

# *Turning Point for the Delta*

*Critical changes  
leading up to the 2002 crash of  
pelagic fish populations*

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Friends of Trinity River  
Revive the San Joaquin

# Overview

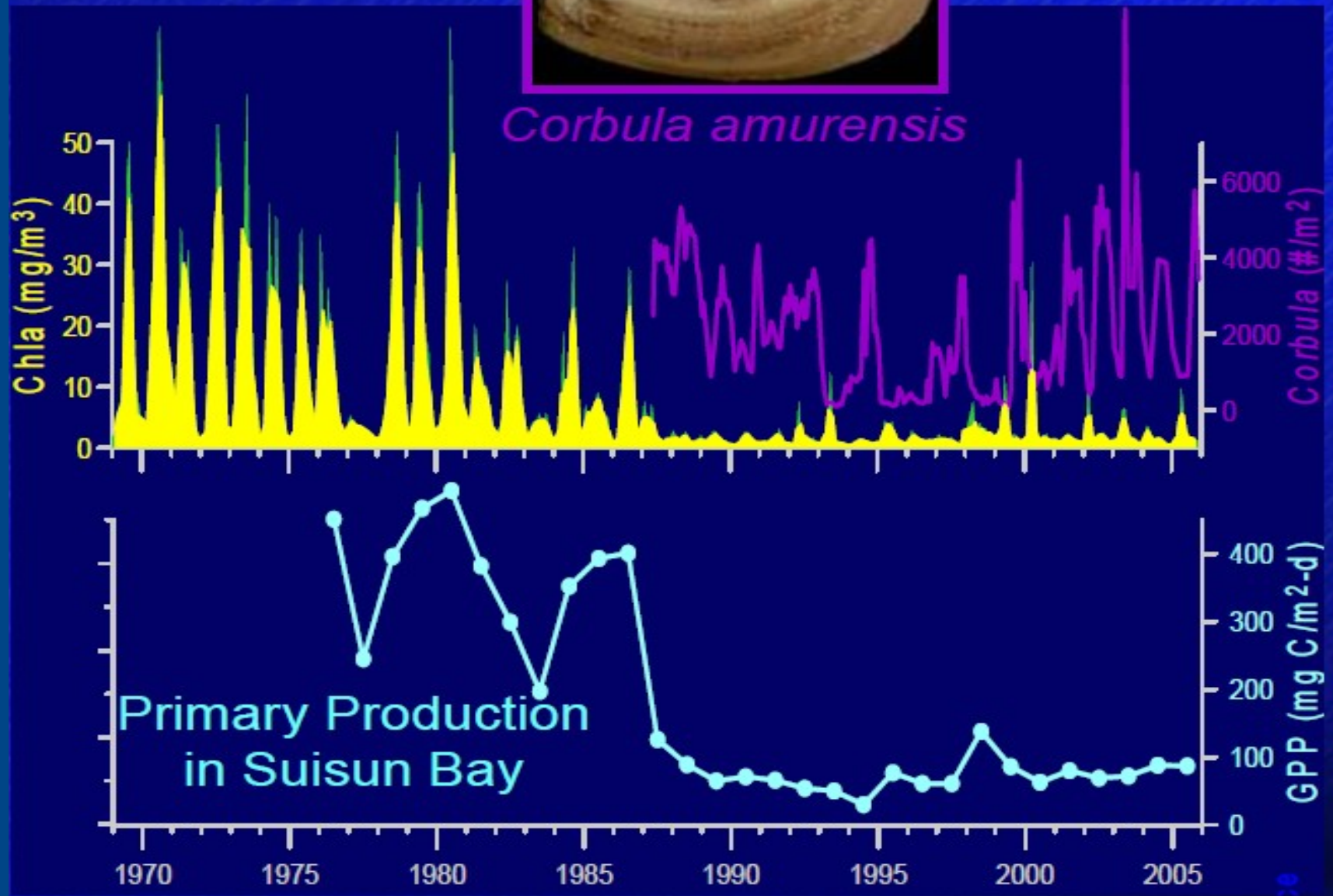
- Collapse of pelagic fish populations in 2002 happened after several years of decline in Delta health
- Decreases in phytoplankton production in Suisun Bay started in 1999, also toxic algal blooms in the Central Delta
- Changes associated with large reduction in Delta outflow in late spring through fall

# *Suisun Bay*

- Invasion of *Corbula* in 1987
- Phytoplankton production crashed in 1987, but increased from 1995-1998
- Second decrease in 1999 associated with reduced Delta outflow, increasing salinity



*Corbula amurensis*



- Source: J. Cloern, 2007, from presentation by Jerry Johns at California Wetlands Conference

# *Corbula expansion correlates with increasing salinity*

- Peterson & Vayssieres 2010
- Benthic Assemblage Variability in the Upper San Francisco Estuary: A 27-Year Retrospective
  - “benthic assemblages were not geographically static, but shifted with salinity, moving down-estuary in years with high delta outflow, and up-estuary during years with low delta outflow”

