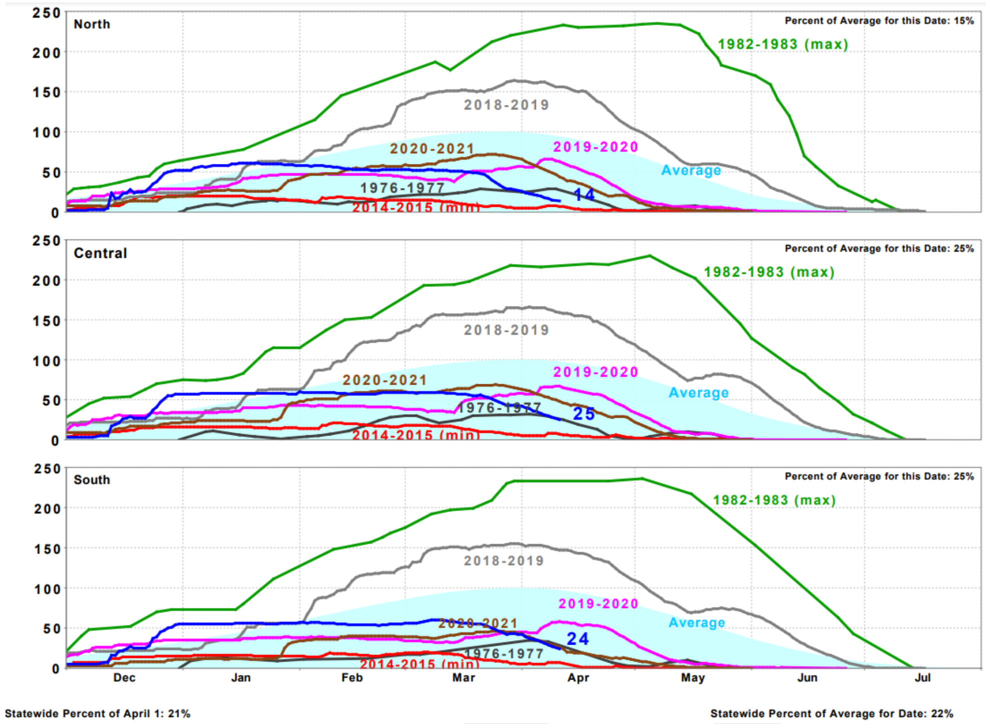

Figure 2. California Snow Water Content as of April 11, 2022; percent of April 1 average. Graph from https://cdec.water.ca.gov/reportapp/javareports?name=PLOT_SWC.

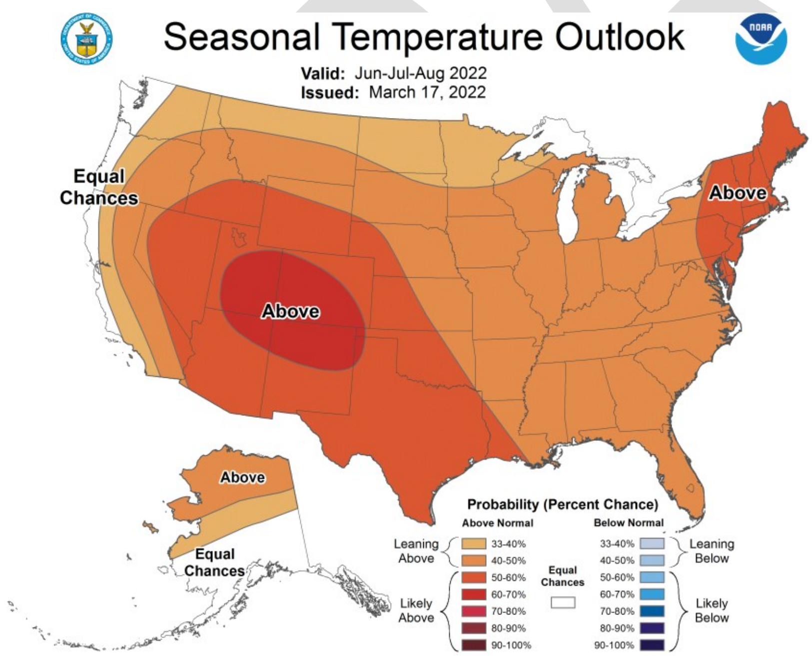

Figure 3. Seasonal temperature outlook for the United States (from NOAA's Seasonal Forecast Center: https://www.cpc.ncep.noaa.gov/products/predictions/long_range/seasonal.php?lead=3).

Structured Decision-Making Process

For the 2022 SFHA SDM process, the DCG agreed to identify the suite of actions to recommend for June to October 2022, given the likely water year types from the January and February forecasts -- Below Normal and Dry. The decision includes both broad categories of action (i.e., whether to implement an action) and options for how to implement the action(s). See Appendix B for complete documentation of the SDM process.

The fundamental objective of the SHFA is improved Delta Smelt recruitment (by improved growth and survival); means objectives address habitat (including contaminants) and prey quality and quantity, effects on other native species, and water supply and resource (i.e., direct management) costs (Table 1). The conceptual model and hypotheses were developed by Baxter et al. (2015) following the Management Analysis and Synthesis Team models. The means-ends diagram below illustrates the hypothesized relationships between the full suite of SFHA management actions and objectives (Figure 4: last updated August 18, 2021).

SDM objectives, sub-objectives, and more detailed hypothesizes are described in Table 1. Performance measures used to calculate consequences for each objective or sub-objective are identified in Table 2. Information sheets were developed for each performance measure. The information sheets include the following: (1) a conceptual model and influence diagram (where possible) describing how the actions are hypothesized to influence the performance measure; (2) the calculations and/or expert elicitation used for scoring; (3) key assumptions and uncertainties that may affect scoring; (4) a table of the scores for each alternative; (5) additional information and context for interpreting the scores; and (6) references. The information sheets for each performance measure, consequence assessment, and anticipated outcomes are included in the 2022 DCG SDM Process document (Appendix B). The final consequence table was compiled as of 4/22/2022 and is provided in this action plan.

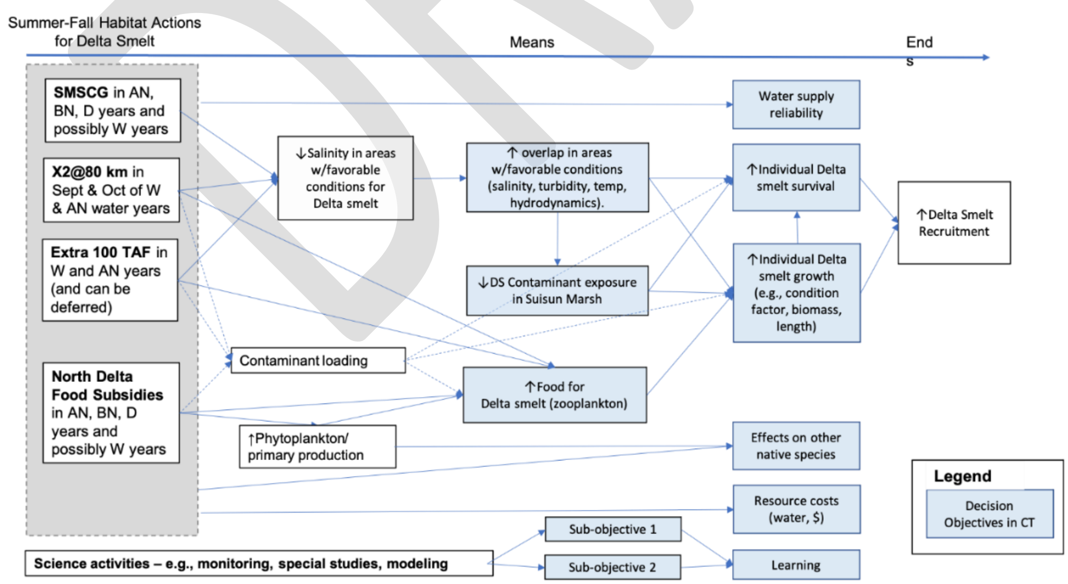

Figure 4. Influence Diagram used for SDM in 2022.

Table 1. Decision objectives identified by the DCG for SDM.

