CSAMP Delta Smelt SDM Project

Dec. 6, 2023, Policy Group Presentation

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Compass Resource Management

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Today's Presentation Objectives

12/6 CSAMP Policy Group Meeting

- Share the CSAMP Delta Smelt TWG's work over the last 6 months following the 6/7 Policy Group presentation on the Round 1 SDM Evaluation:
  - Sensitivity analysis for food, turbidity and flow actions
  - Delta Smelt TWG's characterization of effects uncertainty and technical feasibility for Round 1 actions
- Discuss a possible schedule for wrapping up and documenting Round 1 SDM.

Re-cap:

Round 1 SDM Evaluation Presentation to 6/7 Policy Group Meeting

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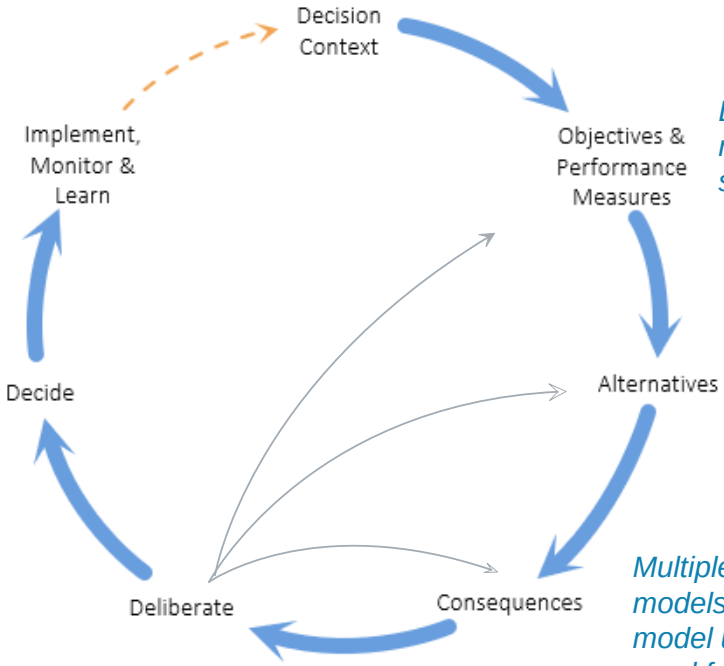
Structured Decision Making for Delta Smelt

What are the best management and science actions to advance CSAMP's Delta Smelt management goal?



Delta Smelt population growth, resource costs (water & financial), salmon effects

Round 1 was scoped to model 13 individual management actions and combinations of those actions.

Multiple Delta Smelt population models used to better understand model uncertainty; coarse methods used for other objectives for comparative purposes

Round 1 Technical Take-aways presented at the 6/7 Policy Group, with deliberation of results leading to further analysis.

Round 1 Takeaways (June 7, 2023)

1. Current management (approximated in Portfolio 1b) is not sufficient to achieve Delta Smelt population growth in the long-term in the absence of consecutive wet years.
2. Recovery is possible through multiple, additional actions with synergistic effects; there's no silver bullet.
3. **Actions and portfolios that improved food and turbidity showed greatest benefits to Delta Smelt across models.**
4. **Strategically increasing flow could grow the population in the near-term.**
5. Portfolios that showed greater benefits to Delta Smelt included actions that have substantial financial costs and feasibility challenges.
6. Exploring more portfolios could inform how to combine types of actions (flow, food, turbidity) and balance financial costs, water resources, and feasibility concerns.

Current Management Actions in Round 1 SDM Evaluation

Current actions targeting food for Delta Smelt:

- Tidal Wetland Restoration (14K acres currently being implemented or planned in EcoRestore)
- North Delta Food Subsidies

Current actions targeting turbidity conditions:

- None

Current actions targeting outflow/salinity:

- Fall X2 <80 km in W/AN years
- Summer/Fall Suisun Marsh Salinity Control Gates

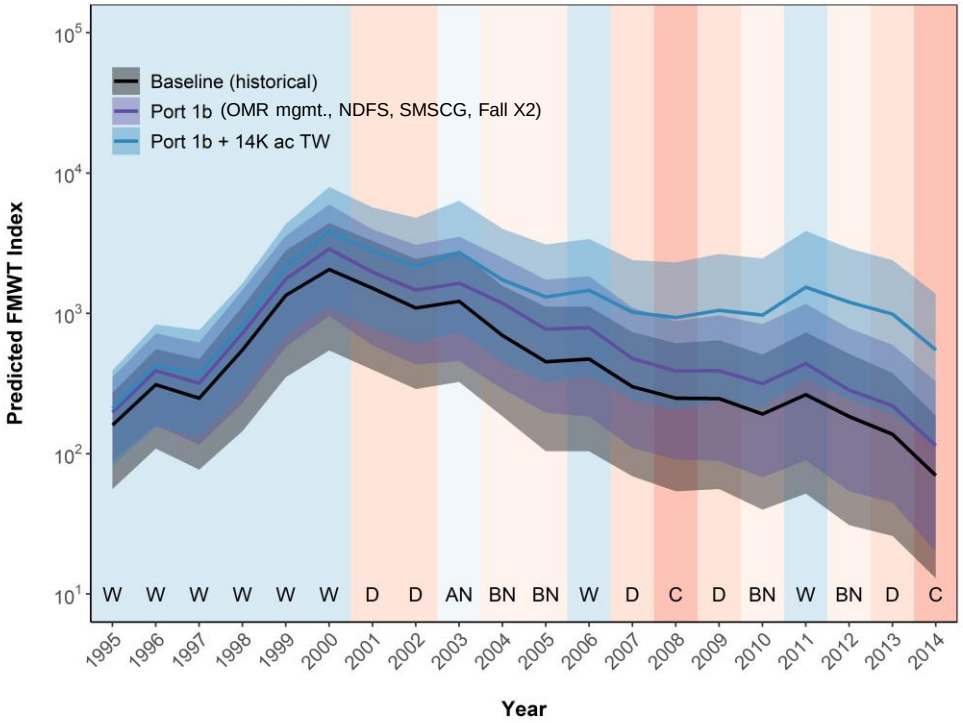
Other:

- OMR management to mitigate entrainment

+ other actions that have general benefits to native estuarine species

Current Management Actions

What are the predicted benefits of current management actions for Delta Smelt?



Delta Smelt Population models predict that current management is not sufficient to achieve Delta Smelt population growth in the long-term in the absence of consecutive wet years.

New Actions in Round 1 SDM Evaluation

Candidate new actions* to increase food for Delta Smelt:

- Tidal Wetland Restoration (more than currently planned)
- Managed wetlands food production
- Deepwater Ship Channel Food production

Candidate new actions* to improve turbidity conditions:

- Aquatic Weed Control
- Sediment Supplementation

Candidate new outflow/salinity actions:

- Summer Outflow (X2 <70/75 km, W/AN or W/AN/BN)
- Full good year outflow (variable spring, summer, and fall outflow targets depending on WYT)

Other:

- Physical point-source contaminants reduction
- Franks Tract Restoration (food, turbidity, and entrainment benefits)
- Engineered First Flush
- Fish Friendly Diversions for CVP/SWP Projects

*The primary purpose of these actions would be to increase food or turbidity. Some actions also have other benefits for DS.

Round 1 Consequence Table (June 7, 2023)

Objective			Performance Measure	Unit	Management Portfolios: 1b Current mgmt (approximation)	2a.2 Full-year flows - 700 TAF water budget	2b Cache Slough	2c Cache Slough & Suisun Marsh	3c.2 Summer flow & tidal wetlands (X2: Summer 65/70km; Fall current)	3c.4 Summer flow & tidal wetlands (X2: Summer 70/75km; Fall current)	3a Self-sustaining/permai management	3d Focus on food	3e Habitat connectivity
Delta Smelt Population													
Change in population growth (from baseline)													
IBMR	Low TW food effect		Avg. % change in population growth	%	1	23	14	27	12	42	99	126	
LCME	Low TW food effect		Avg. % change in population growth	%	2	21	13	25	11	39	58	38	
MDR	Low TW food effect		Avg. % change in population growth	%	29	24	24	17	13	33	33	90	
LF	Low TW food effect		Avg. % change in population growth	%	7	22	7	21	7	29	21	48	
Dynamic Habitat Suitability Index (overlap)													
Yolo/Cache Slough	Low food effect		DHSI	%	20	32	32	21	21	21	33	20	
Confluence & Lower Rivers	Low food effect		DHSI (max of subregion)	%	20	23	20	21	23	23	21	21	
Suisun Marsh & Bay	Low food effect		DHSI (max of subregion)	%	20	23	20	21	23	23	21	21	
Financial resources (above Portfolio 1b)													
Ball-park cost estimate (for comparative purposes only)			Annualized capital and operating cost (range)	$ million / yr	None	None	$1-$5	$1-$5	$21-$30	$21-$30	$101-$150	$151-$200	$76-$100
Water resources (above Portfolio 1b)													
Net additional water (for comparative purposes only): W, AN		^	Annual average	TAF / yr	0	165	0	1100	283	0	0	0	
Net additional water (for comparative purposes only): BN, D, C		^	Annual average	TAF / yr	0	95	0	1100	283	0	0	0	
Salmon Population (relative to Portfolio 1b)													
Potential direct benefits		Avg	Constructed scale (0 to 5)	0 to 5	0	1	0	1	1	2	3	1	
Potential direct risks		Min	Constructed scale (-5 to 0)	-5 to 0	0	-1	0	0	0	0	0	-2	

Policy Group feedback:

- Need more information on uncertainty and feasibility across the Round 1 actions.
- What does ‘strategically’ increase flow specifically mean?
- Monetization of water cost; socio-economic analysis

TWG interest:

- How is population growth predicted to change with increasing levels of food, turbidity and flow?
- Building a strategy for DS recovery

Food, Turbidity & Flow

Delta Smelt Modeling Results

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Delta Smelt population model predictions: Food

More food in more places increases Delta Smelt population growth

- Actions and portfolios that increased food (even minimally) across many subregions increased DS population growth (Figure, right 3 points)
- Combining localized food actions in multiple places (e.g., managed wetlands in Suisun Marsh, DWSC) could have measurable benefits to DS population growth
- Assumptions for the effects of food actions may be more optimistic than other actions

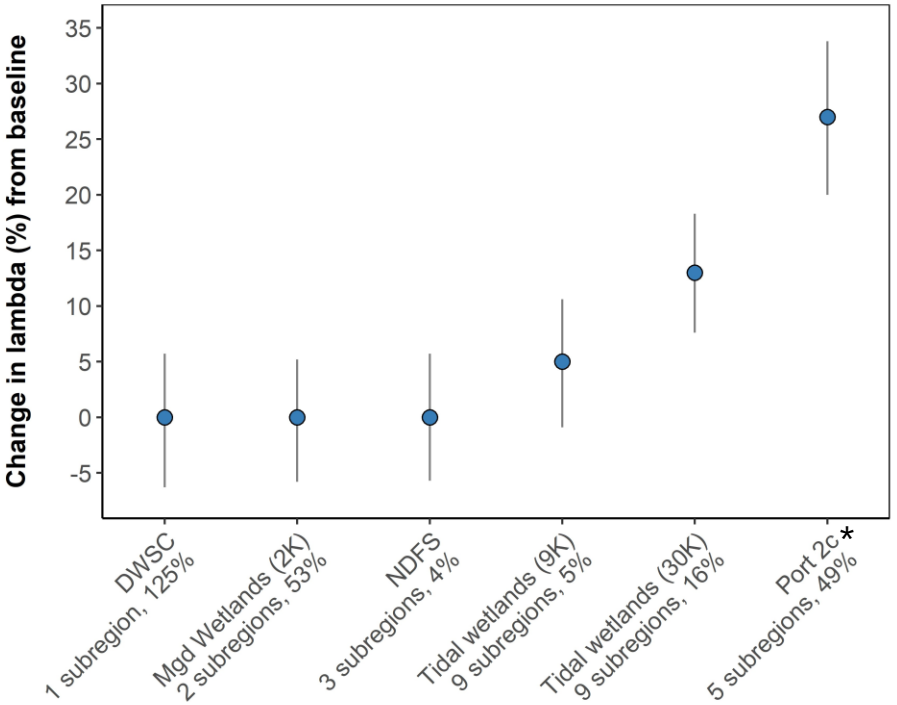
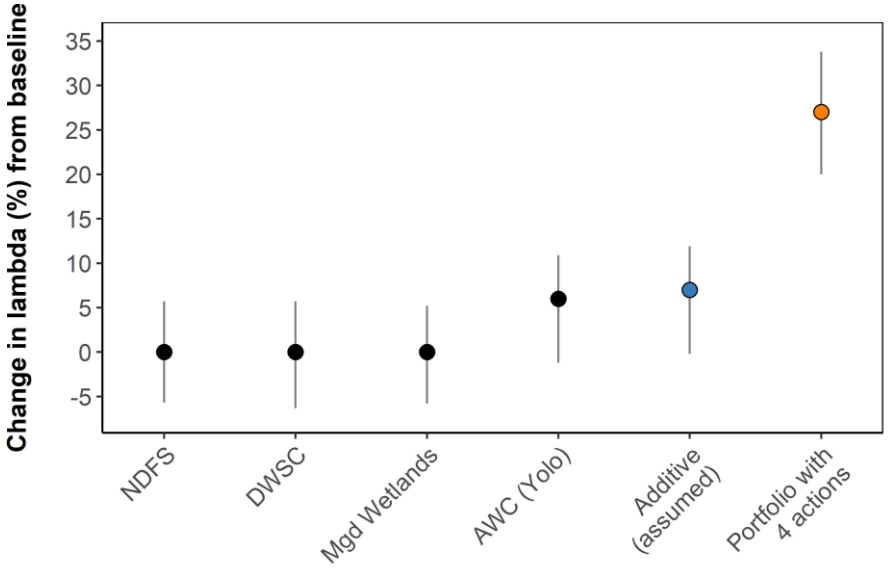


Figure. Predicted percent change from baseline for model runs of representative food actions or portfolios with the IBMR. Labels indicate the action, the number of subregions where food was increased, and the average % change in food (across those subregions and 20-year model timeframe).
* Portfolio 2c also includes current non-food management actions (OMR, SMSCG) and AWC in Yolo/Cache Slough (increases turbidity)

Delta Smelt population model predictions

Turbidity + food and Delta Smelt population growth

Turbidity & food benefits can be synergistic



Legend

- Individual actions
- Additive population growth (illustrative)
- Population growth from portfolio with 4 actions

Food and turbidity actions (black points) were predicted to have no or small increases to Delta Smelt population growth rate from baseline when evaluated independently. Population growth was substantially higher for a portfolio (2c, orange point) that included the four turbidity and food actions shown here, as well as current management actions (SMSCG, fall outflow).