# *Net Delta Outflow Index*

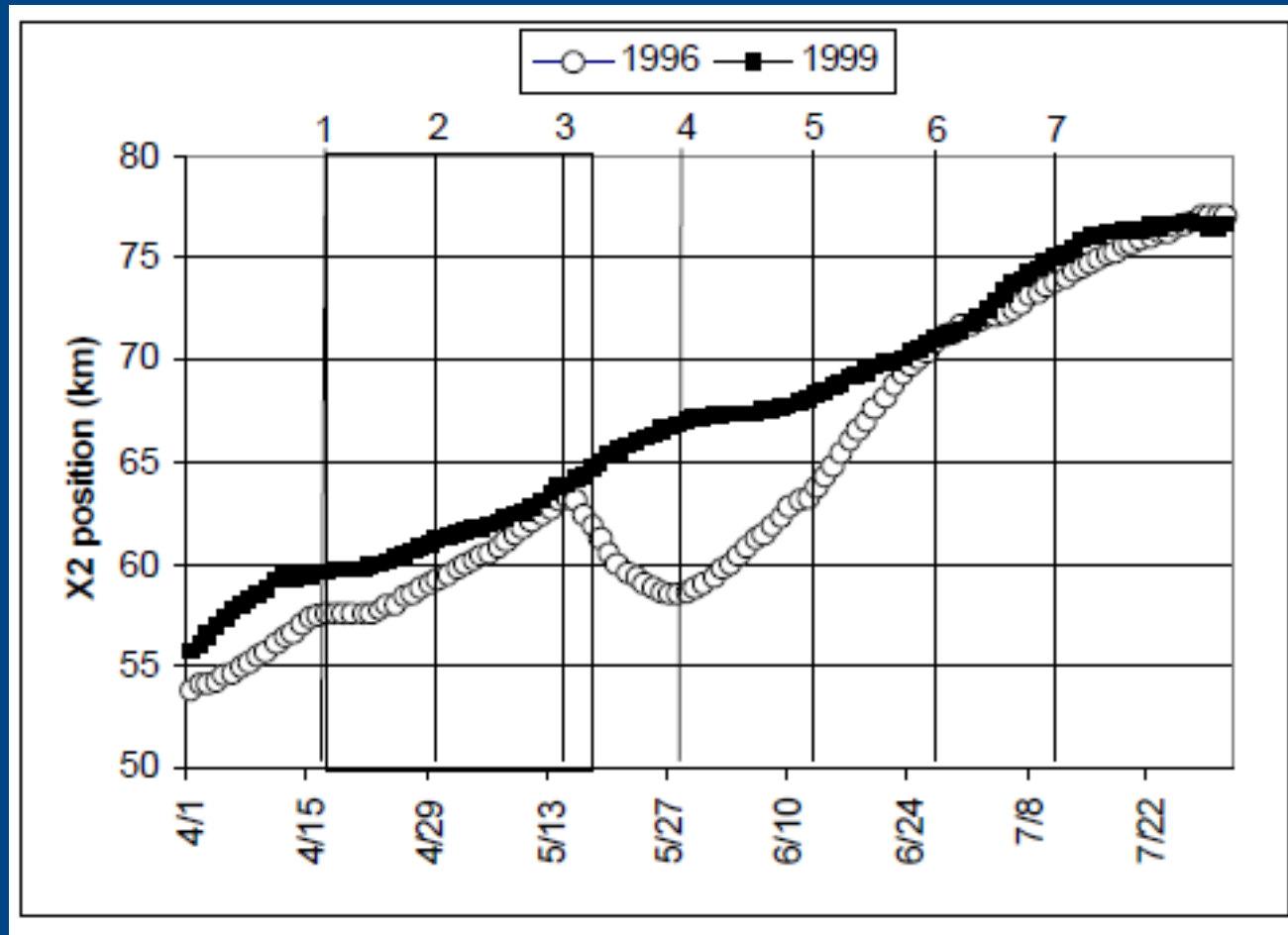
## *WY 1996-2000*

	96	97	98	99	2000
Oct	11400	4625	4842	12267	4263
Nov	8384	8625	10154	20481	6904
Dec	27710	82007	15350	47052	10811
Jan	32016	259536	71738	36373	19933
Feb	126720	117070	231175	105173	97823
Mar	88994	33157	104748	73633	103671
Apr	42050	13566	88512	35004	28554
May	46098	12038	67633	22911	23449
Jun	15373	8143	71835	14052	9907
Jul	9249	9352	30967	10817	9827
Aug	9697	8623	20007	6141	6507
Sept	7359	3958	20119	4754	4921

# Comparison of 96 & 99 outflow

	96	99	Percent
Oct	11400	12267	108%
Nov	8384	20481	244%
Dec	27710	47052	170%
Jan	32016	36373	114%
Feb	126720	105173	83%
Mar	88994	73633	83%
Apr	42050	35004	83%
May	46098	22911	50%
Jun	15373	14052	91%
Jul	9249	10817	117%
Aug	9697	6141	63%
Sept	7359	4754	65%

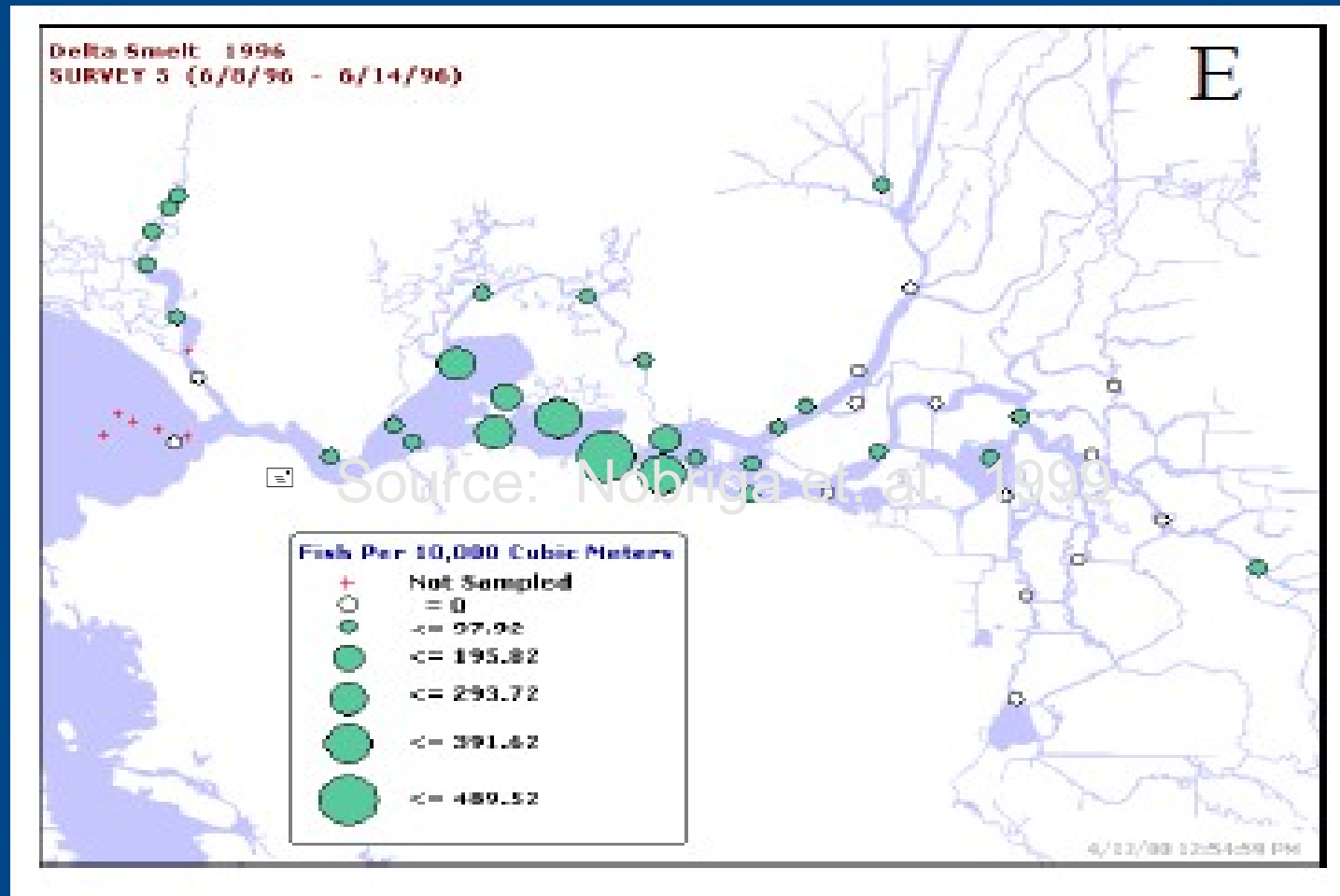
- Position of X2, Apr-July 1996-1999



Source: Nobriga et. al. Environmental factors influencing the salvage of young Delta smelt, IEP Salvage Report 1999