Decision Objective	Sub-Objective	Description
Delta Smelt growth and survival	Individual growth	Increasing Delta Smelt survival and recruitment is the ultimate aim of the SFHAs. Growth, survival, and recruitment are correlated at times, but growth is most readily estimable at present and is the sole PM in this category for the WY 2022 SDM process. Consequences were evaluated separately for four regions: Yolo, Lower Sac, Confluence, and Suisun Marsh.
Delta Smelt growth and survival	Individual survival	See above
Delta Smelt food and habitat	Zooplankton	Targeted actions to increase feeding success of Delta Smelt in key locations are hypothesized to be able to replace more water-costly actions.
Delta Smelt food and habitat	Suitable Habitat	Overlap of salinity, turbidity, temperature, and hydrodynamics suitable for Delta Smelt, based on Bever et al. (2016) and temperature tolerance. Reducing salinity in Suisun Marsh will allow Delta Smelt to more freely access the marsh’s complex, relatively food-rich habitat.
Contaminant Effects	Delta Smelt growth, survival, and recruitment; zooplankton abundance and quality.	Some SFHAs have the potential to increase or decrease Delta Smelt exposure to contaminants, either through changing contaminant concentrations in areas where smelt are expected to be and/or by affecting the overlap of suitable habitat for Delta Smelt and areas of lower contaminant concentrations. For example, Suisun Marsh has lower pesticide contaminant concentrations compared to other areas used by Delta Smelt. Contaminant exposure could directly affect individual smelt growth and survival and effect recruitment directly and through sublethal effects. Contaminant exposure could directly affect zooplankton abundance and composition (quality).
Water supply cost	Consumptive use	Volume of outflow needed to offset the degradation to a controlling location, relative to a no action alternative. Water supply costs will differ for implementation of different suites of actions and action options. The objective is to minimize these costs.
Resource costs	Direct management costs	Costs for staff, operations used to implement actions, and science and monitor including field and lab work, contracting costs, analysis and reporting. Resource costs will differ for implementation of different suites of actions and action options. The objective is to minimize these costs.

Decision Objective	Sub-Objective	Description
Effects on other native species	Winter-run: individual; population (annual cohort)	Changes in reservoir operations to support the SMSCG action could reduce adult spawning success and juvenile survival if the coldwater pool available is decreased. This could result in either an increase or decrease in migration delays, which could have negative or positive effects on adult spawning success. The NDFS action could increase adult salmonid straying into the Yolo Bypass, leading to reduced spawning success and leading to increased contaminant exposure and decreased adult survival. Consequences were evaluated for only a limited set of alternatives because the elicitation team felt it was important to explore consequences of water source in more detail and didn't want to overburden the experts.
Effects on other native species	Spring-run: individual; population (annual cohort)	Changes in reservoir operations to support the SMSCG action could decrease the coldwater pool available for spring-run salmon in the Feather River if Oroville releases are increased to offset salinity increases resulting from the action. If the water year following an action is dry a decrease in Shasta water supply and storage could decrease water available and lead to reduced spawning success and juvenile survival. The NDFS action could increase adult salmonid straying into the Yolo Bypass, leading to reduced spawning success and leading to increased contaminant exposure and decreased adult survival. Consequences were evaluated for only a limited set of alternatives because the elicitation team felt it was important to explore consequences of water source in more detail and didn't want to overburden the experts.
Effects on other native species	Steelhead: individual; population (annual cohort)	Changes in reservoir operations to support the SMSCG action could decrease the coldwater pool available for Steelhead in the American River if Folsom releases are increased to offset salinity increases resulting from the action. This could decrease juvenile survival. The NDFS action could increase adult salmonid straying into the Yolo Bypass, leading to reduced spawning success and leading to increased contaminant exposure and decreased adult survival. Consequences were evaluated for only a limited set of alternatives because the elicitation team felt it was important to explore consequences of water source in more detail and didn't want to overburden the experts.

Decision Objective	Sub-Objective	Description
Effects on other native species	Fall-run: individual; population (annual cohort)	The NDFS action could increase adult salmonid straying into the Yolo Bypass, leading to reduced spawning success and leading to increased contaminant exposure and decreased adult survival. Consequences were evaluated for only a limited set of alternatives because the elicitation team felt it was important to explore consequences of water source in more detail and didn't want to overburden the experts.
Effects on other native species	Green Sturgeon: individual; population (annual cohort)	Not included in influence diagram

Table 2. Performance measures evaluated for each SDM decision objective.

Decision Objective	Sub-Objective	Performance Measures	Units	Direction
Delta Smelt growth and survival	Individual growth	Difference in potential growth predicted by the bioenergetics model, between conditions representing no action and conditions representing the effects of a management action	mm fork length	Higher
Delta Smelt growth and survival	Individual survival	Not evaluated this year	n/a	n/a
Delta Smelt food and habitat	Suitable habitat	Habitat Suitability Index (HSI): Bever et al. (2016) with water temperature threshold added	n/a	Higher
Delta Smelt food and habitat	Zooplankton and mysid biomass in (a) Suisun area and (b) Cache Slough area	The change in a weighted food availability score between an action scenario and a no action scenario. This score is calculated by taking the average zooplankton biomass in each region/month for each scenario and multiplying that by the habitat suitability index	(µg/L)*HSI	Higher
Contaminant Effects	Delta Smelt growth, survival, and recruitment; zooplankton abundance and quality.	Constructed scale: -1 = significant reduction in performance metric relative to the No Action Alternative 0 = insignificant effect on performance metric relative to the No Action Alternative 1 = significant increase in performance metric relative to the No Action Alternative	n/a	Higher
Water supply cost	Consumptive use	Change in outflow	TAF	Lower
Resource costs	Direct management costs	$1000/yr	$1000/yr	Lower

Decision Objective	Sub-Objective	Performance Measures	Units	Direction
Effects on other native species	Winter-run: individual; population (annual cohort)	Constructed scale: 1 = Overall, the action would benefit the salmonid in question 0 = Overall, the action would not affect the salmonid in question -1 = Overall, the action would negatively affect the salmonid in question, with minor sublethal effects (occurring in up to 100% of exposed individuals or up to 10% of the population) and/or low likelihood (occurring in <10% of exposed individuals or <1% of the population) of serious sublethal or lethal effects. -2 = Overall, the action would negatively affect the salmonid in question, with intermediate likelihood of serious sublethal or lethal effects for individuals (occurring in 10%-50% of exposed individuals) and low likelihood for the population (< 10% of the population); and/or the population would experience minor sublethal effects (up to 50% of the population). -3 = Overall, the action would negatively affect the salmonid in question, with high likelihood for individuals (occurring in >50% of exposed individuals) of serious sublethal or lethal effects. For the population, the action would negatively affect the salmonid in question, with minor sublethal effects (occurring in >50% of the population) and/or intermediate to high likelihood (occurring in >50% of the population) of serious sublethal or lethal effects.	n/a	Higher
Effects on other native species	Spring-run: individual; population (annual cohort)	Constructed scale: see above	n/a	Higher

Decision Objective	Sub-Objective	Performance Measures	Units	Direction
Effects on other native species	Steelhead: individual; population (annual cohort)	Constructed scale: see above	n/a	Higher
Effects on other native species	Fall-run: individual; population (annual cohort)	Constructed scale: see above	n/a	Higher
Effects on other native species	Green Sturgeon: individual; population (annual cohort)	Constructed scale: see above	n/a	Higher

Action alternatives, hypotheses, and uncertainties

Based on the January and February 2022 forecasts, which indicated hydrology that might result in a Dry or Below Normal (BN) water year type, the DCG developed SFHA scenarios and implementation options for different combinations of actions in each water year that aligned with Table 9-A of the ITP. Scenarios are as shown in Table 3:

Critical water year type. No managed actions would take place.

Dry water year type.

NDFS

The NDFS is the only action that can be considered for 2022. Since 2021 was classified as critically dry, 2022 would be a dry year following a critically dry year, therefore no SMSCG action would be required. The DCG included the following NDFS implementation options: (1) managed fall agricultural pulse of high magnitude and short duration; or (2) managed fall agricultural pulse of low magnitude and long duration (Table 3).

Uncertainties for NDFS include acquiring the necessary ESA coverage and Colusa Basin agricultural practices in response to temperature and water availability. The timing of the action could occur in August (monitoring July-September) if rice fields are planted early, and summer air temperatures are hot; the action could occur in September (monitoring August-October) if fields are planted late and summer air temperatures are cool (Figure 5).

In dry years, planting of rice in Colusa Basin is typically reduced or water transfers can occur which decreases the volume of drainage water available for a managed flow pulse. Additionally, dissolved oxygen concentrations can be quite low during later summer and fall, which can threaten fish health and survival and may lead to a recommendation not to implement the NDFS action to avoid potential negative effects to other species.

BN Water Year Type

The DCG considered 10 alternatives for the BN water year type, each a different combination including one of two SMSCG action options and one of the five NDFS action options described in Table 3.