Delta Smelt population model predictions

Flow & Delta Smelt population growth

Flow effects on population growth by season

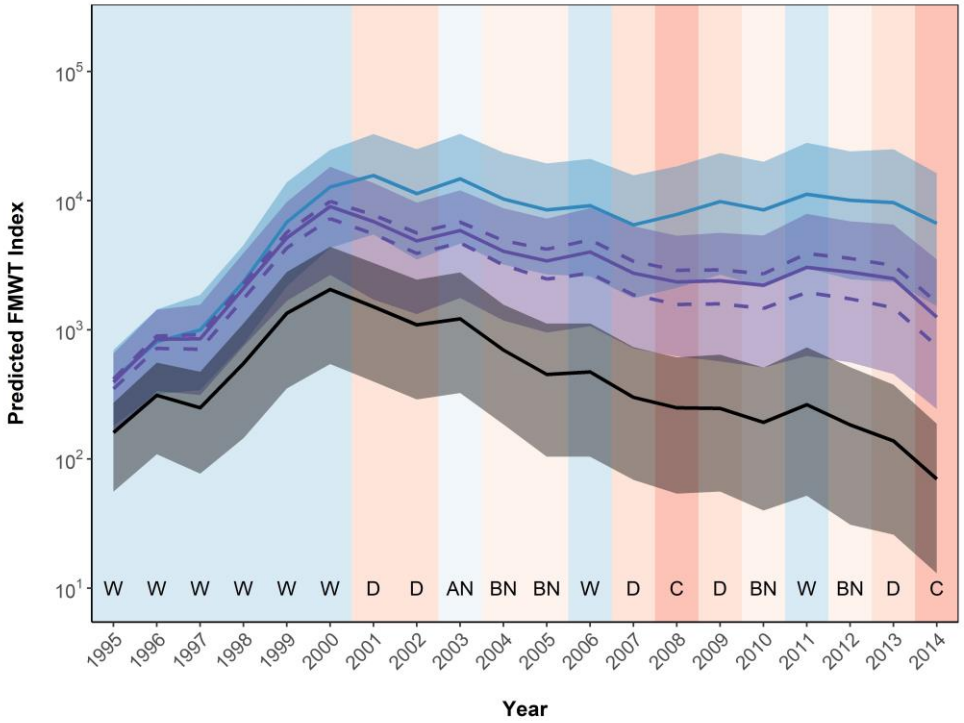
Results from X2 (action-only) sensitivity analysis

X2 Scenario Name	% change in average lambda from baseline (1995-2014)		
	Location targets in W and AN years (Summer = Jul/Aug; Fall = Sep/Oct)	IBMR	LCME
X2 summer low	59 / 66	11%	17%
X2 summer, inc 1	65 / 71	8%	11%
X2 summer, inc 2	70 / 75	3%	4%
X2 summer, inc 3	75 / 80	-4%	-4%
X2 summer high	80 / 84	-12%	-13%
X2 fall low	68 / 72	6%	0%
X2 fall, inc 1	74 / 76	4%	0%
X2 fall, inc 2	80 / 80	-3%	0%
X2 fall, inc 3	83 / 84	-5%	0%
X2 fall high	87 / 88	-4%	0%
Model Run Reference #s		6.24-6.33	6.24-6.33

Delta Smelt population model predictions

Flow & Delta Smelt population growth

Population benefits predicted through different flow actions that vary in timing



Legend

- Full good year outflow (Port 2a)
- Summer outflow, W/AN/BN
- Predicted baseline (historical)

Figure. Average predicted Delta Smelt FMWT Index across model years (1995-2014) for the action of “full good year” outflow (from Portfolio 2a: blue), summer outflow (X2 of 70/75 in Jul/Aug) in W, AN, and BN years (purple) and predicted baseline, historical conditions (black) in the IBMR. The shaded ribbons show background uncertainty (stochasticity, process variation) in the IBMR. The two flow action runs used the median estimate of flow-salinity-food effects from the Bashevkin model (solid line). The average predicted FMWT Index is also shown for summer outflow action runs that used the lower and upper 95% credible intervals of food effects (dashed lines). Water year types are indicated by letters at bottom of figure and blue-red bars.

