Collaborative Adaptive Management Team (CAMT) Investigations: Using New Modeling Approaches to Understand Delta Smelt State Salvage Patterns at the State Water Project and Central Valley Project

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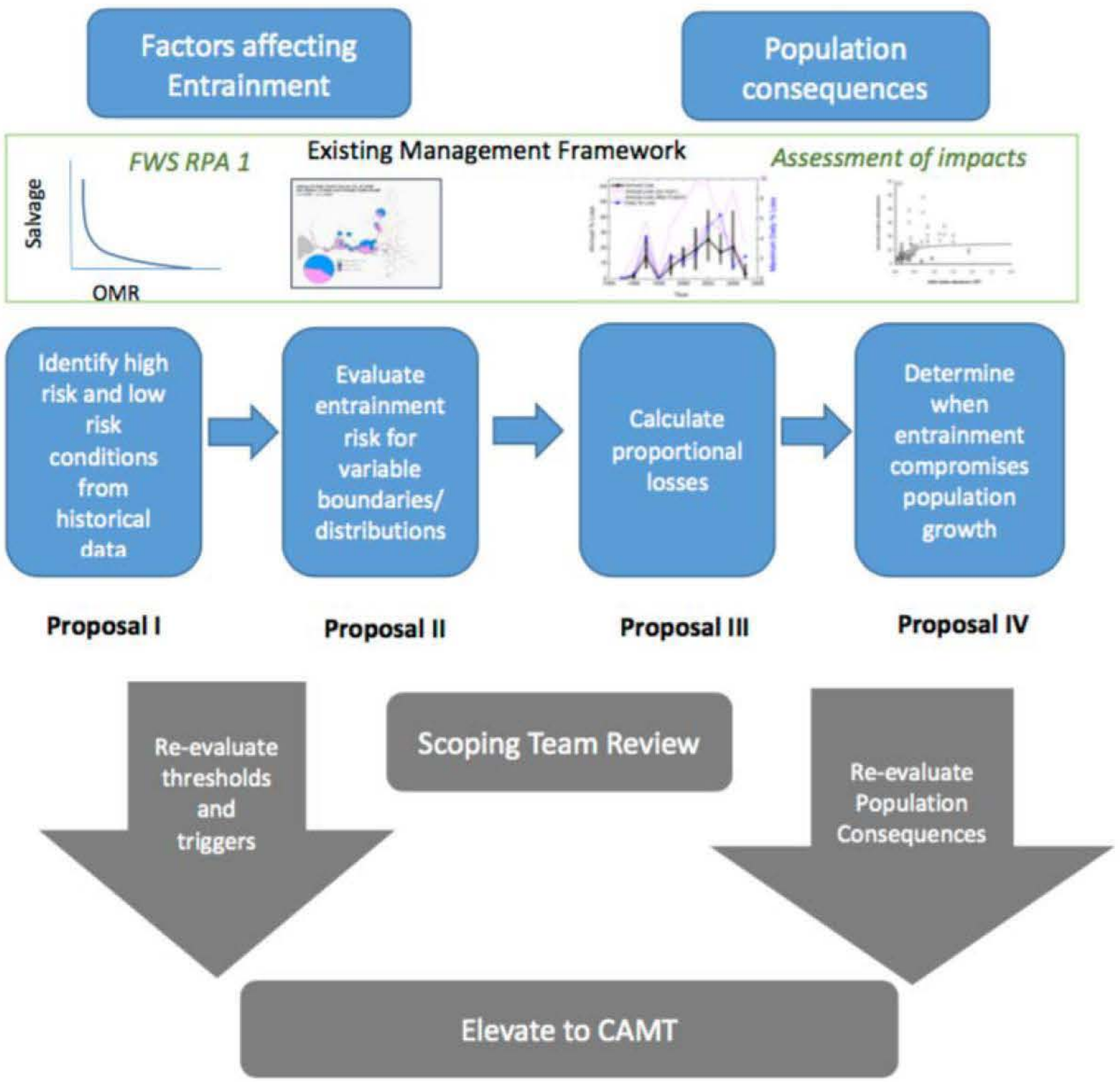
2016 Bay-Delta Science Conference

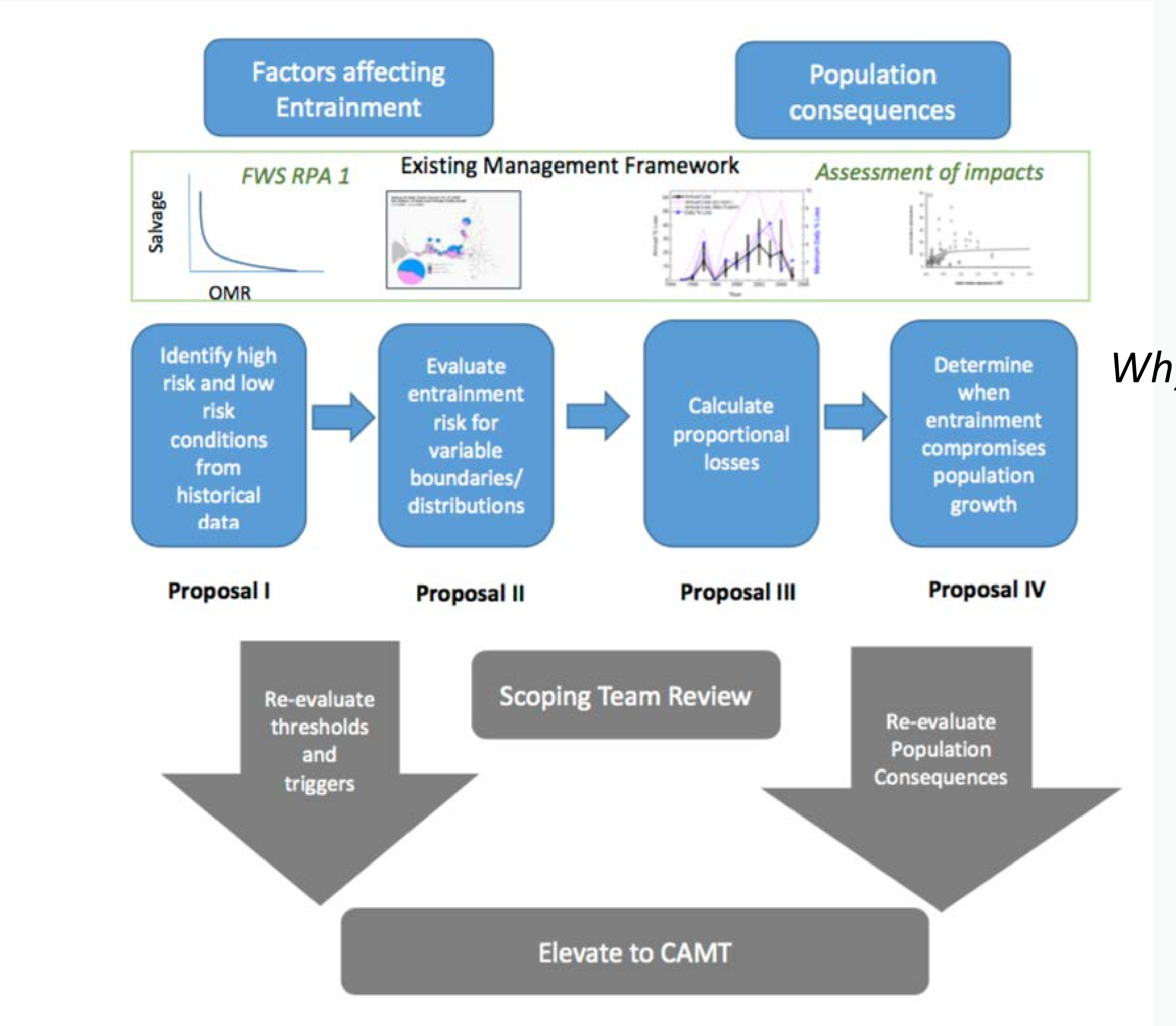
Disclaimer

The viewpoints expressed today are those of the authors and do not necessarily reflect the opinions of the U.S. Department of the Interior or the U.S. Fish and Wildlife Service

The Bigger Picture

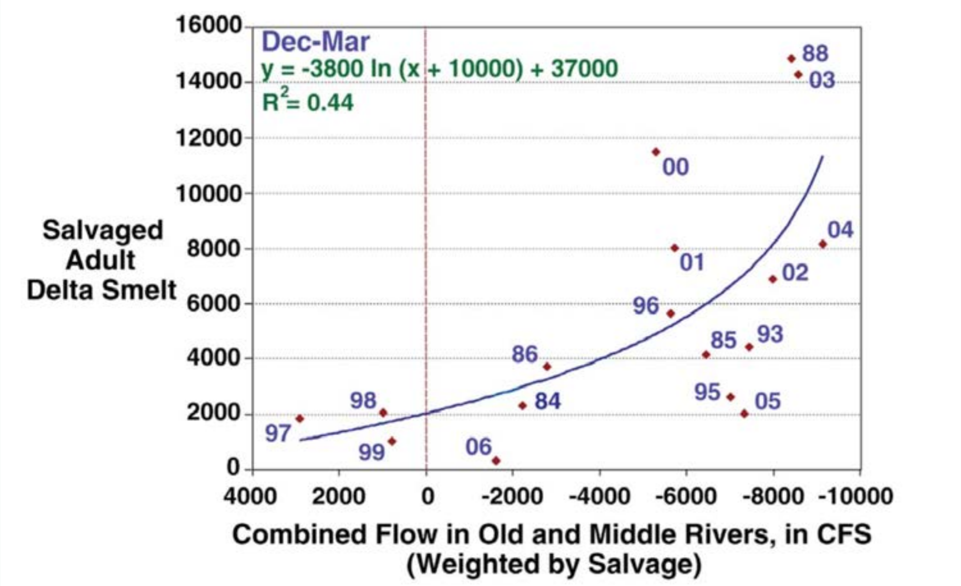


The Bigger Picture



Why revisit the salvage data?

Previous research did not consider:



Note: Data shown are for the period 1984-2007, excluding years 1987, 1989-92, 1994, and 2007 that had low (<12ntu) average water turbidity during Jan-Feb at Clifton Court Forebay.

Figure B-13. OMR-Salvage relationship for adult delta smelt. (source, P. Smith). Data from this figure were the raw data used in the piecewise polynomial regression analysis.

