Delta Smelt Summer and Fall Habitat Action

Integrated Modeling and Structured Decision Making

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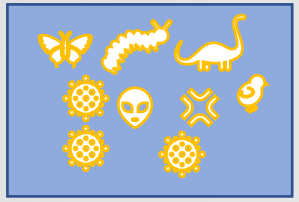
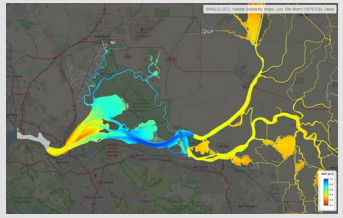
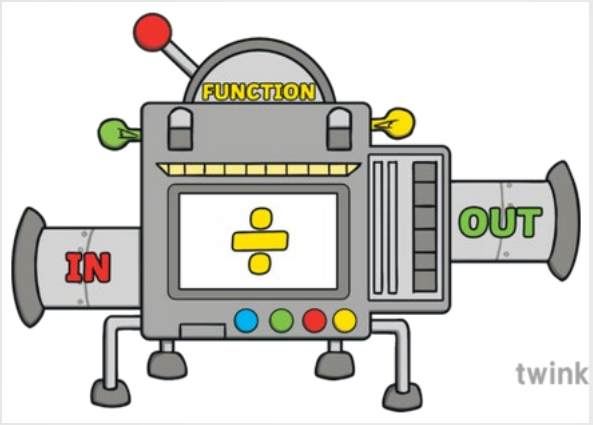
Planning models

Structured Decision Making

Integrated Modeling for Decision Making







Collaborations

Management Guidance

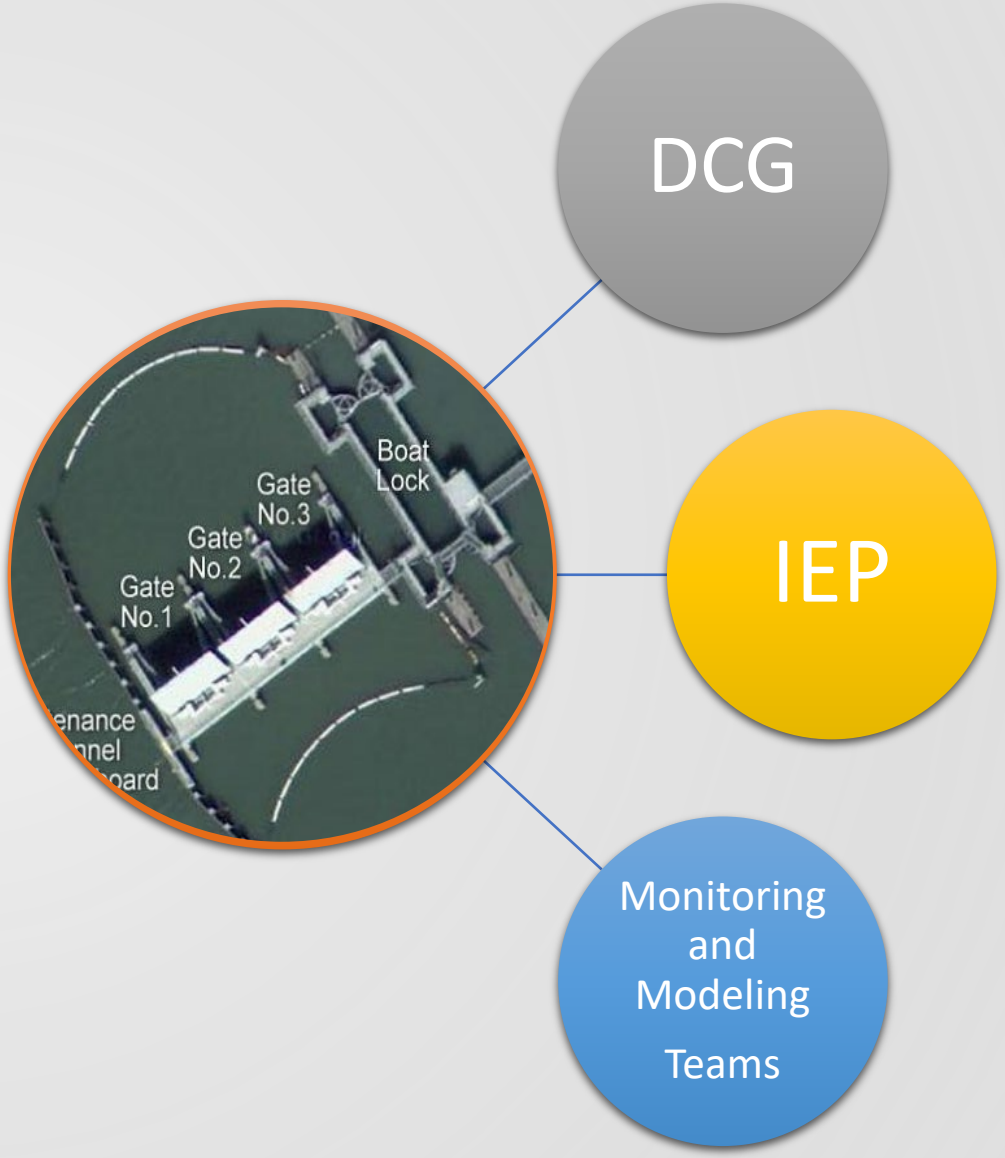
- Delta Coordination Group (DCG)
- Agency leadership