TWG Sensitivity Analysis

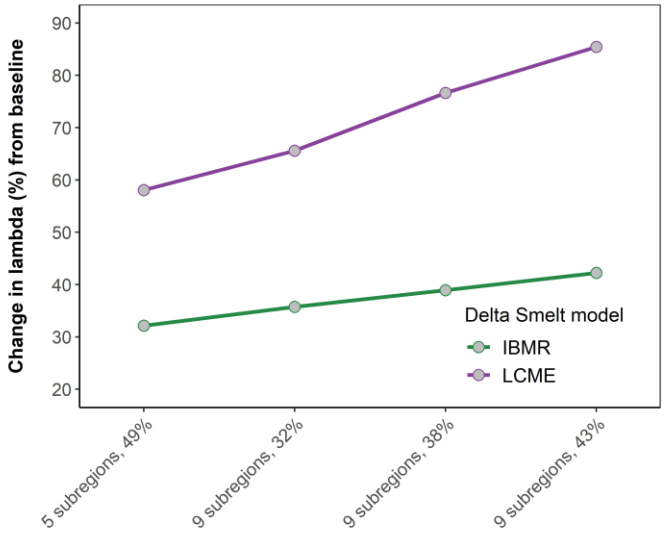
How does Delta Smelt population growth change with increasing levels of food, turbidity and flow?

		Core portfolio	Food varies			Turbidity varies			Flow varies				
Action		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Tidal wetland restoration (4 levels) - include Franks Tract in level 3 & 4		9K ac	0	20K	30K	9K acres			9K acres				
Aquatic weed control (4 levels)		Yolo/Cache (~600 ac)	Yolo/Cache (~600 ac)			0	4 subregions (~1,400 ac)	5 subregions (~3,500 ac)	Yolo/Cache (~600 ac)				
Additional Outflow to 1995-2014 baseline (6 levels)	Summer X2[1]	70/75	70/75			70/75			Baseline	70/75	70/75	70/75	65/70
	Fall X2[1]	80	80			80			Baseline	Baseline	80	74/76	74/76
	Water year type	W/AN	W/AN			W/AN			-	W/AN/ BN	W/AN/ BN	W/AN/ BN	W/AN
	# yrs (out of 20 model yrs)	7	7			7			0	11	11	11	8
Actions held constant across runs		North Delta Food Subsidies (#1.1); Suisun Marsh Salinity Control Gates (#5.2); OMR management (#10.2); DWSC Food Subsidies (#2.2); SM Managed Wetlands food production - 2,000 ac (#3.5)											

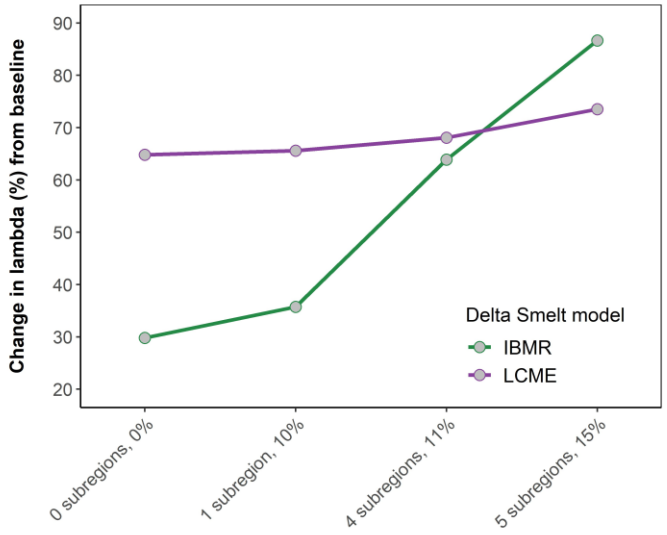
[1] Summer = Jul/Aug; Fall = Sep/Oct.

Food & Turbidity Sensitivity Analysis

How does Delta Smelt population growth change with increasing levels of food and turbidity?



Total **food** increases →



Total **turbidity** increases →

Figure. Predicted percent change from baseline for model runs in a sensitivity analysis that varied food and turbidity effects with the IBMR and LCME. All runs included the following actions while food or turbidity varied: Suisun Marsh managed wetlands, NDFS, DWSC, SMSCG, OMR, and outflow augmentation to meet X2 targets of 70/75 in summer (Jul/Aug) and 80 in fall (Sep/Oct) in W & AN years.

- Population growth increased with increases in food and turbidity across the sensitivity analysis runs.
- Delta Smelt population models show similar relationships between food and population growth; vary in relationships between turbidity and population growth. TWG modelers recommend further investigation into the turbidity relationships for Delta Smelt growth and survival.

Outflow Sensitivity Analysis

How does Delta Smelt population growth change with changes in summer and fall outflow/X2 targets?

- Population growth increased when adding summer outflow in more years
- For runs that included additional summer outflow to meet an X2 target of 70/75 in W/AN/BN years, increasing flow in the fall did not further increase population growth.