2008 USFWS Biological Opinion

1. Finer-scale variability of salvage dynamics (i.e., what drives salvage during first flush periods)

2. Other potentially important predictor variables (e.g., predators, water temperature, etc)

3. Fish behavior during first flush events

4. Population-level impacts (i.e., salvage scaled to previous FMWT abundance)

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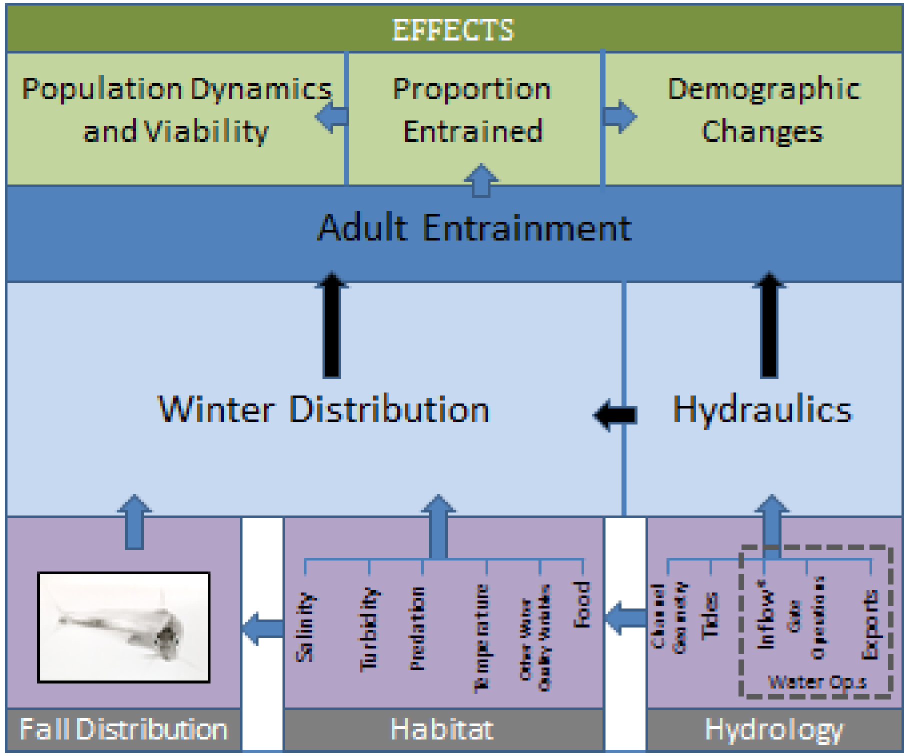
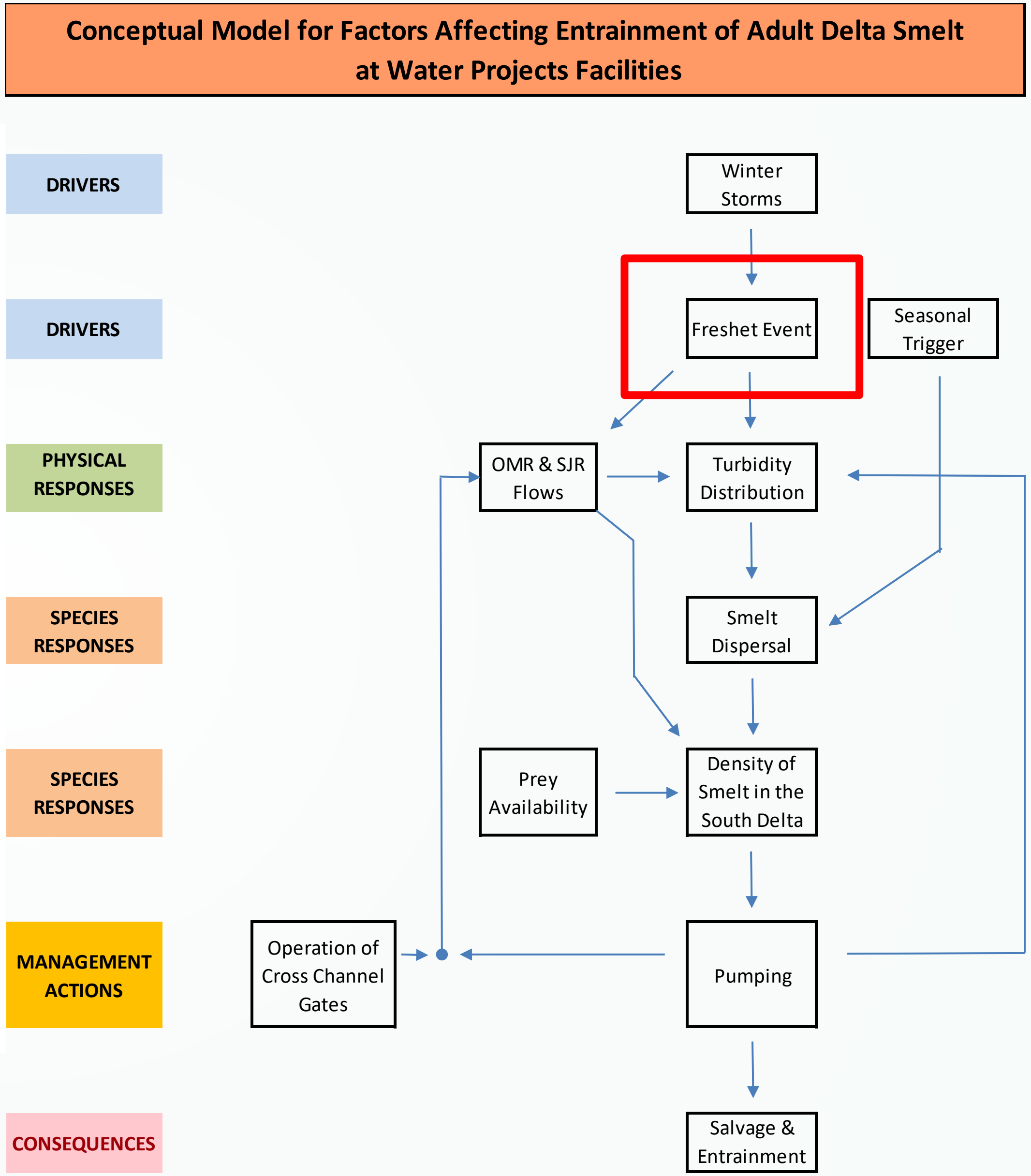
New conceptual models



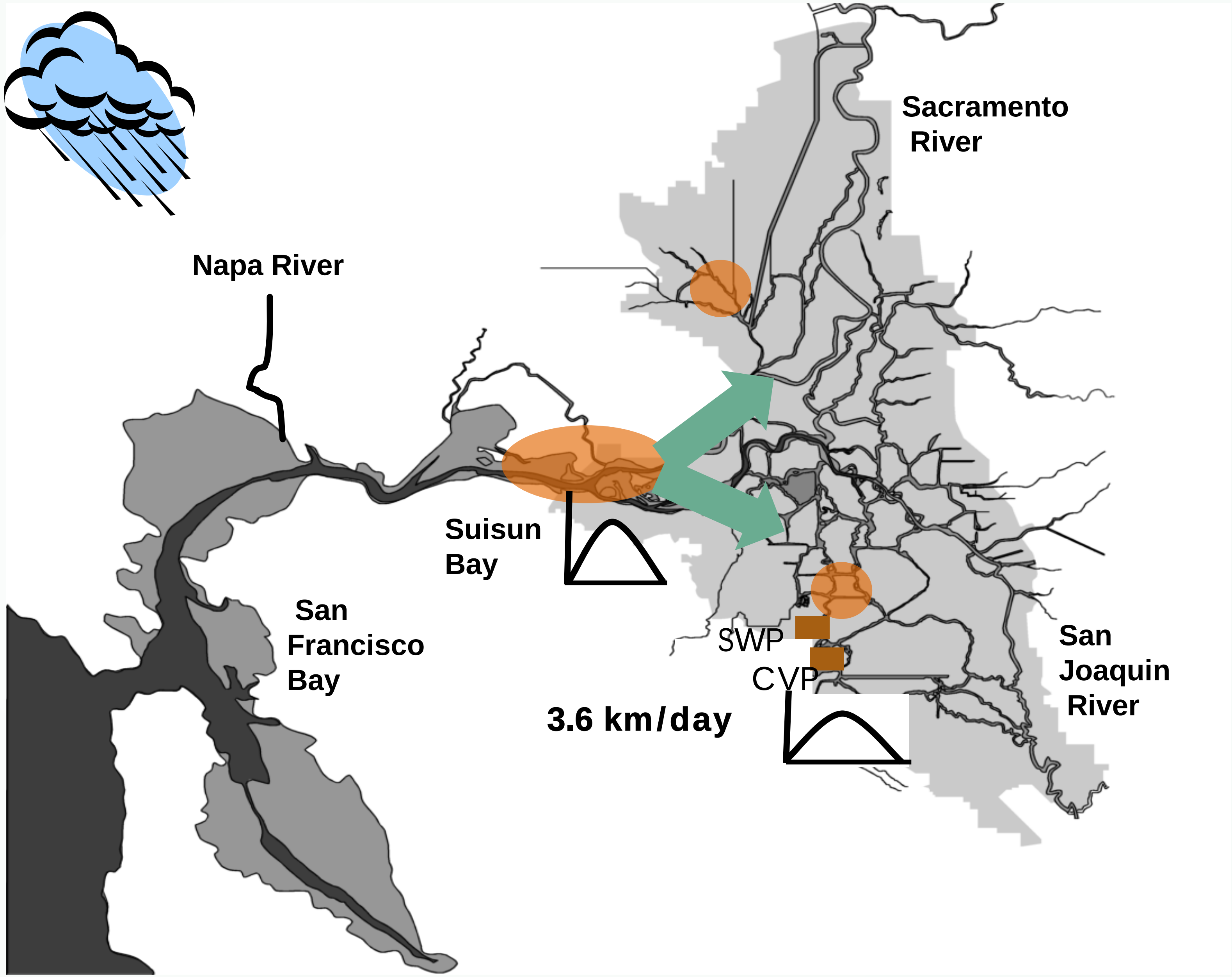
2015 CAMT Progress Report



via Scott Hamilton

Delta smelt movements during first flush

Migration vs diffuse dispersal?



Sommer et al. 2011

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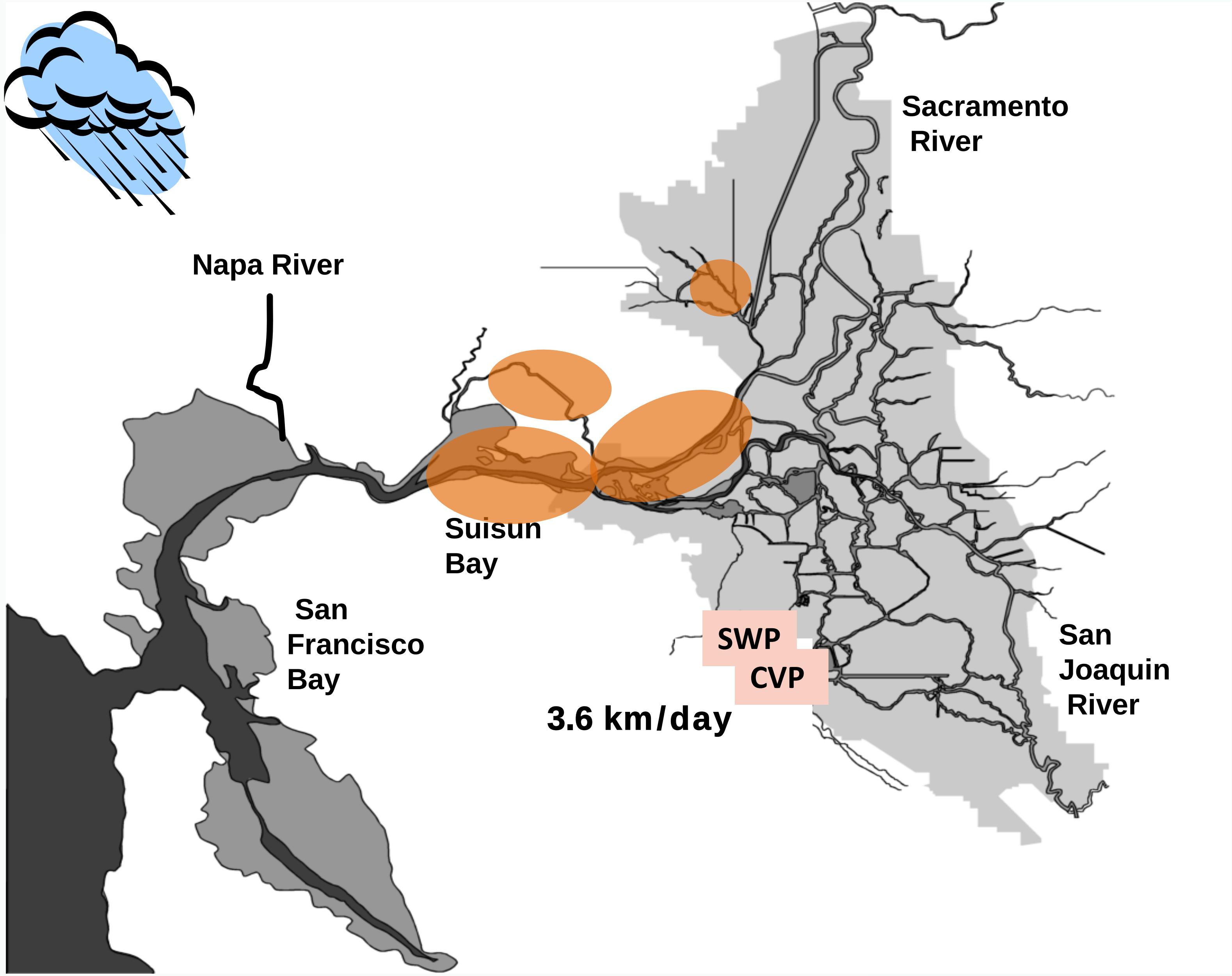