SMSCG operations

The ITP requires 60 days of SMSCG operations between June and October with a target salinity at Belden's Landing of 4ppt. To achieve this the DCG included the following two SMSCG action implementation options: (1) 60 nonconsecutive days, initiated no earlier than June when Belden's Landing salinity becomes greater than 4 ppt; and (2) 60 nonconsecutive days, initiated no earlier than June when Belden's Landing salinity becomes greater than 6 ppt. The additional outflow for water costs was assumed to come from export cuts for this action. The two salinity triggers (4 ppt versus 6 ppt) allow the DCG to consider the potential consequences of keeping salinity as close to 4 ppt as possible throughout the action or achieving more days total that are below 4 ppt, even if salinity is worse on some days. This will also allow us to test whether we can achieve 4 ppt if we do not start operations until salinity becomes greater than 6 ppt.

Uncertainties for the SMSCG action include what schedule of gate operations is most effective at achieving the target salinity, how Delta Smelt will respond to gate operations, and how operations effect contaminants. The SMSCG action assumes that Delta Smelt will more frequently access relatively food-rich habitat in Suisun Marsh in response to the lower salinity levels. The degree to which Delta Smelt outside of Suisun Marsh will detect and respond to the action and move into the marsh is uncertain. Delta Smelt growth modeling in 2022 did not include movement of Delta Smelt to higher quality habitat.

NDFS

In addition to the two managed fall agricultural NDFS flow pulse options described for the Dry year, the DCG also considered: (3) a managed summer Sacramento River pulse of high magnitude and short duration; (4) a summer Sacramento River pulse of low magnitude and long duration; and (5) a summer Sacramento River pulse followed by a managed fall agricultural pulse of low magnitude and long duration. The different magnitude-duration implementation options test the hypothesis that longer duration, lower flow pulses create conditions result in longer water residence times that support a greater zooplankton response to increases in primary production. Agricultural versus Sacramento River pulse water tests the hypothesis that agricultural water is higher in contaminants, which could negatively impact zooplankton survival and reproduction.

Uncertainties for the NDFS action include acquiring the necessary ESA coverage and Sacramento River flows at Wilkins Slough being 4,000 cfs to conduct the Sacramento River action options. Concentrations of contaminants are assumed to be lower in association with the Sacramento River action options compared to the managed agricultural options.

Table 3. Action options evaluated by the DCG during SDM in 2022 for Dry and Below Normal (BN) water year types.

Year Type: Action	**Alt 1**	**Alt 2**	**Alt 3**	**Alt 4**	**Alt 5**	**Alt 6**	**Alt 7**	**Alt 8**	**Alt 9**	**Alt 10**
Dry: NDFS – Ag flow – high mag/low duration	X	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dry: NDFS – Ag flow – low mag/high duration	N/A	X	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BN: SMSCG – nonconsec, start when Beldon's>4ppt, not before June	X	N/A	X	N/A	X	N/A	X	N/A	X	N/A
BN: SMSCG – nonconsec, start when Beldon's>6ppt, not before June	N/A	X	N/A	X	N/A	X	N/A	X	N/A	X
BN: NDFS – Ag flow – high mag/low duration	X	X	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BN: NDFS – Ag flow – low mag/high duration	N/A	N/A	X	X	N/A	N/A	N/A	N/A	N/A	N/A
BN: NDFS – Sac flow – high mag/low duration	N/A	N/A	N/A	N/A	N/A	N/A	X	X	N/A	N/A
BN: NDFS – Sac flow – low mag/high duration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	X	X
BN: Sac summer/ag flow low mag/high duration	N/A	N/A	N/A	N/A	X	X	N/A	N/A	N/A	N/A

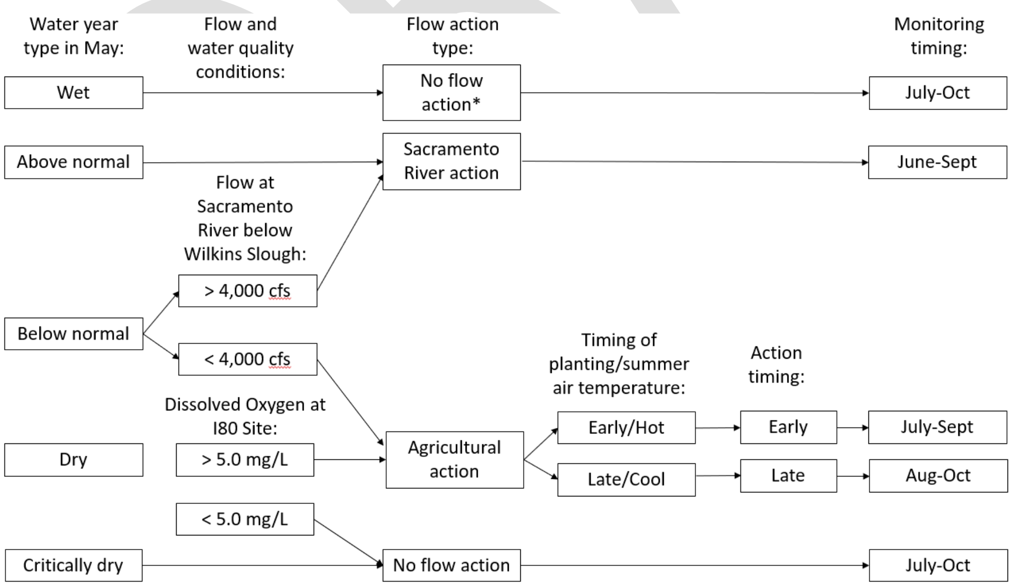

Figure 5. Example of decision framework for the NDFS (from NDFS Operations, Science and Monitoring Plan).

Dry Year Hydrology and Operational Forecast Assumptions

To plan for potential SMSCG operations during a Dry water year, Delta Simulation Model 2 (DSM2) was run assuming conditions from the January 90% exceedance forecast (Table 4), which projected a Dry water year type. This was followed by running the Bay-Delta Semi-implicit Cross-scale Hydroscience Integrated System Model (SCHISM) with historical turbidity and temperature to produce maps of Delta Smelt habitat.

Table 4. January 90% Moderate OMR Delta Coordinated Operations (DCO) Model Flow Forecast (CFS). See Dayflow documentation.

Month	SAC	SJR	Exports (Combined)	NDOI
May	11877	1968	1464	11224
Jun	11195	1428	2420	7245
Jul	15291	732	6977	5071
Aug	13876	651	6359	4798
Sep	12536	773	7058	4326
Oct	9389	1594	4895	5001
Nov	9766	1242	5656	4999

NDFS actions were also considered, with the Sacramento River NDFS actions treated the same as the agricultural NDFS actions for the sake of analysis. To evaluate the NDFS actions, hydrodynamics were adjusted from the Table 4 assumptions as follows:

- **Dry Year No-Action Alternative:** Based on January 90% Exceedance Moderate OMR DCO. Yolo Bypass flows taken from 2021 historical data but adjusted to be no more positive than -50 cfs during summer and fall.
- **NDFS Action (Long Duration, Low Intensity):** 400 cfs swap of flow deducted from the Sacramento River (SAC) at Freeport and added to Yolo baseflow from Aug 15-Sep 15
- **NDFS Action (Short Duration, High Intensity):** 800 cfs swap of flow deducted from the Sacramento River at Freeport and added to Yolo baseflow from Aug 15-Aug 30

Below Normal Year Hydrology and Operational Forecast Assumptions

To plan for potential SMSCG operations during a below normal year, DSM2 was run assuming conditions from the January 50% exceedance forecast (Table 5) which projected a Below Normal water year type. This was followed by running the SCHISM model with historical turbidity and temperature to produce maps of smelt habitat.

Table 5. January 50% Moderate OMR Delta Coordinated Operations Model Flow Forecast (CFS). See Dayflow documentation.