Technical Review

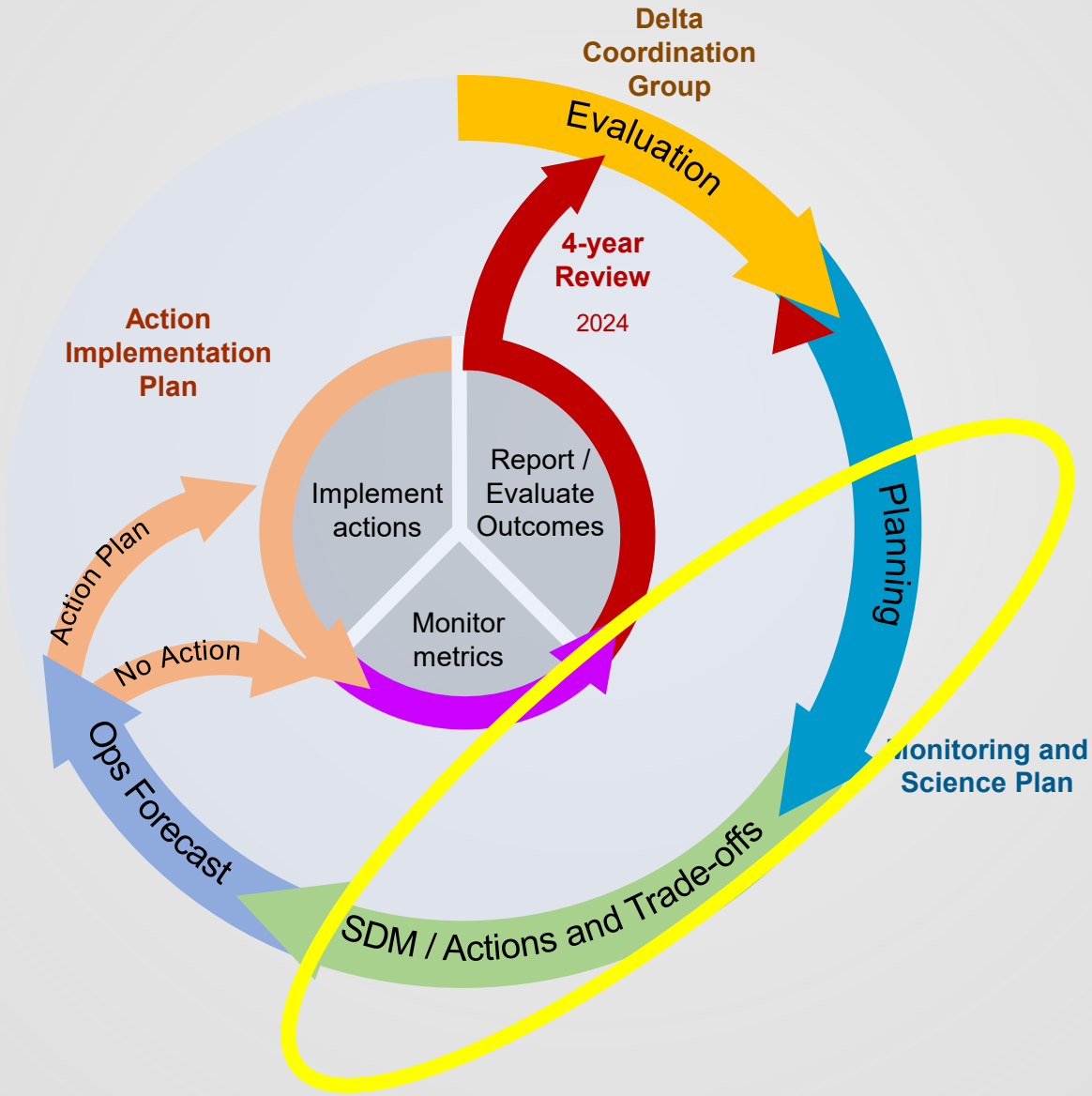
- IEP project work teams

Technical Support

- Monitoring and Research
- Data synthesis
- Modeling

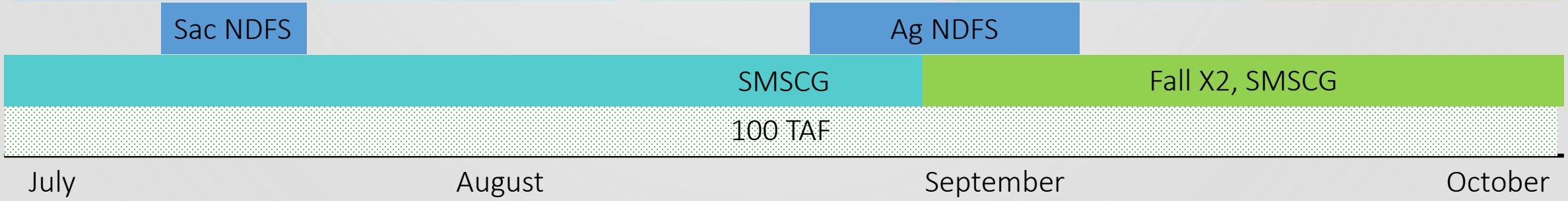


Role in Adaptive Management



Management Actions

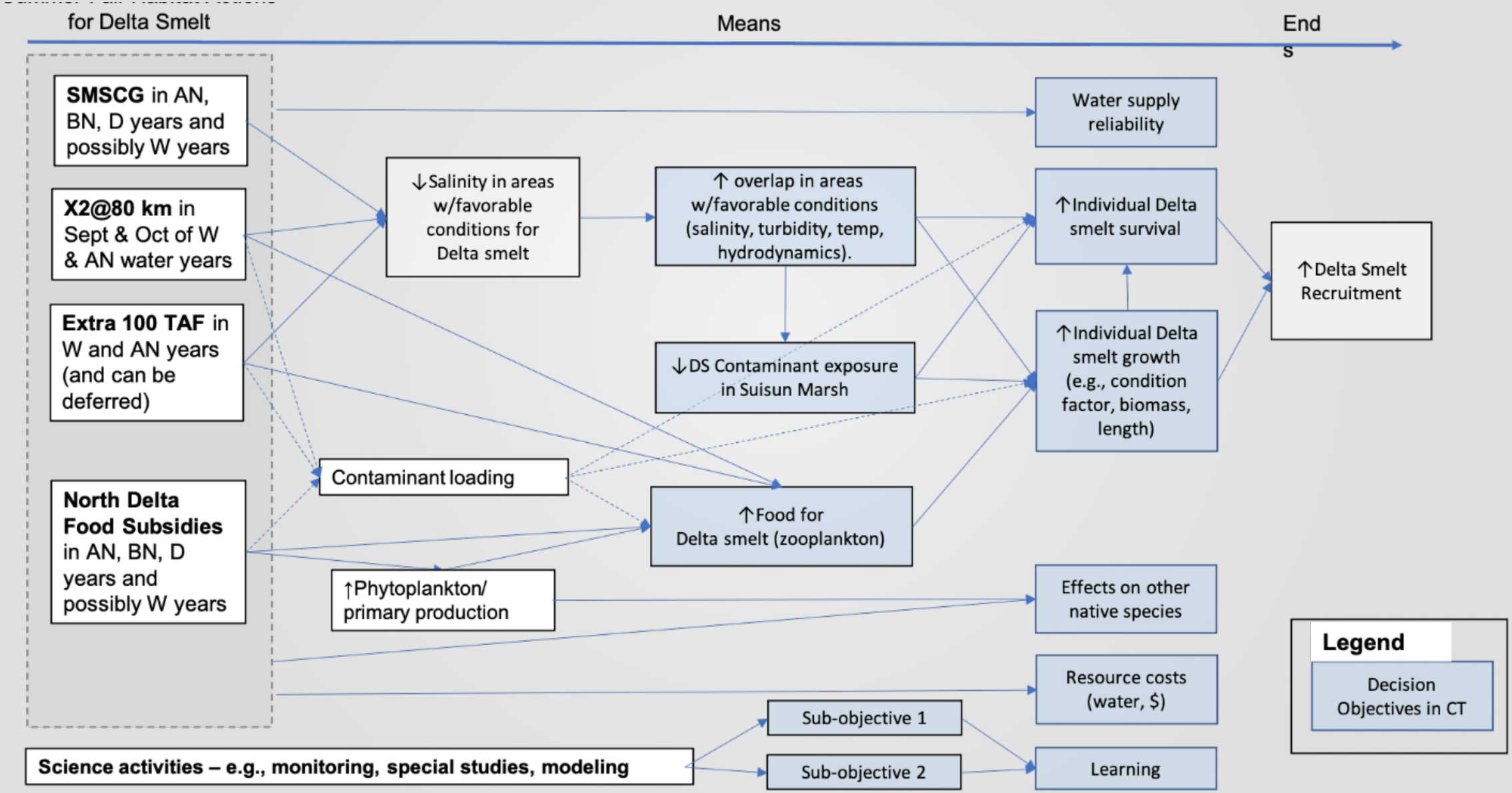
North Delta Food Subsidy (NDFS)	Suisun Marsh Salinity Control Gates (SMSCG)	Fall X2	Additional 100 TAF	Future Actions
• Agricultural or Sacramento River water source • Different magnitude and duration options	• Continuous versus discontinuous • Start early versus start later	• No implementation options	• Use for additional SMSCG actions • Use for fall outflow • Defer to next year for SMSCG or spring outflow	• Sacramento Deepwater Ship Channel • Managed Wetlands