Murphy and Hamilton 2013

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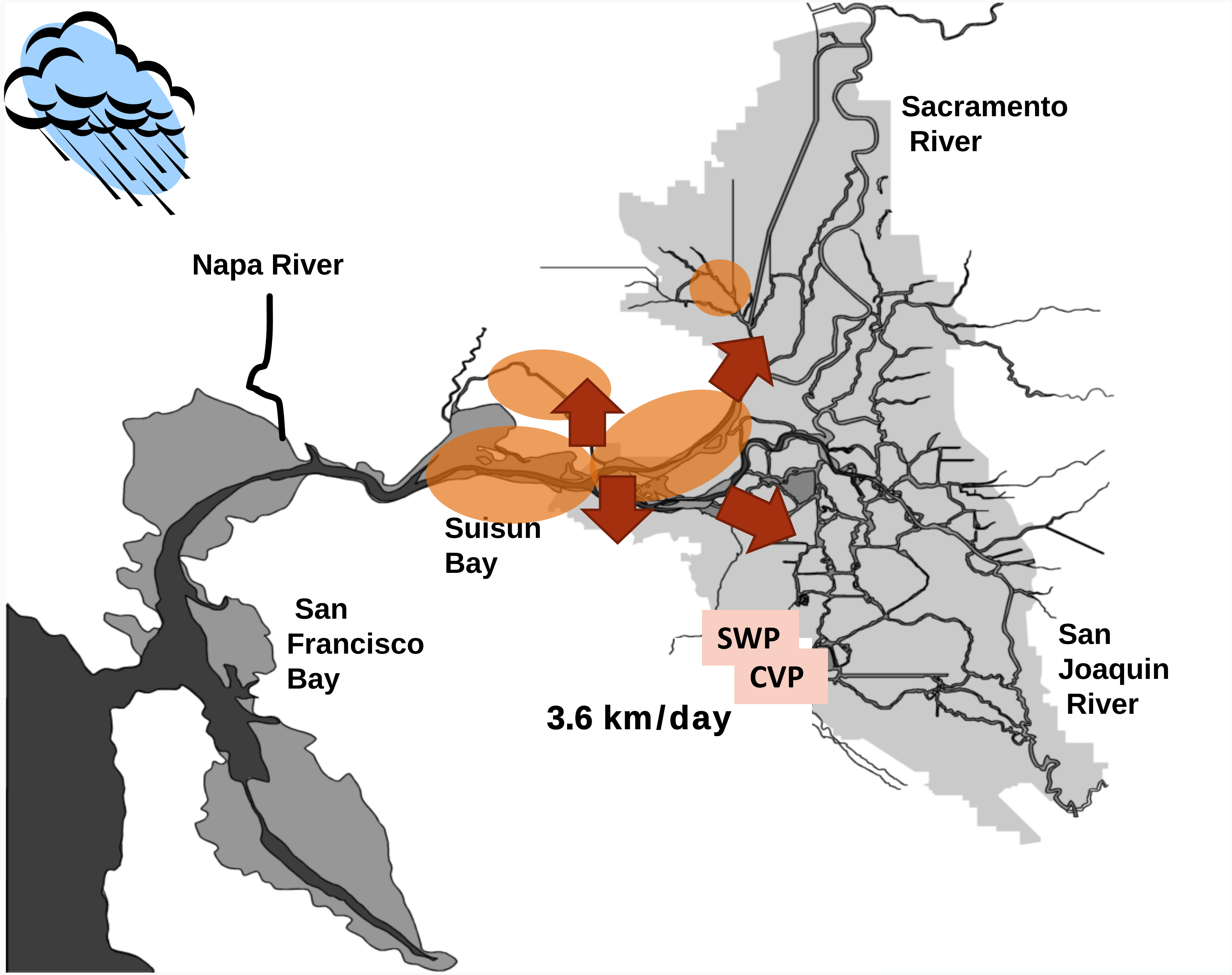
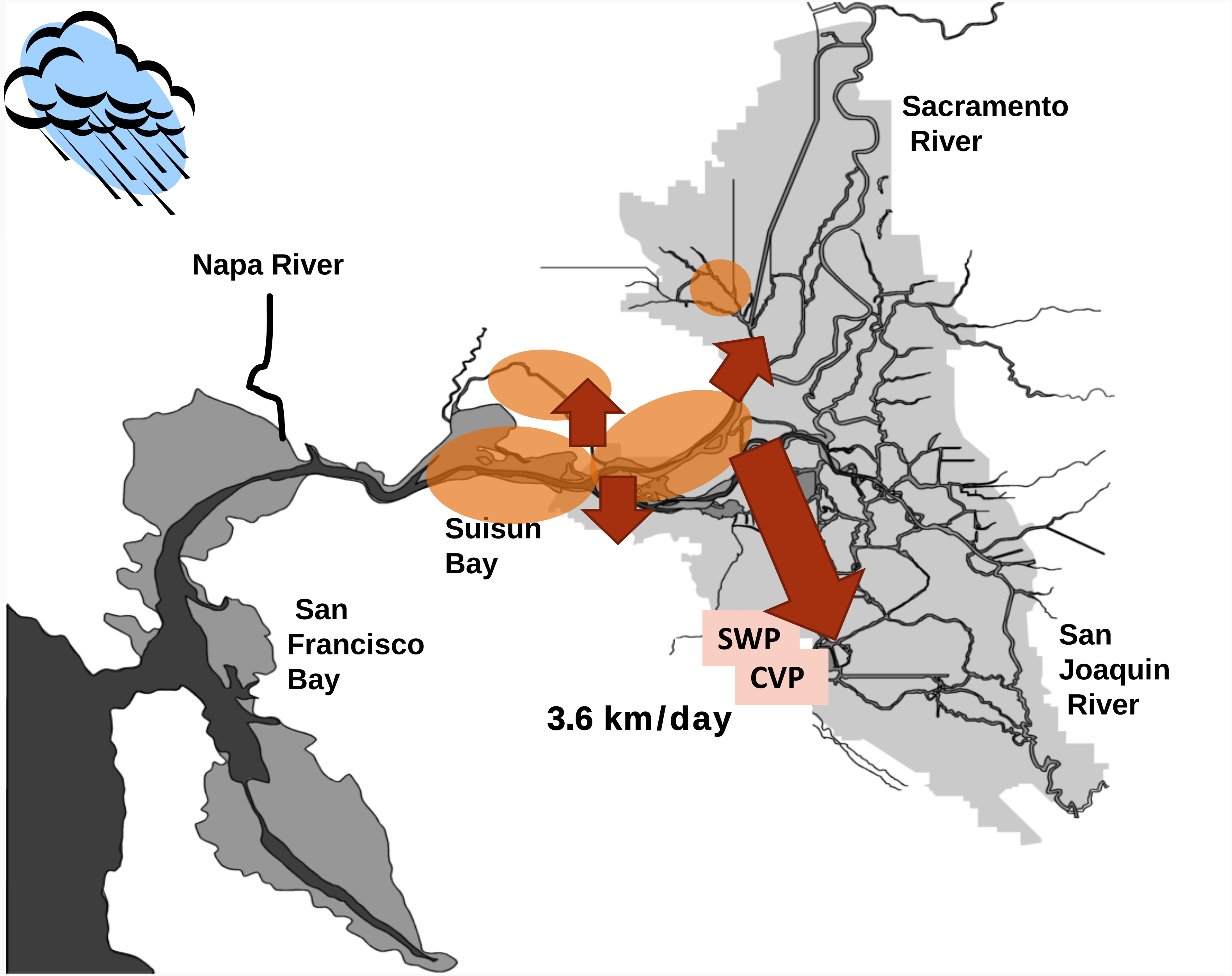


Murphy and Hamilton 2013

Delta smelt movements during first flush

Migration vs diffuse dispersal?

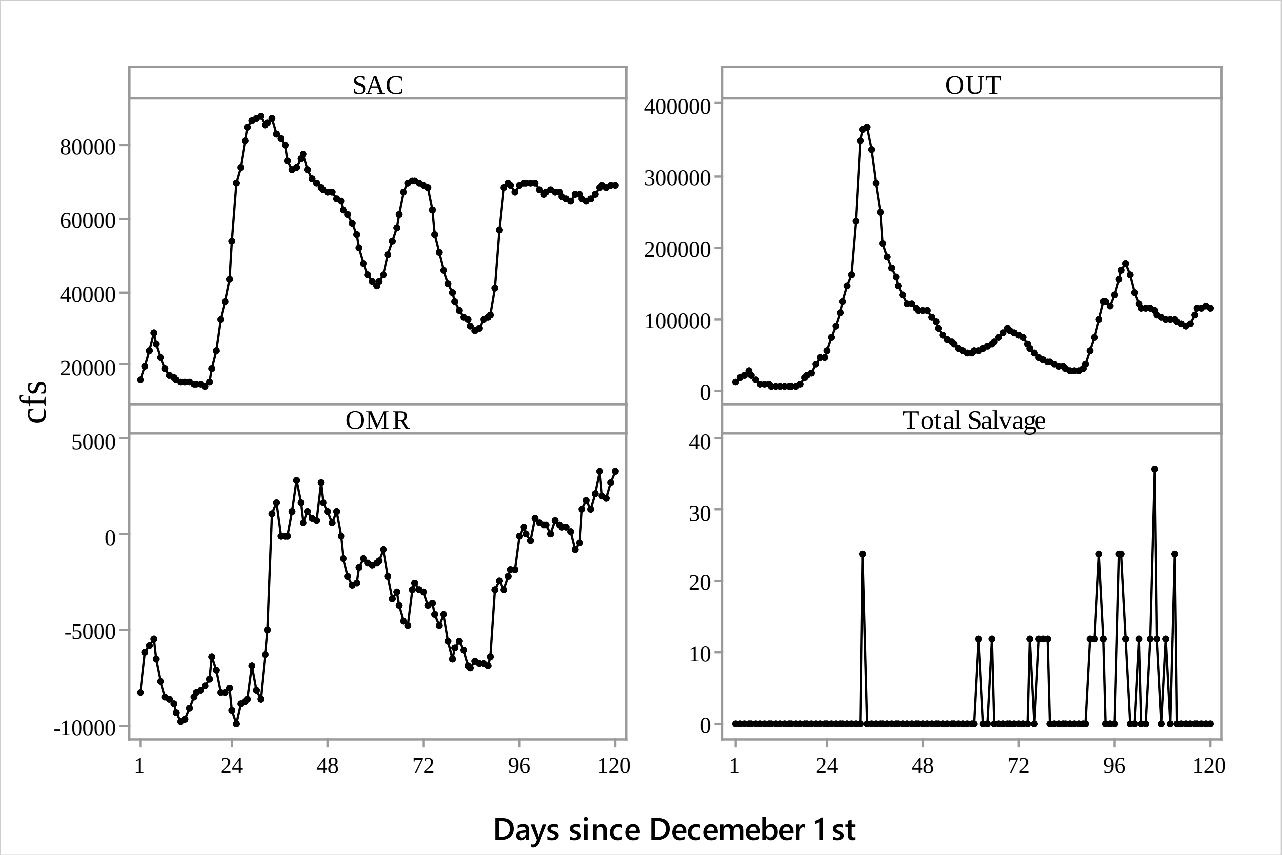
Both models support turbidity bridge CM

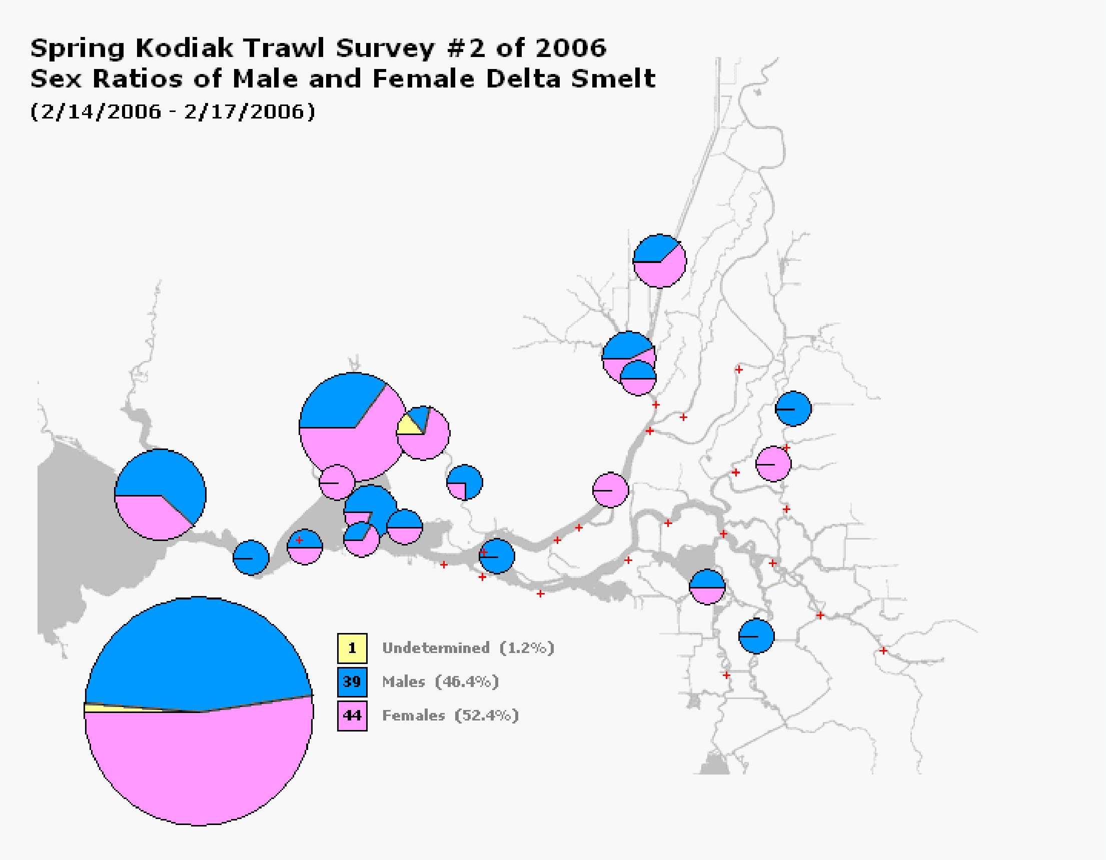


Murphy and Hamilton 2013

Delta Smelt likely employ a combination of unidirectional and diffuse movements during winter storms