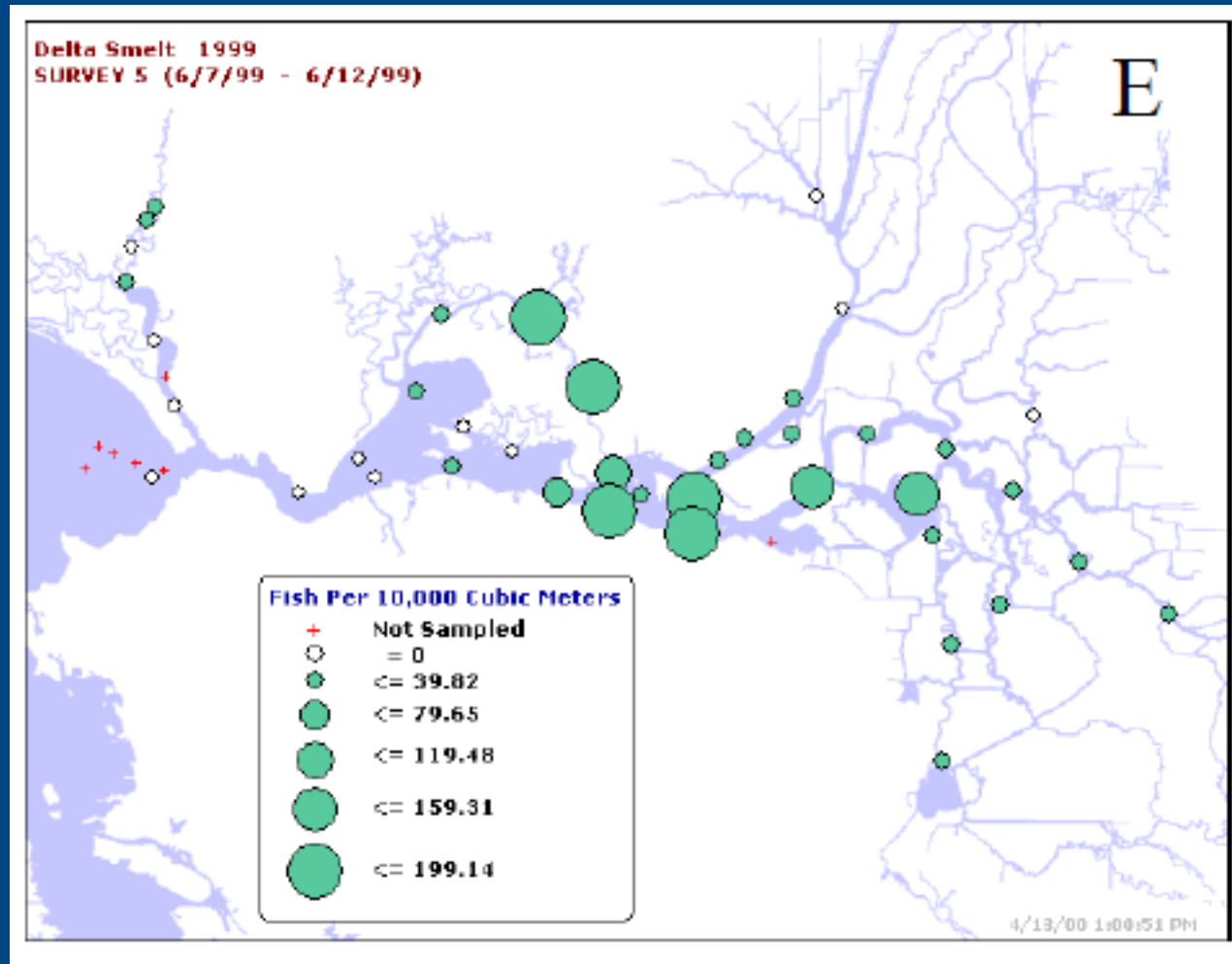


# Delta Smelt locations early June 1996



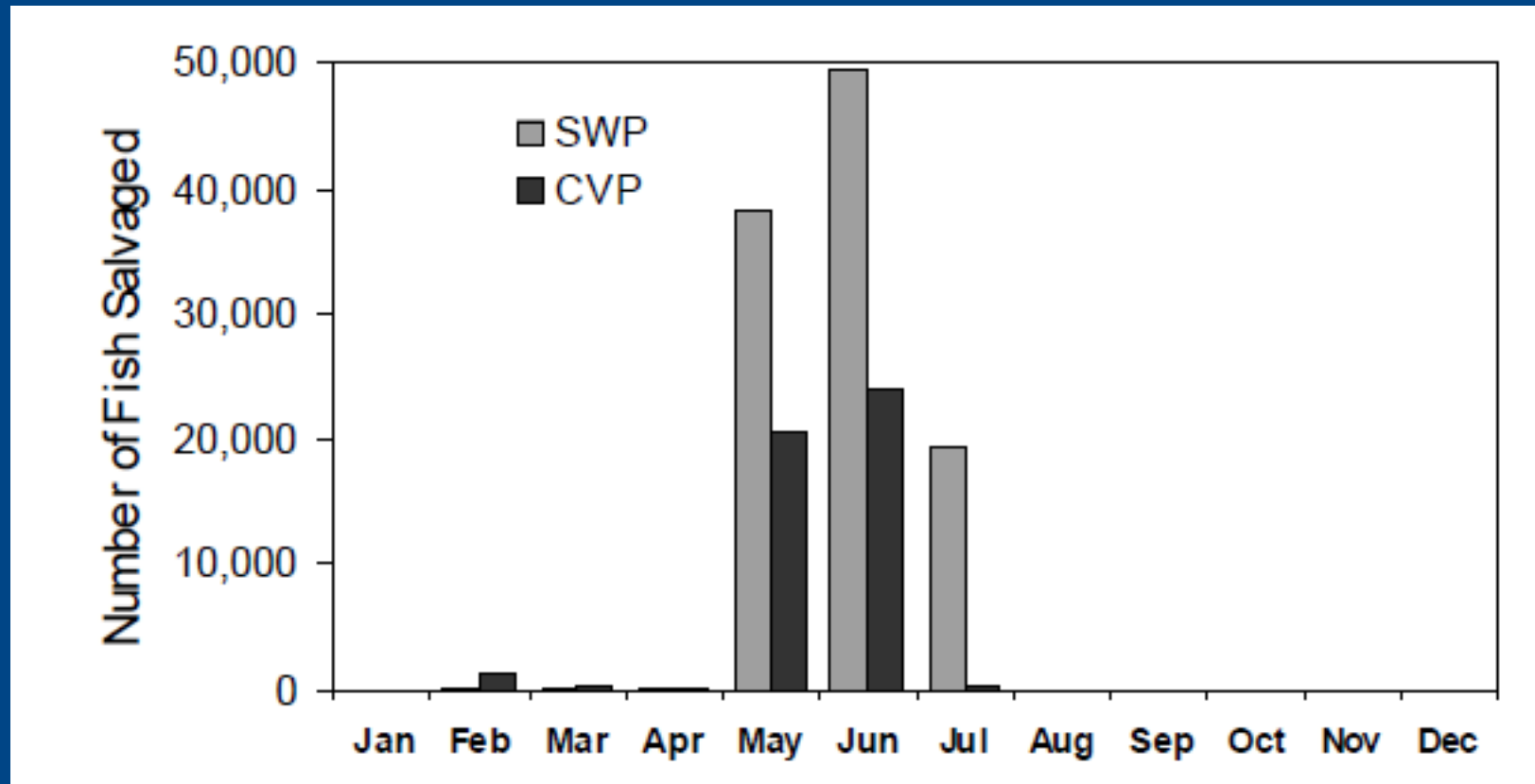
Source: Nobriga et. al. 1999

# Delta Smelt locations early June 1999



Source: Nobriga et. al. 1999

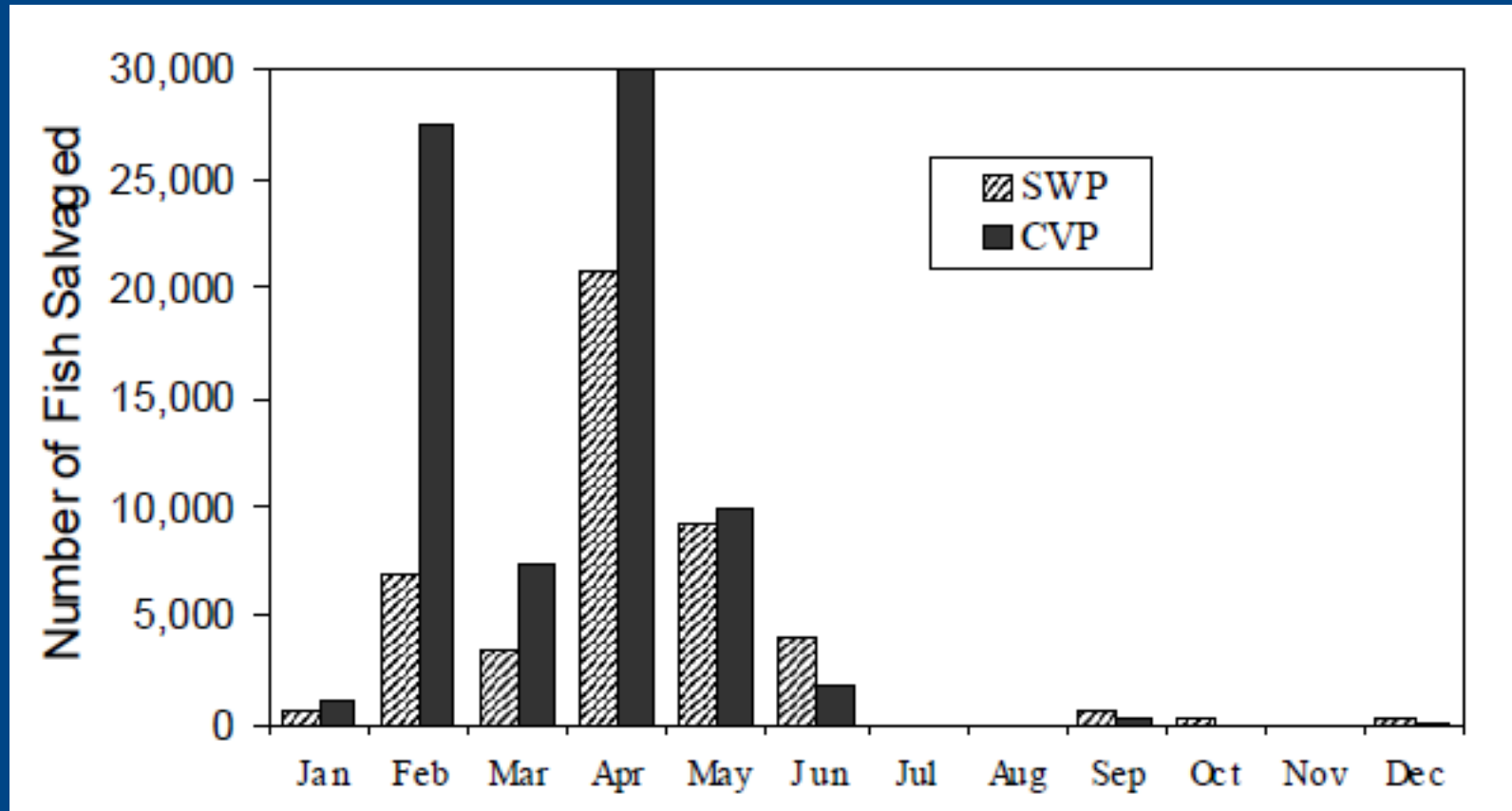