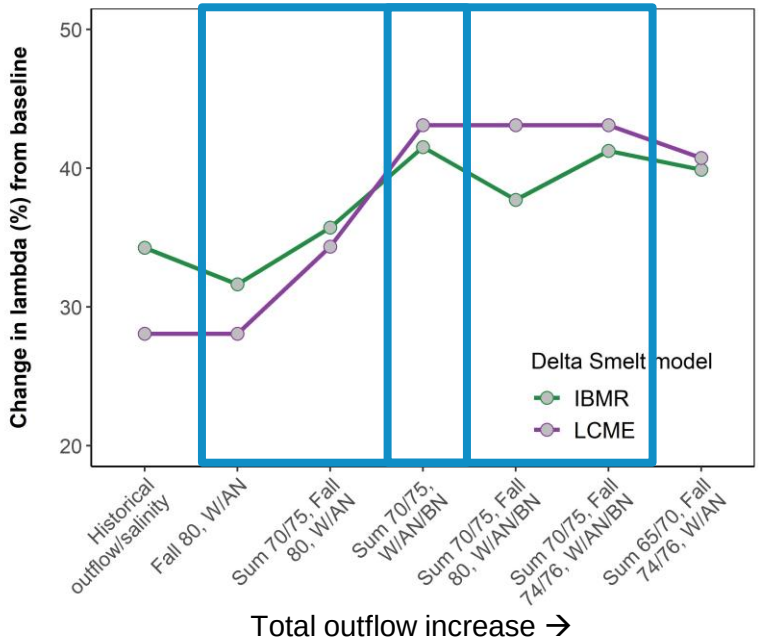


Figure. Predicted percent change from baseline for model runs in a sensitivity analysis that varied outflow augmentation by season (summer and/or fall) and X2 target with the IBMR and LCME. All runs included the following actions while outflow varied: 9K tidal wetland restoration, 2K managed wetland food production in Suisun Marsh, NDFS, DWSC food transport and subsidies, SMSCG Summer/Fall operations, OMR management.

Sensitivity Analysis Consequence Table

	Food varies on top of base actions				Turbidity varies on top of base actions				Flow varies on top of base actions					
	1	2	3	4	1	2	3	4	1	2	3	4	5	6
Delta Smelt Population – *Percent Change in population growth (from baseline)*														
IBMR	32%	36%	39%	42%	30%	36%	64%	87%	34%	36%	42%	38%	41%	40%
LCME – food model[3]	58%	66%	77%	85%	65%	66%	68%	74%						
LCME - X2 model[4]	32%	34%	37%	40%	34%	34%	37%	41%	28%	34%	43%	43%	43%	41%
Water resources (average annual net additional outflow relative to 1995-2014 observed outflow, for comparative purposes only)														
W/AN years (avg. TAF/yr)	412	412	412	412	412	412	412	412	0	412	345	412	794	1548
BN years (avg. TAF/yr)	-	-	-	-	-	-	-	-	-	-	810	924	1507	-
Financial resources (above Portfolio 1b, ballpark estimates for comparative purposes only)														
Average $ million / yr across 20-yr model period	1-5	26-30	51-60	61-70	21-25	26-30	26-30	36-40	26-30	26-30	26-30	26-30	26-30	26-30

- The IBMR and LCME predict that different combinations of food, turbidity and flow increases could lead to Delta Smelt population growth.
- While increases in all three of these categories are not necessary for population growth, across these model runs, population growth is expected to be highest when combining: food (level 4), turbidity (level 4), with flow (level 3).

Uncertainty and Technical Feasibility for Round 1 Actions

(focus on candidate new management actions)

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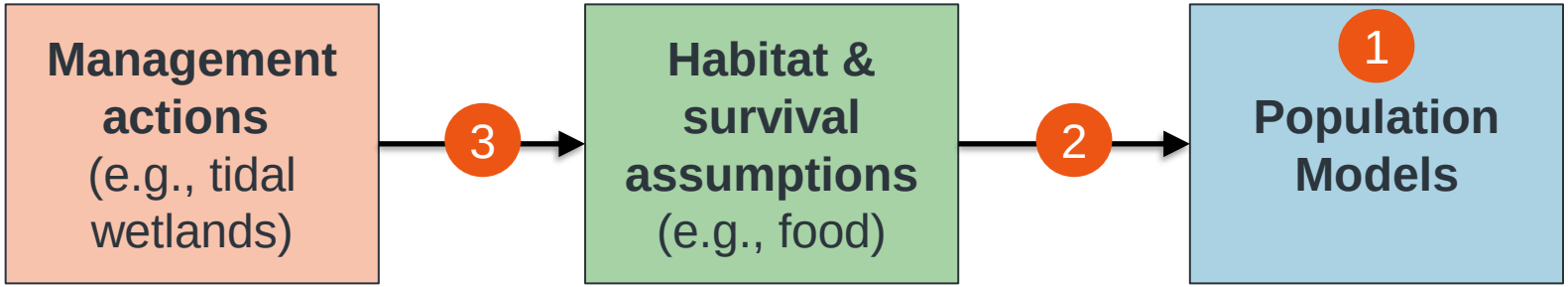
TWG Characterization of Uncertainty for Delta Smelt Predictions

