Round 1 Evaluation
CSAMP Delta Smelt SDM Project

June 7, 2023, Policy Group Presentation

Presented by Sally Rudd and Brian Crawford,
Compass Resource Management

compass

Presentation and Discussion Objectives

- Report out on the key takeaways of the Round 1 Evaluation.
- Discuss results and identify key unanswered questions.
- Seek feedback on the next steps of this Project.

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SDM Project Purpose*

Provide analysis and opportunities to deliberate across CSAMP membership on the following question:

What are the best management and science actions to advance CSAMP's Delta Smelt management goal, in consideration of uncertainties and trade-offs with other socio-economic and environmental objectives?

CSAMP MANAGEMENT GOAL FOR DELTA SMELT

Reverse the trajectory of the Delta Smelt population from one in decline to one experiencing overall increases within 5-10 generations with the long-term aim of establishing a self-sustaining population.

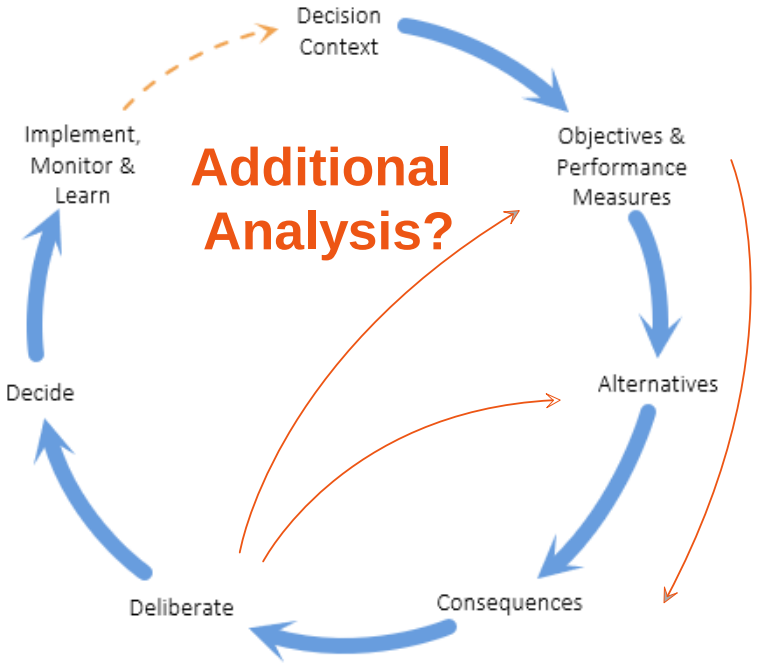
To achieve this goal, CSAMP members will work collaboratively, and with urgency, to prioritize and implement management actions that are targeted at known or hypothesized stressors, habitat needs or other critical factors affecting the Delta Smelt population, and to learn through implementation.

Endorsed by Policy Group, Oct. 30, 2019.

*Project purpose documented in the CSAMP Delta Smelt Organizational Framework and the CSAMP Delta Smelt SDM Process Guidelines

Structured Decision Making for Delta Smelt

SDM Process

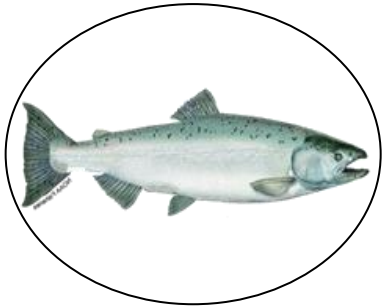


Round 1

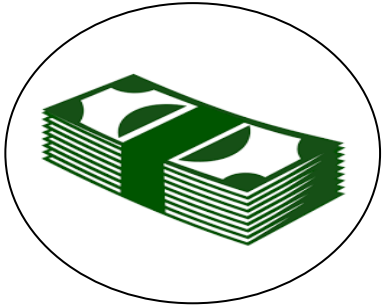
Round 1 Objectives

Delta Smelt Population Growth

Salmon Abundance



Financial Resources



Water Resources

Round 1 Delta Smelt Actions

Food actions

1. North Delta Food Subsidies*
2. DWSC Food Production and Transport
3. Managed Wetlands flooding and draining*
4. Tidal wetland restoration*

