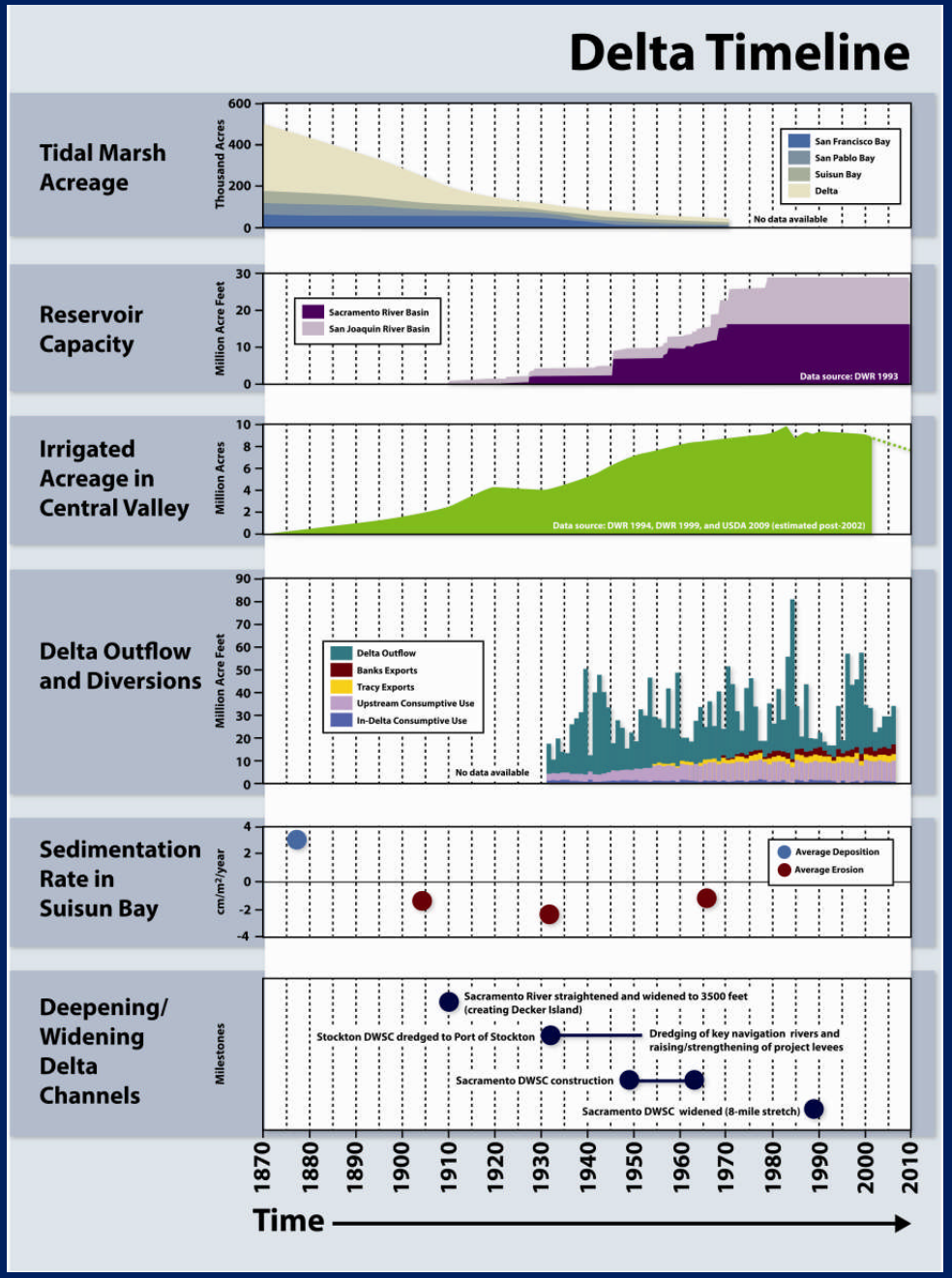
DELTA INTERIOR FLOWS AND RELATED STRESSORS

PUBLIC WATER AGENCIES SLDMWA/SWC

Environmental Context: Highly Altered System

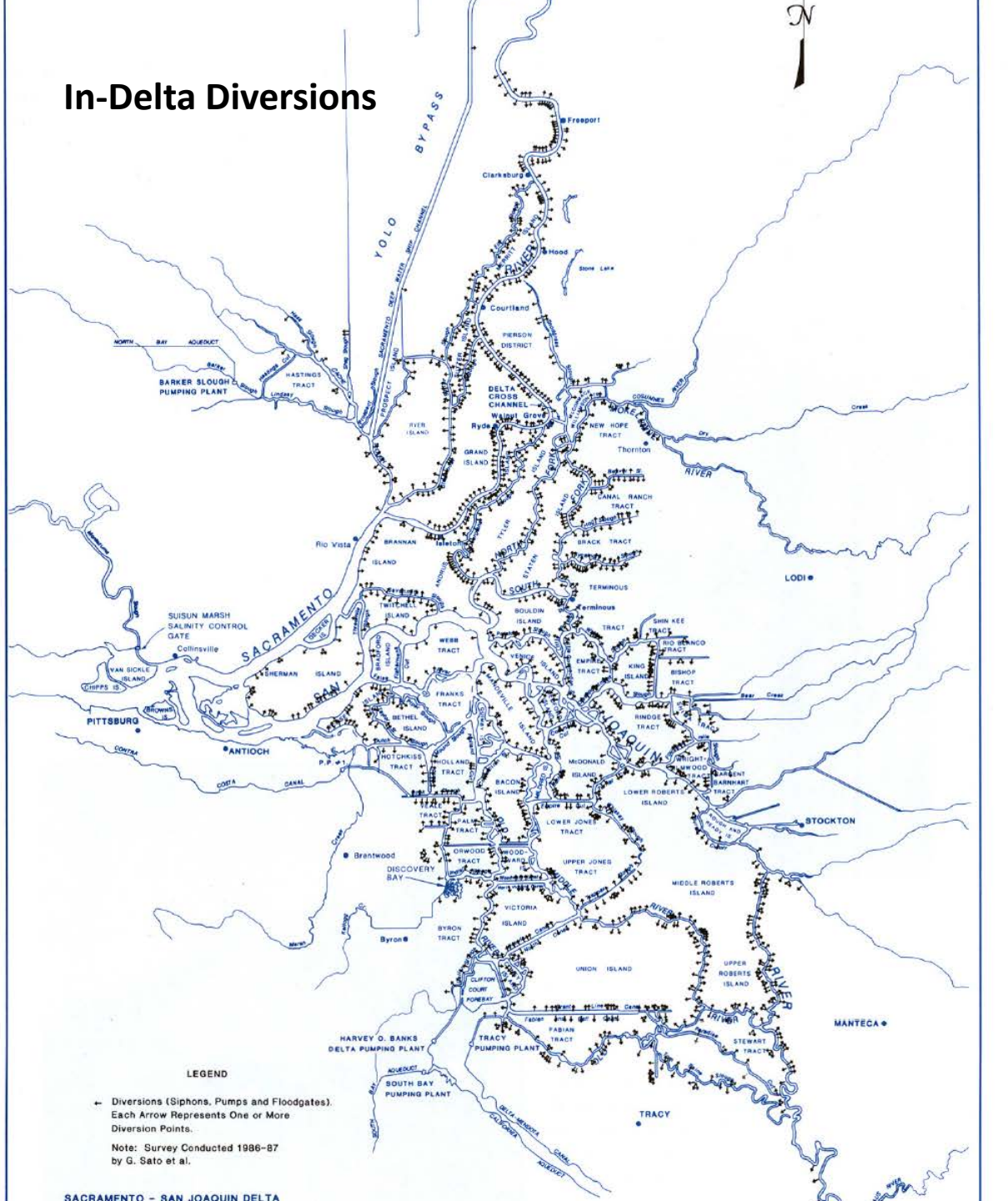


Outflow

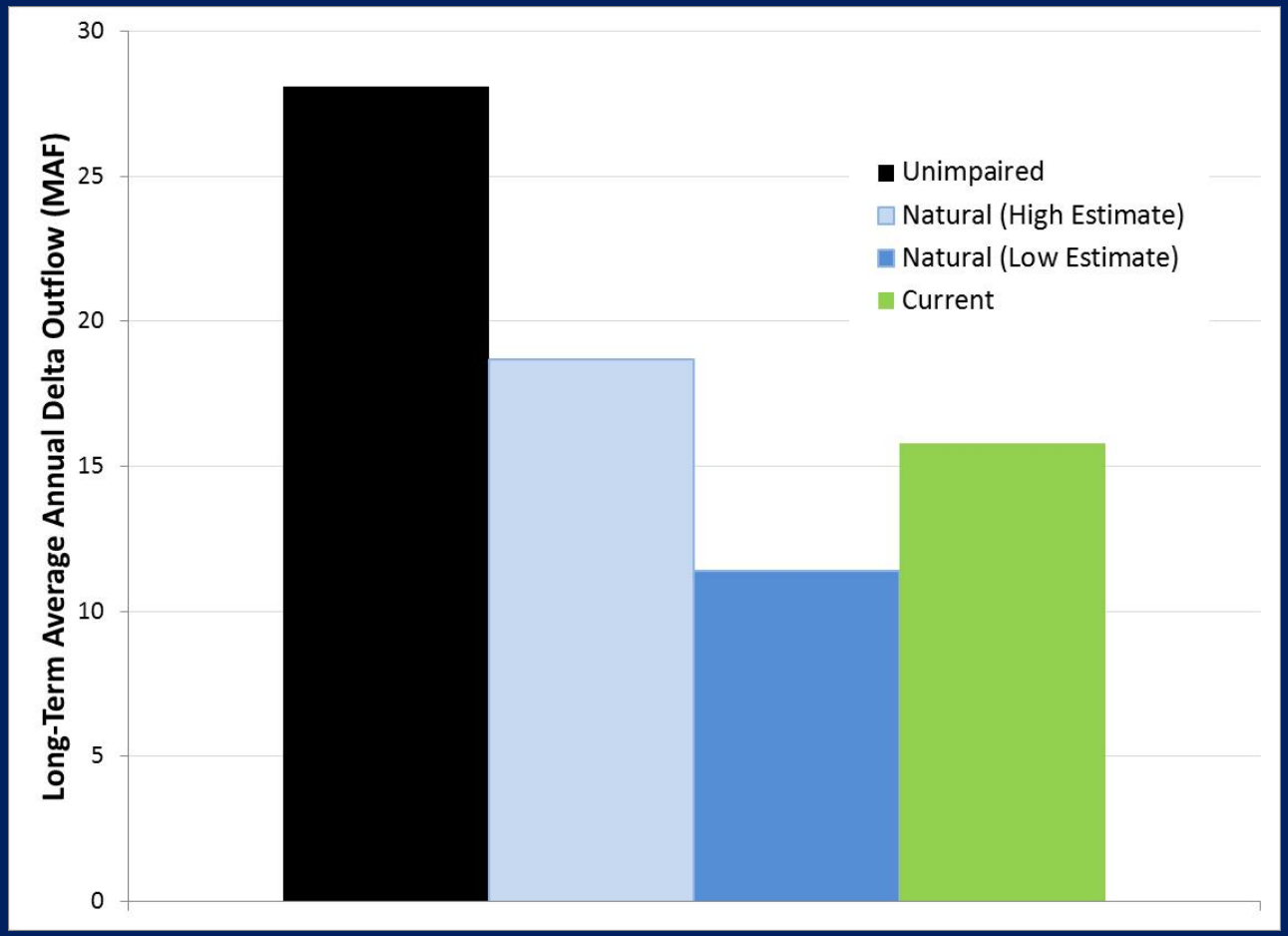
Exports

Consumptive Use

In-Delta Diversions



1,800 in-Delta diversions, with peak summer diversions exceeding 4,000 cfs



The unimpaired outflow calculation does not accurately represent pre-development outflow.

Need to Determine What Restoration Can And Should Be Achieved

"Can reestablishing the natural flow regime serve as a useful management and restoration Goal? We believe it can, although to varying degrees, **depending on the present extent of human intervention and flow alteration affecting a particular river**." (Poff 1997).

A literature review by Poff and Zimmerman (2010) revealed, "Fish abundance, diversity and demographic rates **consistently declined in response to both elevated and reduced flow magnitude**."

"The advice from aquatic ecologists on environmental flows might be regarded at this point in time as **largely untested hypotheses** about the flows that aquatic organisms need and how rivers function in relation to flow regime." (Bunn and Arthington 2002).

Effect Of Water Project Operations On SJR Out-Migrating Salmons

"…associations between water export levels and survival probabilities were weak to negligible." (Newman 2008, p. 4.)

"…substantial uncertainties remain regarding the effects of water operations on the survival and behavior of out-migrating salmonid smolts." (Anderson et al. 2012, p. 28.)

"…VAMP findings were that survival along all routes combined was less than 2% in 2011." (Anderson et al. 2012, p. 27.)

Effect Of Water Project Operations On Sacramento River Out-Migrating Salmons

Juvenile salmon do not go with net discharges (max flux) rather salmon behavior is influenced by tidal dynamics. (Jon Burau, USGS.)

Survival higher if stay in Sacramento River relative to other routes. (Russell Perry, USGS.)