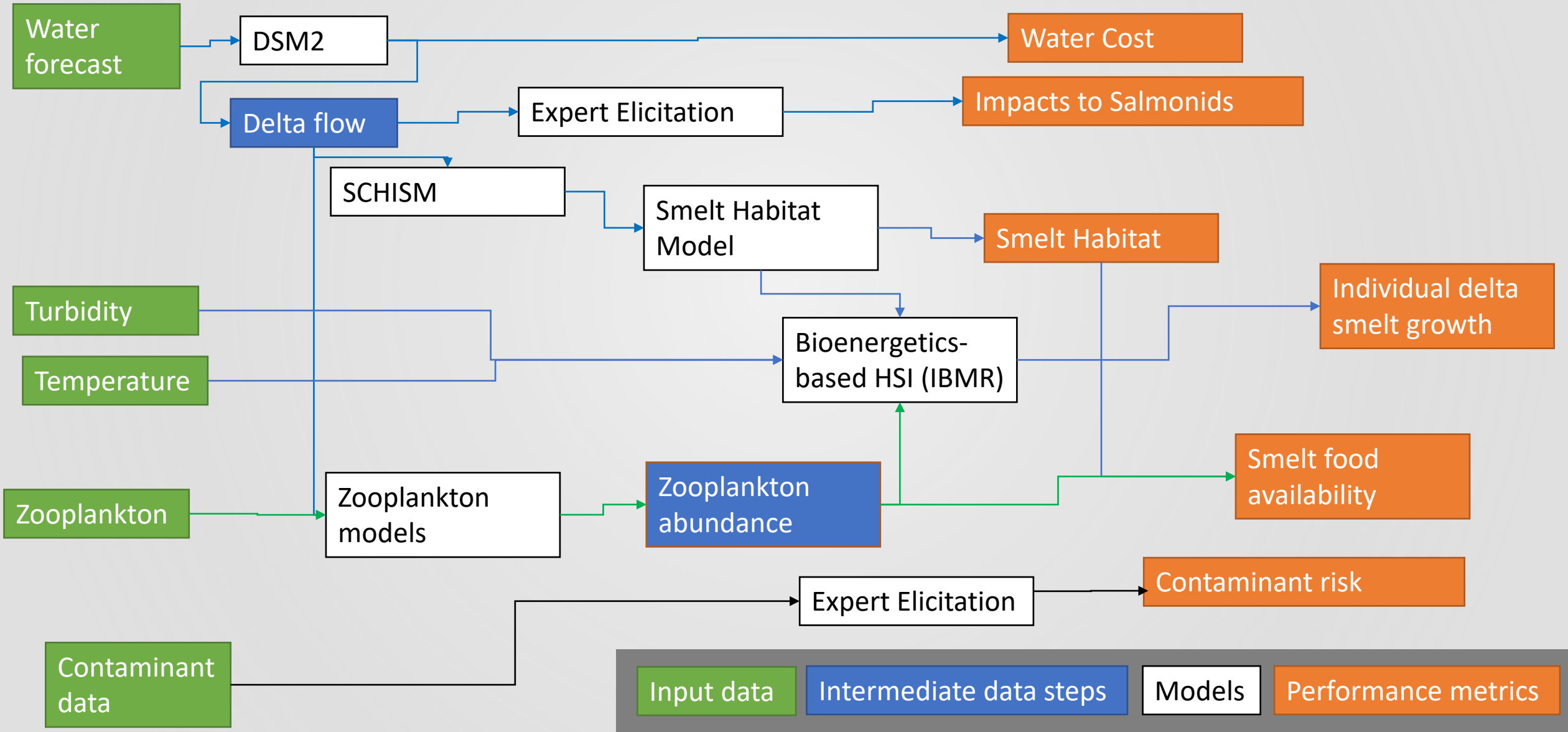
Objectives and Performance Measures

- Increase Delta Smelt food - zooplankton
- Increase Delta Smelt Habitat – suitability index
- Increase Delta Smelt Growth and Survival - bioenergetics
- Minimize Water Cost - hydodynamics
- Minimize contaminant toxicity – expert opinion
- Minimize impacts to other species – expert opinion
- Increase our ability to learn for the future (added in 2023)