Turbidity/food actions

5. Sediment supplementation*
6. Aquatic weed control*
7. Franks Tract Restoration*

Temperature actions

Investigated but not included in Round 1

Flow/salinity actions

8. Summer/Fall SMSCG*
9. X2/outflow management*

Entrainment actions

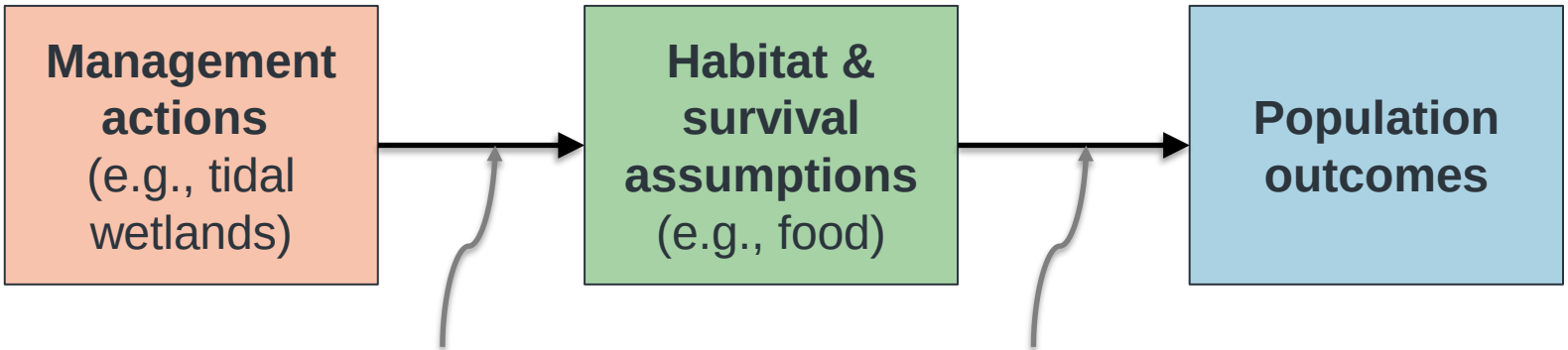
10. OMR management
11. Engineered First Flush
12. Fish-friendly diversions

Other

13. Physical point-source contaminants restoration*
14. Silverside population management
15. Supplementation

**Delta Smelt Resiliency Strategy (2016) actions*

Predicting effects for Delta Smelt



Effects methods:
- Published studies
- Original analyses using monitoring data
- Expert judgment

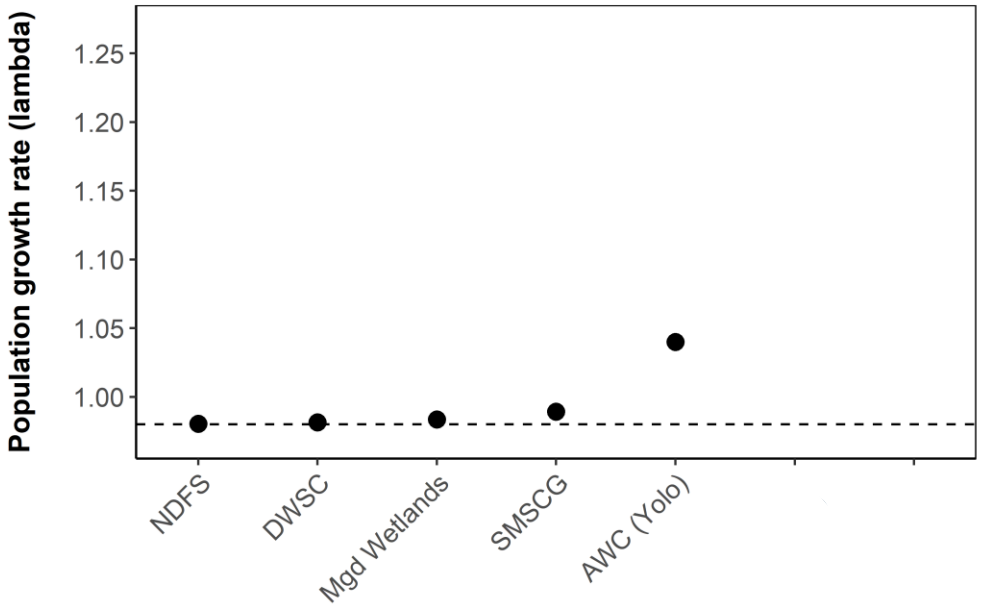
4 Delta Smelt models:
- Individual-Based Model in R (IBMR)
- Limiting Factor model (LF)
- Life Cycle Model with Entrainment (LCME)
- Maunder & Deriso Model in R (MDR)

Evaluation timeframe: 1995-2014

Evaluation question: If conditions were the same as 1995-2014, how would the implementation of a management action have changed Delta Smelt population growth?