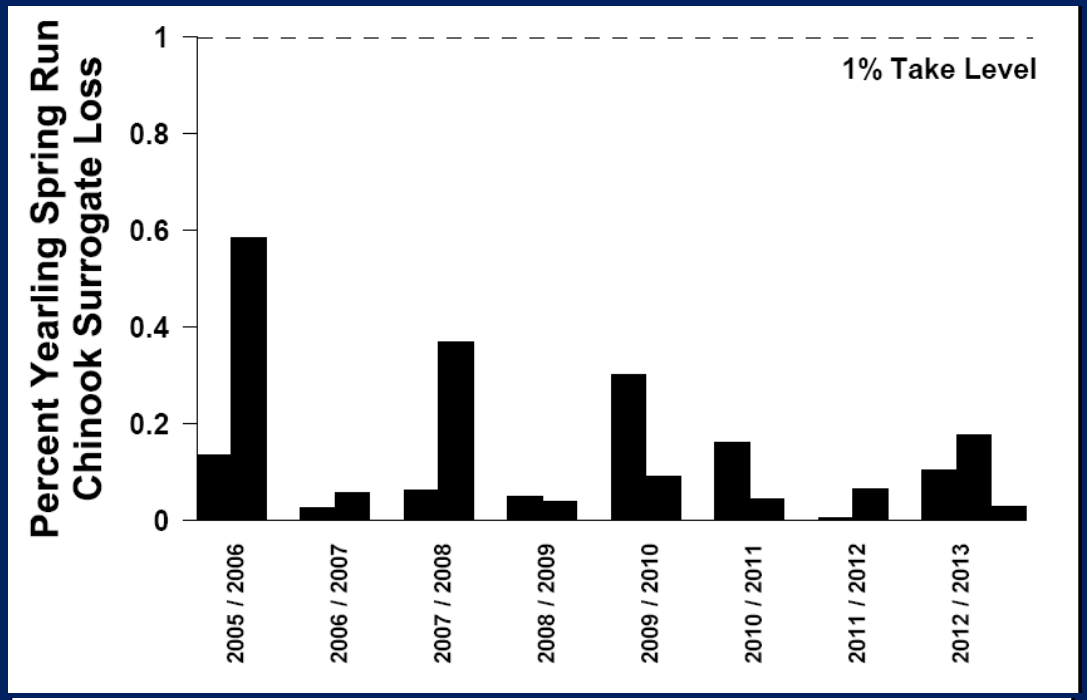
At flow junctions the fate of juvenile salmon is influenced by their position in the river and local hydrodynamic conditions, which can be manipulated with barriers and channel geometry. (Jon Burau, USGS.)

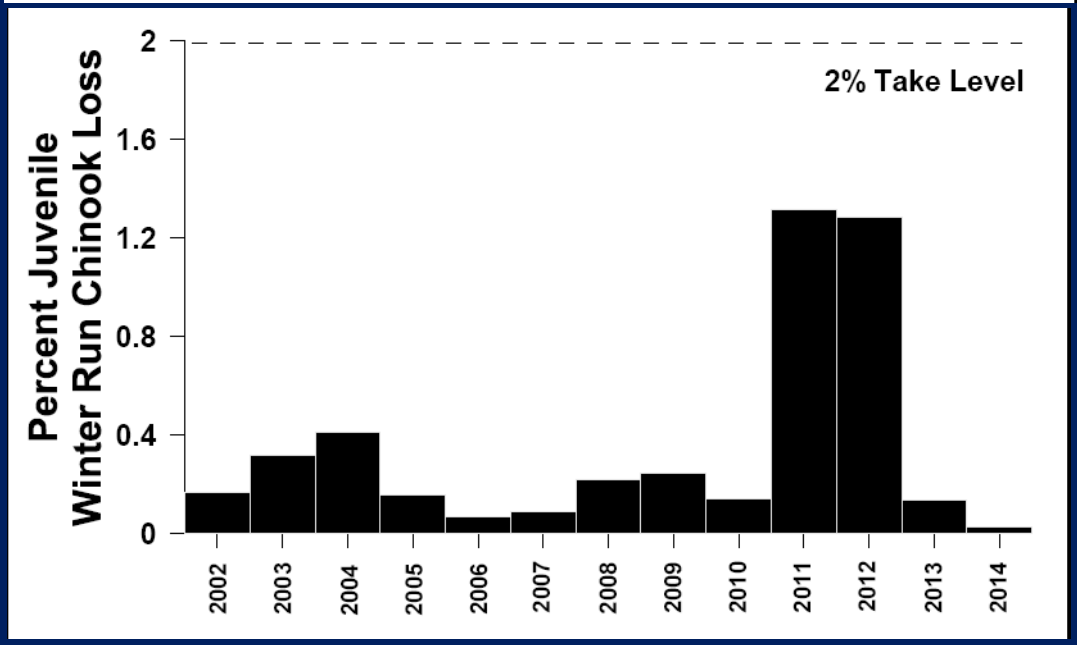
If keep juvenile salmon in the Sacramento River, overall survival increased by 2-7%. (Russell Perry, USGS.)

Chinook Salmon Losses At CVP-SWP Have Been Low For A Long Time

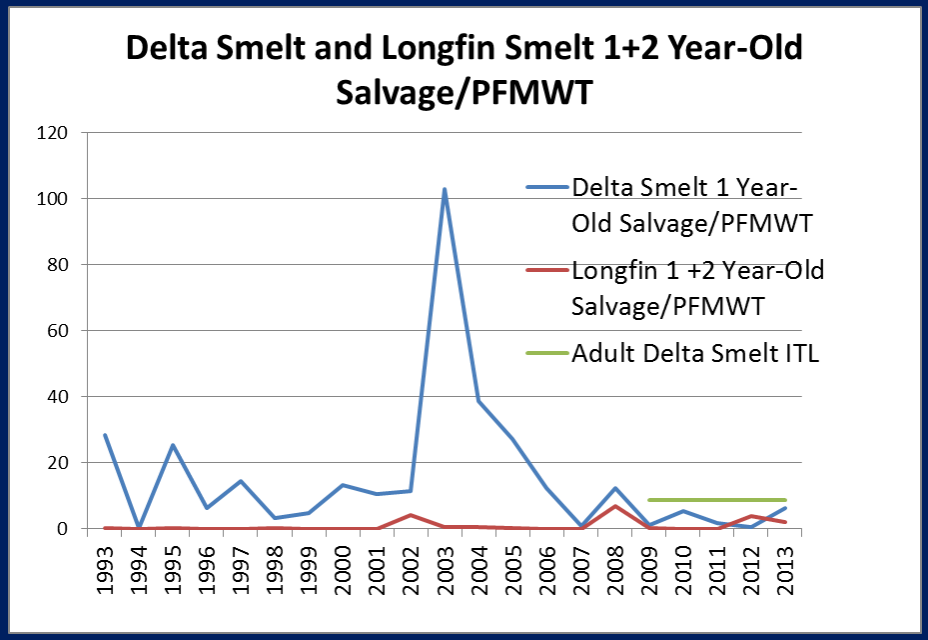
NMFS take limits:
<1% spring-run population
<2% winter-run population