Influence Diagram



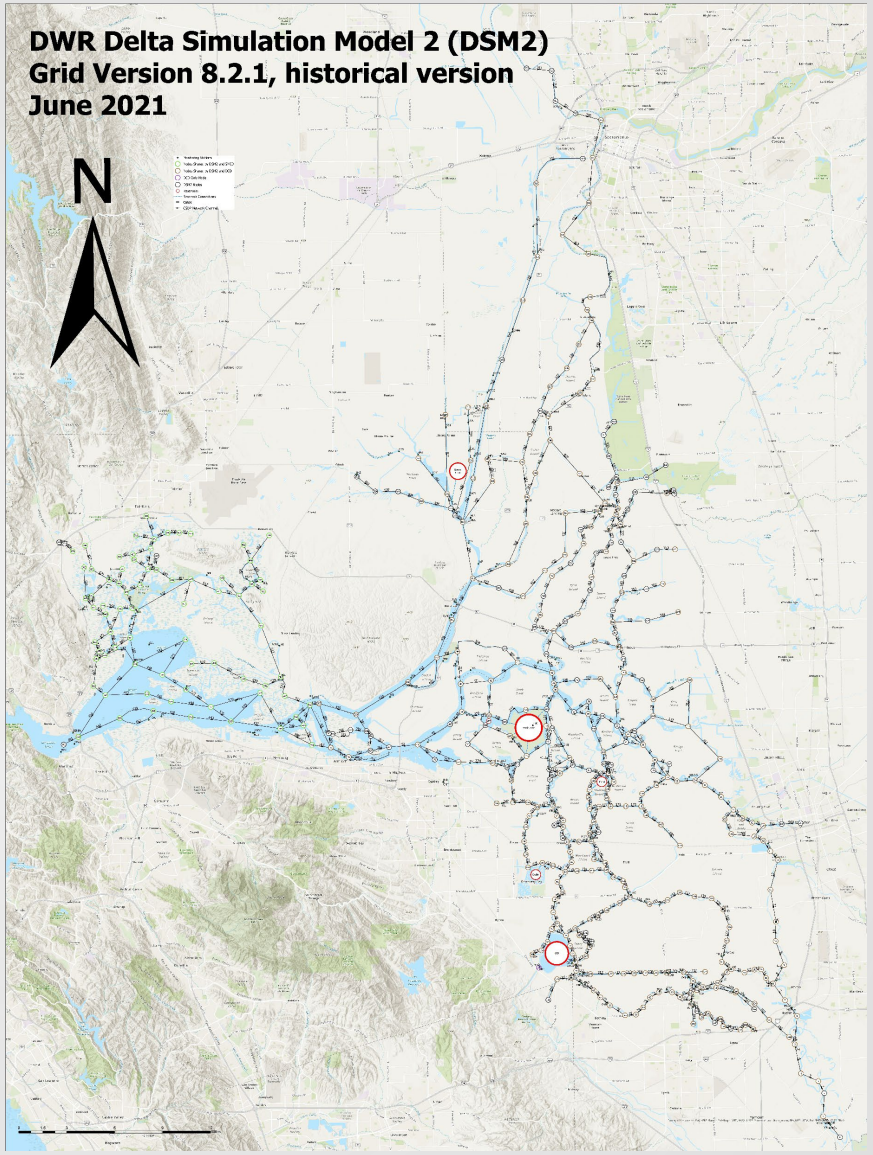
Modeling Approach



Hydrodynamics

Delta Simulation Model (DSM) 2

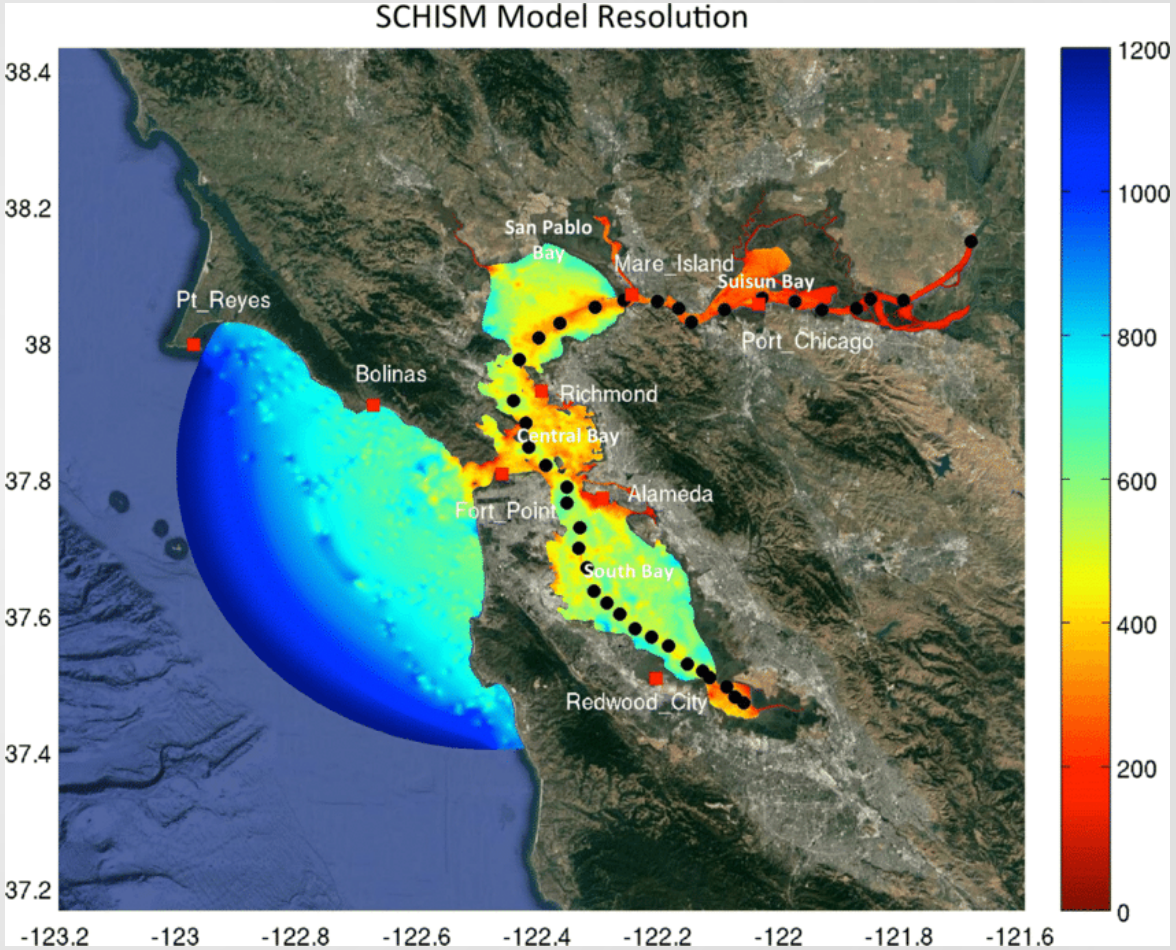
- One-dimensional channel network
- Flow, salinity, temperature, dissolved oxygen