Actions could have interactive effects, requiring evaluation of portfolios.

Results from single actions should be interpreted with caution.



Legend

Baseline | Individual actions | Additive population growth (illustrative) | Population growth from portfolio with 5 actions

Round 1 Portfolios

Action name	1b Current management (approximation) 2020 ROD/ITP	2a Full-year flows Short-term, flow	2b Cache Slough Short-term, non-flow	2c Cache Slough & Suisun Marsh Short-term, non-flow	3a Self-sustaining/ permanent management Long-term, non-flow	3c Summer flow & tidal wetlands Short-term, flow + non-flow	3d Focus on food Short + Long, non-flow	3e Habitat connectivity Short + Long, non-flow
NDFS	✓	✓	✓	✓	✓	✓	✓	✓
DWSC Food			✓	✓			✓	
Managed wetlands				✓ 2K ac			✓ 4K ac	
Tidal wetlands					✓ 9K ac	✓ 9K ac	✓ 30K ac	✓ 2K ac
SMSCG	✓	✓	✓	✓	✓	✓	✓	✓
X2/outflow	Fall (W,AN)	All seasons/yrs	Fall (W,AN)	Fall (W,AN)	Fall (W,AN)	Sum-Fall (W,AN)	Fall (W,AN)	Fall (W,AN)
Sediment supp								✓
Aquatic Weed Control			✓ 1 subregion	✓ 1 subregion			✓ 5 subregions	✓ 3 subregions
Franks Tract					✓			✓
OMR mgmt	✓	✓	✓	✓	✓	✓	✓	✓
Engineered First Flush		✓						
Contaminant reduction					✓ 12 subregions		✓ 12 subregions	✓ 8 subregions
Total portfolio runs (with sensitivity analysis)	3 (low, med, high food effect from X2/outflow)	2 (annual water budget of 700 TAF or unlimited)	1	1	2 (low/high food effect of tidal wetlands)	8 (low/high food effect of tidal wetlands; 4 X2 scenarios)	4 (low/high food effect of tidal wetlands, current/relaxed Fall X2)	2 (low/high food effect of tidal wetlands)

Key: Action is included in portfolio

See pre-read memo for more description

Round 1 actions not in portfolios

- Fish-friendly diversions
  - Partial analysis completed, but need more time for review.
- Silverside population management
  - Early modeling by LCME did not find sufficient evidence to include silverside abundance as a covariate in LCME modeling.
  - Specific implementation method also unclear.
- Supplementation
  - Delta Smelt TWG reviewed LCME modeling of supplementation at different scales and life stages. General finding: ↑ supplementation, ↑ population growth.
  - Modeling assumes equal survival for hatchery fish as wild fish and these assumptions are being tested now through experimental release.
  - Adding supplementation to Round 1 portfolios would not add additional insight.

Limitations & disclaimers

1. Be careful about over-interpreting results.

2. Round 1 actions vary in their physical feasibility & effect uncertainty.

3. Water balancing has not been done for flow actions.

Full Consequence Table

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/perma management	3d Focus on food	3e Habitat connectivity
Less Preferred / More Preferred												
Less Preferred / More Preferred												
Delta Smelt Population												
Change in population growth (from baseline)												
IBMR	Low TW food effect	Avg. % change in population growth	%	1	23	14	27	15	12	42	99	126
LCME	Low TW food effect	Avg. % change in population growth	%	20	25			33	27	27	58	38
MDR	Low TW food effect	Avg. % change in population growth	%	29	15			24	17	13	33	90
LF	Low TW food effect	Avg. % change in population growth	%	5	7	22	47	22	21	29	64	48
Dynamic Habitat Suitability Index (overlap)												
Yolo/Cache Slough	Low food effect	DHSI	%	20	20	32	32	21	21	21	33	20
Confluence & Lower Rivers	Low food effect	DHSI (max of subregion)	%	7	7	7	7	7	7	7	12	30
Suisun Marsh & Bay	Low food effect	DHSI (max of subregion)	%	20	23	20	21	23	23	21	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	0	1100	283	0	0	0
Net additional water (for comparative purposes only): BN, D, C	^	Annual average	TAF / yr	0	195	0	0	0	0	0	0	0
Salmon Population (relative to Portfolio 1b)												
Potential direct benefits	Avg	Constructed scale (0 to 5)	0 to 5	0	1	1	1	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	-1