2006





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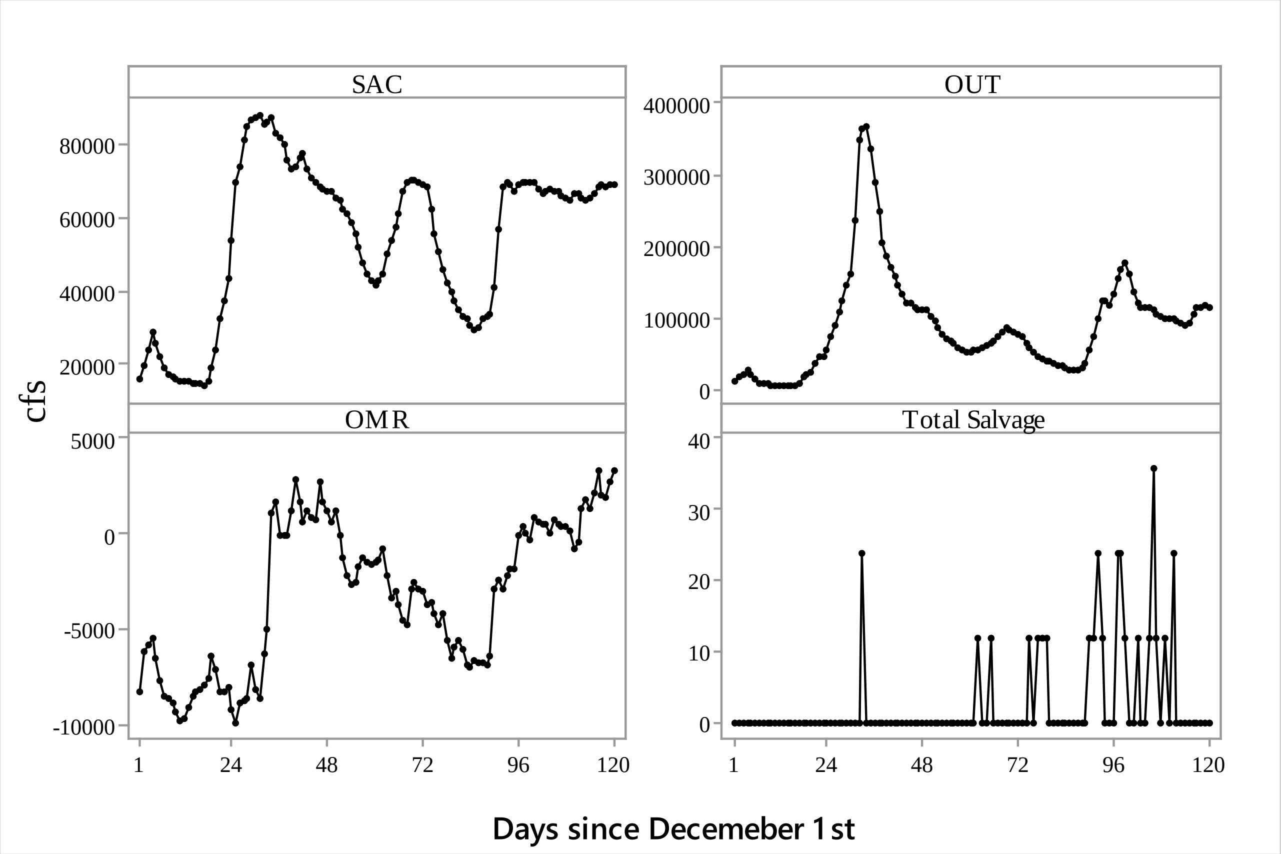

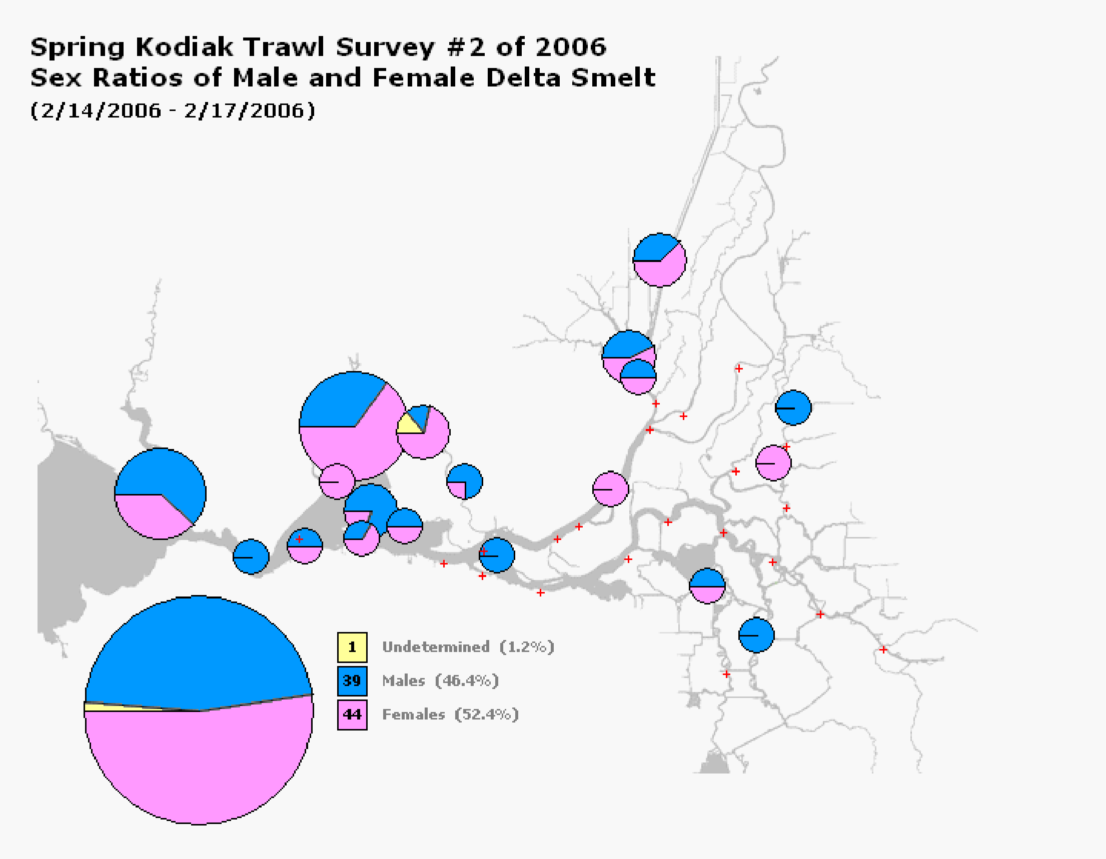

Behaviors are complicated! Stay for Ed's talk

First flush storms historically led to high Delta Smelt salvage

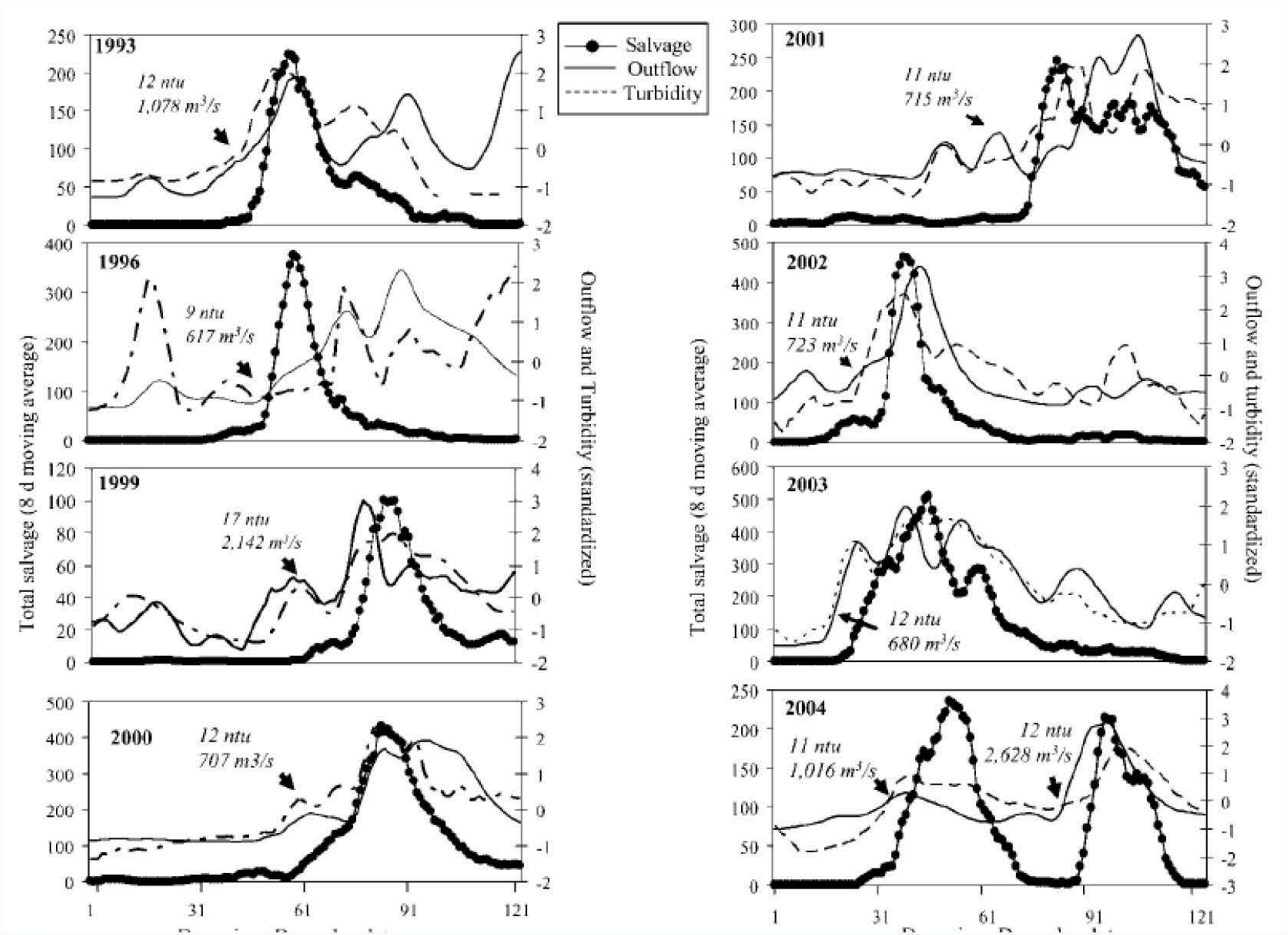

Figure 6, Grimaldo et al. 2009

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First flush storms historically led to high Delta Smelt salvage