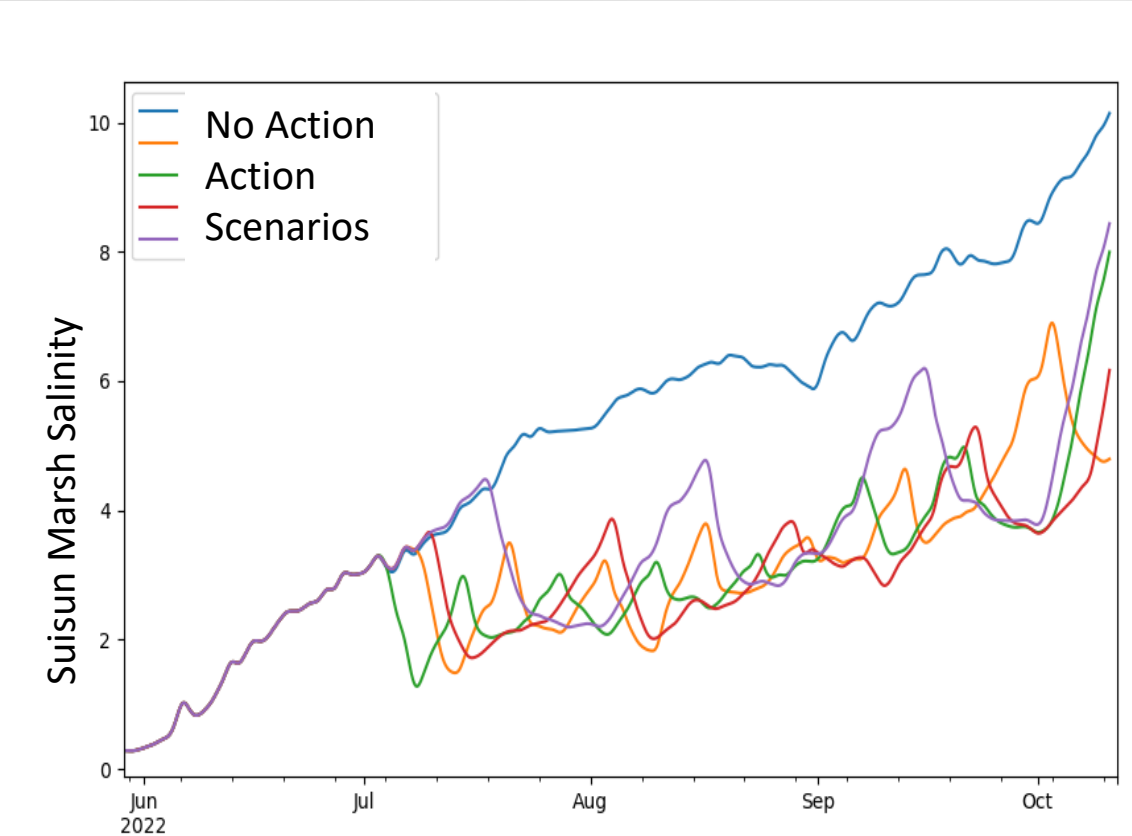
Hydrodynamics

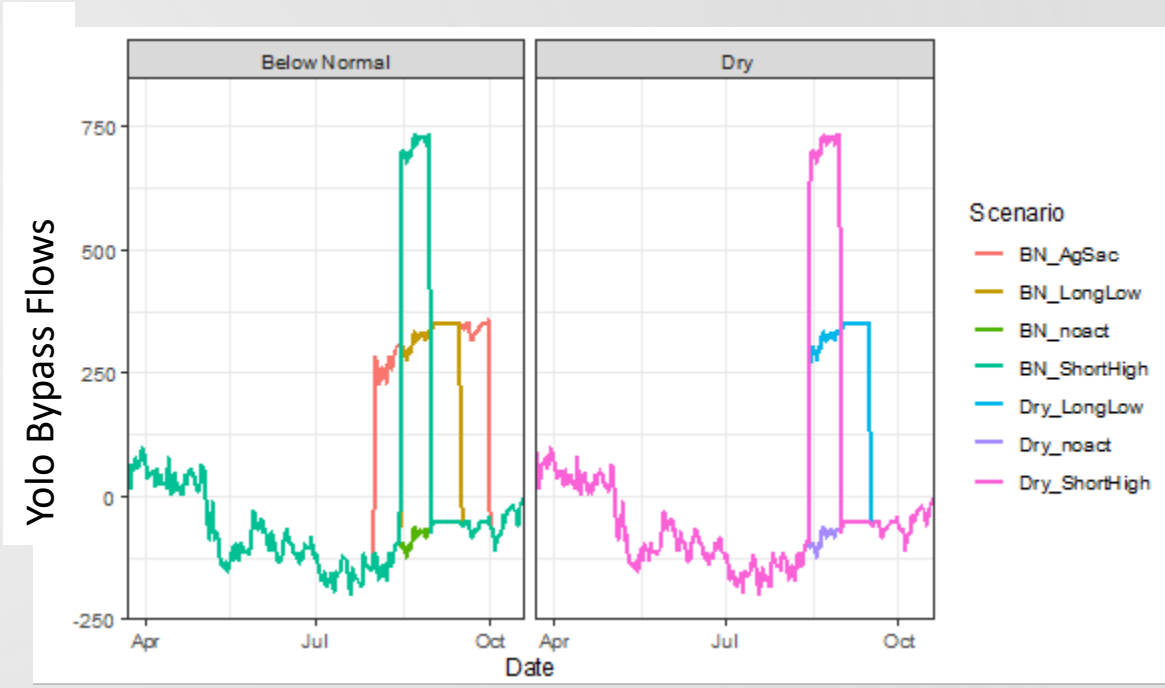
Semi-implicit Cross-scale Hydroscience Integrated System Model (SCHISM)

- 3-D hydrodynamics and transport
- Salinity, temperature, current speed, turbidity



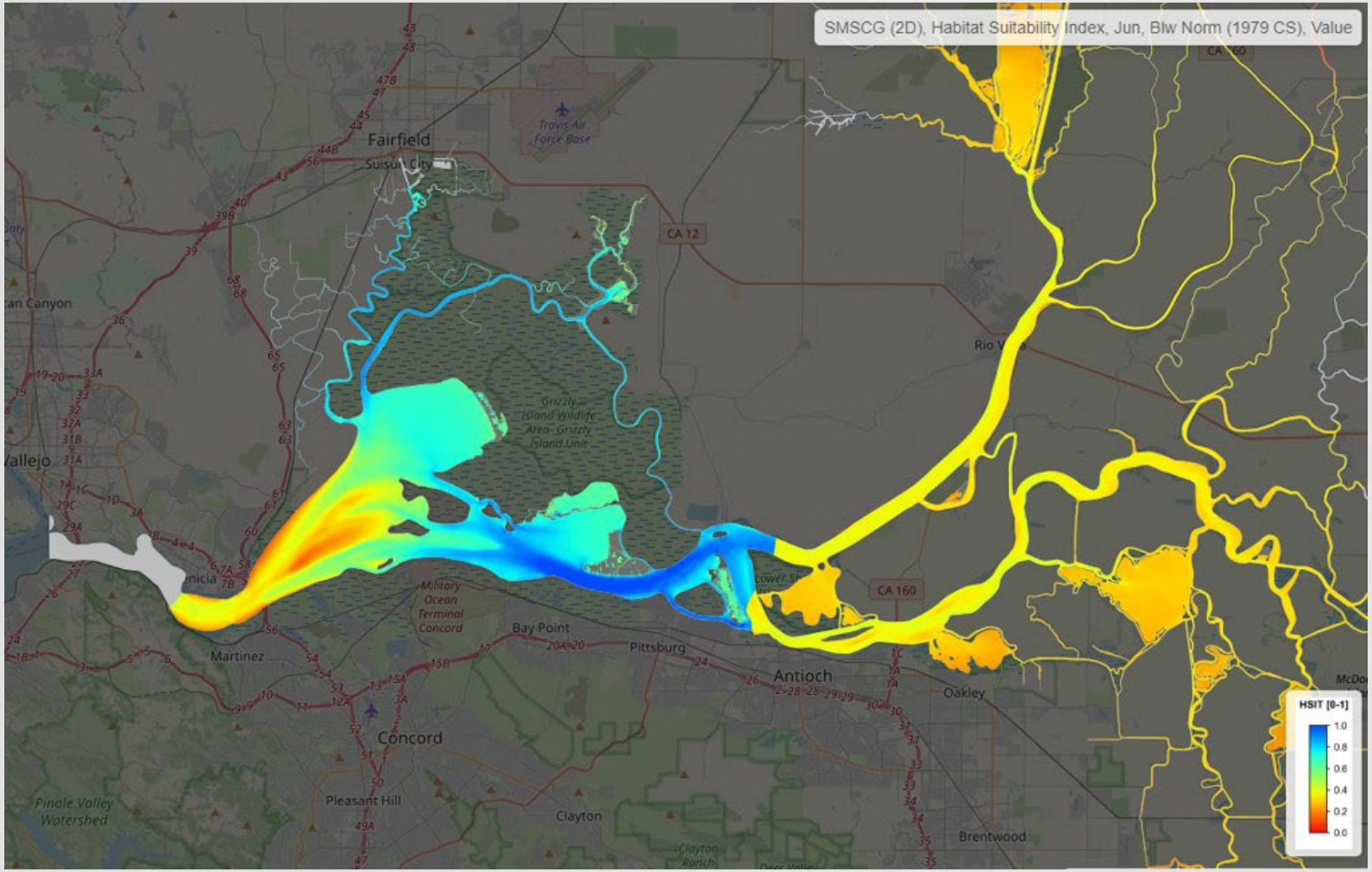
Forecast flows and salinity





Forecast Habitat Suitability

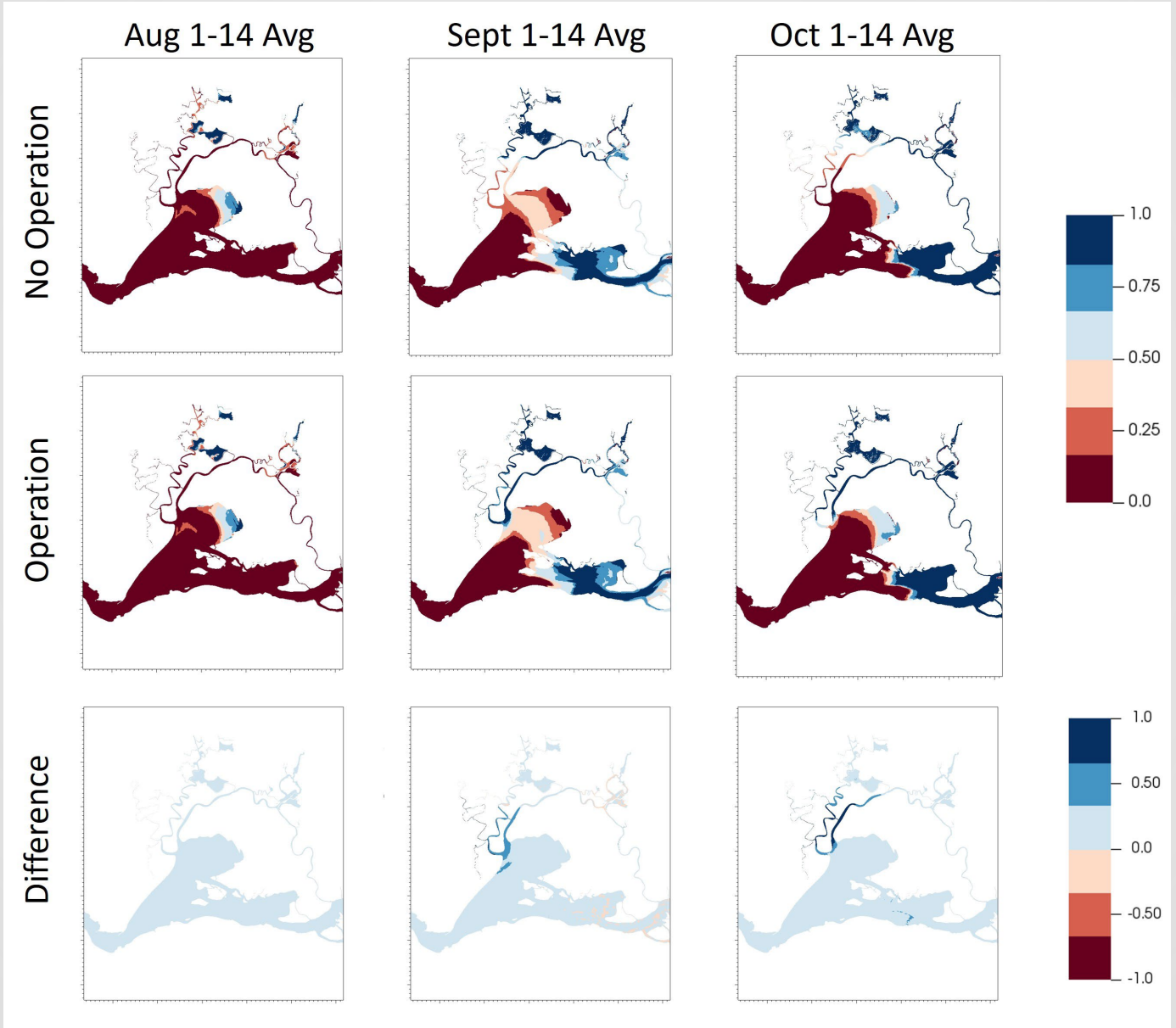
Temperature, Turbidity, Current Speed, and Salinity (Bever et al. 2016 + Temperature)