Consequence Table: Delta Smelt Population growth

Objective		Performance Measure	Unit	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/perma management	3d Focus on food	3e Habitat connectivity
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- Population growth metrics shown for each Delta Smelt model
- Models agree more than disagree
- Portfolios with higher population outcomes had more actions, at larger scales, and targeted multiple stressors

Consequence Table: Dynamic habitat

Objective	Less Preferred / More Preferred	Performance Measure	Unit	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	3c.4 Summer flow & tidal wetlands (X2: Summer 70/75km; Fall	3a Self-sustaining/perma management	3d Focus on food	3e Habitat connectivity
				Management Portfolios								
Dynamic Habitat Suitability Index (overlap)												
Yolo/Cache Slough	Low food effect	DHSI	%	20	20	32	32	21	21	21	33	20
Confluence & Lower Rivers	Low food effect	DHSI (max of subregion)	%	7	7	7	7	7	7	7	12	30
Suisun Marsh & Bay	Low food effect	DHSI (max of subregion)	%	20	23	20	21	23	23	21	21	21

- Dynamic Habitat Suitability Index: % of months with overlapping suitable conditions for temperature, turbidity, salinity, and food
- Reported for different regions
- Did not see consistent patterns between habitat and population outcomes

Consequence Table: Financial & water resources

- Financial and water resource metrics are coarse (for comparative purposes only)
- Water balancing (within and across yrs) not included in Round 1 evaluation
- Range of financial costs (annualized over a 20-yr period)
- Most Round 1 portfolios did not require additional water

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	3c.4 Summer flow & tidal wetlands (X2: Summer 70/75km; Fall	3a Self-sustaining/permai management	3d Focus on food	3e Habitat connectivity
Financial resources (above Portfolio 1b)												
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Consequence Table: Salmon effects

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/perma management	3d Focus on food	3e Habitat connectivity
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Yolo/Cache Slough	Low food effect	DHST	%	20	20	33	32	21	21	33	33	20
Confluence & Lower Rivers	Low food effect		%	7	7	7	7	7	7	12	30	30
Suisun Marsh & Bay			%	20	23	20	21	23	23	21	21	21
Financial resources (above Portfolio 1b)												
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Potential direct benefits	Avg	Constructed scale (0 to 5)	0 to 5	0	1	1	1	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	-1

- Direct benefits and risks to salmon scored by experts
- Most actions were predicted to have benefits for salmon
- Actions deemed to have any potential risks were Aquatic Weed Control and increasing Fall X2

Full Consequence Table

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Confluence & Lower Rivers	Low food effect	DHSI (max of subregion)	%	7	7	7	7	7	7	7	12	30
Suisun Marsh & Bay	Low food effect	DHSI (max of subregion)	%	20	23	20	21	23	23	21	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
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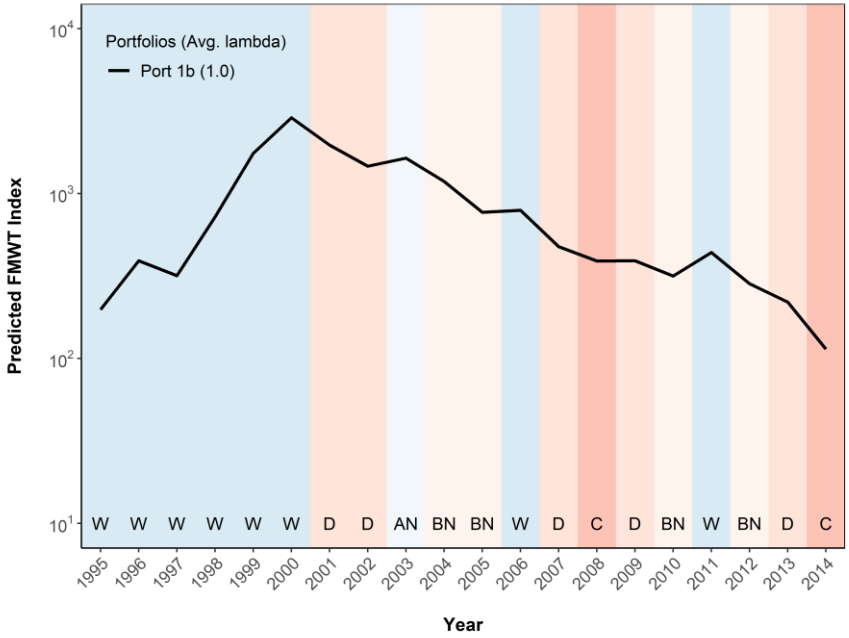
Potential direct risks	Min	Constructed scale (-5 to 0)	-5 to 0	0	-1	0	0	0	0	0	-2	-1