Month	SAC	SJR	Exports (Combined)	NDOI
May	17597	2846	1464	18494
Jun	15377	1160	2235	11696
Jul	19467	878	9904	6503
Aug	18947	846	10945	5443
Sep	16385	958	10940	4583
Oct	10474	1903	6050	4994
Nov	10724	1393	6495	5007

- **BN Year No-Action Alternative:** Based on January 50% Exceedance Moderate OMR DCO. Yolo Bypass flows taken from 2021 historical data, but adjusted to be no more positive than -50 cfs during summer and fall. The flashboards were assumed to be removed from the SMSCGs from June-September.
- **NDFA (Long Duration, Low Intensity):** 400 cfs swap of flow deducted from Freeport and added to Yolo baseflow from Aug 15-Sep 15
- **NDFA (Short Duration, High Intensity):** 800 cfs swap of flow deducted from Freeport and added to Yolo baseflow from Aug 15-Aug 30
- **NDFA (Combined SAC/Ag action):** 400 cfs swap of flow deducted from Freeport and added to Yolo baseflow from Aug 1-Sep 30
- **Intermittent SMSCG operation of 60 days with 4ppt trigger:** Strategy was to operate the gates for 15 days on, followed by 10 days off. Includes additional outflow for water cost, assumed to come from export cuts. The flashboards were assumed to be left in place and the boat lock staffed for the entire summer.
- **Intermittent SMSCG operation of 60 days with 6ppt trigger:** Strategy was to operate the gates for 15 days on, followed by 15 days off. Includes additional outflow for water cost, assumed to come from export cuts The flashboards were assumed to be left in place and the boat lock staffed for the entire summer.

Results

Modeling & Elicitations

The modeling results reported hereafter have been updated since the initial version of the 2022 Action Plan was reviewed by the DCG in early April. Model corrections were required for zooplankton and weighted food availability, and Delta Smelt growth and survival. Errors in SCHISM model runs were also corrected but revised HSI calculations were not completed due to balancing resources in this no-action year. Improvements to modeling will occur in future years. The DCG discussed model corrections, revised SDM consequence tables, and approved updates in the current Action Plan at the late April meeting.

Delta Smelt Growth

Bioenergetic modeling (BEM) showed all combinations of water year type, regions, and action scenarios (SMSCG and NDFS), could produce a potential benefit to growth rate. Regional differences in potential growth rate indicated the most energetically favorable region was Suisun Marsh and least favorable Lower Sacramento region (Table 6). The Marsh region had greater predicted growth of 3.4 and 3.6 mm in Dry and Below Normal years, respectively, as compared to Lower Sacramento. The incremental differences between the action scenarios on energetics and growth were much smaller ranging from 0-0.6 mm across the summer (Table 7). The highest predicted incremental growth was from a NDFS SacAg action (0.63mm/summer). SMSCG action scenario of 4ppt had greater incremental growth compared to 6ppt; however, all results were relatively small with unknown variability around the growth value.

Table 6. Bioenergetics model predicted and reference Delta Smelt length at the end of October, assuming a July 1 length of 30mm FL.

Region	BEM-based (No action) Year type = Below Normal	Reference Year type = Below Normal
Yolo	62.36	59.21
Lower Sac	62.07	59.21
Confluence	62.76	59.21
Marsh	65.64	59.21
n/a	BEM-based (No action) Year type = Dry	Reference Year type = Below Normal
Yolo	62.10	59.21
Lower Sac	61.81	59.21
Confluence	62.42	59.21
Marsh	65.24	59.21

Table 7a-b. Growth increment (performance measure) for each region-year type-scenario combination. Growth increment was the difference between BEM-predicted growth with simulated action minus predicted growth with no action.

Table 7a: Below Normal Year Type

Region	NDFS-AgLong-Low	NDFS-AgShort-High	NDFS-SacAg	NDFS-SacLong-Low	NDFS-SacShort-High	SMSCG-4ppt	SMSCG-6ppt
Yolo	0.30	0.22	0.63	0.33	0.21	0	0
Lower Sac	0.05	0.05	0.07	0.05	0.05	0	0
Confluence	0	0	0	0	0	0	0
Marsh	0	0	0	0	0	0.43	0.34

Table 7b: Dry Year Type

Region	NDFS-AgLong-Low	NDFS-AgShort-High	NDFS-SacAg	NDFS-SacLong-Low	NDFS-SacShort-High	SMSCG-4ppt	SMSCG-6ppt
Yolo	0.42	0.34	--	--	--	--	--
Lower Sac	0.07	0.07	--	--	--	--	--
Confluence	0	0	--	--	--	--	--
Marsh	0	0	--	--	--	--	--

Delta Smelt Habitat and Food

Modeling for SMSCG showed salinity at Belden's Landing reached 4 ppt in mid-June for the Dry year no-action alternative and mid-July for the Below Normal year no-action alternative (Figure 6). Operating the gates with a 4 ppt trigger resulted in salinity at Belden's fluctuating above and below 4 ppt for the duration. Operating the gates with a 6 ppt trigger made it difficult to decrease salinity in the Marsh below 4 ppt with the modeled timing. Future modeling may need to assess other alternative gate operation schedules.

Modeling for NDFS showed flow in the Yolo Bypass as Lisbon Wier became positive under each scenario compared to the no-action alternative. The scenario that has not yet been experimented - a summer Sacramento action followed by a fall agricultural action - would result in the longest duration of positive net flow (Figure 7).

Overall habitat suitability for Delta Smelt had the largest change in the Suisun Marsh region compared to other regions in the estuary in a BN year (Figure 8). Operations of SMSCG increased HSI, particularly in August and September. The salinity trigger of 4 ppt had greater benefit for smelt habitat than the 6ppt trigger. NDFS alternatives had no effect on HSI and hence Dry year HSI is not shown.

As noted previously, models runs were conducted without the Suisun Marsh Salinity Control Gate flashboards closed while the radial gates were operating, this was not corrected in the current results; however, salinity was still controlled a fair amount in the expected way by the residual effect of the radial gates but the summer-fall habitat is likely significantly underestimated for all but the no-action alternative. Corrections will be made in future years.

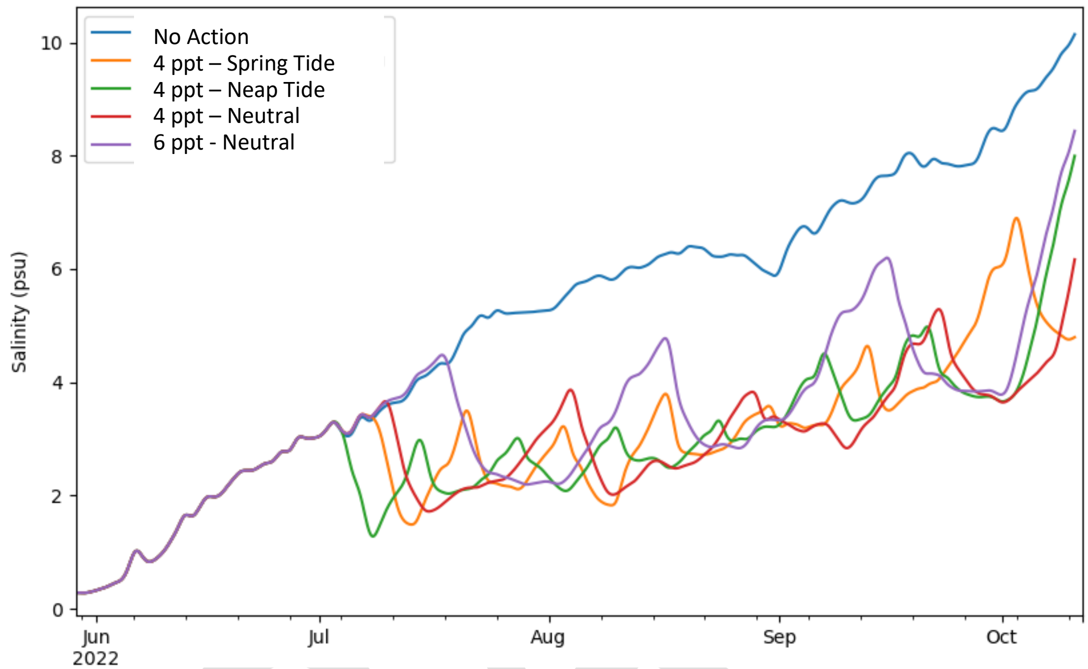

Figure 6. Forecast salinity at Beldon's Landing for a Below Normal water year type and operational scenarios (4 v. 6 ppt trigger) as modeled by SCHISM.