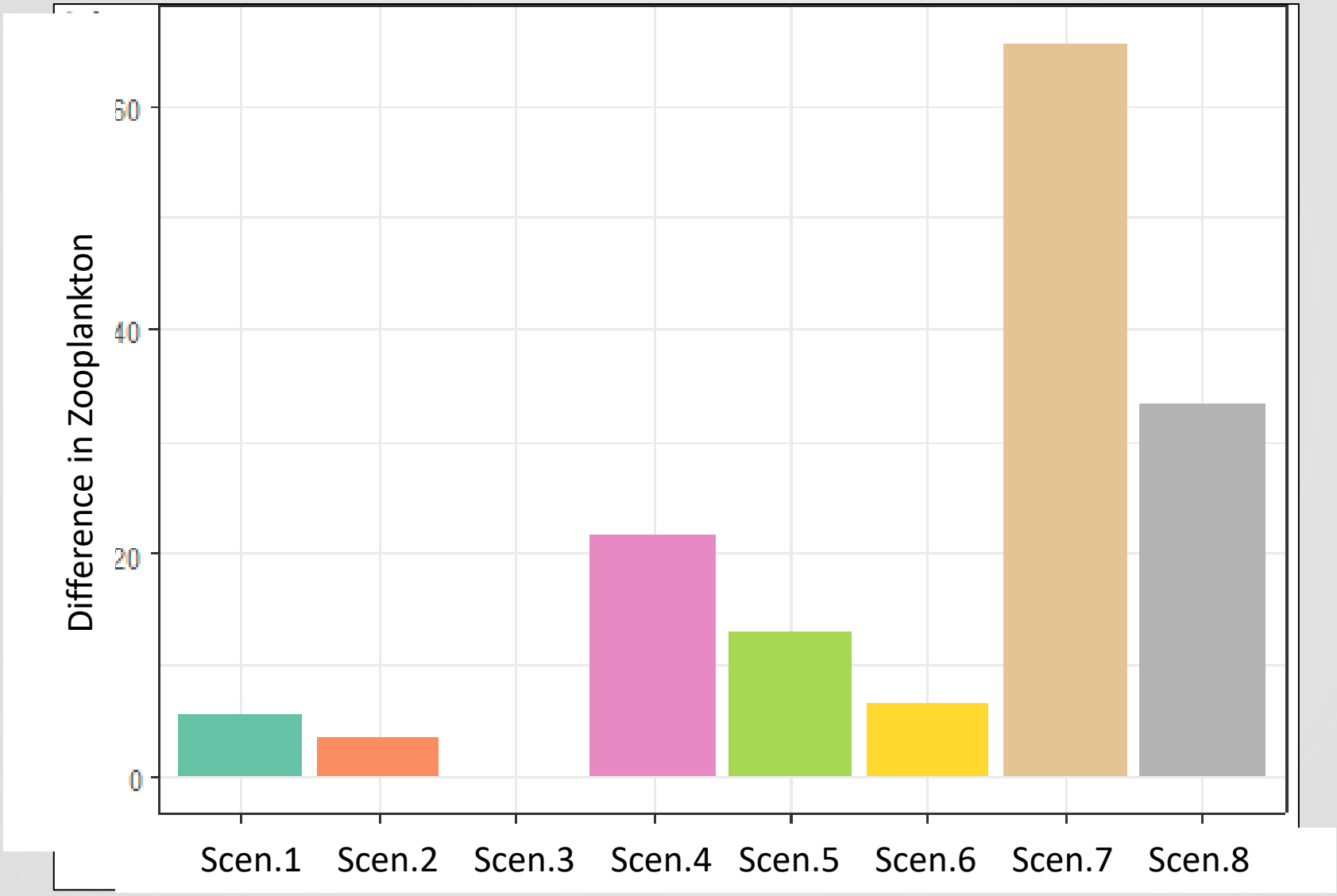
ccrm.vims.edu/schismweb/

https://cadwrdeltamodeling.github.io/BayDeltaSCHISM/html/index.html

Hindcast Habitat suitability



Zooplankton – Salinity relationships



Smelt Growth – Bioenergetic model

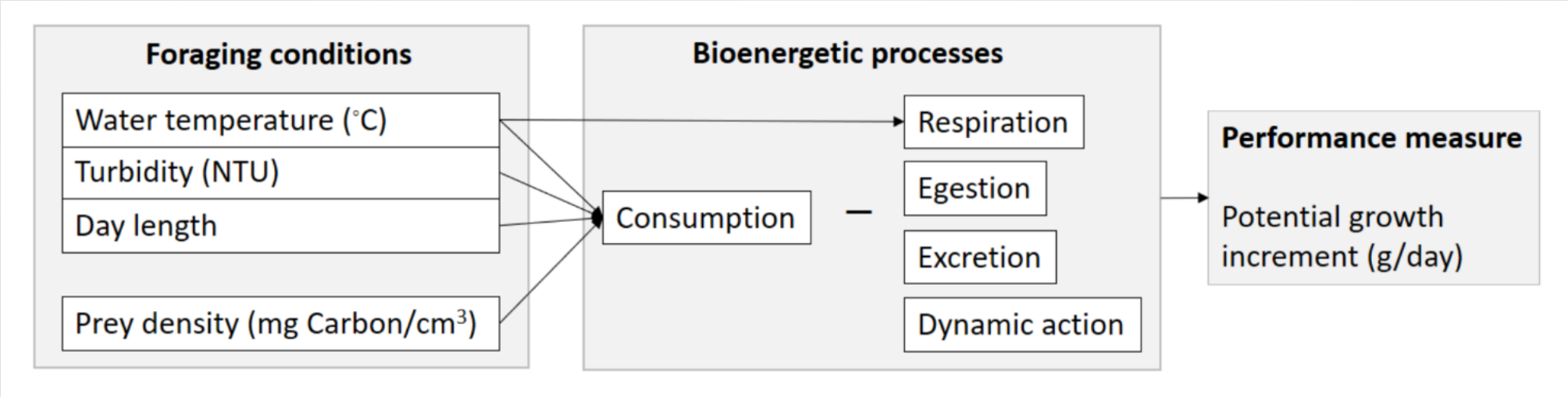


Table 2. Growth increment (performance measure) for each region-year type-scenario combination. Growth increment was the difference between BEM-predicted growth with simulated action minus predicted growth with no action (Table 1).