Takeaway #1:

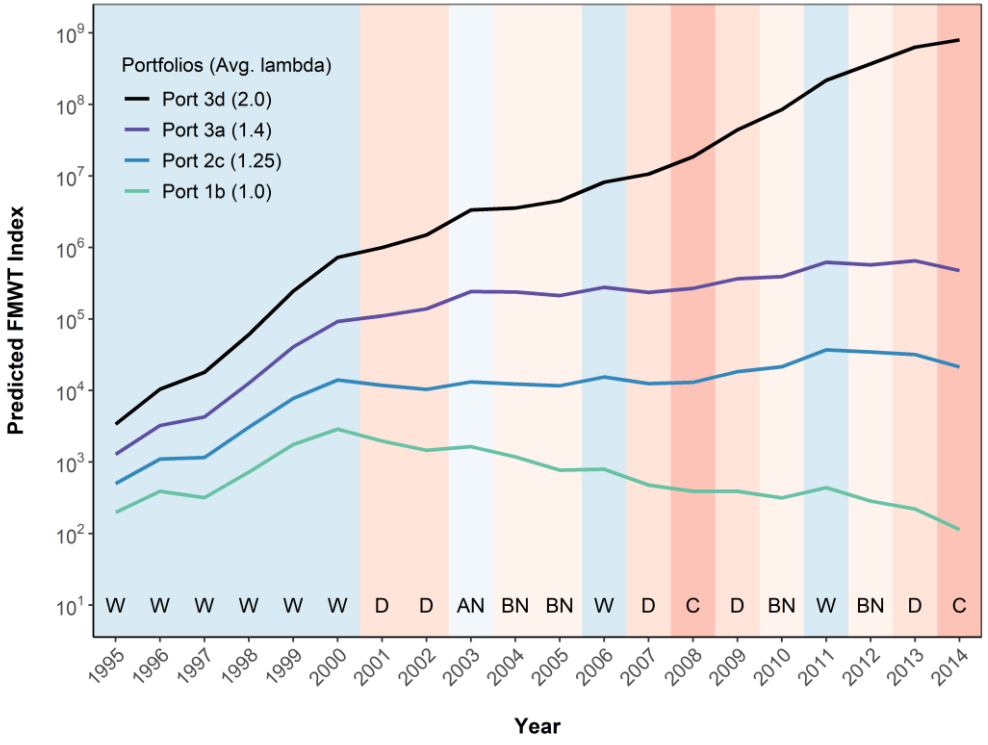
Current management (approximated in Portfolio 1b) is not sufficient to achieve Delta Smelt population growth in the absence of consecutive wet years



Average predicted Delta Smelt FMWT Index across model years (1995-2014) for the Reference Portfolio 1b in the IBMR. Water year types are indicated by letters at bottom of figure and blue-red bars.

Context of Reference Portfolio 1b

- Included current Fall X2 (80 km), OMR, SMSCG, and NDFS
- Designed to mitigate project impacts (not for species recovery)