# 1999 salvage of Delta Smelt



- red light levels exceeded in May, June, & July

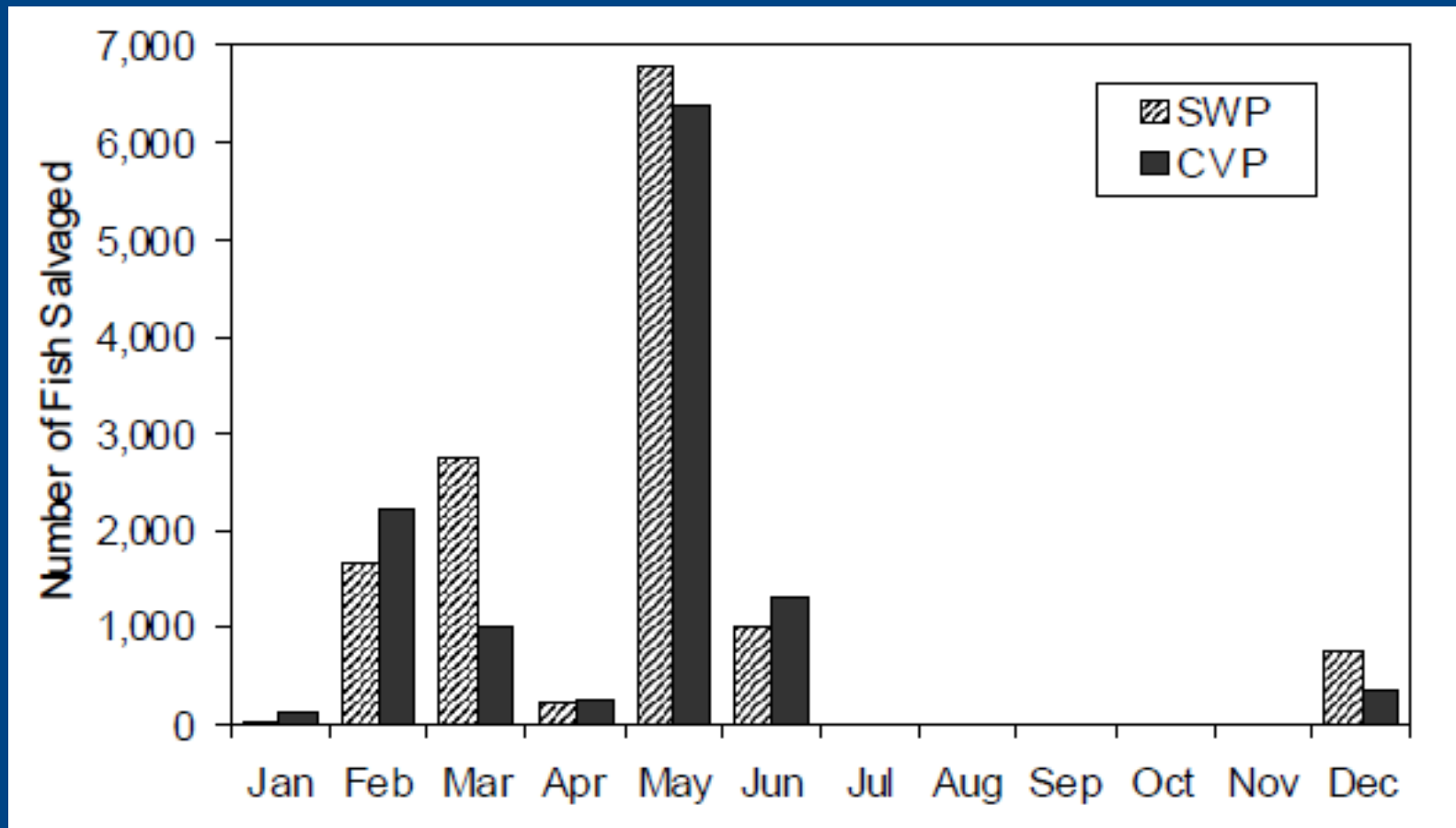
☐ Source: Nobriga et. al. 1999

# 2000 salvage of Delta Smelt



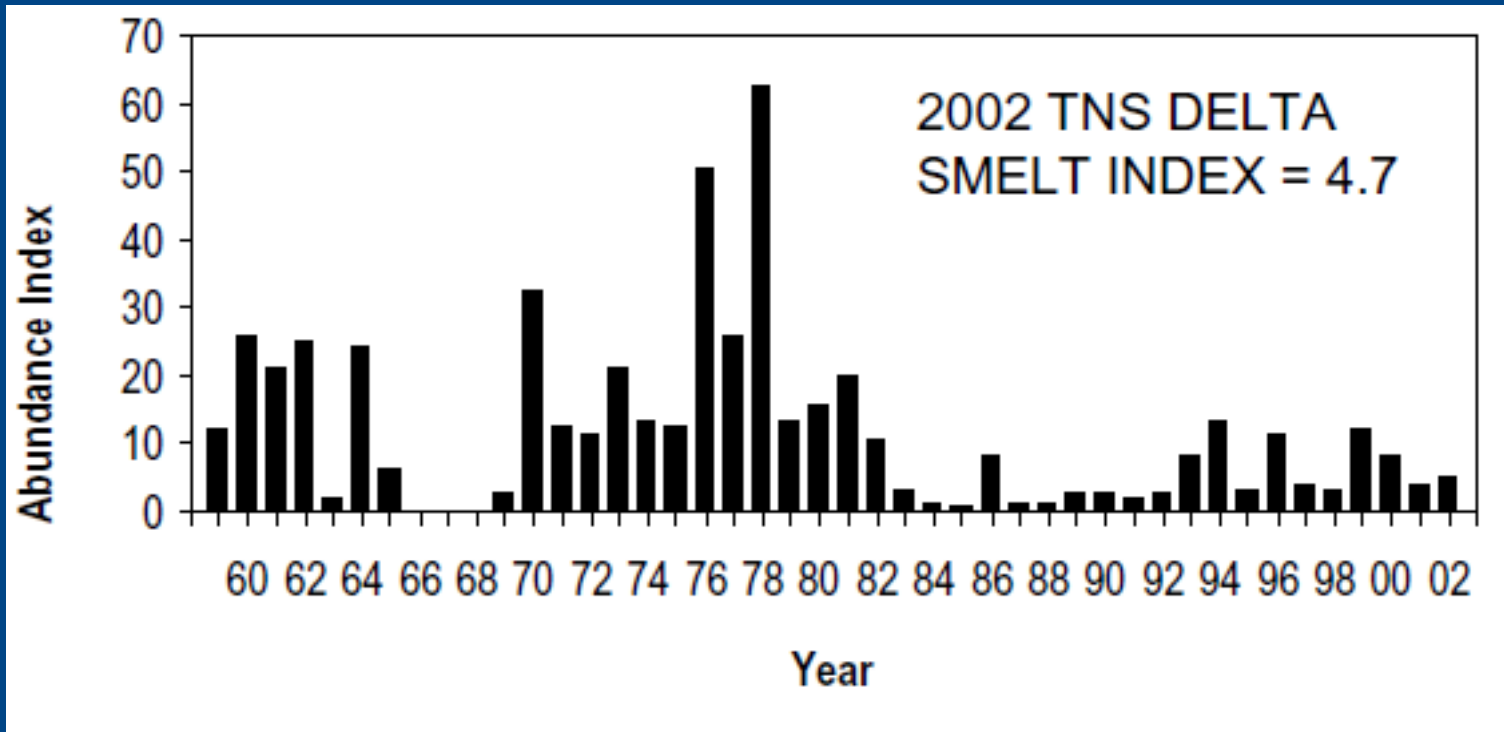
- Red light levels exceeded in May & June