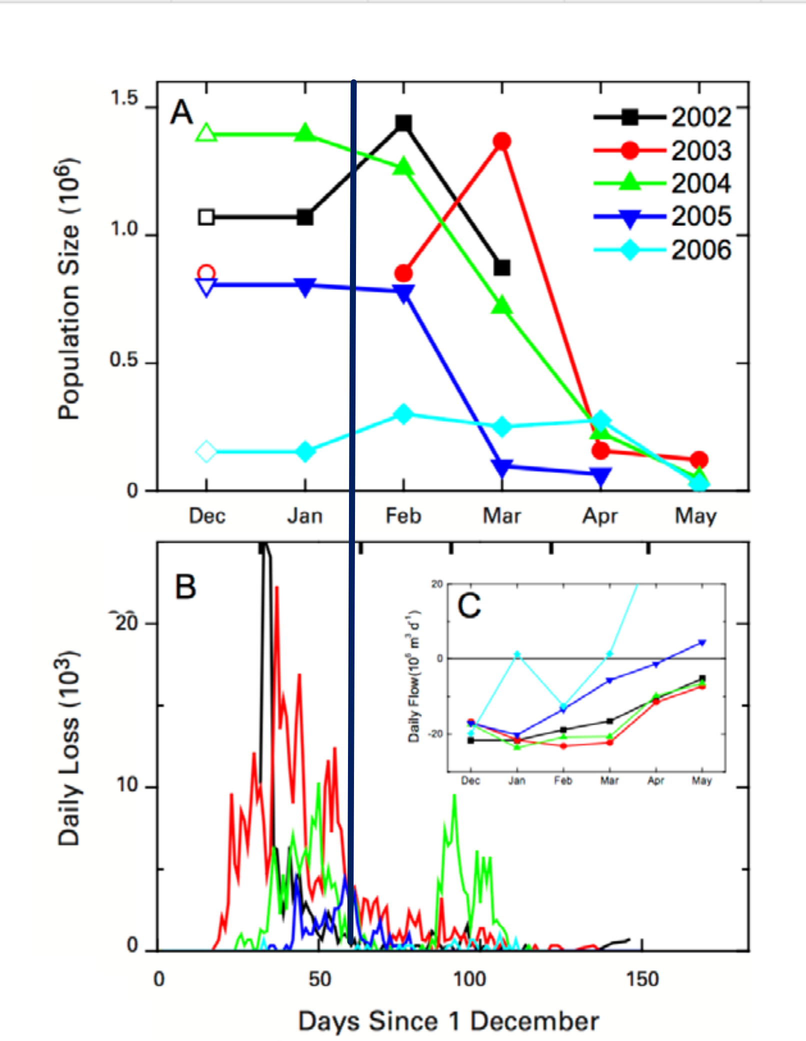
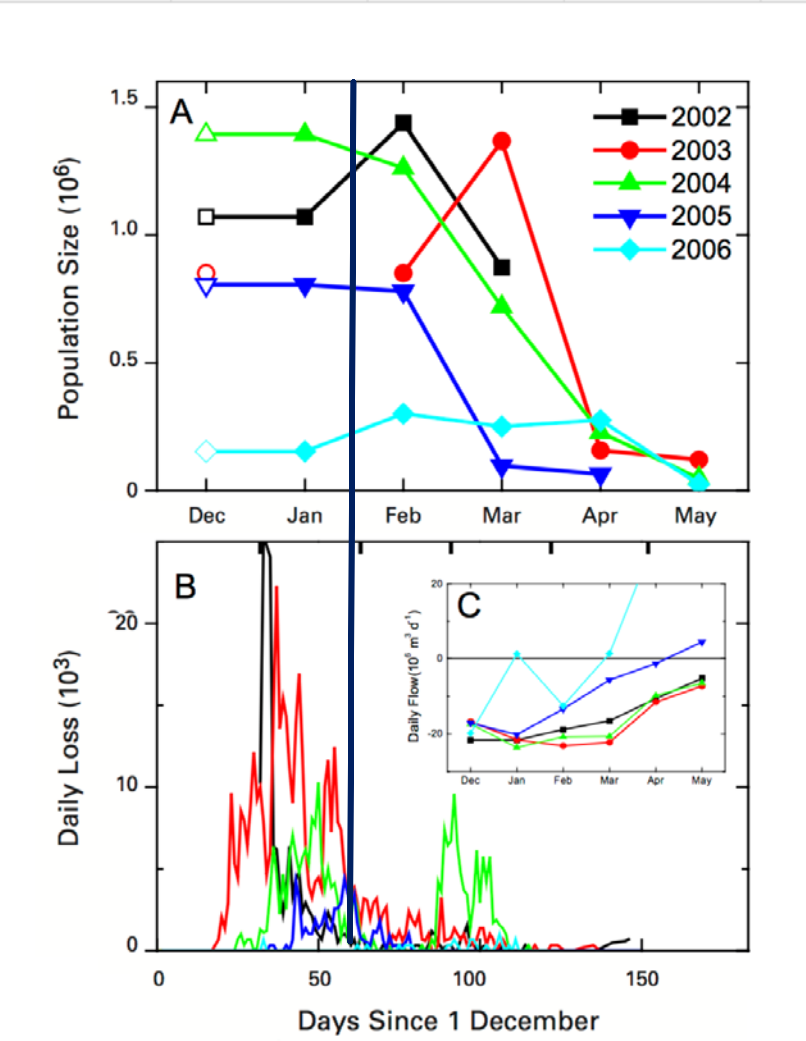


Figure 11, Kimmerer 2008

Salvage can be over or nearly over before population estimates are confidently assessed from the Spring Kodiak Trawl

First flush storms historically led to high Delta Smelt salvage



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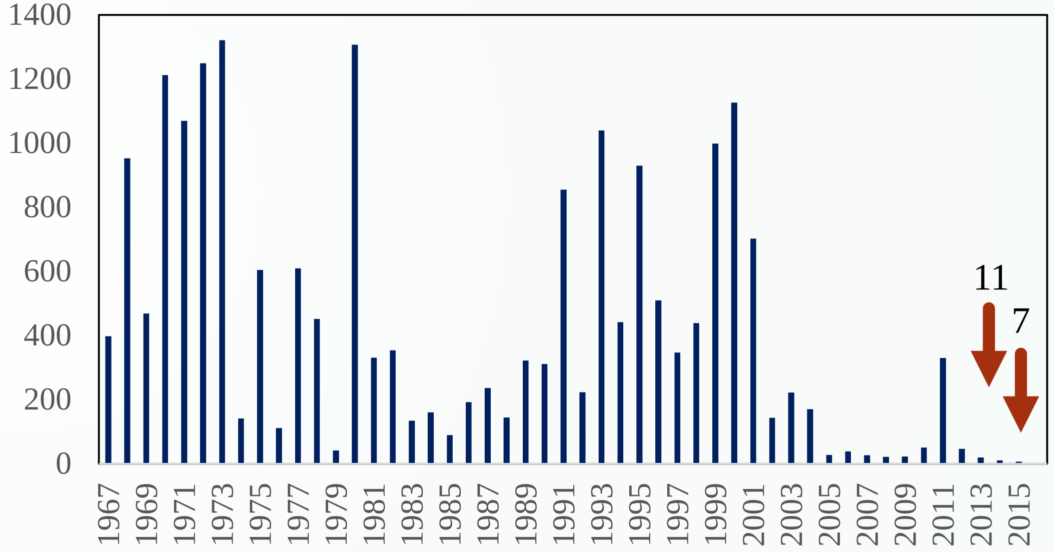
Too few fish caught in fall nowadays to provide reliable adult abundance estimates, especially using the FMWT net (SKT gear better net)



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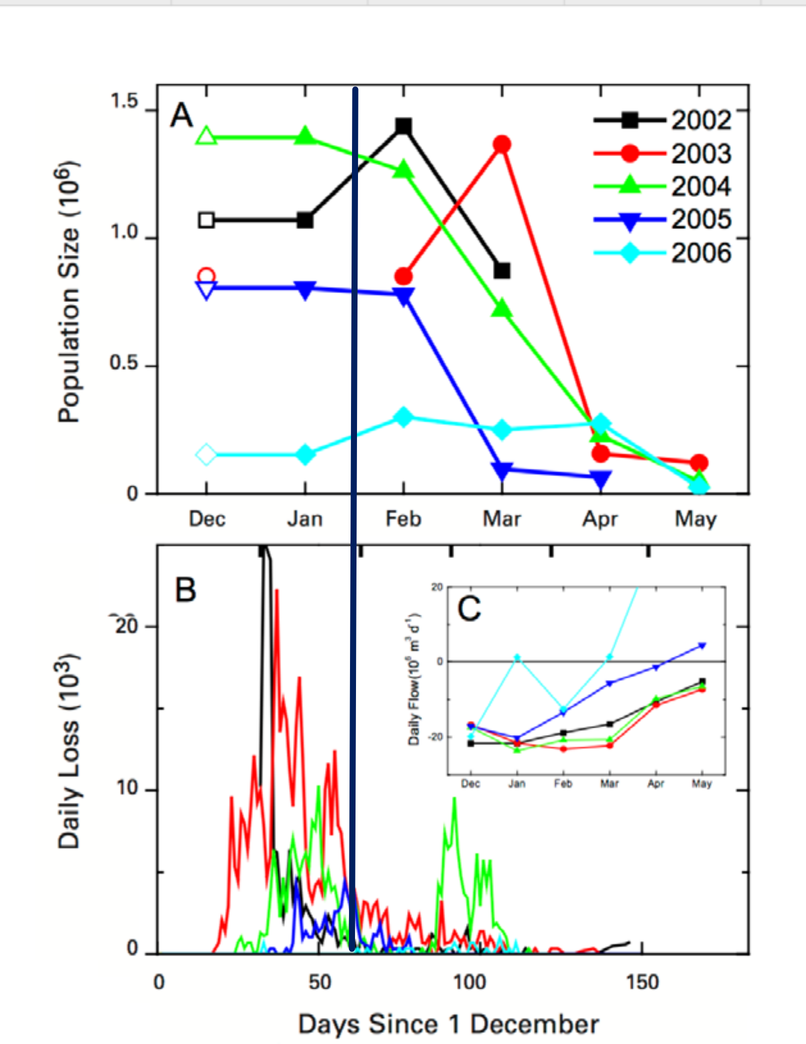

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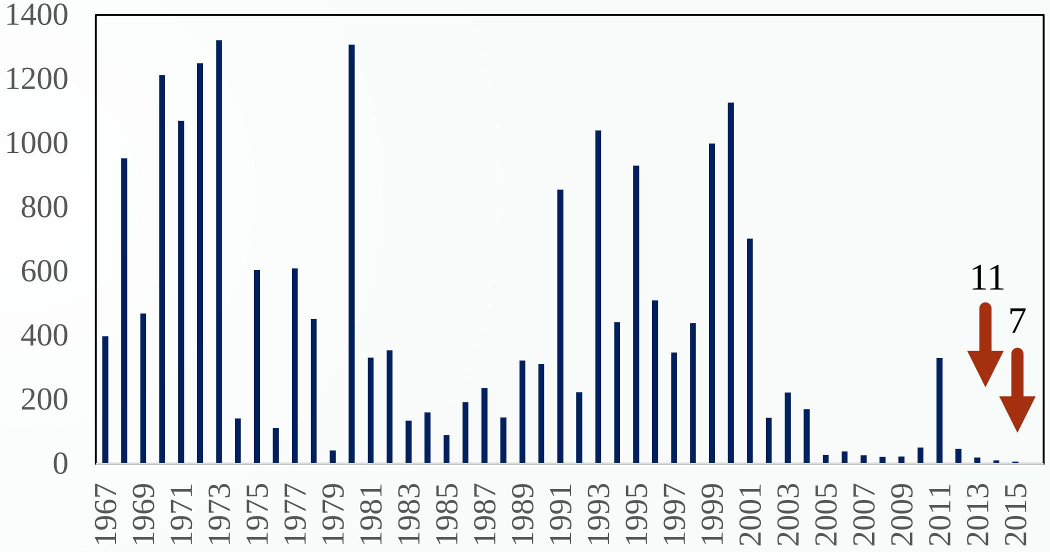


Why not use the SKT starting in September?

First flush storms historically led to high Delta Smelt salvage

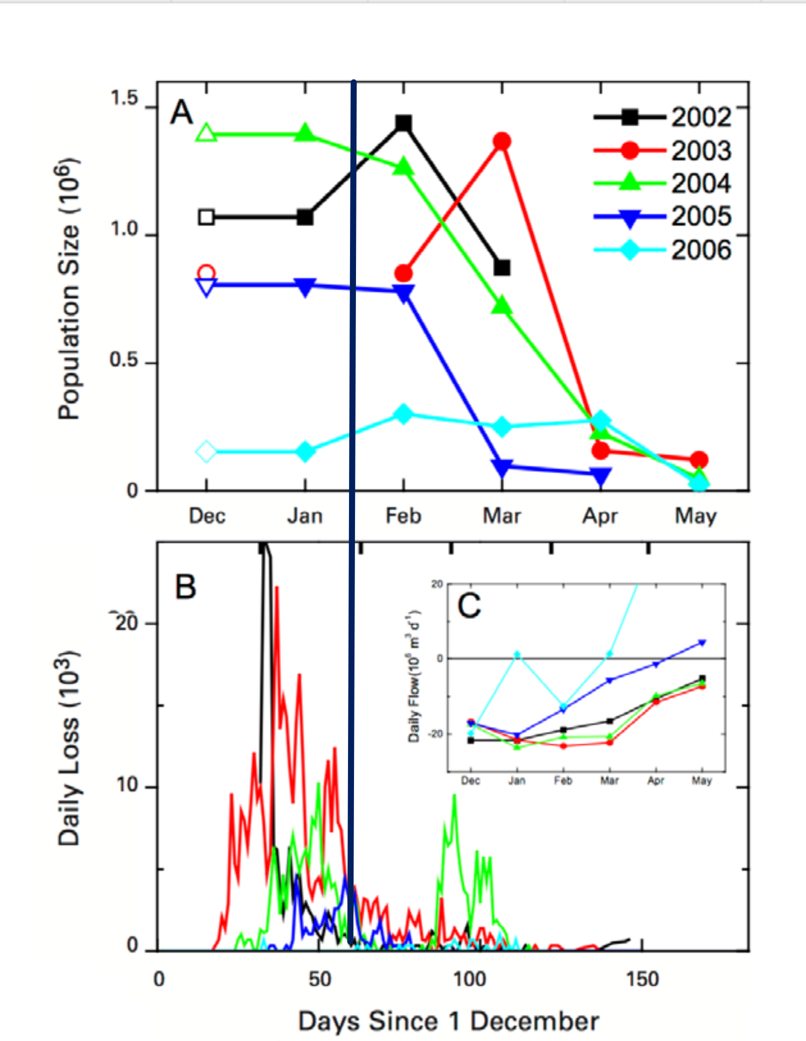
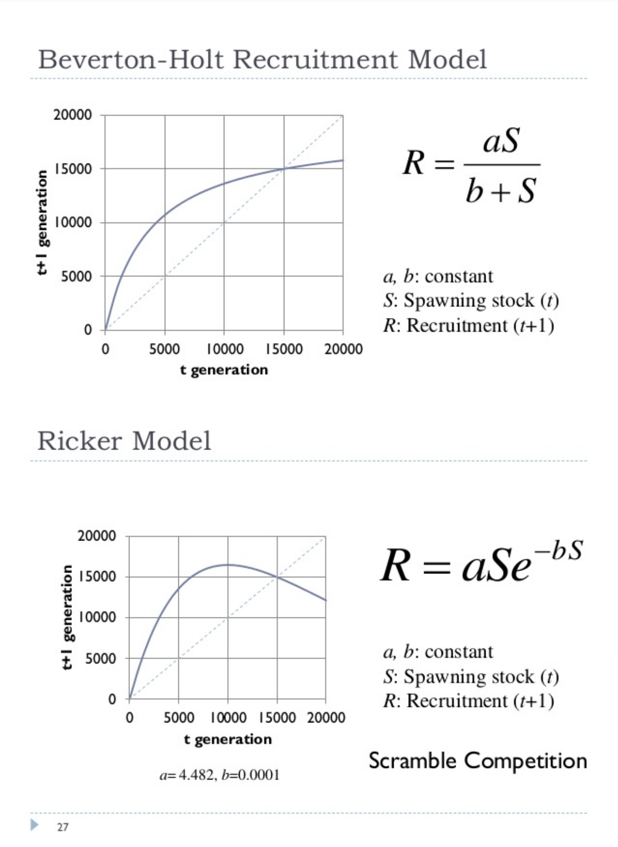