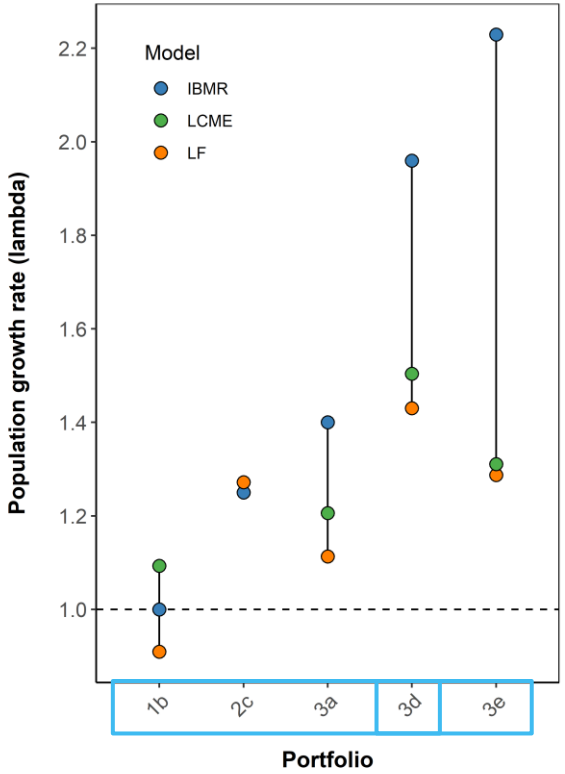
Takeaway #2:
Recovery is possible through multiple, additional actions with synergistic effects; there's no silver bullet

Takeaway #1:
Current management (approximated in Portfolio 1b) is not sufficient to achieve Delta Smelt population growth in the absence of consecutive wet years

Average predicted Delta Smelt FMWT Index across model years (1995-2014) for 4 portfolios that varied by average growth rate (lambda) in the IBMR. Water year types are indicated by letters at bottom of figure and blue-red bars. Populations increased in early Wet years for all portfolios shown. Populations were predicted to remain stable or growing in drier years as well for portfolios with multiple actions and synergistic effects. The top three lines show three example portfolios that were predicted to achieve a stable or growing population over the 20-year period.

Takeaway #3:

Actions and portfolios that improved food and turbidity showed greatest benefits to Delta Smelt across models



Food actions

- North Delta Food Subsidies
- DWSC Food Production
- Managed wetlands in SM
- Tidal wetland restoration

Turbidity actions

- Sediment supplementation

- Aquatic weed control
- Franks Tract restoration

Food benefits can be cumulative

Turbidity & food benefits can be synergistic

Takeaway #4:

Strategically increasing flow could grow the population in the near-term