# 2001 salvage of Delta Smelt

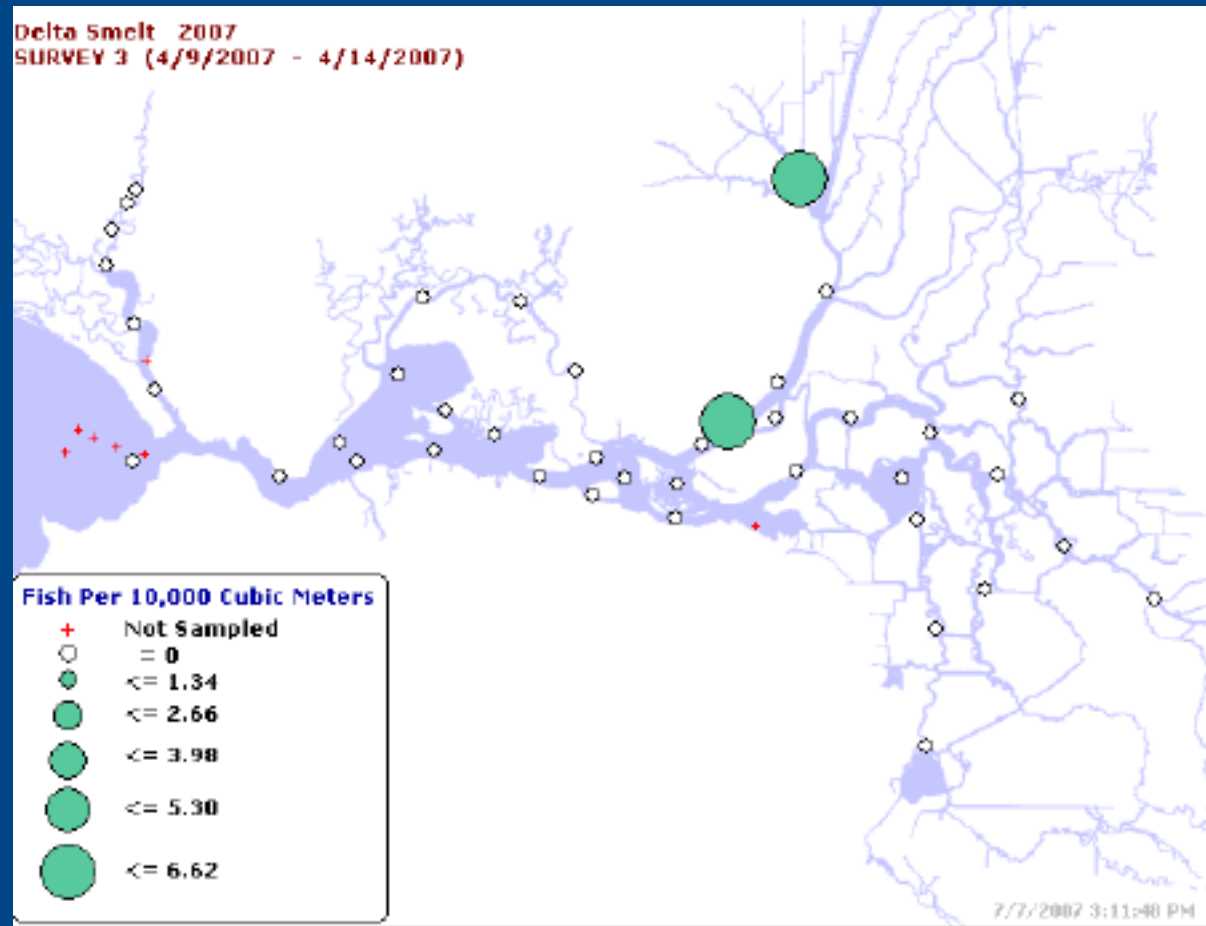


- Reduction in salvage associated with declining abundance

# Tow Net Survey 2002



# Delta Smelt locations April 2007



- Only present in Cache slough and lower Sacramento River

# *Delta Smelt Decline Factors*

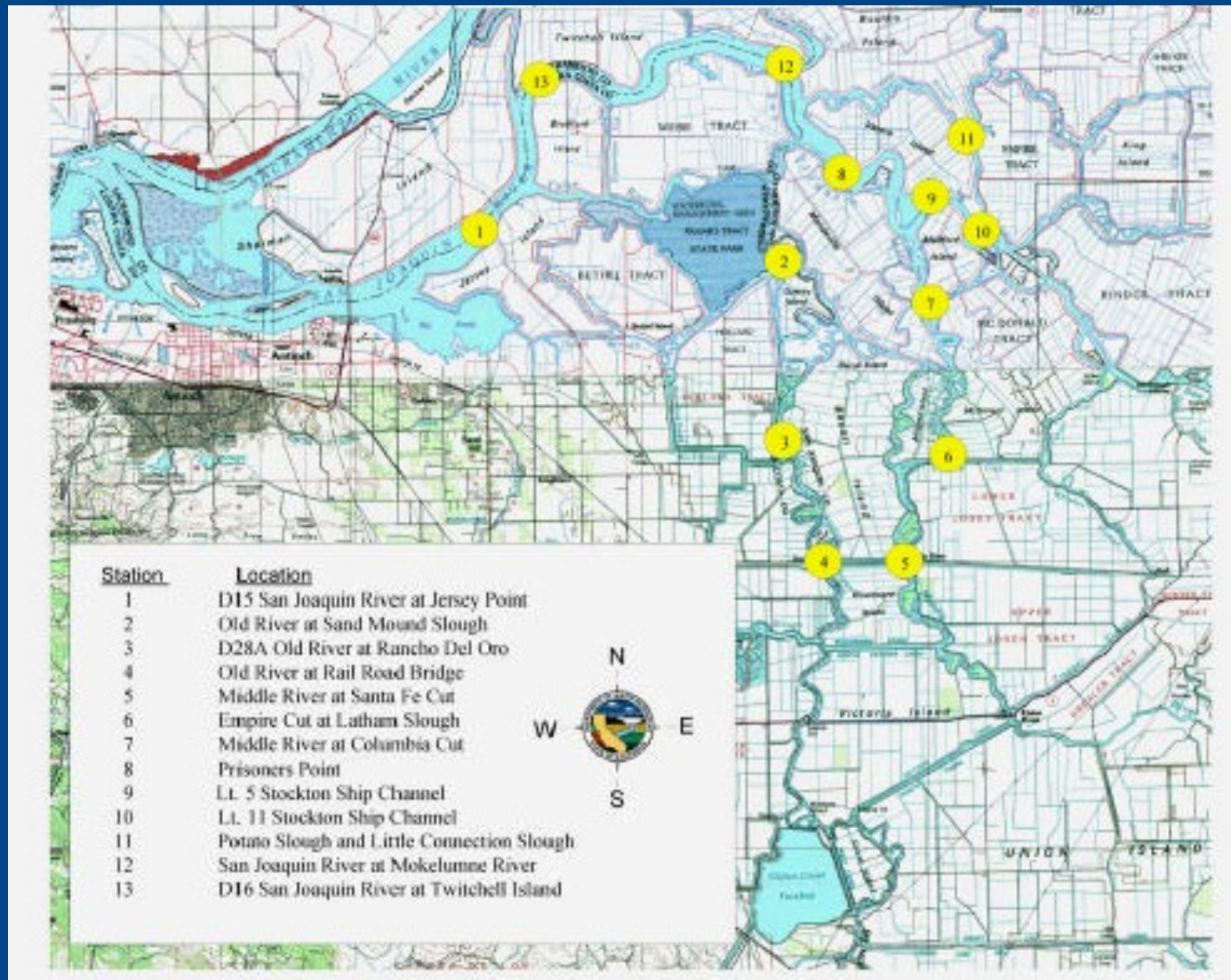
- Habitat loss
  - Suisun Bay: salinity, lack of food
  - Central / Southern Delta: toxic algal blooms?
- Effects of increased pumping
  - Larger zone of entrainment in Central Delta due to increased negative flows
  - Possible increased salvage at pumps as smelt populations moved east



# *Toxic Algal Blooms*

- First Microcystis bloom discovered in September 1999
- Dense patch in lower San Joaquin River (eastern DWSC), also in Southern and Central Delta
- Speculated that bloom was associated with low flows, warm temperatures, increased water clarity, and high nutrient inputs associated with exceptionally warm and dry fall
- Source: Hayes & Waller, IEP fall 1999