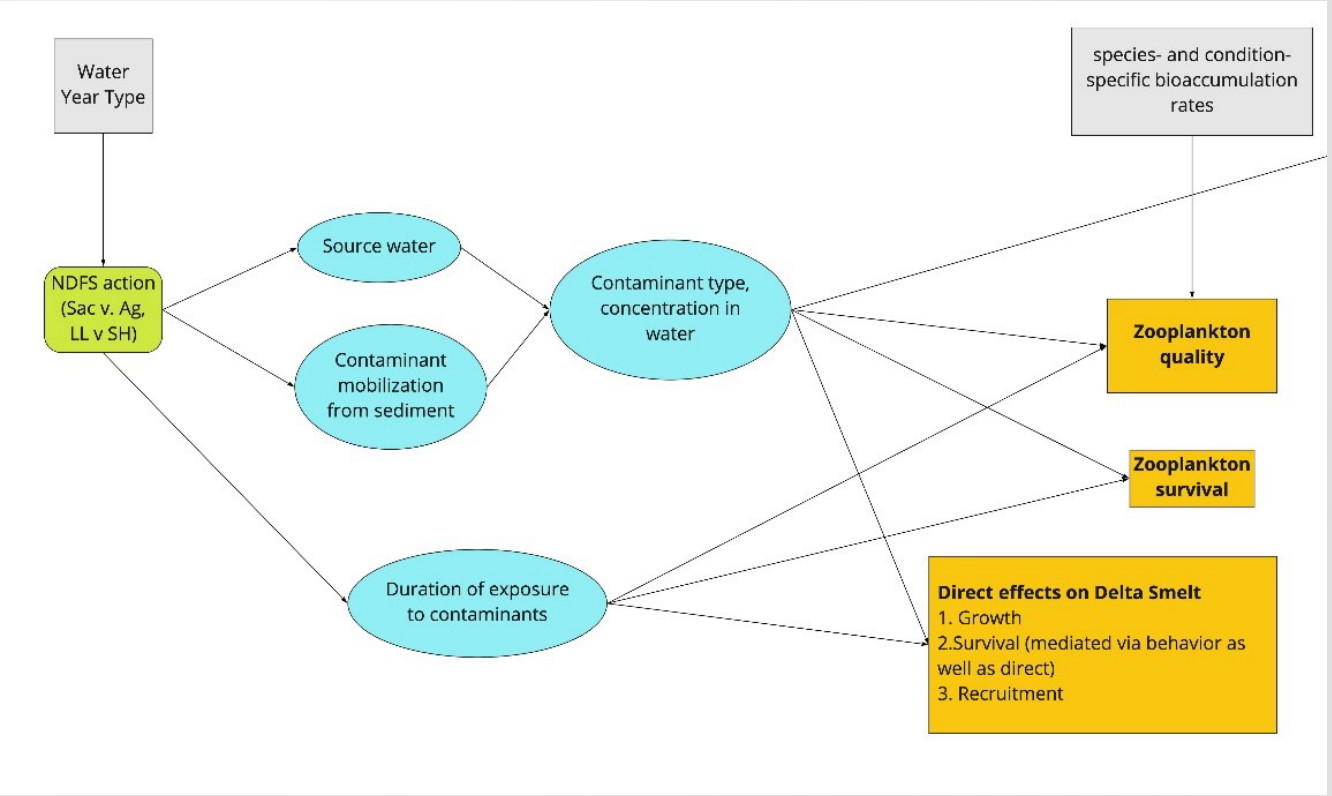
Region	Year type = Below Normal						
	AgLong-Low	AgShort-High	SacAg	SacLong-Low	SacShort-High	SMSCG-4ppt	SMSCG-6ppt
Yolo	0.26	0.20	0.58	0.32	0.21	0	0
Lower Sac	0.04	0.04	0.06	0.04	0.04	0	0
Confluence	0	0	0	0	0	0	0
Marsh	0	0	0	0	0	0.41	0.31

Smith, W. E., and M. L. Nobriga. 2023. A bioenergetics-based index of habitat suitability: spatial dynamics of foraging constraints and food limitation for a rare estuarine fish. Transactions of the American Fisheries Society. 152 (5). https://doi.org/10.1002/tafs.10427

Contaminants

- Conceptual model predicted more impact of NDFS than SMSCGs
- Source water was important
- Duration of exposure important
- 8 respondents

Performance Metric	Ag Long-Low	Ag Short-High	Sac Long-Low	Sac Short-High	Sac-Ag
Zooplankton Quality	-0.88	-1.25	0.38	-0.25	-0.38
Zooplankton Survival	-0.75	-0.88	0.25	-0.25	-0.13
Delta smelt growth	-0.63	-0.75	0.13	-0.25	-0.25
Delta smelt survival	-0.13	-0.63	0.00	-0.25	-0.29
Delta smelt recruitment	-0.50	-0.57	0.13	-0.13	-0.29
Overall mean	-0.58	-0.81	0.18	-0.23	-0.26



Effects to other Species

- Salmon and Sturgeon
- Actions may change migration, impact contaminants, food
- Expert elicitation – 4 respondents
- High uncertainty

Action(s) implementation approaches	Months of Action	Expert	Spring Run	
			Individual	Population
Dry Water Year Type				
NDFS - 4 week pulse using Sacramento River water	June, July, August	CDFW - Below Normal	0	0
		CFS - Below Normal	0	0
		NMFS - Below Normal	0 for juveniles 0 for adults	0 for juveniles 0 for adults
		DWR	0 to -1 juveniles 0 adults	0 adults
Average score (juveniles/sub-adults)			-0.25	0
Average score (adults)			0	0
Average score (stage-agnostic and stage-specific averaged together)			-0.08	0
NDFS - 4 week pulse uses agriculture return water	September, October	CDFW	-1	0
		CFS	0	0
		NMFS	0 for juveniles 0 for adults	0 for juveniles 0 for adults
		DWR	0 to -1 juveniles 0 adults	0 adults
Average score (juveniles/sub-adults)			0.25	0
Average score (adults)			0	0
Average score (stage-agnostic and stage-specific averaged together)			-0.25	0

Learning

Feasability – can we do the action?

Effectiveness – did it work?

Special studies – learning more with more science.