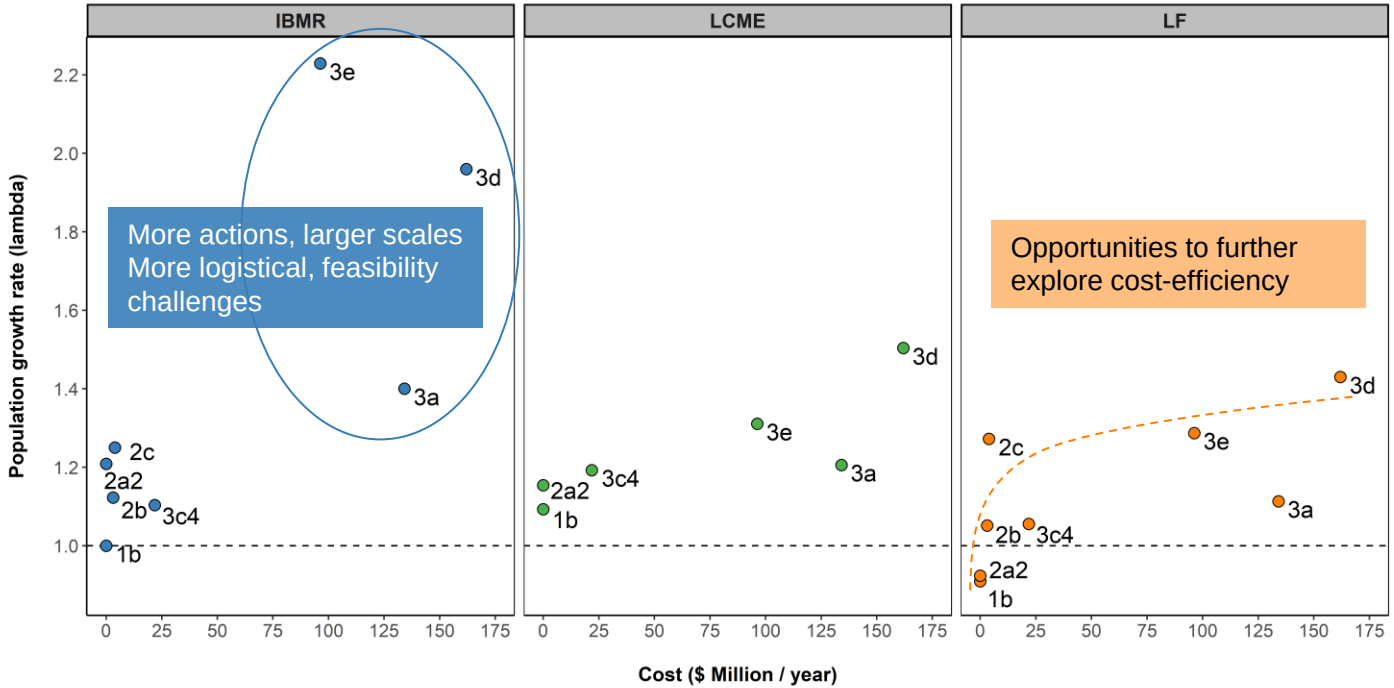
Objective	Less Preferred / More Preferred	Performance Measure	Unit	2a.2 Full-year flows - 700 TAF water budget	3c.2 Summer flow & tidal wetlands (X2: Summer 65/70km; Fall current)	3c.4 Summer flow & tidal wetlands (X2: Summer 70/75km; Fall current)	3c.3 Summer flow & tidal wetlands (X2: Summer 70/75km; Fall < 88)
Delta Smelt Population							
Change in population growth (from baseline)							
IBMR	Low TW food effect	Avg. % change in population growth	%	23	15	12	14
LCME	Low TW food effect	Avg. % change in population growth	%	25	33	27	27
MDR	Low TW food effect	Avg. % change in population growth	%	15	24	17	17
LF	Low TW food effect	Avg. % change in population growth	%	7	22	21	21
Financial resources (above Portfolio 1b)							
Ball-park cost estimate (for comparative purposes only)		Annualized capital and operating cost (range)	$ million / yr	None	$21-$30	$21-$30	$21-$30
Water resources (above Portfolio 1b)							
Net additional water (for comparative purposes only): W, AN	^	Annual average	TAF / yr	165	1100	283	216
Net additional water (for comparative purposes only): BN, D, C	^	Annual average	TAF / yr	195	0	0	0
Salmon Population (relative to Portfolio 1b)							
Potential direct benefits	Avg	Constructed scale (0 to 5)	0 to 5	1	1	1	1
Potential direct risks	Min	Constructed scale (-5 to 0)	-5 to 0	-1	0	0	-3