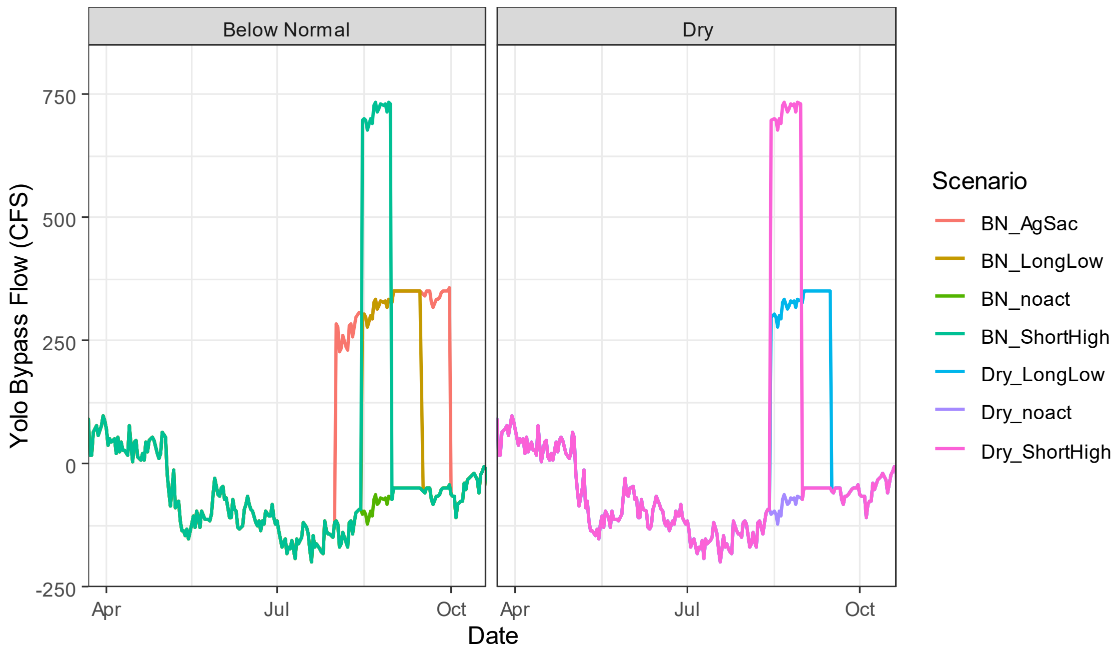

Figure 7. Modeled flow (CFS) in Yolo Bypass as Lisbon Wier for different water year type and operation scenarios as modeled by DSM2.

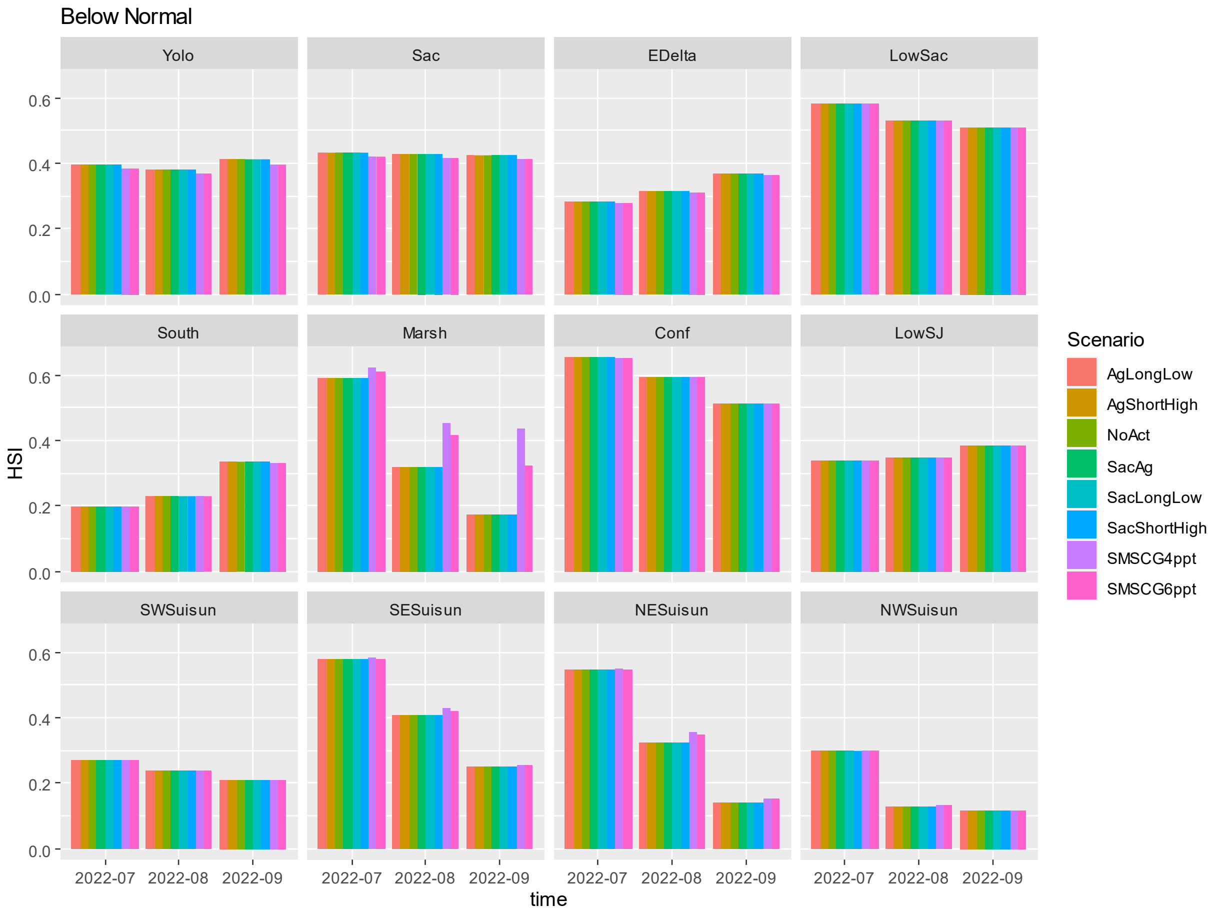

Figure 8. Modeled Habitat Suitability Index (HSI) by region, scenario, and month for a Below Normal water year.

Zooplankton Biomass

Gate operations increased modeled zooplankton biomass within Suisun Marsh due to increased biomass of freshwater calanoid copepods. When weighed by HSI, this resulted in a large increase in the overlap of good physical habitat and high zooplankton biomass (Figure 9 9). These increases were larger when operating the gates to a 4ppt trigger than a 6ppt trigger. For the NDFS action, modeled summer Sacramento River actions had a greater increase in zooplankton biomass than an agricultural action, and long duration, low intensity pulses had greater increases than a short duration, high intensity pulse. The combination of a summer Sacramento River action and fall Agricultural action had the highest increase in zooplankton. However, zooplankton biomass is generally highly variable. The standard error on the mean biomass used for the baseline and the salinity-biomass relationships for Suisun were quite large. The expert elicitation for the NDFS action was also subject to the differing opinions of the experts used and the inputs to the RMA copepod model used to base the relationships on.

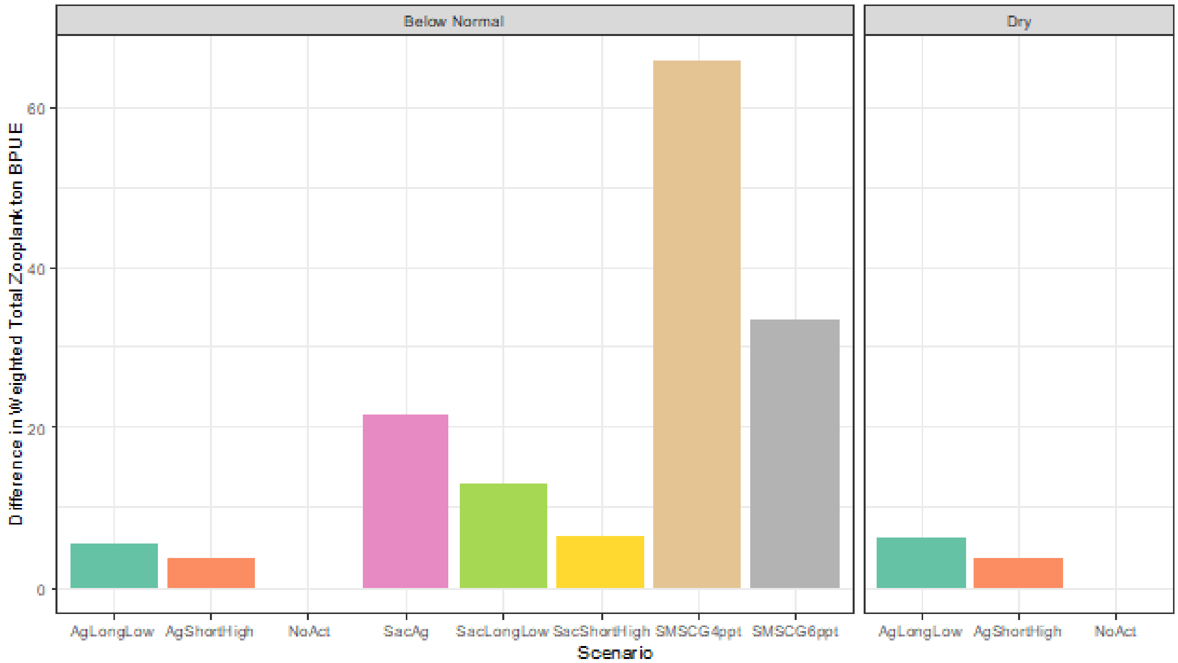

Figure 9. Modeled difference in weighted total zooplankton biomass (BPUE) between operational scenarios (NDFS and SMSCG) and a no-action scenario for Below Normal and Dry water year types.