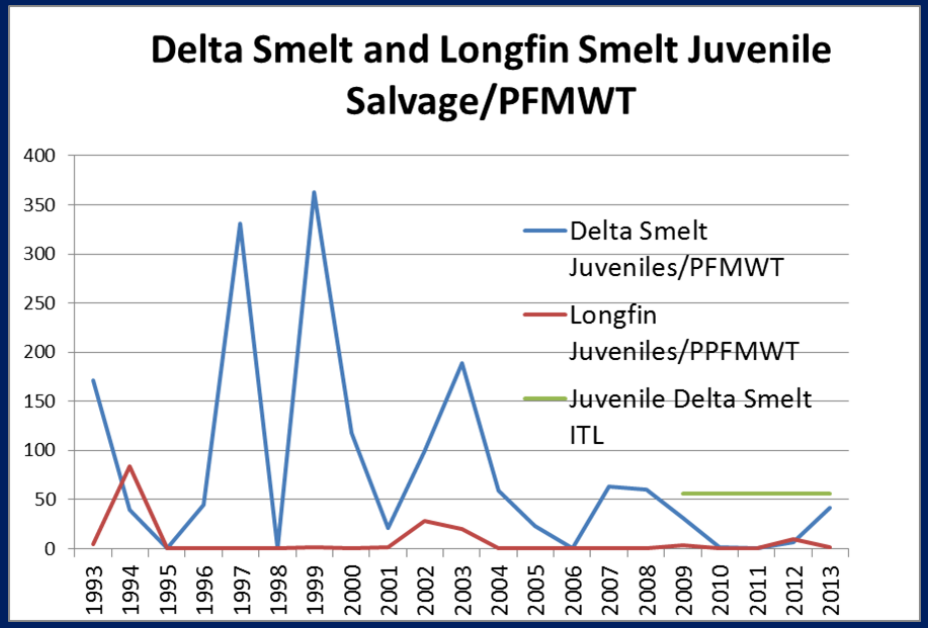
Actual Take:
Spring-run always <1% limit
Winter-run always <2% limit





Smelt Salvage Has Been Low For A Long Time





Delta smelt salvage has been consistently low since 2006.

Longfin smelt salvage has been consistently low for several decades.

Kimmerer 2008 Analysis Of Percent of Delta Smelt Population Taken By CVP-SWP Is Based On Numerous Assumptions

Kimmerer "[e]stimates have large confidence limits…." (Kimmerer 2008)

"Kimmerer observed that, "…no effect of export flow on subsequent midwater trawl abundance is evident." (Kimmerer 2008)

Kimmerer estimates should have been no higher than 13% of population, likely much lower. (Miller 2011)

Life stage	Assumption	Problem	Resulting Bias	Correction
Adult	Kodiak takes representative sample	No samples taken where significant fraction of population existed	Bias upward	Adjust proportional entrainment downward to account for unsampled, occupied areas
Adult	Entrainment proportional to OMR	Delta smelt do not necessarily "go with the flow"	Bias upward	Adjustment cannot be quantified
Adult	Θ estimated as Poisson error function	Inappropriate estimation method produces overestimate of entrainment relative to salvage	Bias upward	Modify method, recalculate, and apply new value
Larval-juvenile	Delta smelt in vicinity of export pumps are lost from population	Larval-juvenile delta smelt are not neutrally buoyant particles	Bias upward	Adjustment cannot be quantified
Larval-Juvenile	Six stations in southeast Delta provide estimate of delta smelt entrained	Abundance at those six stations not related to salvage	Bias upward	Adjustment cannot be quantified
Larval-juvenile	Mean CPU represents entire population	Small larvae not detected, smelt in downstream areas sometimes not detected, significant proportion of population not sampled.	Bias upward	Some adjustment can be quantified
Larval-juvenile	OMR is relevant flow toward export pumps	Larval-juvenile delta smelt are not neutrally buoyant particles	Bias upward	Adjustment cannot be quantified
Larval-Juvenile	Daily entrainment equals product of density at six stations and OMR	Larval-juvenile delta smelt are not neutrally buoyant particles	Bias upward	Adjustment cannot be quantified
Larval-juvenile	Gear efficiency for 20 mm survey is logistic function	Gear efficiency correction inappropriate for delta smelt <10mm	Bias upward	Adjustment cannot be quantified
Larval-Juvenile	Daily mortality is constant	Mortality likely higher near export pumps	Bias upward	Adjustment cannot be quantified
Larval-juvenile	Delta smelt hatch at 5mm length and grow at constant rate	Growth likely lower near export pumps	Bias upward	Adjustment cannot be quantified

Miller 2011, p. 23 (modified Table 9, upwardly biased assumptions)

Delta Smelt Life Cycle Models - No Strong Indication of Export Effect

Maunder and Deriso 2011: Best fit model **did not** identify entrainment as important covariate. Entrainment identified in alternative model but not in best fit.

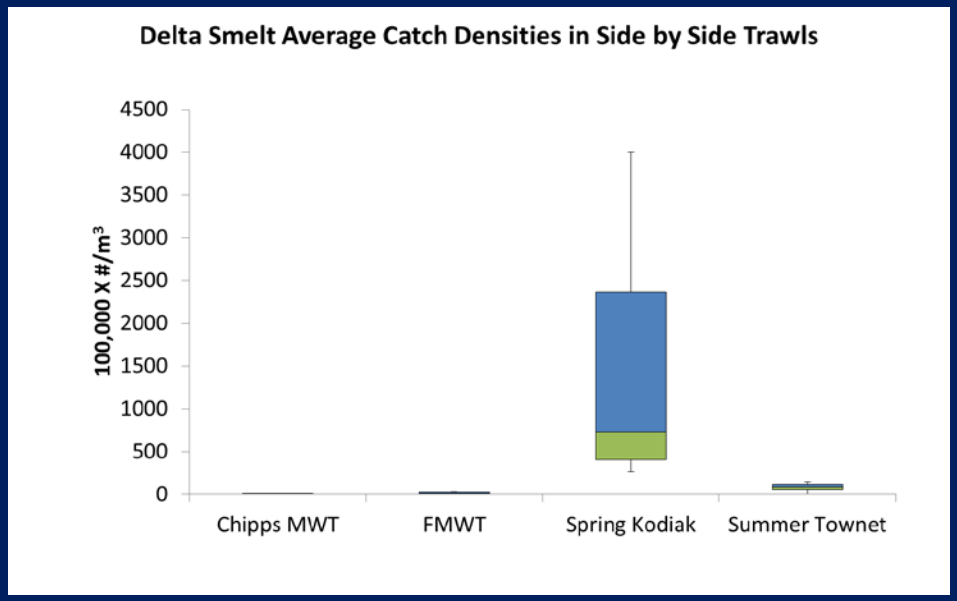
Model was rerun in 2012 with an update of data through 2010 and updated results indicate **entrainment not robust covariate**.

Miller et al. 2012: Entrainment correlated to survival from fall to summer but, "…entrainment was **not a statistically significant factor in survival from fall to fall**."

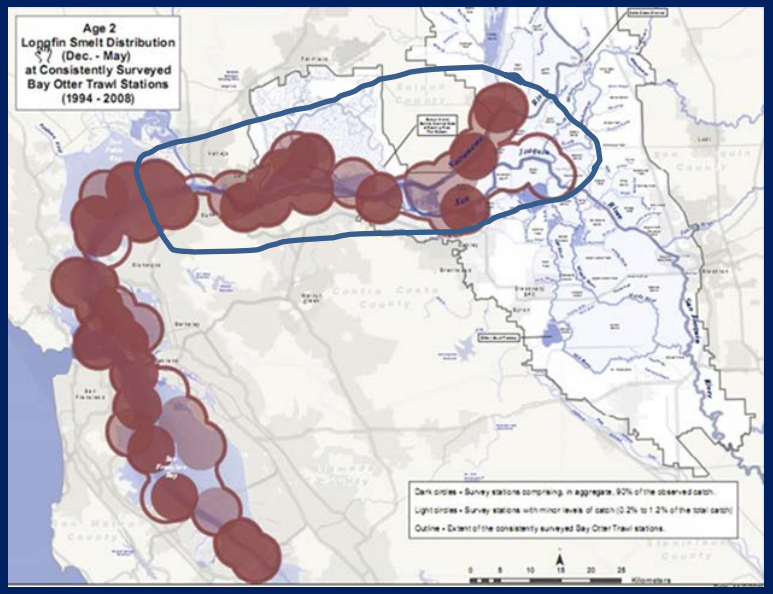
Thomson et al. 2010: "…[D]ata support **relatively small** effects of winter exports."