Flow strategies:

- Portfolio 1b (current): fall X2 mgmt
- Portfolio 2a: Condition-specific additional flows across year
- Portfolio 3c: Increased summer flows
  - Vary additional summer flow
  - Vary fall X2 mgmt

Takeaway #5:

Portfolios that showed greater benefits to Delta Smelt included actions that have substantial resource costs and feasibility challenges



Note: Portfolios 2a and 3c also require additional water resources

Takeaway #6:

Exploring more portfolios could inform how to combine types of actions (flow, food, turbidity) and balance financial costs, water resources, and feasibility concerns.

The Delta Smelt Technical Working Group has identified potential areas of focus:

New portfolios could be designed around:

- Near-term, highly feasible actions (flow, food, turbidity)
- Actions with greatest Delta Smelt benefits – develop an ‘ultimate vision’ for Delta Smelt recovery
- More dynamic portfolios (e.g., best actions in wet vs. dry years, depending on limiting factors)
- “Optimize” benefits to resource costs

Other possible topics for investigation:

- Fish-friendly diversions (only a partial evaluation has been completed to date)
- Refine water resources performance measure and evaluation approach
- Future climate change in evaluation approaches and metrics

Round 1 Takeaways

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.

Questions & Reactions

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Next Steps

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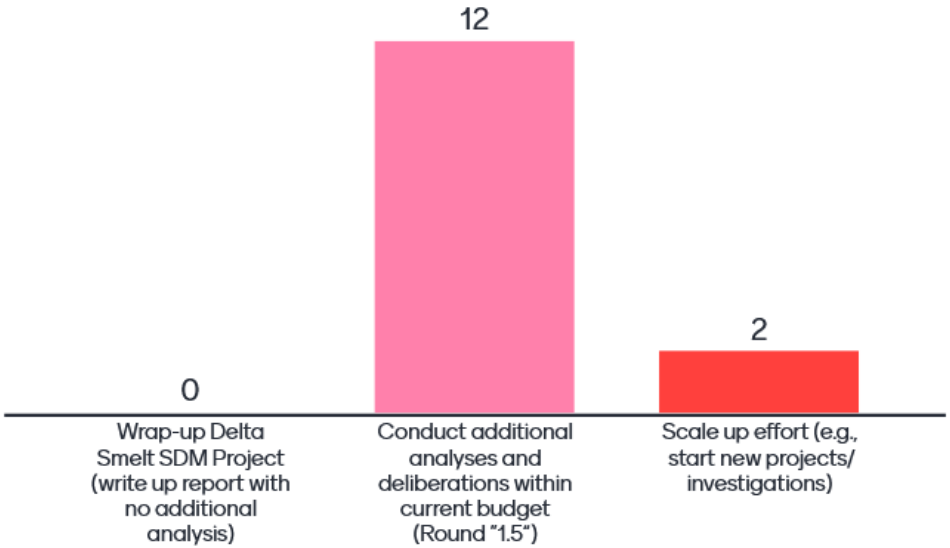
Next Steps Discussion

Where to go from here?

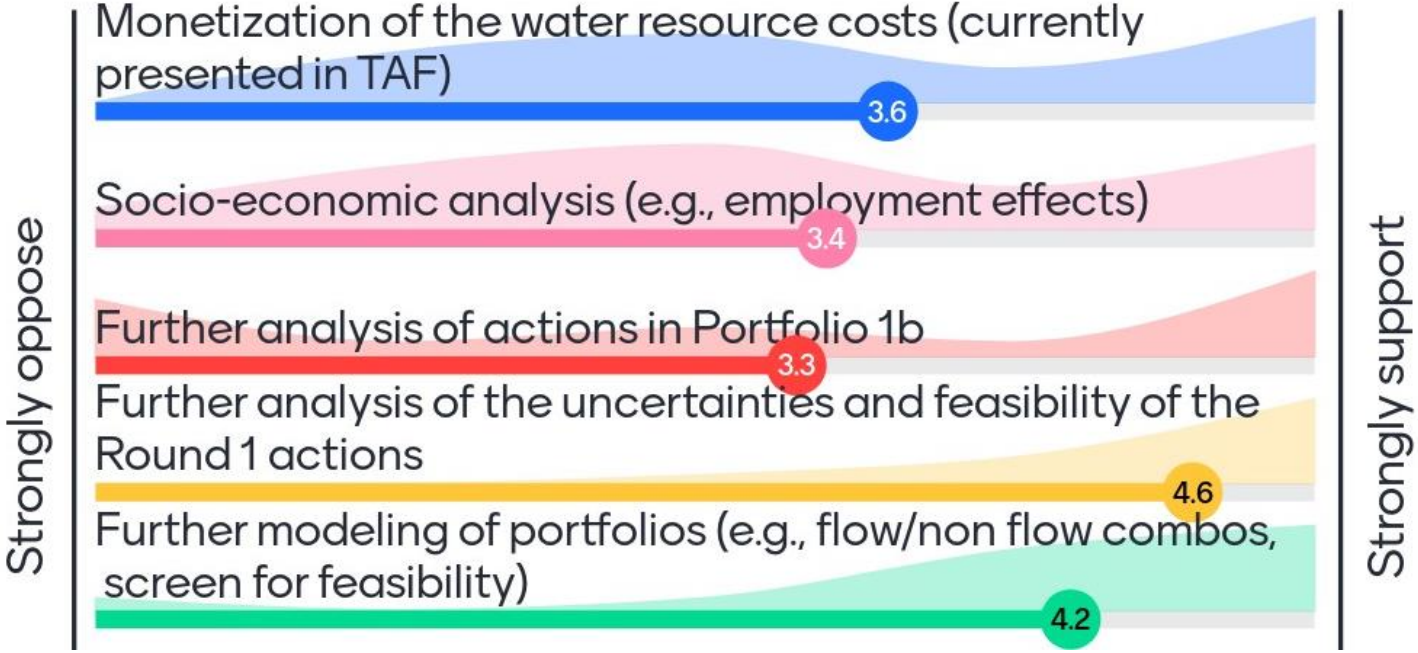
Options to consider:

1. Wrap-up Delta Smelt SDM Project (write up report with no additional analysis)
2. Conduct additional analyses and deliberations within current budget (Round “1.5”)
3. Scale up effort (e.g., start new projects/investigations)

Mentimeter Exercise



Mentimeter Exercise



THANK YOU

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www.compassrm.com

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Model references

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