Water Costs

Modeling water costs for operating the gates in a Below Normal year when salinity at Belden's Landing was >4 ppt differed than if salinity was >6ppt. Operating the gates at the 4 ppt trigger corresponds with times of greatest exports, resulting in a higher water cost (69 TAF) as compared to the 6ppt trigger that includes a period of lower exports in October making the operation more efficient (63 TAF) as it operates the gates for some of the allotted 60 days during this period. Both the 4ppt and 6ppt scenarios for a SMSCG action result in greater operation costs than a no-action year (0 TAF). The NDFS action re-routes flow with minimal difference in losses between the paths and therefore water costs are inconsequential.

Contaminants

An expert elicitation was conducted to evaluate the effect of action alternatives on potential contaminant impacts to food quality and Delta Smelt. The elicitation effort involved 1) a conceptual model group to develop the constructed scale of effects of alternatives on contaminant effects and, 2) a respondent group with subject matter expertise to provide their scores for each action alternative. Experts participated in the respondent group and contributed opinions on the potential impacts of the actions on zooplankton quality, zooplankton survival, Delta Smelt growth, Delta Smelt survival, and Delta Smelt recruitment. The conceptual model group developed the constructed scale of -1 to 1, with 1 being increase and -1 being decrease from the no-action alternative. There were some contrasting scores, with some scores of -1 and 1 on a performance metric for the same alternative. Many experts did not feel qualified to state an opinion about some of the actions, particularly the SMSCG action.

Overall elicitation results were consistent with the conceptual models and previous studies. The NDFS Sacramento River action alternative was better supported for relatively less contaminant toxicity as compared to the NDFS Agricultural action. The elicitation concluded the NDFS agricultural action alternatives would result in decreases in performance metrics for zooplankton and Delta Smelt due to increases in contaminant exposure which was consistent with prior reports on the actions showing increases in contaminants for the NDFS Ag actions (Orlando et al. 2020). In respect to SMSCG, the elicitation conclusions suggest that the action in general is better than the no-action alternative which is consistent with prior studies finding contaminant impacts being lower in Suisun Marsh relative to locations like Cache Slough (Weston et al. 2014, 2016) and studies that showed decreases prevalence and severity of toxicity effects in Delta smelt collected in Suisun Marsh relative to other locations (Hammock et al. 2015; Teh et al. 2020). Future expert elicitations should consider inclusion of a workshop with the experts to make sure they understand the actions and allow them to discuss any differences in scores.

Effects to other species

Effects to salmonids and sturgeon were evaluated using expert elicitation (see Appendices for elicitation materials and conceptual models). However, the action alternatives, as they were developed for evaluating impacts to Delta smelt, proved insufficient to adequately evaluate impacts to salmonids. For example, experts felt that the source of the extra flow used in the SMSCG action (releases from Shasta, Oroville, Folsom, or export reductions) was an important driver of potential impacts to salmonids but water source was not an element of the original alternatives table. The DCG did get helpful information from the pilot expert elicitation for effects to other species this year. Future expert elicitations for effects to salmonids and sturgeon should include more workshops with the experts to make sure they understand the actions and allow them to discuss any differences in scores.

While the preliminary feedback from experts regarding effects to salmonids was not explicitly included in the final alternative selection for a 2022 action, there was general consensus that the impacts of the various Dry or Below Normal year actions were likely low.

Resource Costs

Baseline science and monitoring for a no-action scenario costs approximately $1 million. Additional costs to implement a SMSCG action costs approximately $250K, which would be the same for a 4ppt trigger and a 6ppt trigger. Additional costs for an agricultural NDFS action cost approximately $100K, which would be the same for short-high and long-low. Additional costs for a Sacramento River action would be approximately $250K. Conducting a summer Sacramento River + fall Agriculture NDFS action would be the most expensive option because baseline monitoring would be extended from roughly 3 months to 5 or 6 months, giving a cost of $500K above baseline.

Table 8. Consequence table with scoring of each alternative based on the sub-objectives and performance measures chosen by the DCG.

Objective	Sub-objective	Performance Measure	Unit	Preferred Direction	Dry No Action	Dry NDFA Ag Short-High	Dry NDFA Ag Long-Low	BN No Action	BN SMSCG 4ppt	BN SMSCG 6ppt	BN NDFA Sac Short-High	BN NDFA Sac Long-Low	BN NDFA Ag Short High	BN NDFA Ag Long-Low	BN NDFA Sac-Ag
Delta Smelt Growth and Survival	Yolo	Growth increment	mm	Higher	0	0.34	0.42	0	0	0	.21	0.33	0.22	0.30	0.63
Delta Smelt Growth and Survival	Lower Sac	Growth increment	mm	Higher	0	0.07	0.07	0	0	0	0.05	0.05	0.05	0.05	0.07
Delta Smelt Growth and Survival	Confluence	Growth increment	mm	Higher	0	0	0	0	0	0	0	0	0	0	0
Delta Smelt Growth and Survival	Marsh	Growth increment	mm	Higher	0	0	0	0	0.43	0.34	0	0	0	0	0
Habitat Suitability Index (HSI)	Yolo HSI	HSI + temp	n/a	Higher	0.38	0.38	0.38	0.40	0.38	0.38	0.40	0.40	0.40	0.40	0.40
Habitat Suitability Index (HSI)	Sac HSI	HSI + temp	n/a	Higher	0.41	0.41	0.41	0.43	0.42	0.41	0.43	0.43	0.43	0.43	0.43
Habitat Suitability Index (HSI)	E Delta HSI	HSI + temp	n/a	Higher	0.33	0.33	0.33	0.32	0.32	0.33	0.32	0.32	0.32	0.32	0.32
Habitat Suitability Index (HSI)	Low Sac HSI	HSI + temp	n/a	Higher	0.53	0.53	0.53	0.54	0.54	0.53	0.54	0.54	0.54	0.54	0.54

Objective	Sub-objective	Performance Measure	Unit	Preferred Direction	Dry No Action	Dry NDFA Ag Short-High	Dry NDFA Ag Long-Low	BN No Action	BN SMSCG 4ppt	BN SMSCG 6ppt	BN NDFA Sac Short-High	BN NDFA Sac Long-Low	BN NDFA Ag Short High	BN NDFA Ag Long-Low	BN NDFA Sac-Ag
Habitat Suitability Index (HSI)	South HSI	HSI + temp	n/a	Higher	0.28	0.28	0.28	0.26	0.25	0.28	0.26	0.26	0.26	0.26	0.26
Habitat Suitability Index (HSI)	Marsh HSI	HSI + temp	n/a	Higher	0.16	0.16	0.16	0.36	0.51	0.42	0.36	0.50	0.36	0.36	0.36
Habitat Suitability Index (HSI)	Confluence HSI	HSI + temp	n/a	Higher	0.50	0.50	0.50	0.59	0.59	0.55	0.59	0.59	0.59	0.59	0.59
Habitat Suitability Index (HSI)	Low SJ HSI	HSI + temp	n/a	Higher	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
Habitat Suitability Index (HSI)	SW Suisun HSI	HSI + temp	n/a	Higher	0.23	0.23	0.23	0.24	0.24	0.23	0.24	0.24	0.24	0.24	0.24
Habitat Suitability Index (HSI)	SE Suisun HSI	HSI + temp	n/a	Higher	0.25	0.25	0.25	0.41	0.42	0.36	0.41	0.42	0.41	0.41	0.41
Habitat Suitability Index (HSI)	NE Suisun HSI	HSI + temp	n/a	Higher	0.15	0.15	0.15	0.34	0.35	0.29	0.34	0.35	0.34	0.34	0.34
Habitat Suitability Index (HSI)	NW Suisun HSI	HSI + temp	n/a	Higher	0.12	0.12	0.12	0.18	0.18	0.16	0.18	0.18	0.18	0.18	0.18
Zooplankton	Delta-wide	Change in weighted food	(ug/L)*HSI	Higher	0	3	6	0	66	33	7	13	6	3	22