MacNally et al. 2010: "Several expectations were more **weakly** supported by the data, but were not refuted. Spring exports were negatively associated with abundances of delta smelt and threadfin shad."

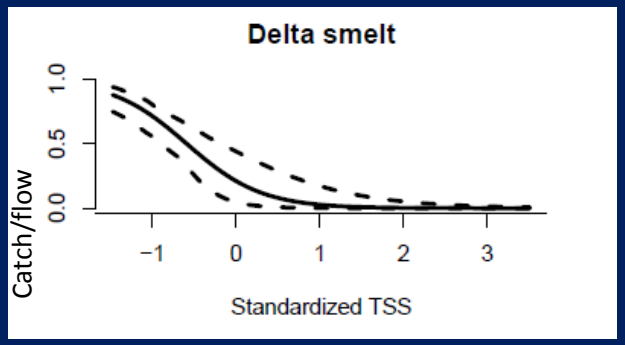
Surveys May Not Be Representative Of Populations Raising Questions About Some Data Analyses



Can be orders of magnitude differences in side by side delta smelt trawling

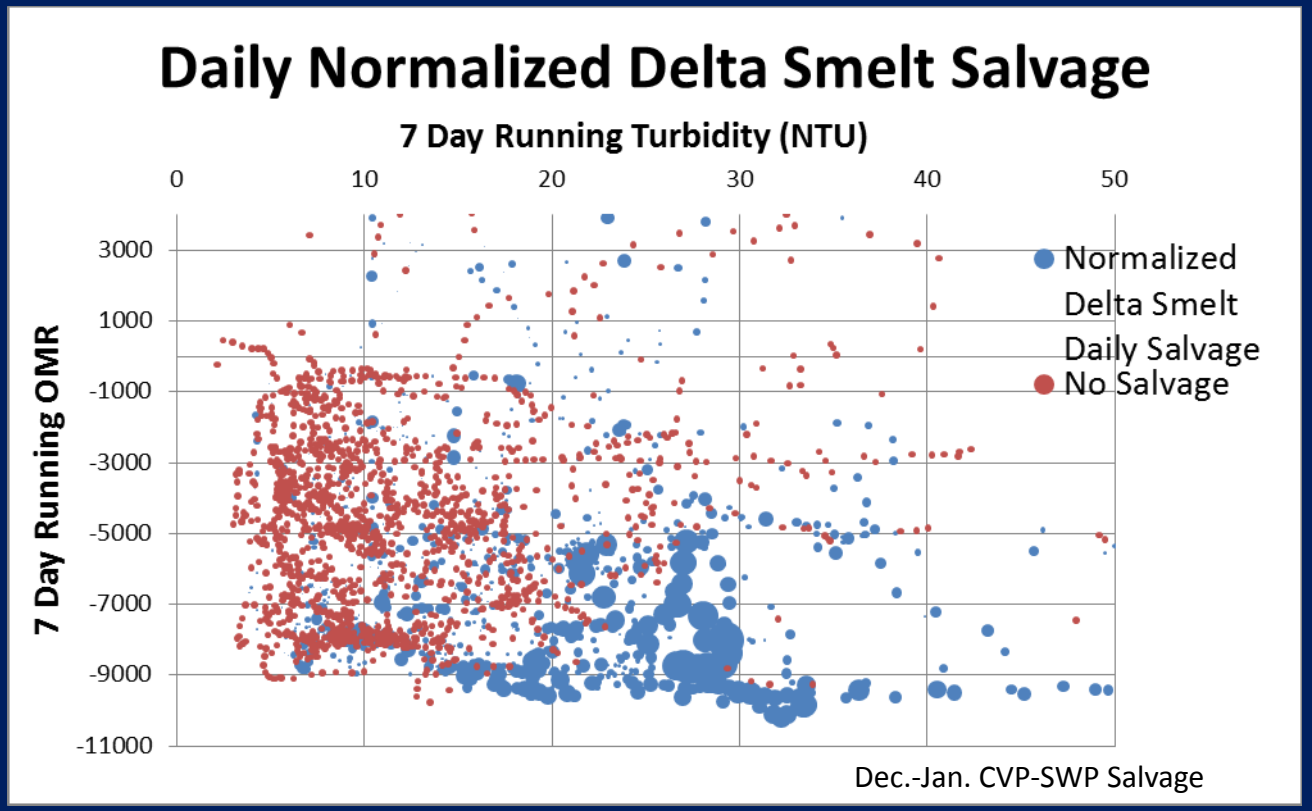


FMWT covers only a small portion of longfin smelt range



Latour (2014) reported probability of false zero closely related to TSS (turbidity).

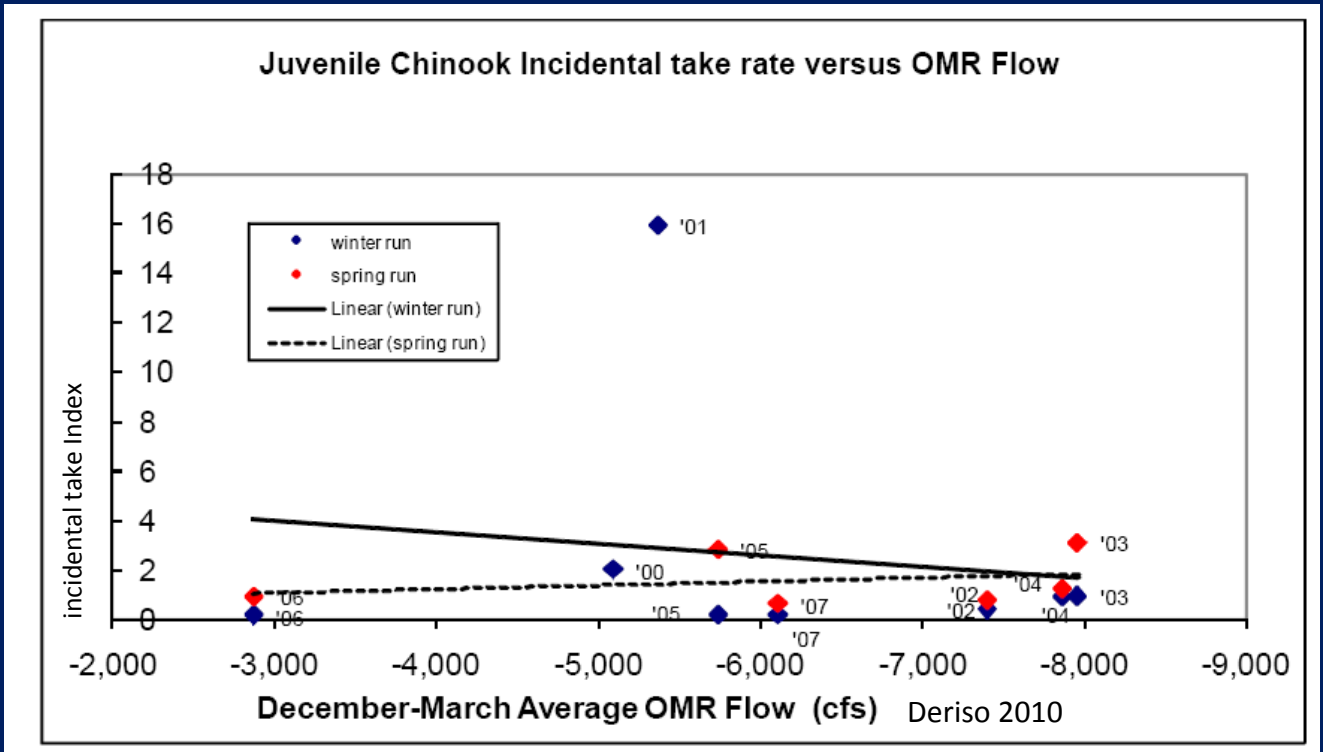
OMR Has Variable Utility For Managing Delta Smelt Salvage