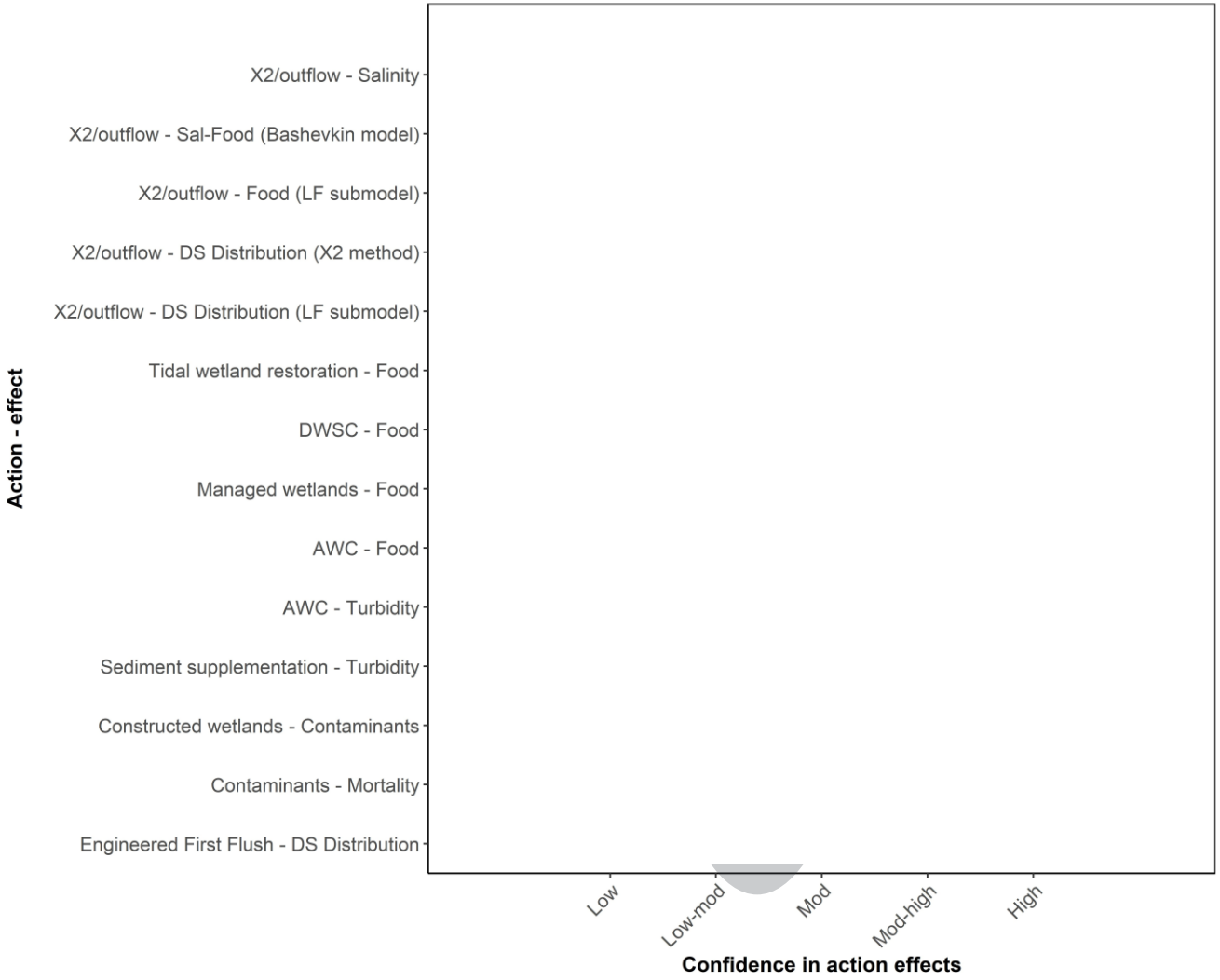


Understanding uncertainty through multiple methods:

1. Multi-model approach
2. Uncertainty in relationships between habitat/survival and population growth
3. Uncertainty in the effect assumptions for management actions

TWG Survey Question for Confidence in Effect Assumptions:

What is your level of confidence in the quantified proximate effect of Action [X] (e.g., on food, turbidity, salinity, flow) that are used as inputs to the Delta Smelt Population Models?
(Low, Low-Moderate, Moderate, Moderate-High, High, Unsure / Not enough information to answer)



Technical Feasibility of New Candidate Management Actions for Delta Smelt

Technical feasibility of the action?