Objective	Sub-objective	Performance Measure	Unit	Preferred Direction	Dry No Action	Dry NDFA Ag Short-High	Dry NDFA Ag Long-Low	BN No Action	BN SMSCG 4ppt	BN SMSCG 6ppt	BN NDFA Sac Short-High	BN NDFA Sac Long-Low	BN NDFA Ag Short High	BN NDFA Ag Long-Low	BN NDFA Sac-Ag
		availability score													
Contaminant Effects	Zoop quality effects	constructed scale	-1 to 1	Higher	0	-0.75	-0.25	0	0	0.25	-0.75	0.25	-0.75	-0.25	-0.5
Contaminant Effects	Zoop abundance (survival) effects	constructed scale	-1 to 1	Higher	0	-0.75	-0.25	0	0	0.25	-0.5	0.5	-1	-0.33	0
Contaminant Effects	DS growth effects	constructed scale	-1 to 1	Higher	0	-1	-0.25	0	0	0.25	-0.5	0.5	-1	-0.25	0
Contaminant Effects	DS survival effects	constructed scale	-1 to 1	Higher	0	-0.67	0	0	0.25	0.5	0.33	0.67	-0.67	0	0
Contaminant Effects	DS recruitment effects	constructed scale	-1 to 1	Higher	0	-0.75	-0.25	0	0.25	0.5	-0.25	0.5	-0.75	-0.25	0
Resource Costs	Water Cost	Change in outflow	TAF	Lower		0	0	0	69	63	0	0	0	0	0
Resource Costs	Operating Cost	Difference from no-action	$1000/yr	Lower	0	100	100	0	250	250	250	250	100	100	500

Consequence Evaluations

Performance metric scores for each objective and sub-objective were compiled into a single table above (Table 8) for all alternative actions (SMSCG and NDFS in Dry and BN years). The *AltaViz* SDM application tool was used for the DCG to visually compare and discuss consequences and tradeoffs between action alternatives in a given year. Across all alternatives and water years, the DCG discussed greater interest in effects of contaminants on Delta Smelt growth, even though the expert elicitation identified other metrics (effects to zooplankton, survival) in the objectives. The DCG also discussed that the elicitation results for the 'Effects to other species' did not fit well with the rest of the consequence analysis and results were not explicitly considered in evaluations. Improvements to both expert elicitations (contaminants and effects to other species) will be done for next year. The following describes DCG evaluations for each water year and action alternatives.

Dry Year

The DCG assessed NDFS alternatives: (1) Dry No Action; (2) Dry NDFS Ag Short-High; (3) Dry NDFS Ag Long-Low. Habitat suitability was uninformative for comparisons, but differences in Delta Smelt growth and survival (in Yolo and Lower Sacramento), zooplankton availability, and contaminants were evaluated (Figure 10). NDFS Ag long-low alternative scored better than Ag short-high alternative, and therefore the evaluation ignored the short-high alternative and focused on NDFS long-low pulse compared to no-action. The main tradeoff identified in the Ag long-low alternative was between gains in smelt growth and survival and consequences (losses) for both contaminant effects and operation costs. The DCG discussed challenges comparing quantitative smelt growth values with a constructed scale values from contaminants and the confidence in the elicitation, but also the 0.42 mm growth increment across a summer in Yolo for the Ag long-low is potentially within the margin of error. In the end the DCG determined the analysis may not be sufficient to show the gains in smelt growth and survival are worth the costs. While some members thought that no-action might be preferable, the DCG agreed learning is an important objective that was not included in this year's SDM. Implementation of the fall NDFS Ag long-low alternative would increase learning, although enhanced monitoring of effects to other species, contaminants, and improved understanding of pulse effects on smelt growth should occur. Even members who originally stated a preference for the no-action scenario agreed to an action if we could increase learning.

Objective (Expand All Collapse All)	Performance Measure	Unit	Dry No Action	Dry NDFA Ag Short-High	Dry NDFA Ag Long-Low
Delta Smelt					
Delta Smelt Growth and Survival					
Yolo	Growth increment	mm	0	0.34	0.42
Lower Sac	Growth increment	mm	0	0.07	0.07
Confluence	Growth increment	mm	0	0	0
Marsh	Growth increment	mm	0	0	0
Suitable Habitat					
Zooplankton					
Delta-wide	Change in weighted food availability score	(ug/L)*HSI	0	3	6
Contaminant Effects					
Zoop quality effects	Constructed scale	-1 to 1	0	-.75	-.25
Zoop abundance (survival) effects	constructed scale	-1 to 1	0	-.75	-.25
DS growth effects	constructed scale	-1 to 1	0	-1	-.25
DS survival effects	constructed scale	-1 to 1	0	-0.67	0
DS recruitment effects	constructed scale	-1 to 1	0	-.75	-.25
Resource Costs					
Water Cost	Change in outflow	TAF	0	0	0
Operating Cost	Difference from No Action Alternative	$1000/year	0	100	100
Effects on other native species					

Figure 10. AltaViz tool evaluation of NDFS alternatives in a Dry year. Blue is the highlighted alternative for comparison, red indicates the other alternative does worse, green does better, and white the same.

Below Normal Year

The DCG evaluated SMSCG alternatives; (1) BN No-action; (2) BN SMSCG 4ppt; (3) BN SMSCG 6ppt (Figure 11). All sub-objectives had relatively informative score differences between alternatives. Only the Marsh region had informative differences for Delta Smelt growth and survival and habitat suitability score whereas all other regions were uninformative and ignored in the evaluation. Measures of Delta Smelt growth increment of 0.4 mm/summer, zooplankton availability, and habitat suitability were all greater in the SMSCG 4 ppt alternative compared to the 6ppt and no-action alternatives. Review of the contaminant expert comments from the elicitation revealed more project information was needed to provide meaningful scores with confidence and consistency across scorers. As a result of the contaminant uncertainty, contaminant scores were not considered in the trade-off assessment of benefits of the SMSCG alternatives on smelt growth, habitat and food availability compared to water and operation costs. Unless contaminant modeling and monitoring can be improved in the future, the group discussed that contaminants may not be a good objective for inclusion in the SDM assessment.

Overall, it was clear the benefits of operating the SMSCG with the 4 ppt trigger at Belden's Landing was greater than a 6 ppt trigger, and the group supported the implementation of a SMSCG 4ppt alternative over no-action in a BN year.

Objective (Expand All Collapse All)	Performance Measure	Unit	BN No Action	BN SMSCG 4ppt	BN SMSCG 6ppt
Delta Smelt					
Delta Smelt Growth and Survival					
Yolo	Growth increment	mm	0	0	0
Lower Sac	Growth increment	mm	0	0	0
Confluence	Growth increment	mm	0	0	0
Marsh	Growth increment	mm	0	0.43	0.34
Suitable Habitat					
Marsh HSI	HSI -T	0 - 1	0.36	.5	.41
Zooplankton					
Delta-wide	Change in weighted food availability score	(ug/L)*HSI	0	66	33
Contaminant Effects					
Zoop quality effects	Constructed scale	-1 to 1	0	0	0.25
Zoop abundance (survival) effects	constructed scale	-1 to 1	0	0	0.25
DS growth effects	constructed scale	-1 to 1	0	0	0.25
DS survival effects	constructed scale	-1 to 1	0	0.25	0.5
DS recruitment effects	constructed scale	-1 to 1	0	0.25	0.5
Resource Costs					
Water Cost	Change in outflow	TAF	0	69	63
Operating Cost	Difference from No Action Alternative	$1000/year	0	250	250
Effects on other native species					

Figure 11. AltaViz tool evaluation of SMSCG alternatives in a Below Normal year. Blue is the highlighted alternative for comparison, red indicates the other alternative does worse, green does better, and white the same.