OMR and turbidity predictive of salvage events in December-January, when larger salvage events have historically occurred.

No significant salvage events unless OMR more negative than -5,000 and turbidity is at least 12 NTU. Later in year, salvage patterns less clear, particularly at Tracy. Later in year, salvage has occurred at Skinner and Tracy even when OMR is positive.

OMR Should Not Be Used For Managing Salmon Entrainment



There is no statistically significant relationship between take index (normalized data) and OMR flows.

***Juvenile Chinook salmon incidental take index is the incidental take divided by escapement. The estimates are made separately for spring-run and winter-run. Incidental take does not include tagged and hatchery fish.

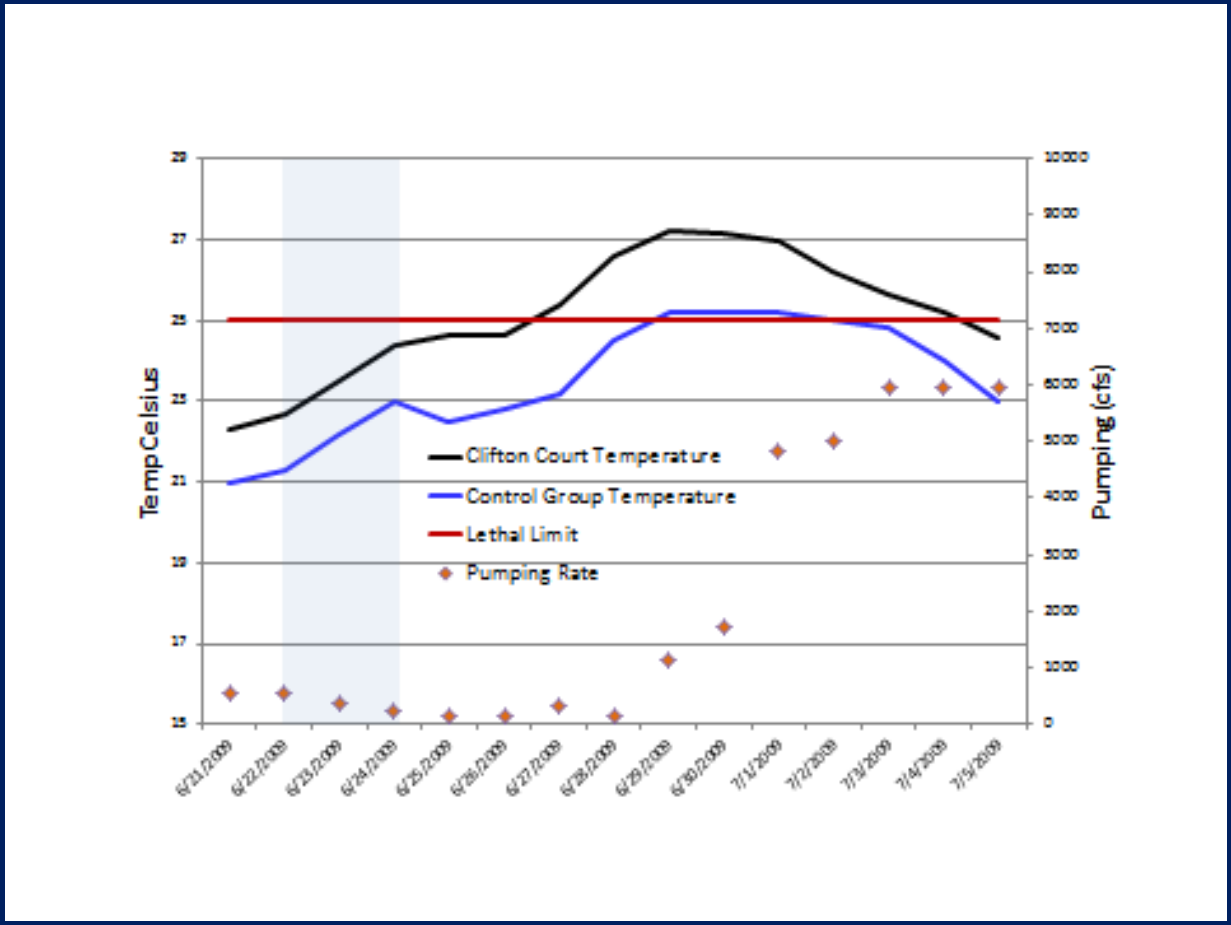
Castillo Should Be Interpreted With Caution (Juvenile Delta Smelt)

Experimental conditions: high temp, low pumping.

Greatest entrainment concern is under low temp, high pumping conditions earlier in season.

Additional tests under different experimental conditions are needed before results can be broadly applied.

Recommend new studies that more directly measure entrainment.



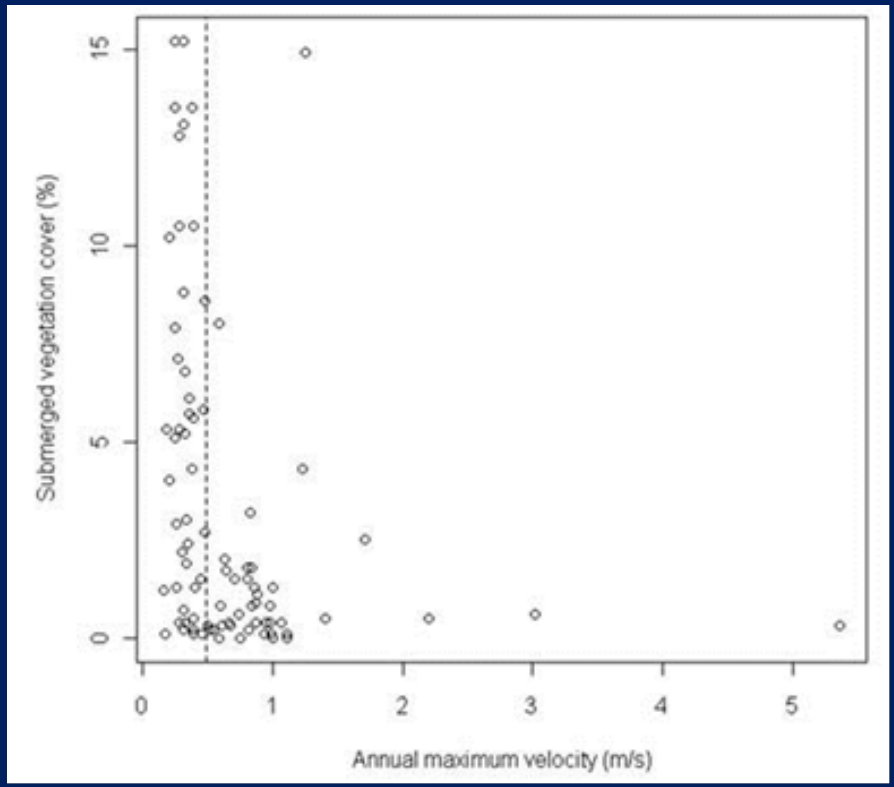
Nutrients May Be Important Driver of SAV Growth (Other Stressors)