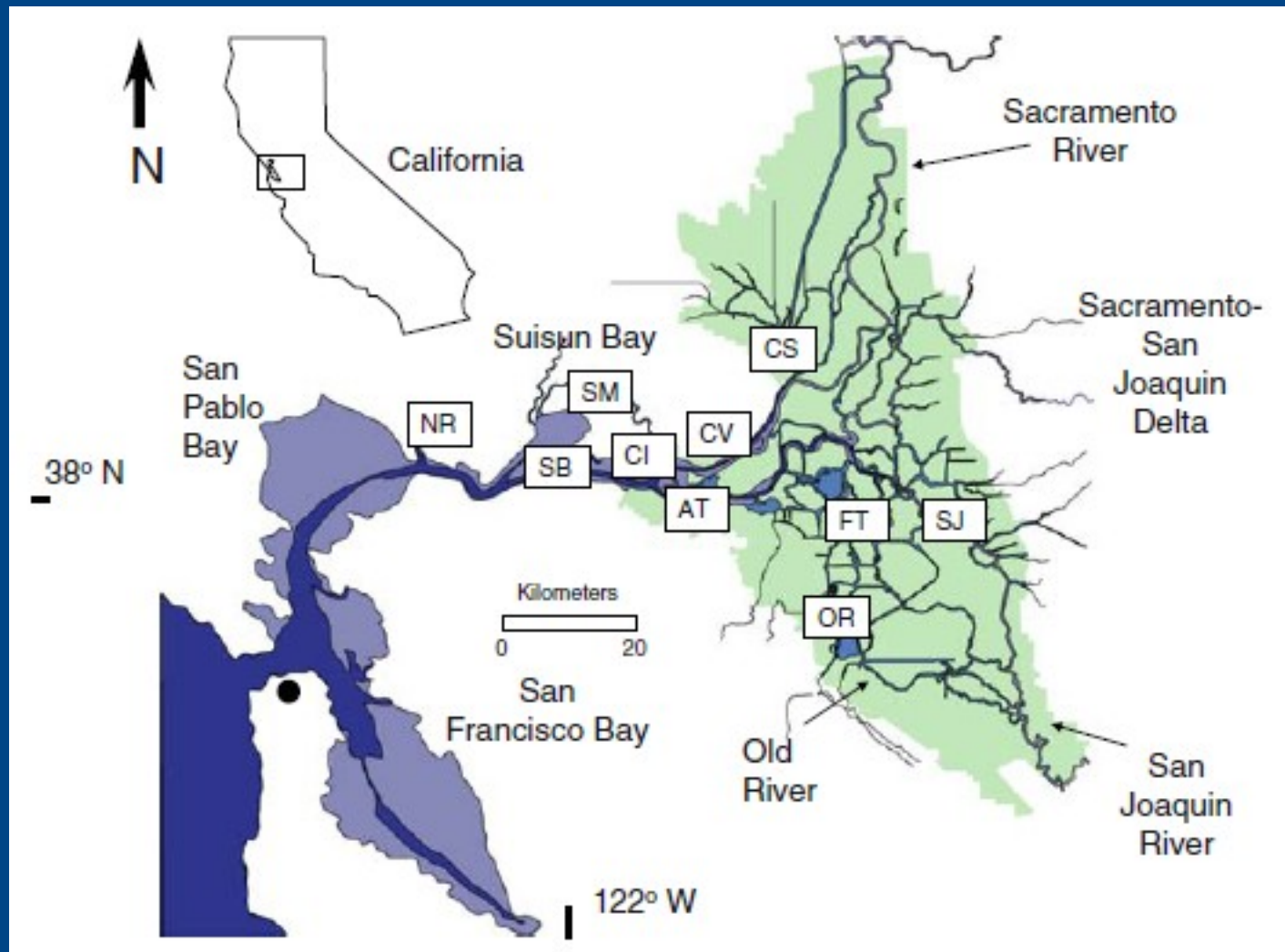
# Microcystis Survey Sept 1999



# *Microcystis* sampling 2005

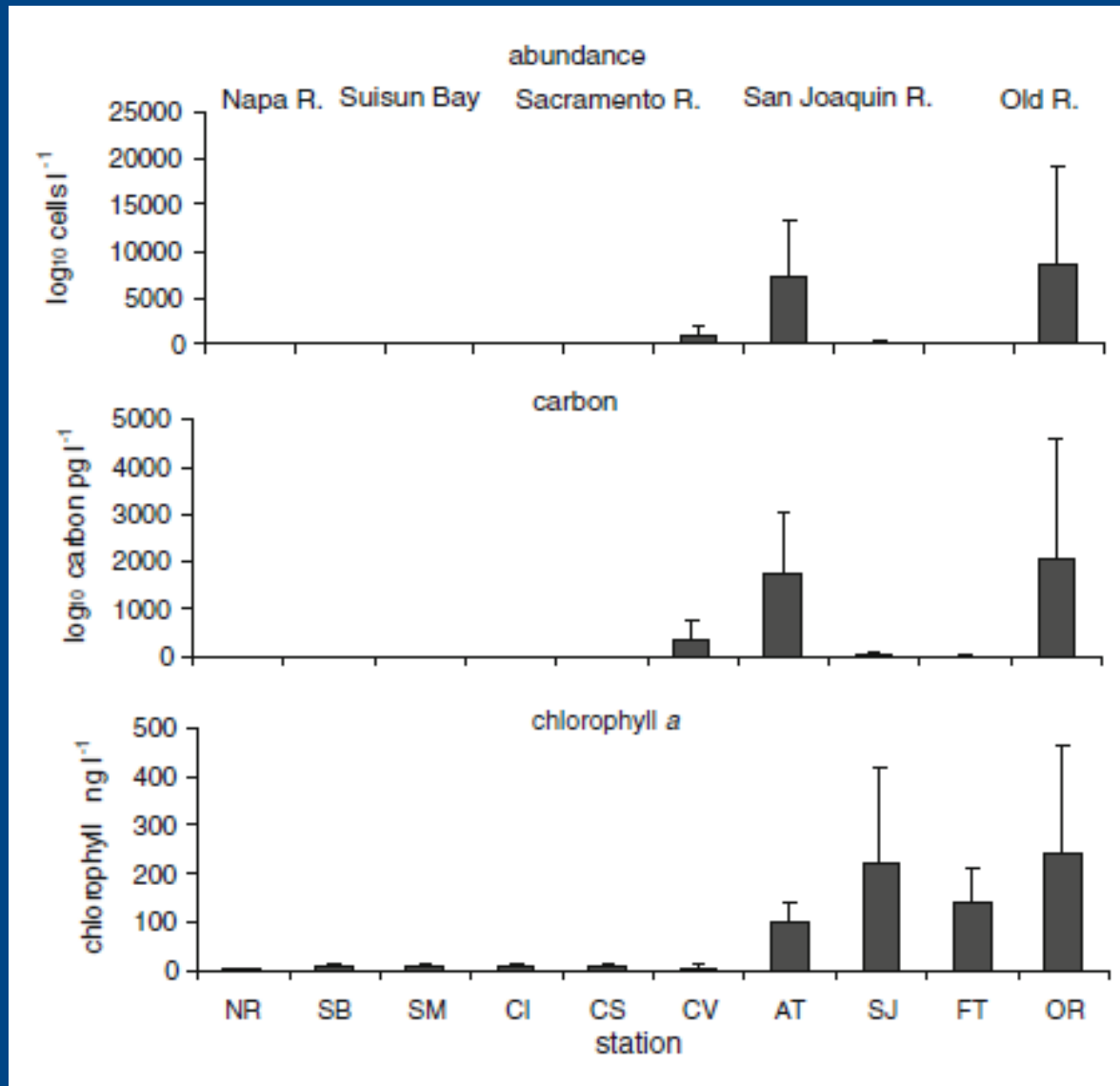
- Blooms have continued every year
- Extensive sampling and testing by Lehman et. al. in 2005 as part of POD task force
- Reported in 2010 in *Hydrobiologica*:  
“Initial impacts of *Microcystis aeruginosa* blooms on the aquatic food web in the San Francisco Estuary”
- P. W. Lehman • S. J. Teh • G. L. Boyer • M. L. Nobriga • E. Bass • C. Hogle