The DCG assessed Below Normal NDFS alternatives: (1) Dry No Action; (2) Dry NDFS Ag Short-High; (3) Dry NDFS Ag Long-Low (4) NDFS Sac short-high; (5) NDFS Sac Long-Low; (6) NDFS Sac+Ag (Figure 12). As in the Dry year assessment, habitat suitability was uninformative for comparisons and water costs are inconsequential for NDFS, therefore, both were ignored in the trade-off evaluation. Delta Smelt growth and survival (in Yolo and Lower Sacramento), zooplankton availability, contaminants, and operation costs were evaluated. The DCG removed both agricultural alternatives (NDFS long-low and short-high) from the comparative assessment as all alternatives re-routing Sacramento River water had greater incremental smelt growth and less negative effects of contaminants. The Sac short-high alternative was also removed with less gains in smelt growth and survival, zooplankton, and slightly increased contaminants scores. The narrowed set of alternatives for evaluation became the NDFS Sac+Ag alternative compared to the Sac long-low or no-action alternatives. The uncertainty of the biological significance of small differences in gains of smelt growth and food was discussed. For example, is the gain in 0.3 mm/summer growth increment, or near doubling of food availability significant between the Sac+Ag and the Sac long-low? Understanding the significance of the gains would aid in better evaluation of the operation and monitoring cost increases with the associated alternatives ($250-500k). Additionally, more information on the effects to other species, and how the timing and water sources of alternatives could negatively affect salmonids. Many of the experts from the elicitation suggested the potential for increased straying and/or entrainment from NDFS alternatives; however, those were noted for fall agriculture actions, and would be less of a concern during summer Sacramento River alternatives. In the end the DCG determined again that the analysis may not be sufficient to show the gains in smelt growth and survival and zooplankton are worth the operation costs. While some members alluded to no-action, the DCG agreed learning more about NDFS alternative is important. Implementation of the NDFS Sac long-low alternative would increase learning, although enhanced monitoring of effects to other species, contaminants, and improved understanding of pulse effects on smelt growth should occur.

Objective (Expand All Collapse All)	Performance Measure	Unit	BN No Action	BN NDFA Sac Short High	BN NDFA Sac Long-Low	BN NDFA Ag Short High	BN NDFA Ag Long-Low	BN NDFA Sac-Ag
Delta Smelt								
Delta Smelt Growth and Survival								
Yolo	Growth increment	mm	0	0.21	0.33	0.22	0.3	0.63
Lower Sac	Growth increment	mm	0	0.05	0.05	0.05	0.05	0.07
Confluence	Growth increment	mm	0	0	0	0	0	0
Marsh	Growth increment	mm	0	0	0	0	0	0
Suitable Habitat								
Zooplankton								
Delta-wide	Change in weighted food availability score	(ug/L)*HSI	0	7	13	3	6	22
Contaminant Effects								
Zoop quality effects	Constructed scale	-1 to 1	0	-.75	.25	-.75	-.25	-.5
Zoop abundance (survival) effects	constructed scale	-1 to 1	0	-.5	.5	-1	-.33	0
DS growth effects	constructed scale	-1 to 1	0	-.5	.5	-1	-.25	0
DS survival effects	constructed scale	-1 to 1	0	0.33	0.67	-0.67	0	0
DS recruitment effects	constructed scale	-1 to 1	0	-.25	.5	-0.75	-.25	0
Resource Costs								
Water Cost	Change in outflow	TAF	0	0	0	0	0	0
Operating Cost	Difference from No Action Alternative	$1000/year	0	250	250	100	100	500
Effects on other native species								

Figure 12. AltaViz tool evaluation of NDFS alternatives in a Below Normal year. Blue is the highlighted alternative for comparison, red indicates the other alternative does worse, green does better, and white the same.

Offramps

While the DCG modeled and evaluated all the scenarios listed above, the final actions chosen for 2022 will depend on the final water year type and other constraints. Due to the extremely dry hydrology and other conflicting resource needs, the ESA coverage for the NDFS action will not be complete by fall of 2022, so all scenarios for this action will not be included this year. However, the evaluation of the alternatives will be a useful starting point for future year's actions.

Primary Conclusions of SDM from DCG

Dry Year

In a Dry year, the DCG would recommend the NDFS agriculture flow pulse with low intensity and long duration as part of the SFHA. However, the recommendation came with a contingent offramp regarding dissolved oxygen levels (<5 mg/L) and poor water quality in the upper reach of the project that could negatively affect salmonids in the project area. Several DCG members leaned towards no NDFS action due to the small effects on Delta Smelt growth and concerns with contaminant effects and potential effects to other species (though those scores were ignored in evaluation), but all were not opposed to the Ag long-low action for the need to learn more with respect to benefits and contaminants. Others indicated that with sequential dry year conditions implementation of NDFS agriculture actions are worth the risks. The DCG recommends continued science and monitoring to reduce uncertainties including contaminants and potentially the use of Delta Smelt enclosures for evaluating sublethal effects. Lastly, the DCG suggested the need to develop additional hypotheses, off-ramps, and may need to modify the alternative actions to reduce trade-offs.

Below Normal Year

In a BN year, the DCG would recommend implementation of a SFHA that included SMSCG operations to the 4ppt threshold at Belden's landing and the NDFS summer Sacramento River managed flow pulse with low intensity and long duration. All members supported the decision for SMSCG and agreed contaminants should not be included in SDM unless information is improved. In contrast, conclusions for NDFS, one member expressed they would favor no-action due to operation costs and uncertainty in benefits; however, they would not stop implementation of the action if the rest of the group consensus was to implement an action and learning occurred. Other members expressed varied interests in support of the recommended NDFS Sac alternative including, improving net positive flow for as long as possible with the least cost, less negative effects to salmonids, the Sac+Ag alternative while the greatest gains to smelt growth and food has not been tested and is most expensive, and the need to repeat alternatives to improve learning and data analysis to inform adaptive management (thresholds and offramps) of NDFS.

Following the above DCG conclusions of SDM for SFHA in a Dry or Below Normal year, the DCG modeling team found a minor error in one of the early steps in the modeling process, causing inaccurate numbers in zooplankton model inputs. In correcting this error, values for Delta Smelt food availability and growth and survival were slightly modified; however, the relative benefits of the different action types remained the same and we would assume that the uncertainty did not change significantly either. Therefore, our confidence in the new results are no different than how we perceived the prior results. Ideally, a mistake of this nature would have necessitated another SDM meeting but since this is a no-action year, and the relative benefit between actions remains the same, a short follow-up discussion with the DCG occurred late April presenting the corrections and revised consequence tables. The DCG concluded that the corrections would not change their SDM conclusions and approved the changes to be included in the present plan.

Monitoring and Scientific Investigations

Both the NDFS and the SMSCG actions include robust monitoring programs that occur in both action and non-action years. This includes collection of phytoplankton, zooplankton, and water quality monitoring, as well as special studies of contaminants, benthic invertebrates, and fish. A full description of the monitoring can be found in the study plans for the actions (Appendices C and D).

The project-specific monitoring occurs in the context of the larger Interagency Ecological Program monitoring enterprise. Data on fish response to the actions, in particular relies heavily on data collected by existing monitoring surveys, such as the Fall Midwater Trawl, Environmental Monitoring Program, Summer Townet Survey, Yolo Bypass Fish Monitoring Program, and the Directed Outflow Project. All these data sources are integrated to assess the effectiveness of the actions.

Future science priorities are evaluated through the DCG Science and Monitoring work group. In 2022, the Science and Monitoring Work Group identified their highest priority science actions to include a better understanding of the response of zooplankton and flow, collecting baseline data on zooplankton in Roaring River, and additional contaminant sampling. Experimental deployment of smelt enclosures is also a high priority in action years, though will generally not be used in non-action years.

The SFHA Monitoring and Science Plan (Appendix A) is updated annually to provide general descriptions of ongoing monitoring activities and identify topics for potential work plan modifications or directed studies. Full action study plans are provided as appendices.

Coordination and Communication

The DCG will continue to meet monthly throughout 2022. From June through October, meetings will include monthly science and monitoring updates. The DCG will contribute to the development and review of annual deliverables including the annual SFHA report and updated Science and Monitoring Plan. The DCG anticipates using lessons learned from this year's SDM process to identify and prioritize knowledge gaps and science needs for future decision-making and to consider additional models, data, and tools that could be used to inform future decision-making. The Science and Monitoring Work Group and Hydrology and Operations Work Group will continue to meet approximately monthly to provide technical support and to evaluate directed science proposals aimed at filling information gaps and reducing uncertainty. SDM for water year 2023 is anticipated to begin in October 2022.

The DCG may provide occasional updates to different groups upon request, such as the Long-Term Operations coordination group, Collaborative Science and Adaptive Management Program's Delta Smelt SDM effort, and the Interagency Ecological Program's Science Management Team and Project Work Teams.

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Appendices

A. Summer Fall Habitat Action (SFHA) Science and Monitoring Plan
B. 2022 Delta Coordination Group Structured Decision Making (SDM) Decision-Process Document and supporting appendices
C. SMSCG Science and Monitoring Plan
D. NDFS Operations, Science and Monitoring Plan

Appendices are provided as separate attachments.