No evidence that CVP-SWP operations increase spread of SAV.

Small differences in local channel flow outside influence of CVP-SWP can have some effect on SAV. See Hestir 2010.

High N:P may favor *E. densa* growth. (Glibert *et al*. 2011, 2012).

E. densa may preferentially use ammonium over nitrate Feijoo *et al.* (2002) and Reddy *et al.* (1987).



Hestir (2010)

Ammonia May Be Important Driver Of Microystis blooms (Other Stressors)

No evidence that CVP-SWP operations increase spread of Microystis.

"Isotopic analysis of *Microcystis*-dominated sites indicates NO_3 was of minor importance as an N source, *and NH_4 was likely the primary* source of nitrogen to cyanobacteria in the Delta."

(Kendall et al., 2011)

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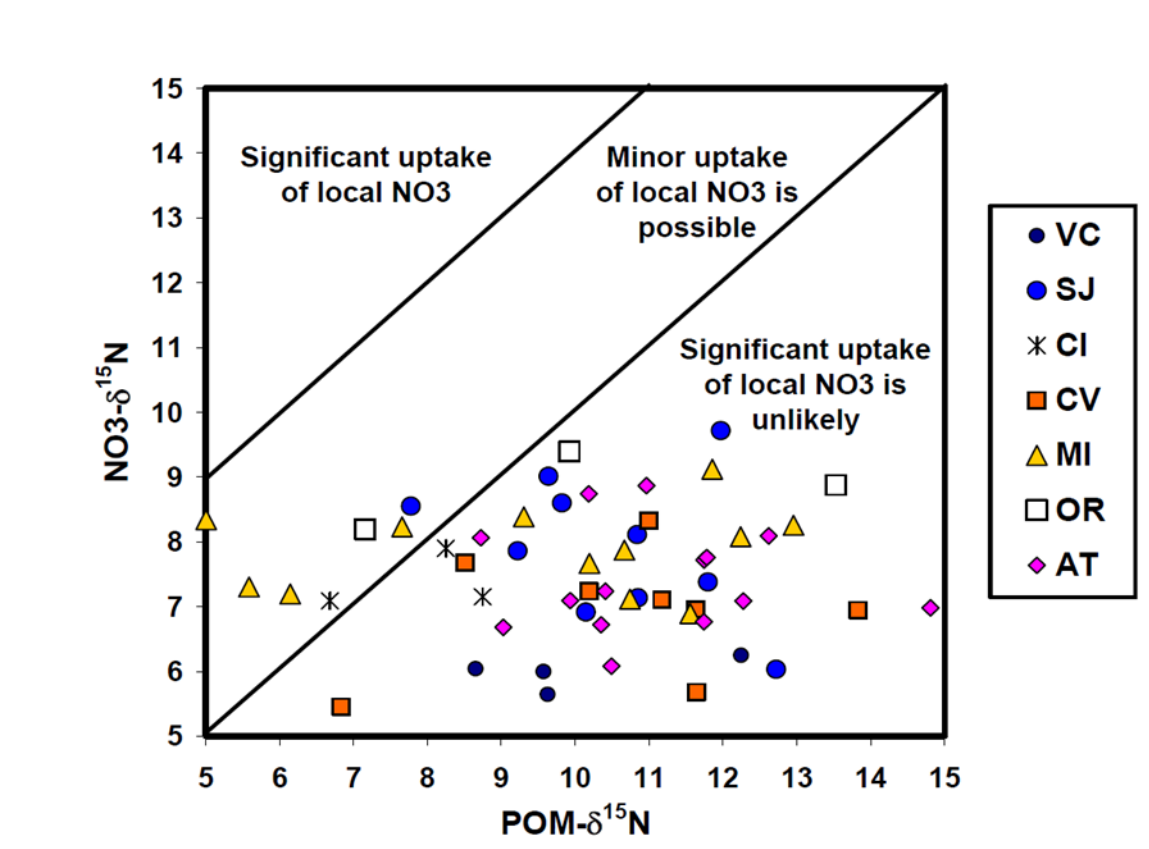