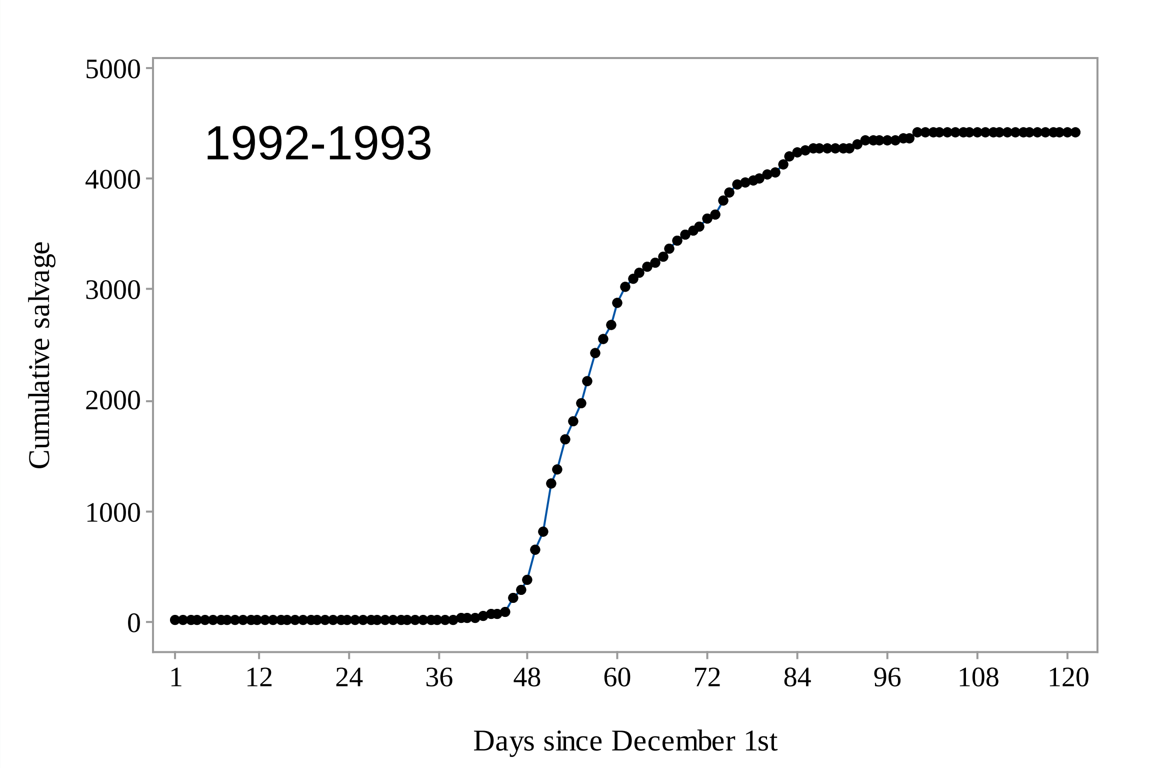
Figure 11, Kimmerer 2008

Could potentially allow for salvage (losses) to be evaluated in context of recruit-per-spawner models



Source: Matsuishi 2014

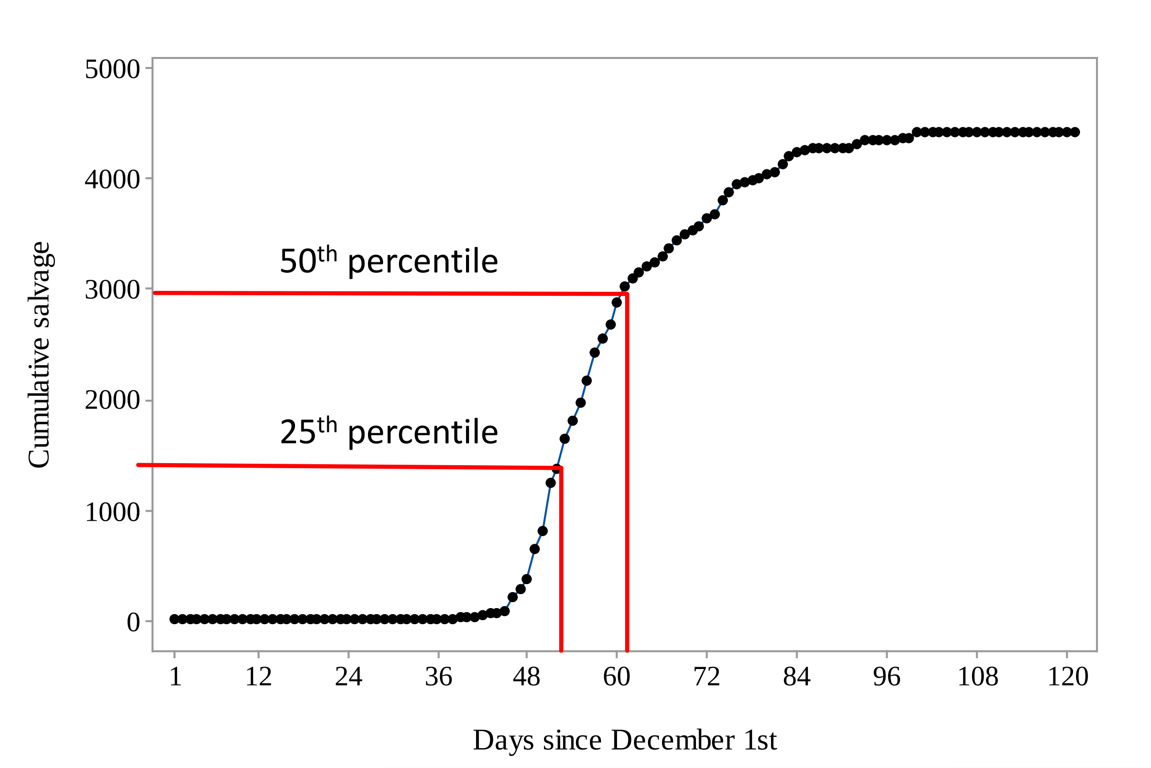
Revised analyses-Focus on conditions that explain salvage during first flush



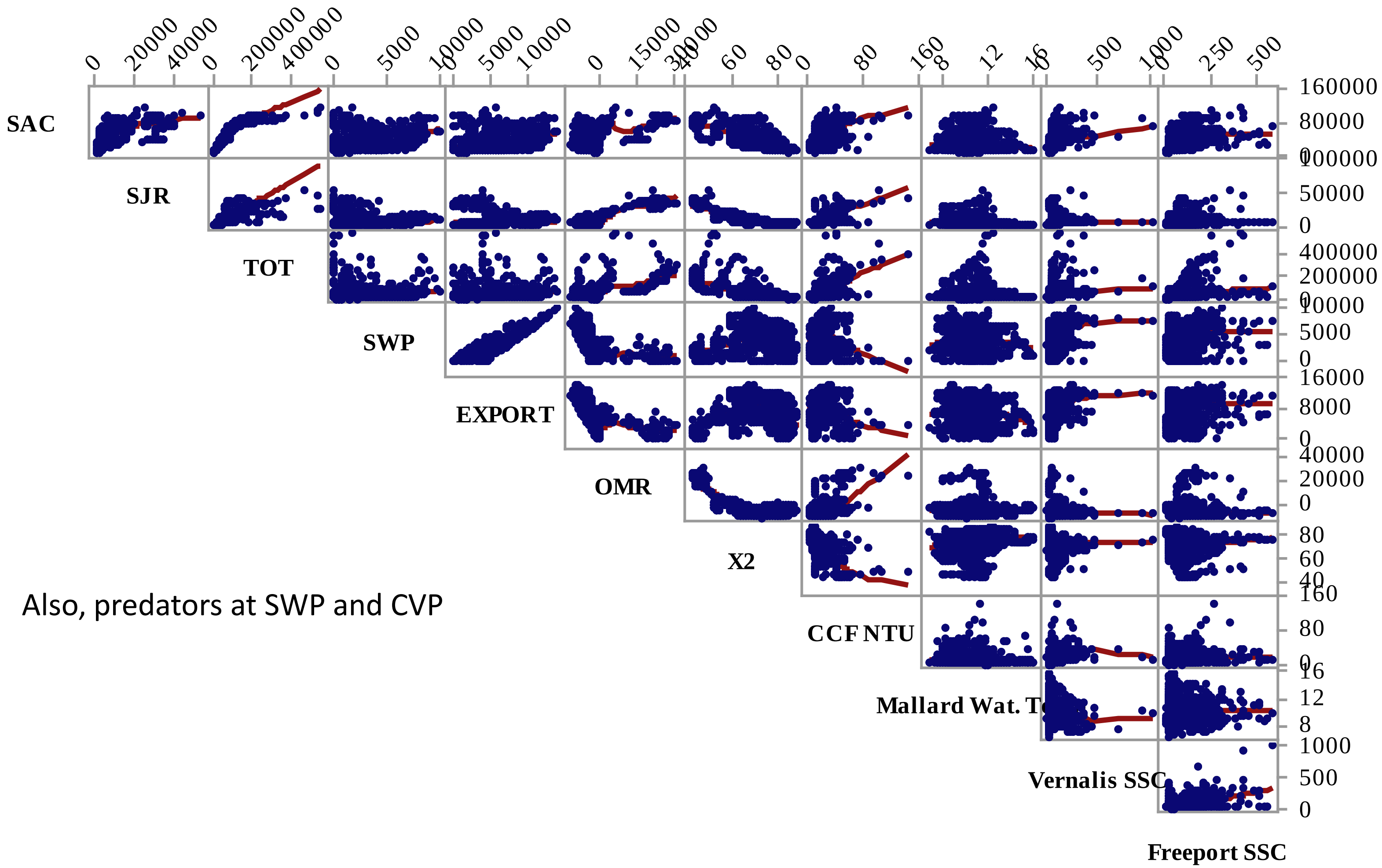
Revised analyses-Focus on conditions that explain salvage during first flush

- GLM negative binomial models
- GAM
- Boosted Regression Trees

-describe response surface
-rather than one best model, average over MANY poorly fitting models
-method to sort through MANY potential variables
-interactions are automatically included
-stepped predictions identify thresholds between high and low risk conditions