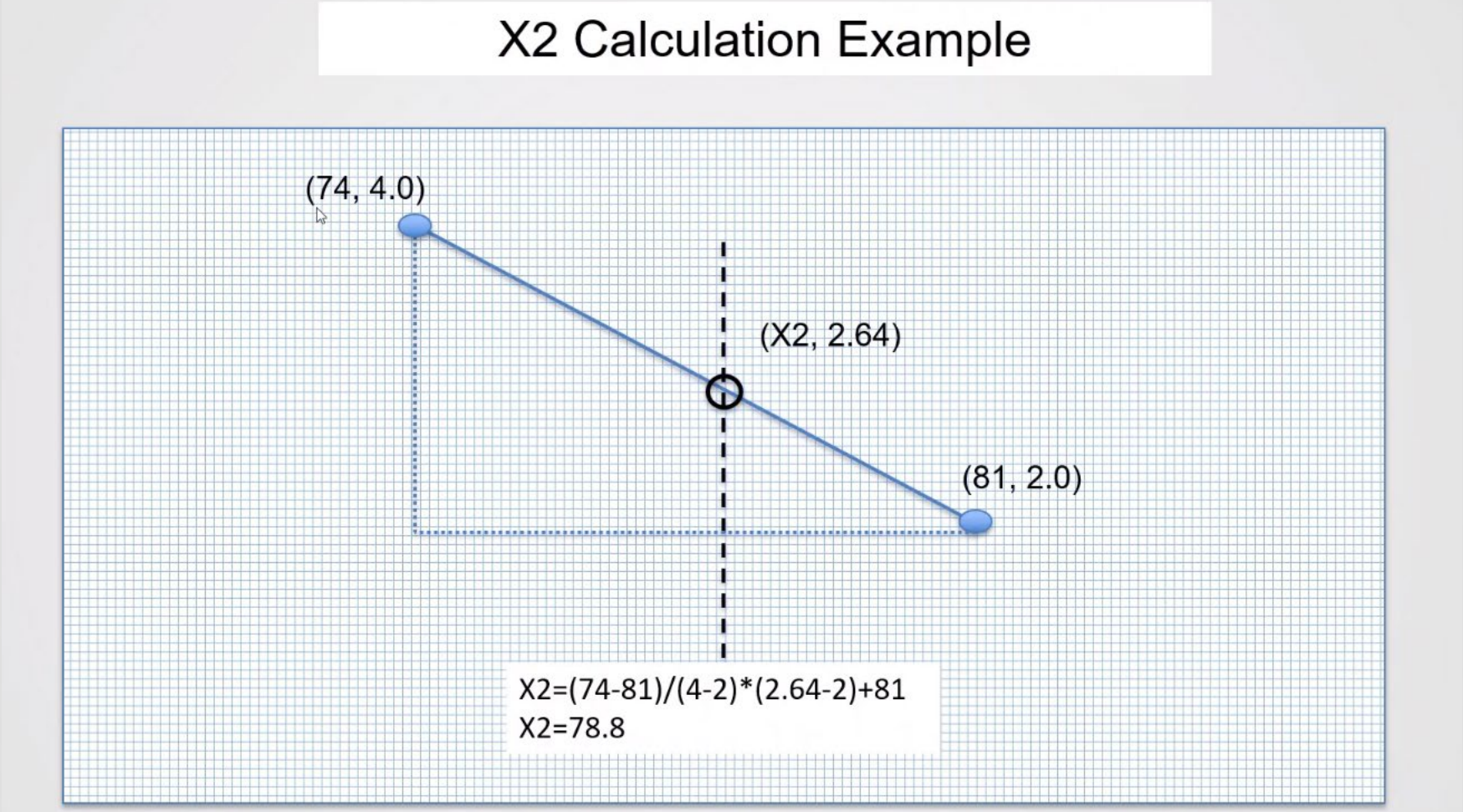
Metric Integration

- Plugged all model results into online ‘AltaViz’ tool for visualizing alternatives
- DCG discussed trade-offs, risks, recommendations
- Final decision based on water year type and DCG recommendation

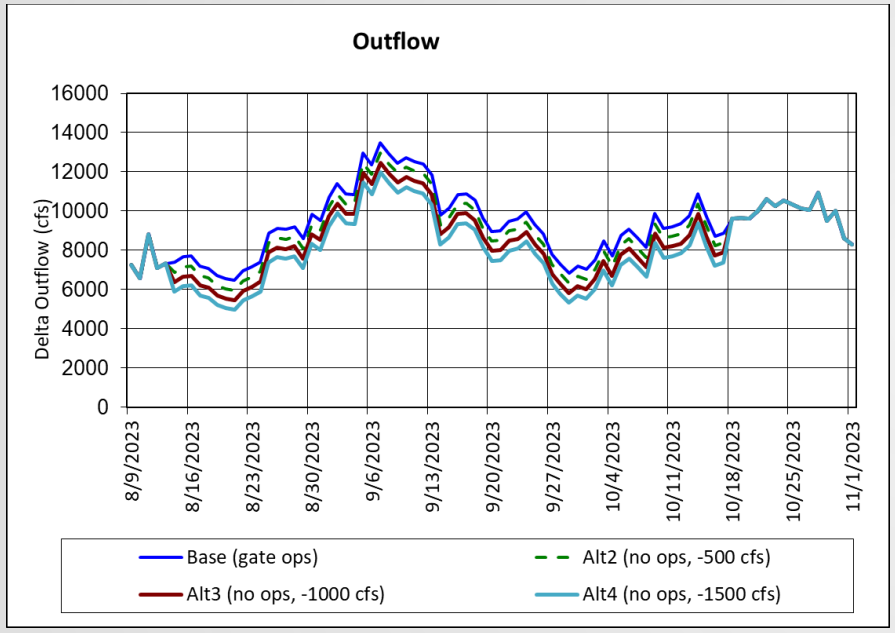
Objective Expand All Collapse All	Performance Measure	Unit	BN No Action	BN SMSCG 4ppt	BN SMSCG 6ppt
Delta Smelt					
Delta Smelt Growth and Survival					
Yolo	Growth increment	mm	0	0	0
Lower Sac	Growth increment	mm	0	0	0
Confluence	Growth increment	mm	0	0	0
Marsh	Growth increment	mm	0	0.43	0.34
Suitable 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					

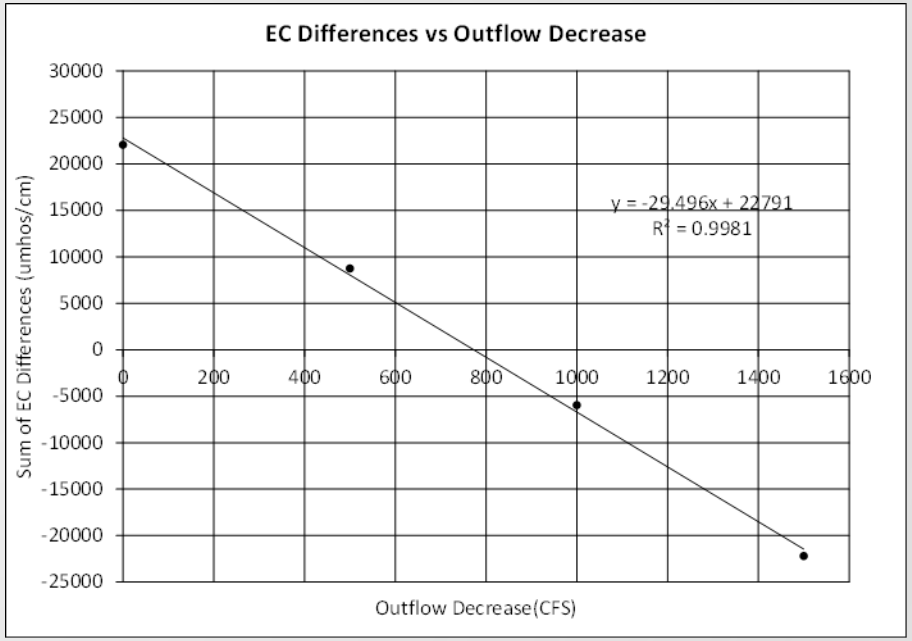
Real-Time Modeling

X2 Position


X2 Calculation Example
(74, 4.0)
(X2, 2.64)
(81, 2.0)
X2=(74-81)/(4-2)*(2.64-2)+81
X2=78.8

Water Cost – near-real-time





Future Directions

- Improvements to zooplankton-flow relationships
- Improvements in bioenergetic models
- Adjusting temperature suitability curves
- Accuracy of X2 calculations
- Incorporate results of special studies

Questions?