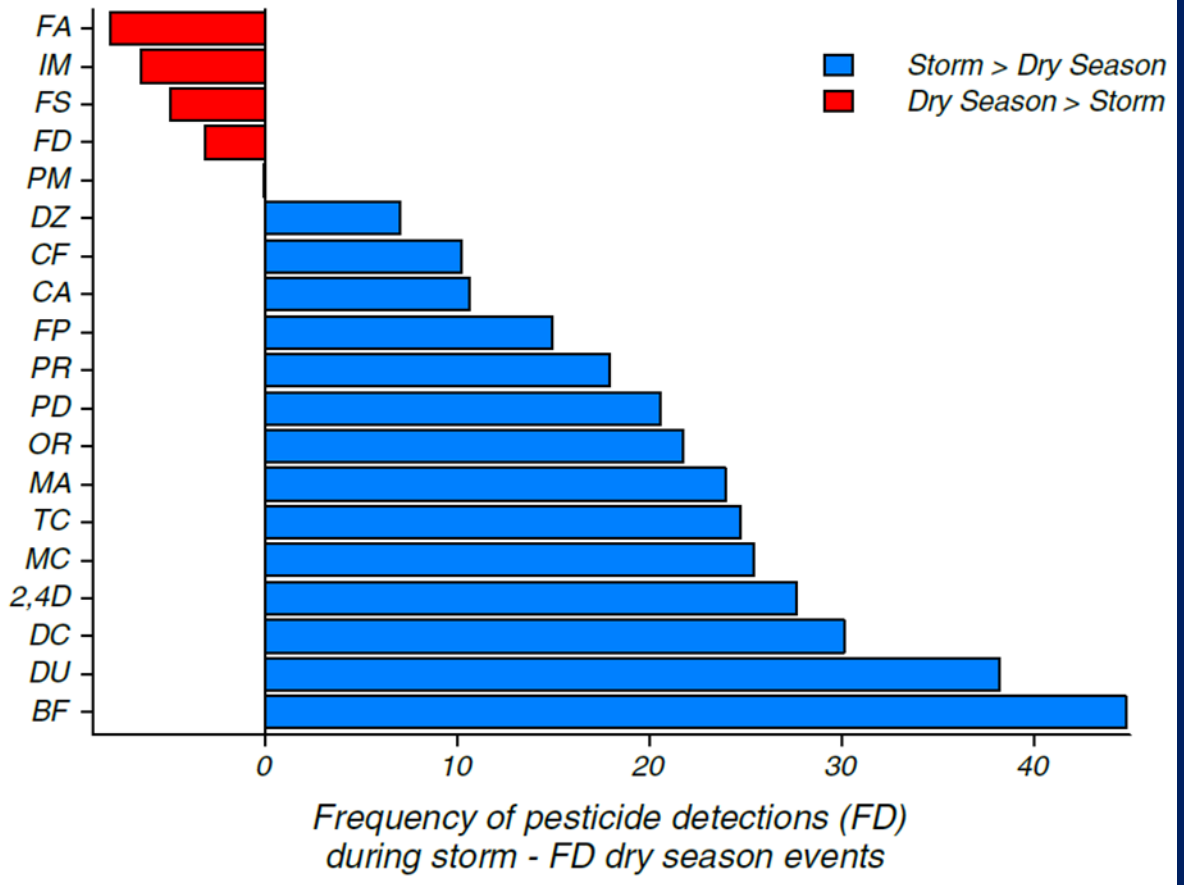
Kendall *et al.*, 2011

Microcystis bloom, 2008
Photo by P. Lehman

CVP-SWP Reservoir Releases Ineffective At Diluting Contaminants In Delta (Other Stressors)

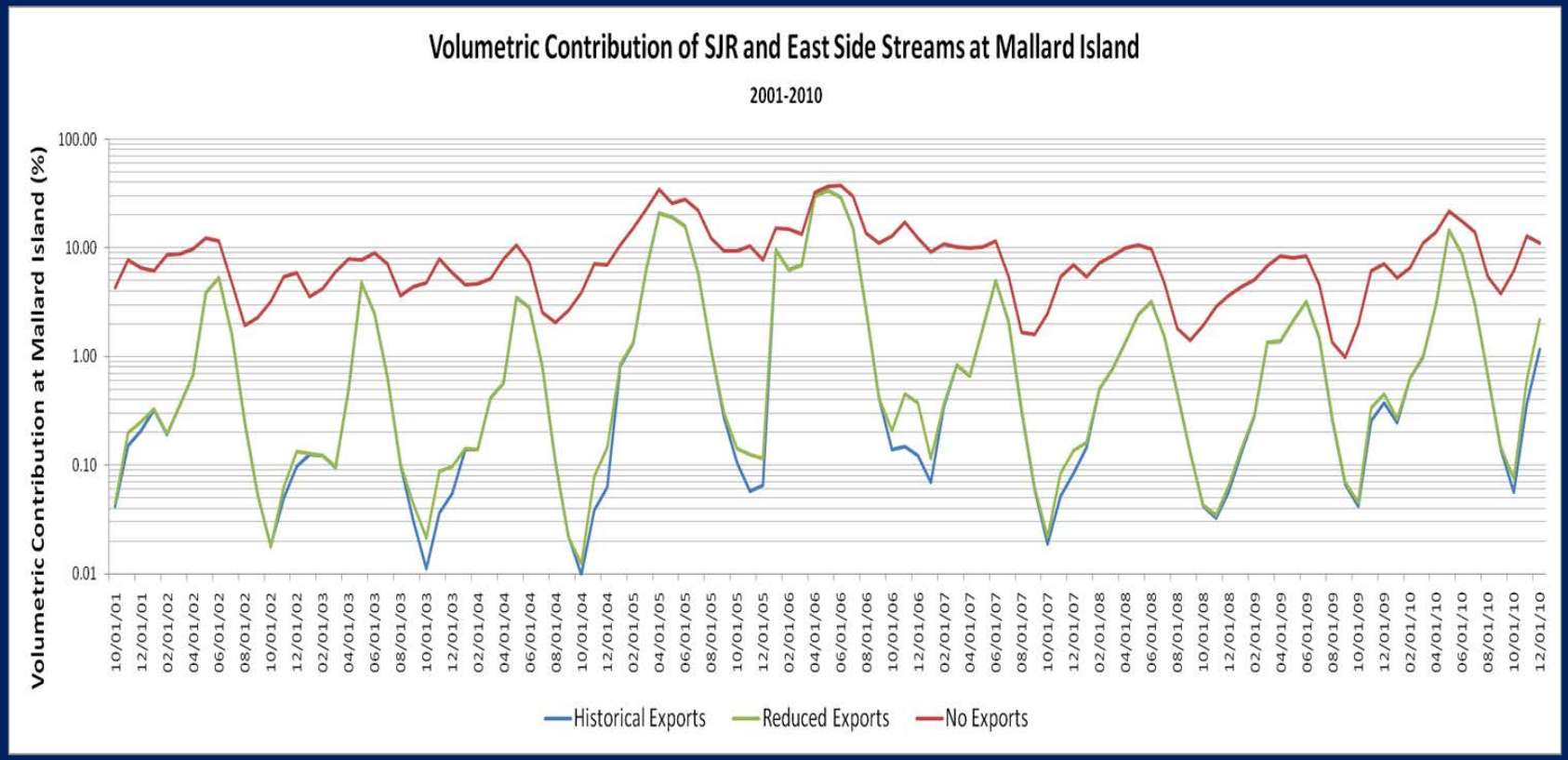
Contaminant detections are highest during storm events when dilution flows ineffective.

Fig. 6 Influence of storm sampling on pesticide detections. Data is statewide; *BF*, bifenthrin; *DU*, diuron; *DC*, dicamba; *MC*, MCPA; *TC*, triclopyr; *MA*, malathion; *OR*, oryzalin; *PD*, pendimethalin; *PR*, prodiamine; *FP*, fipronil; *CA*, carbaryl; *CF*, cyfluthrin; *DZ*, diazinon; *PM*, permethrin; *FD*, FP desulfinyl; *FS*, FP sulfone; *IM*, imidacloprid; *FA*, FP amine



Ensminger *et al.*, 2012

Exports Have Little Effect On Delta Smelt Presence-Food Supply Mismatch



CVP-SWP operations likely not effecting transport of food across Delta as almost no San Joaquin River water reaches western Delta even in “no exports” scenario.

Under “no exports” scenario, plankton densities in San Joaquin region would have to be an order of magnitude greater than in the Sacramento region to make a significant contribution to food densities in the confluence and Suisun Bay regions.

Thinking About How To Define And Solve Problems…

1. Need to identify function of interior Delta flows under predevelopment conditions and identify how to recreate those functions in this altered system.

2. Need to identify what is achievable and identify opportunities for restoring habitat functions to benefit native species, using all available tools.

3. Gaining new insight on how flows effect fish distribution as well as natural processes. There is no indication that more regulation of hydrodynamic flows will result in a measureable improvement in species health.

4. Most promising solutions include combination of tools and approaches to restore ecosystem functions in interior Delta (e.g., BDCP).