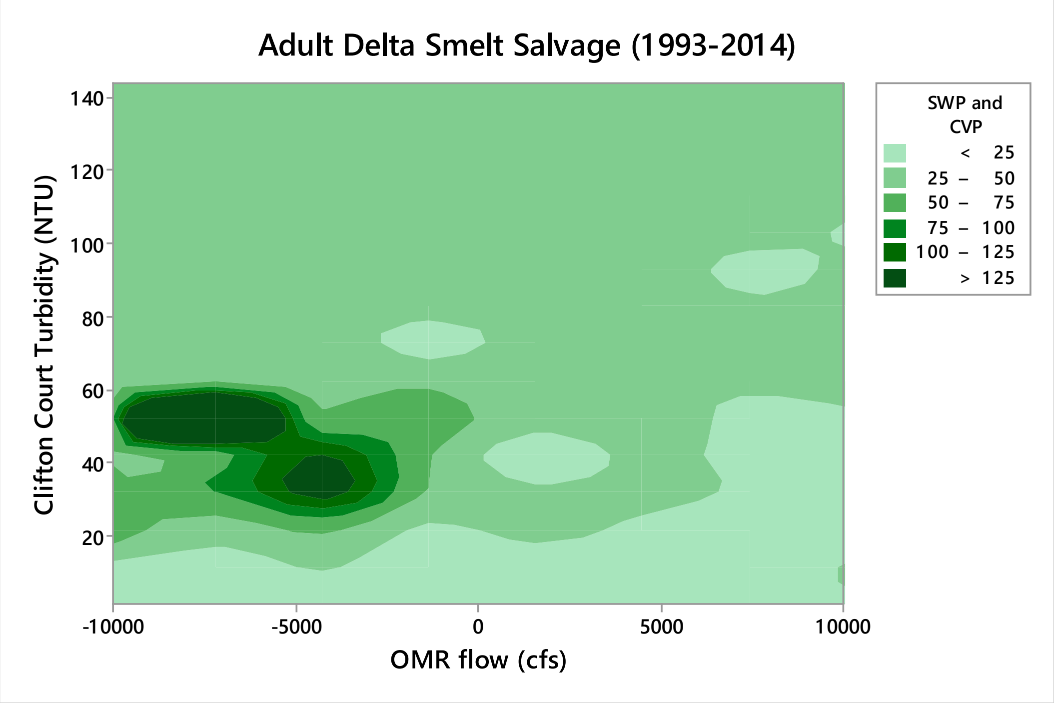
Variables considered- Old and New

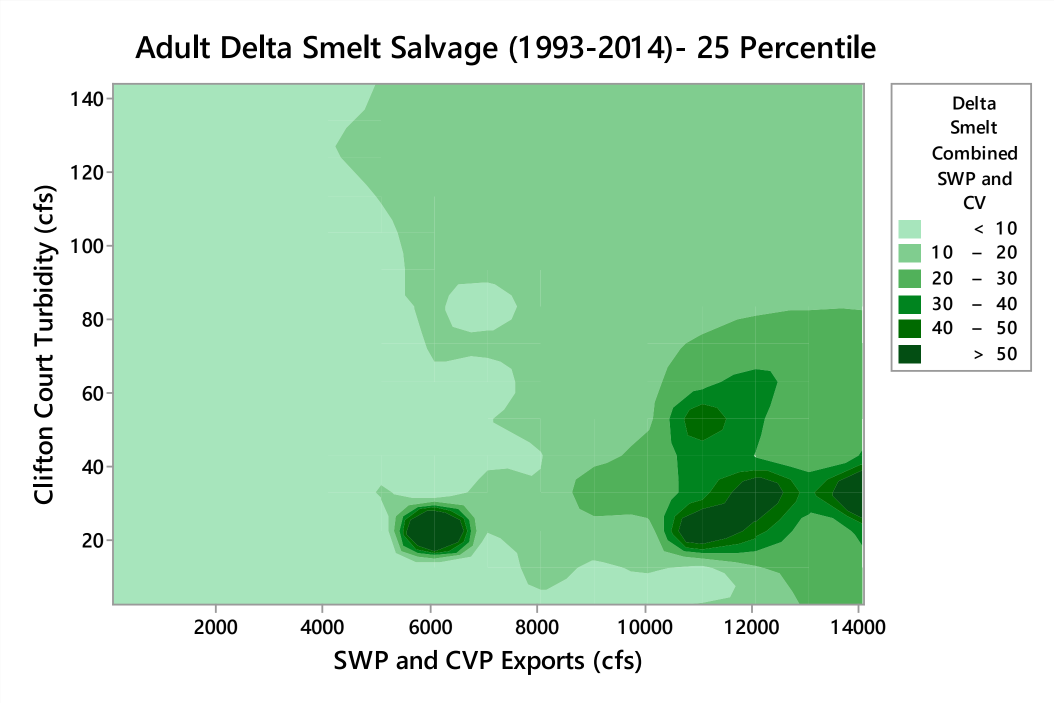


Also, predators at SWP and CVP

GLM Negative Binomial Model Summary

Model Run	Exports	OMR	Water Temp	Vernalis SSC	Freeport SSC	CCF NTU	Outflow	PFMWT	Best model r-square
25th	X				X	X			0.52
50th	X					X	X		0.54
Annual		X			X	X		X	0.65





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Boosted Regression Tree Results

Physical PC rotations

	PC1	PC2	PC3	PC4
interpretation	Outflow	PRJEXP.OMR.SSC	CCC.NBAQ.X2	MISDIV
lambda	4.59	1.98	1.31	1.00
cumulative variance explained	0.38	0.55	0.66	0.74
Freeport.SSC	0.23	0.35	-0.01	-0.03
Vernalis.SSC	0.24	0.43	0.05	0.05
CCC	-0.08	-0.10	-0.58	-0.02
PRJEXP	-0.08	0.56	-0.21	-0.18
NBAQ	-0.16	-0.06	0.56	-0.10
PREC	0.24	0.32	0.33	0.14
MISDV	0.09	-0.08	0.03	-0.95
WEST	0.44	-0.16	0.08	0.11
RIO	0.43	0.05	0.00	-0.10
OUT	0.44	0.00	0.02	-0.05
OMR	0.32	-0.48	0.10	0.02
X2	-0.35	0.08	0.42	-0.06

	Relative influence (Rank)		
Variable	full dataset	25th percentile	50th percentile
Phy.PC.PRJEXP.OMR.SSC	0.28 (1)	0.24 (1)	0.29 (1)
FMWT	0.20 (2)	0.19 (3)	0.23 (2)
Bio.PC.Bull.Pminn	0.13 (3)	0.19 (2)	0.12 (4)
Phy.PC.CCC.NBAQ.X2	0.10 (4)	0.05 (6)	0.14 (3)
Spawn.day	0.05 (5)	0.08 (4)	0.04 (7)
Bio.PC..SWPSMB.CVPcrappie	0.05 (6)	0.05 (7)	0.05 (5)
Phy.PC.MISDIV	0.03 (7)	0.03 (10)	0.04 (6)
Bio.PC.CVPpminnSMB.SWPcrappie	0.03 (8)	0.01 (13)	0.02 (10)
Bio.PC..CVPLMBcrappie	0.03 (9)	0.03 (8)	0.01 (11)
Phy.PC.Outflow	0.03 (10)	0.02 (11)	0.02 (9)
Mallard.Temp	0.03 (11)	0.07 (5)	0.03 (8)
Bio.PC.Blackbass.Pminn	0.03 (12)	0.03 (9)	0.01 (13)
Bio.PC.CVPbullCHN.SWPbass	0.02 (13)	0.02 (12)	0.01 (12)

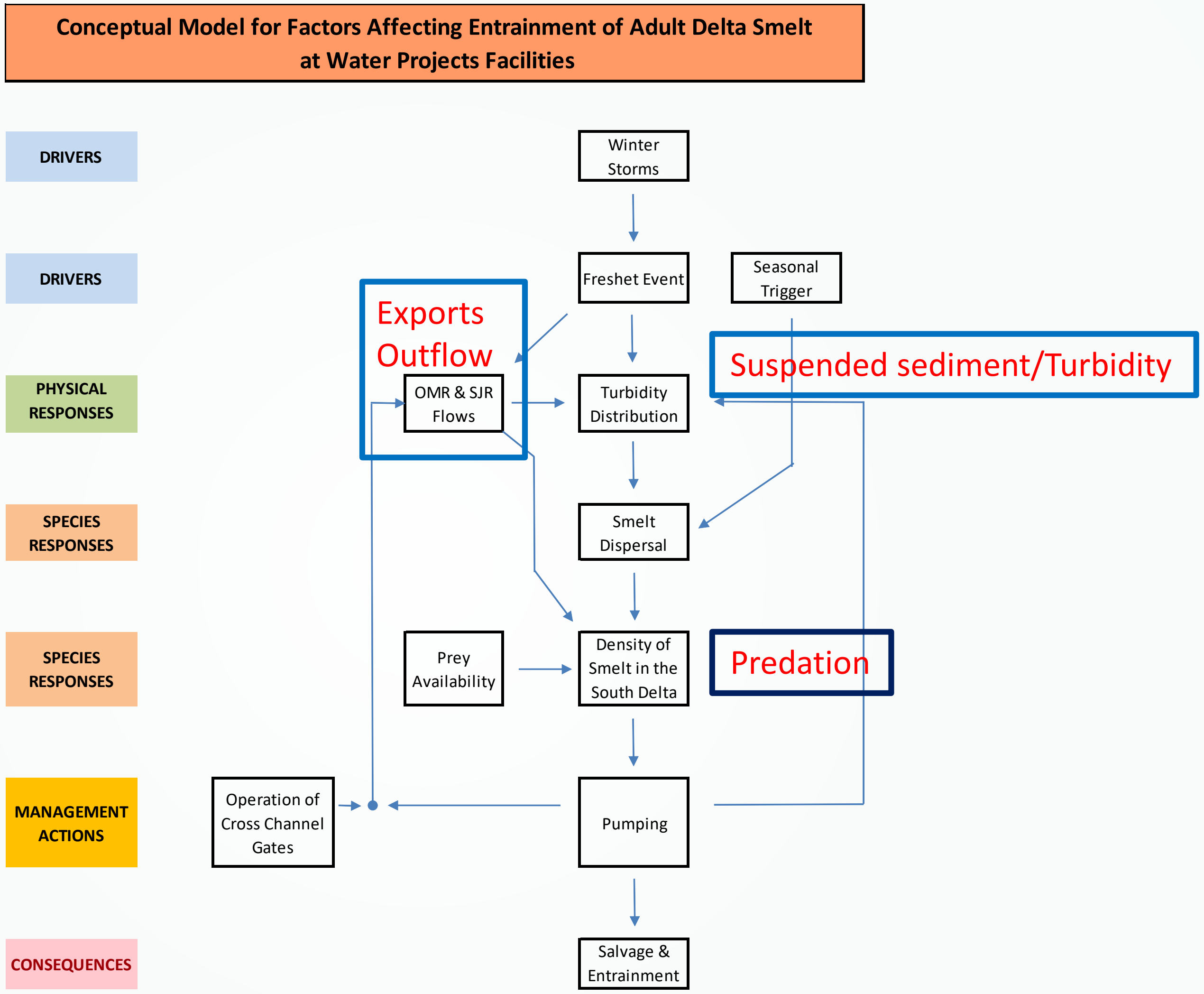
Small differences between facilities but same story

	SWP		CVP	
Equation	Season	Event	Season	Event
3 (season base)	0.35		0.41	
3 (event base)		0.26		0.38
5: *NDOI*	0.33	0.23	0.48	0.45
6: *OMR*	0.47	0.41	0.38	0.35
7: *NTU*	0.32	0.25	0.49	0.48
8: *FF*	0.42	**0.53**	0.38	0.44
9: *OMR + NTU*	0.46	0.45	**0.51**	0.48
10: *NDOI + OMR + NTU*	0.49	**0.55**	**0.63**	**0.63**
4 (season base)	0.49		0.45	
4 (event base)		0.38		0.41
11: *NDOI*	0.47	0.35	0.47	0.44
12: *E*	**0.56**	**0.66**	**0.64**	0.49
13: *OMR*	**0.50**	0.49	0.43	0.39
14: *NTU*	0.48	0.44	**0.62**	**0.57**
15: *FF*	0.49	**0.68**	0.43	0.47
16: *OMR + NTU*	**0.51**	**0.62**	**0.63**	**0.58**
17: *NDOI + OMR + NTU*	0.48	**0.62**	**0.68**	**0.68**
18: *E + NTU*	**0.54**	**0.67**	**0.75**	**0.67**
19 *NDOI + E + NTU*	**0.51**	**0.65**	**0.78**	**0.77**