# Sampling locations Aug 2005



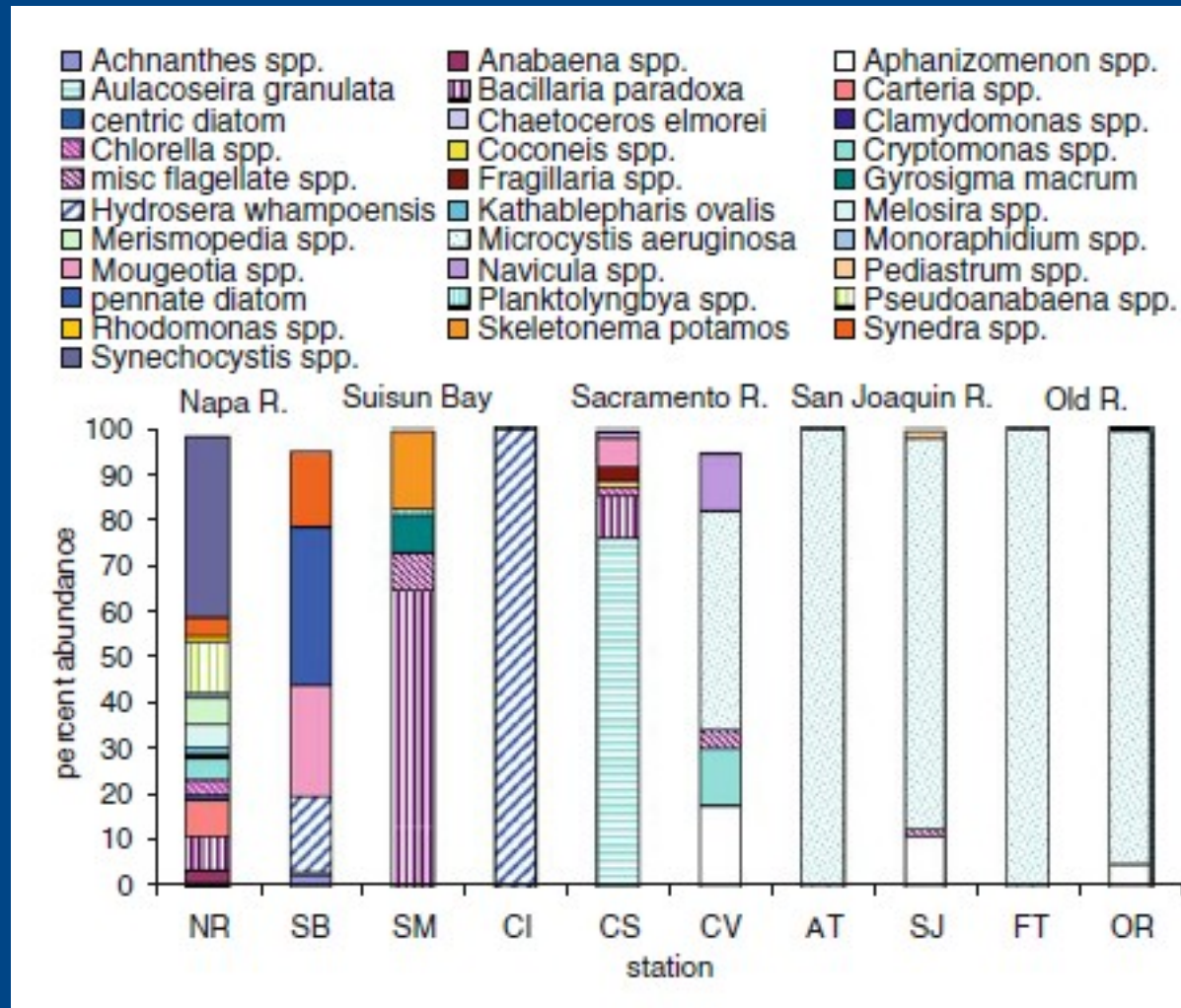
- Source: Lehman et. al. Hydrologica 2010

# Microcystis Abundance Aug 2005



- Source: Lehman et. al. Hydrologica 2010

# Composition of Phytoplankton 2005



• Source: Lehman Hydrologica 2010

# *Phytoplankton Analysis (Lehman)*

- Microcystis correlated with water quality
- Negatively correlated with with chloride, total suspended solids, and total organic carbon
- Positively correlated with nitrate-N, soluble phosphorus, and total nitrogen (nitrate-N plus ammonium-N)