Assuming a decision is made to advance the action toward implementation in 2024, what's your best guess of how long it will take to achieve full implementation, including research of technical aspects of the action and generation of expected benefits for Delta Smelt? Assume that any necessary permitting issues for the action can be resolved.

Can implement in <5 yrs

May be able to implement in >5 yrs

More feasible candidate management actions (Implementation with AM in **< 5 years**); need more science now to specify how & effects

- **Mgd Wetlands Food**: Small scale, Suisun Marsh — 0%
- **Aquatic Weed Control:** Small scale with current permitted methods, Cache Slough focus — 6%
- **Outflow Action:** Full good year flows — 21%
- **Outflow Action:** ↑ Summer Outflow — 7%
- **Engineered First Flush** — 7%

Less feasible candidate management actions (Implementation in **> 5 years**); need to invest in science now to inform next steps

- **Tidal Habitat Restoration:** 9k - 30k acres — 5-13%
- **Mgd Wetlands Food**: Large scale, North Delta Arc — 0%
- **DWSC Food** — 0%
- **Franks Tract Restoration** — 16%
- **Aquatic Weed Control:** Large scale with new methods, Cache Slough/Sac/Confluence focus — 49%
- **Sediment supplementation** — 73%
- **Contaminants Reduction:** Start with Ulatis Creek and expand to other hotspots — 1-16%
- **Fish Friendly Diversions**

Legend

Median IBMR predicted change in population growth

- Food
- Turbidity
- Flow and Food
- Other / entrainment

Candidate Science Suggestions for Round 1 Actions

Emerging TWG member suggestions in consideration of potential benefits and uncertainties

Emerging Science Suggestions	Rationale
Outflow Action: Hydrology/Operations modeling for summer outflow action and/or full good year flows concept; additional study of outflow/salinity and food effects	Moderate confidence* in food benefit; Uncertainty in the water supply impacts of actions; differences of opinion among TWG members on outflow/salinity and food effects
Mgd Wetlands Food: Continue to study and investigate ways to scale up – e.g., apply concept for food production in North Delta Arc	Moderate confidence* in food benefit in combination with other actions; uncertainties in how to do best and in accessing land to implement
Tidal Habitat Restoration: Study benefits for Delta Smelt – food, temperature, other	Low-Moderate confidence* in food benefit; 14K acres already in the pipeline, new information could inform whether/where/how to do more
Aquatic Weed Control: Pilot studies with alternative SAV/FAV control (mechanical, biological, chemical)	Moderate confidence* in turbidity benefit; Need to develop more effective control methods (some work ongoing by DSC and DBW)
Sediment supplementation: Experiments with localized sediment supplementation for understanding feasibility	Low-Moderate confidence* in turbidity benefit; Uncertainties about where to source sediment and how to effectively implement
Physical Point Source Contaminants Reduction: Study feasibility/design of implementation at a known hotspot (Ulatis Creek) along with design of food web and fish monitoring and/or experiments	Moderate confidence* in contaminant benefit; need feasibility/design study and partnerships to implement at Ulatis; monitoring benefits for food and DS will inform whether to scale up

*TWG average

Possible Next Steps

Possible next steps and schedule for wrapping up Round 1 SDM
(for discussion)

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How to wrap-up Round 1 SDM?

What have we done to date?

- Technical analysis of 13 management actions (at multiple scales/timings):
  - Deep-dive into Delta Smelt effects (4 population models, new methods developed for estimating action effects, characterization of uncertainties and feasibility).
  - Ball-park methods for estimating financial and water resources for comparative purposes
  - Qualitative evaluation of salmon effects
- Delta Smelt TWG definition of alternative portfolios for evaluation
- Round 1 Takeaways (Technical) & Emerging science suggestions

Gaps?

- Alternative portfolios that consider multiple objectives and other considerations
- Monetization of water resource estimates
- Socio-economic analysis of actions/portfolios (would require hydrology/operations modeling)
- Round 1 SDM Report
- Other?

Possible work plan to wrap up Round 1

Task	Dec	Jan	Feb	Mar	Apr	May
Water monetization						
Policy Group members work with TWG/CAMT members to develop alternative strategies (optional)						
Evaluation of alternative strategies (existing methods/measures)						
Policy Group Meeting/Workshop (PG members share rationale for strategies; presentation of evaluation results; deliberation)						
Socio-economic analysis: high-level scoping discussions						
Write Round 1 SDM Evaluation Report		First Draft		Second Draft		Final Draft

What does a comprehensive strategy to recover Delta Smelt look like?

The TWG suggests that a comprehensive strategy for recovering Delta Smelt would be composed of:

Current Management Actions (and any adjustments)

+

New management actions for near-term implementation (Implementation in < 5 years)

+

New management actions to develop (Implementation in > 5 years)

+

Science actions to advance new management actions

THANK YOU

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