AIC 5 units lower than base model

AIC 2 units lower than base model

Conceptual Model Review



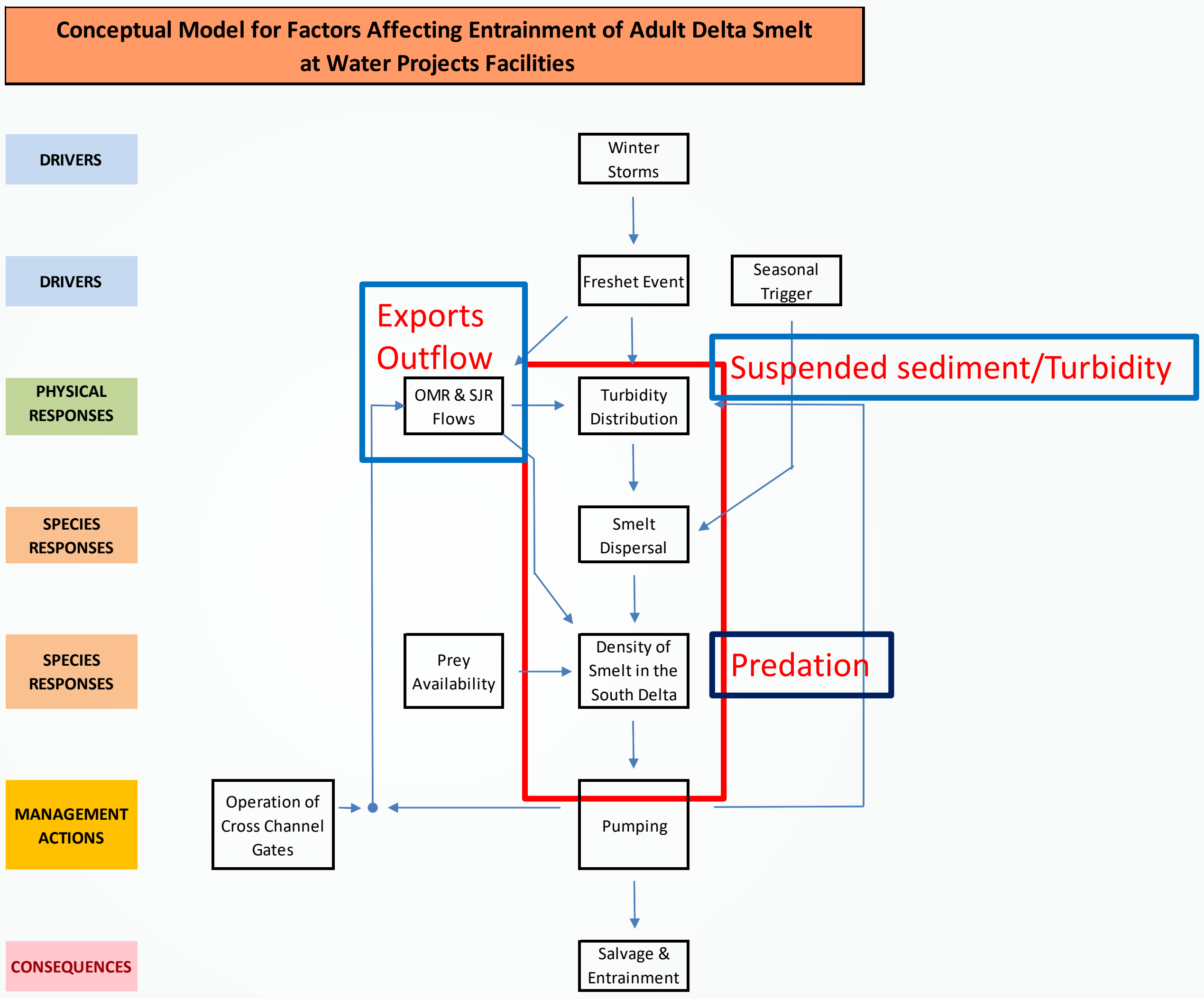
Conceptual Model Review

Some questions best answered by other approaches

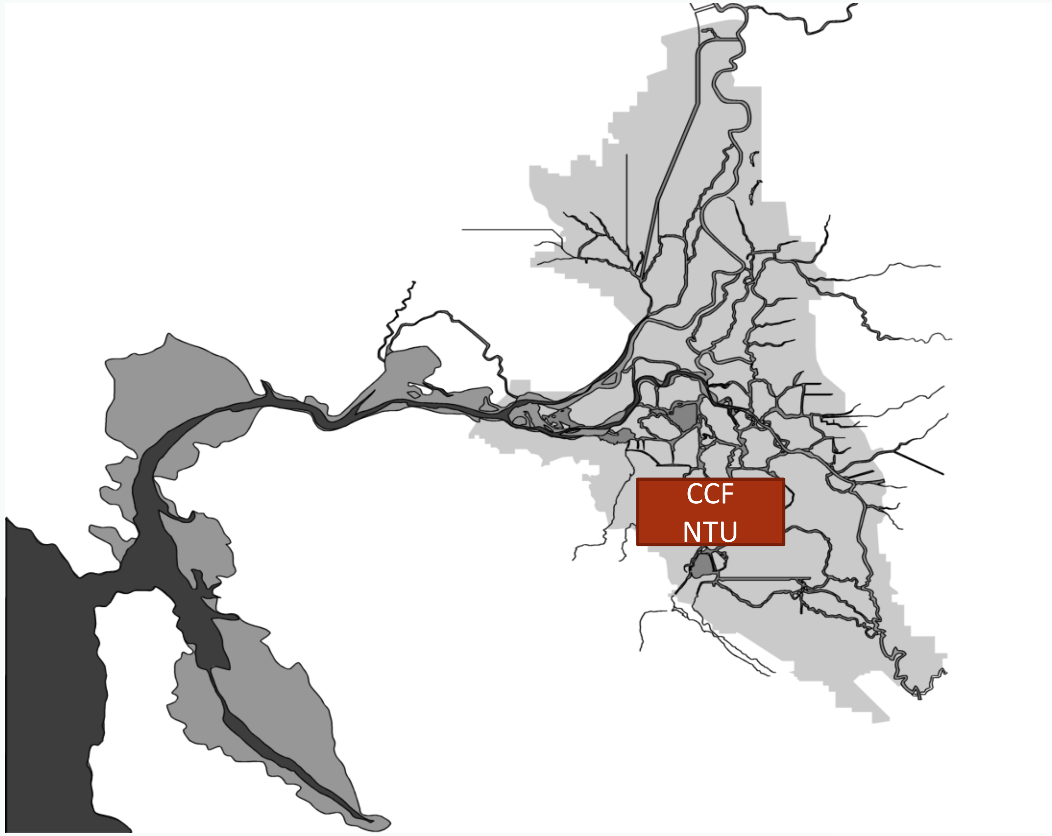
-Hydrodynamic models

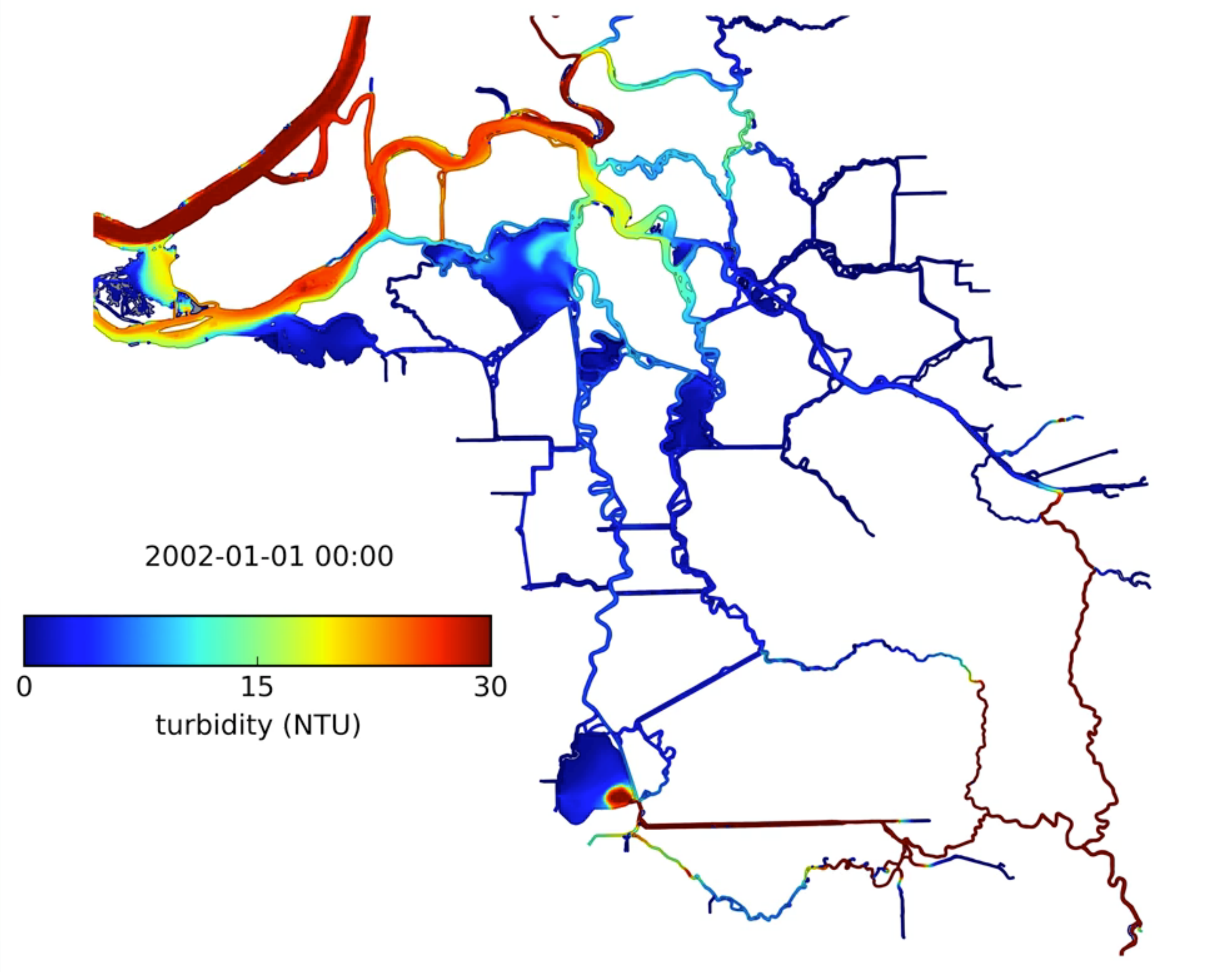
-Tagged fish releases

-Predator studies



Delta more complex than can be gleamed from single stations





Seriously, stay for the next talk

Acknowledgements

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SFCWA (Proposal Development)
DWR and Reclamation

Delta Smelt Scoping Team (led by Steve Culberson and Scott Hamilton)
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LeAnne Rojas
Jillian Burns
Andrew Kalmbach
Tara Morgan King
Jennifer Sibilla
James Gleim
Dean Messer

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Broad recognition that ecosystem-based management is preferred to single-species management

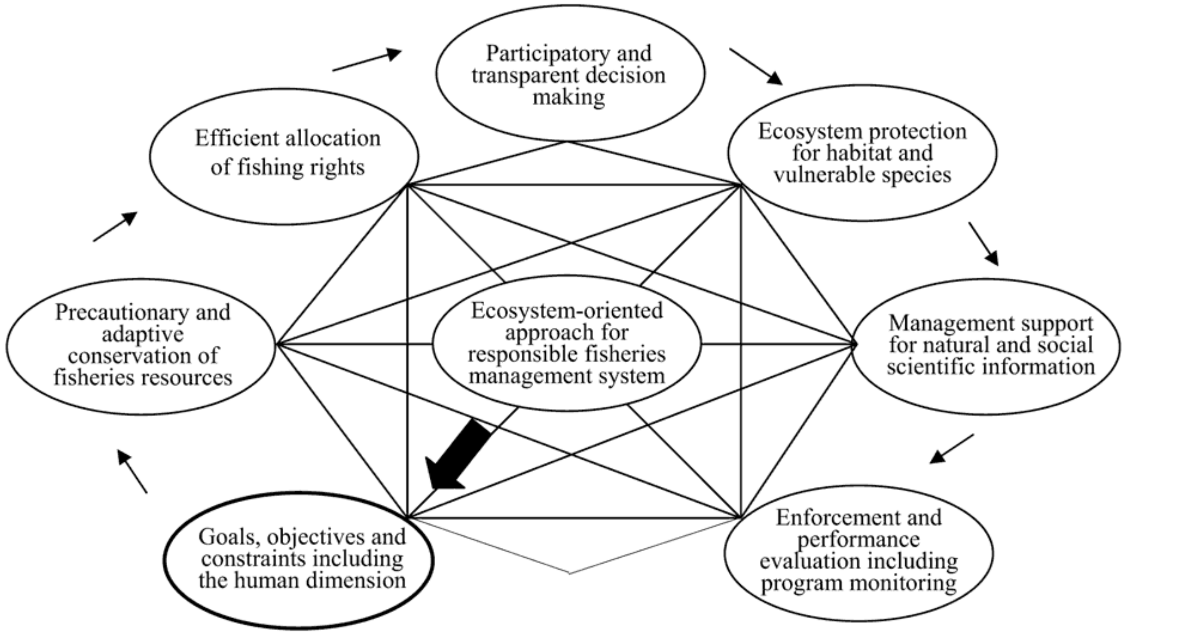

Figure 20. Based on scientific literature, and the stewardship experiences of Sissenwine and Mace (2003), an ecosystem approach to a responsible fisheries management system ought to encompass the listed parameters. An ecosystem approach also needs to take into account environmental variability upon fisheries resources. Six of the seven parameters of the fisheries ecosystem management system are also employed for single-species fisheries management (Sissenwine and Mace, 2003). It should not be a surprise, in the similarity between single-species fisheries management and ecosystem approaches.

Gable FJ. 2005. A large marine ecosystem voluntary environmental management system approach to fisheries practices.

Ecosystem management focuses on:

-Functions of the environment

-Species communities rather than individual species

-Responses in terms of growth and survival rates, not numbers of fish per se

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