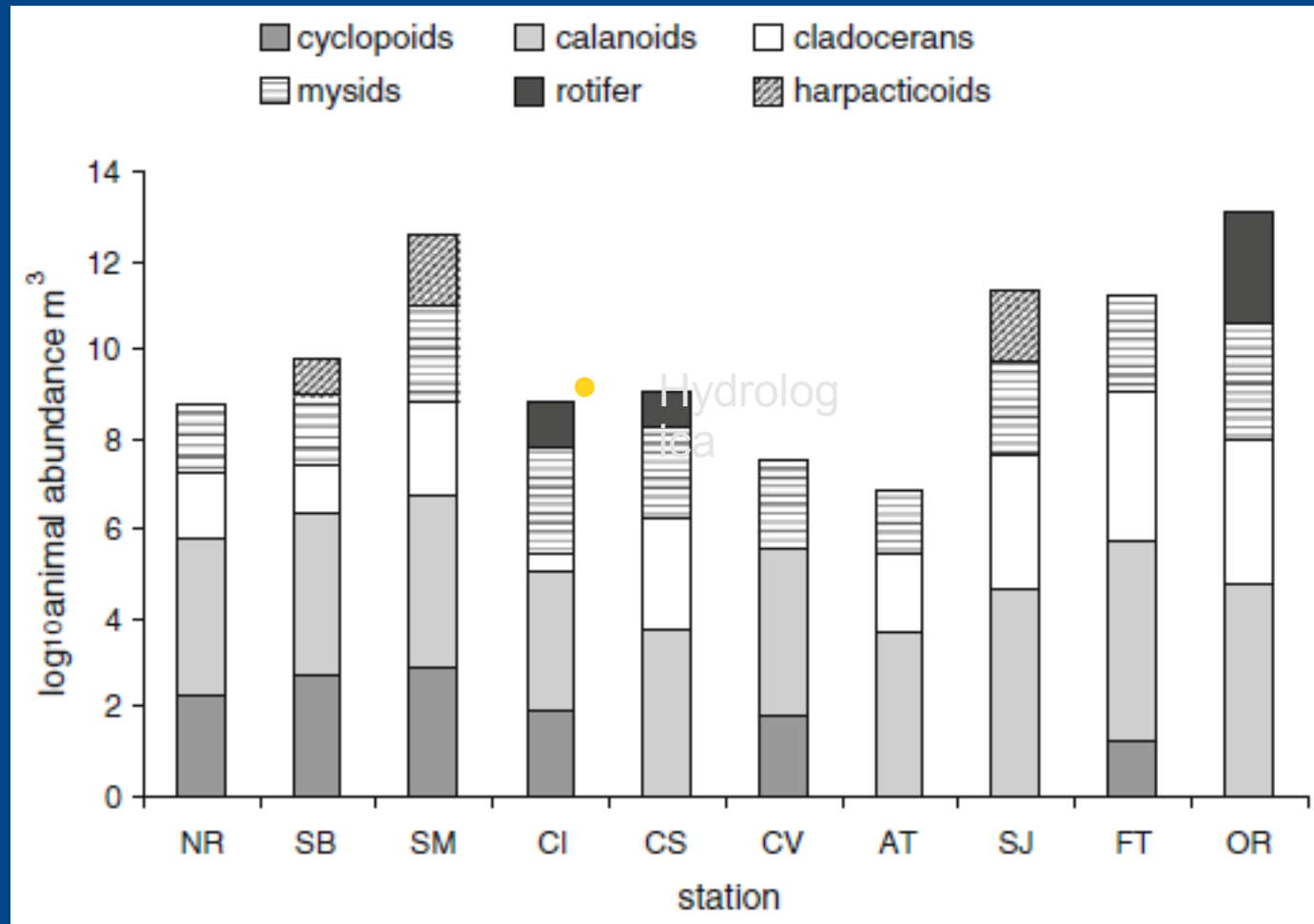
- Source: Lehman et. al. Hydrologica 2010

# *Phytoplankton Analysis (Lehman)*

- Not significantly correlated with ammonium
- “Although ammonium-N concentration was elevated at some stations in the western and central delta and the neither it nor the total nitrogen (nitrate-N and nitrite-N plus ammonium-N) to soluble phosphorus molar ratio (NP) was significantly correlated with *Microcystis* abundance across all regions or within the western and central delta separately.”

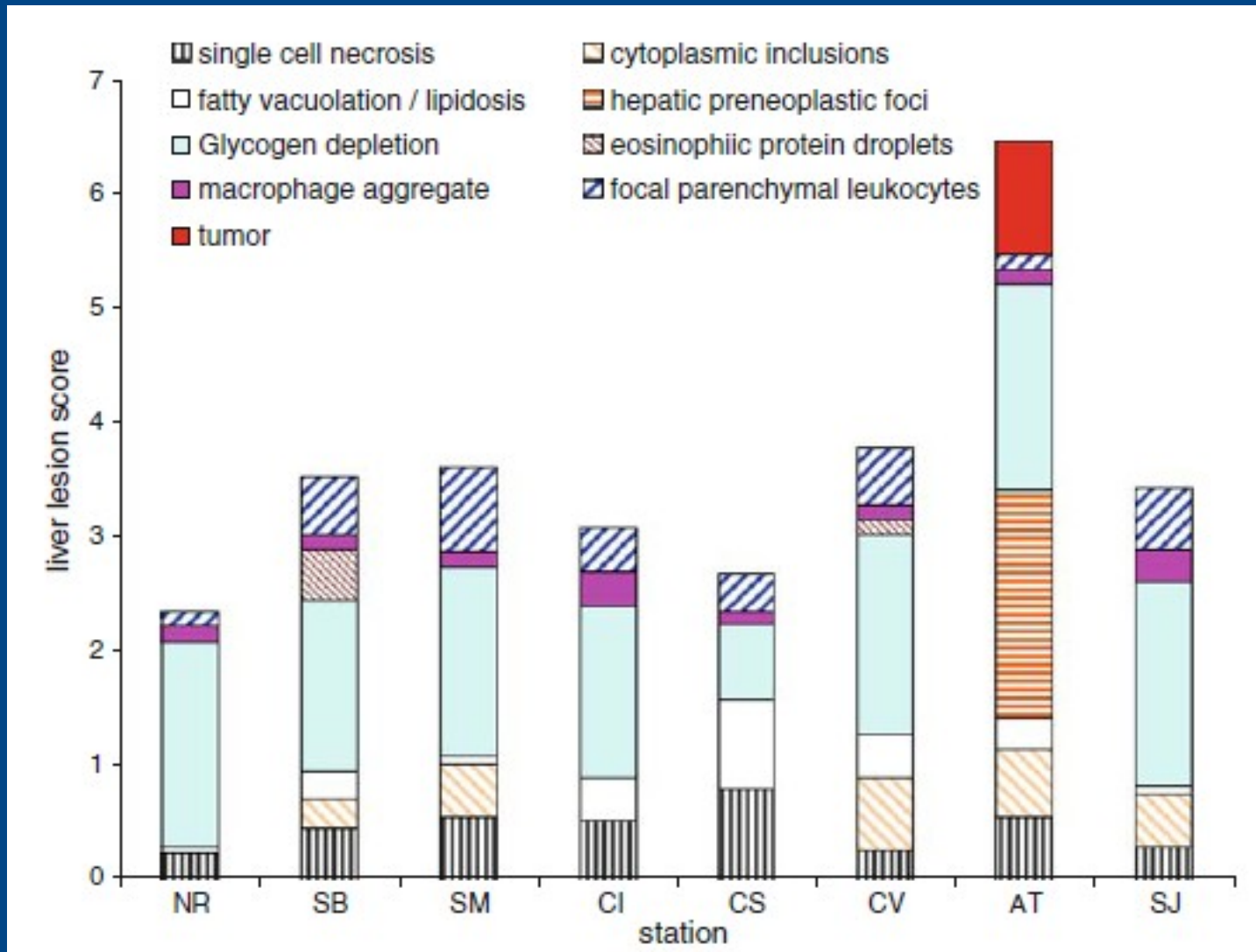


# Composition of Zooplankton 2005



- Source: Lehman et. al. Hydrologica 2010

# Liver Lesion Scores of Juvenile Striped Bass



- Source: Lehman et. al. Hydrologica 2010

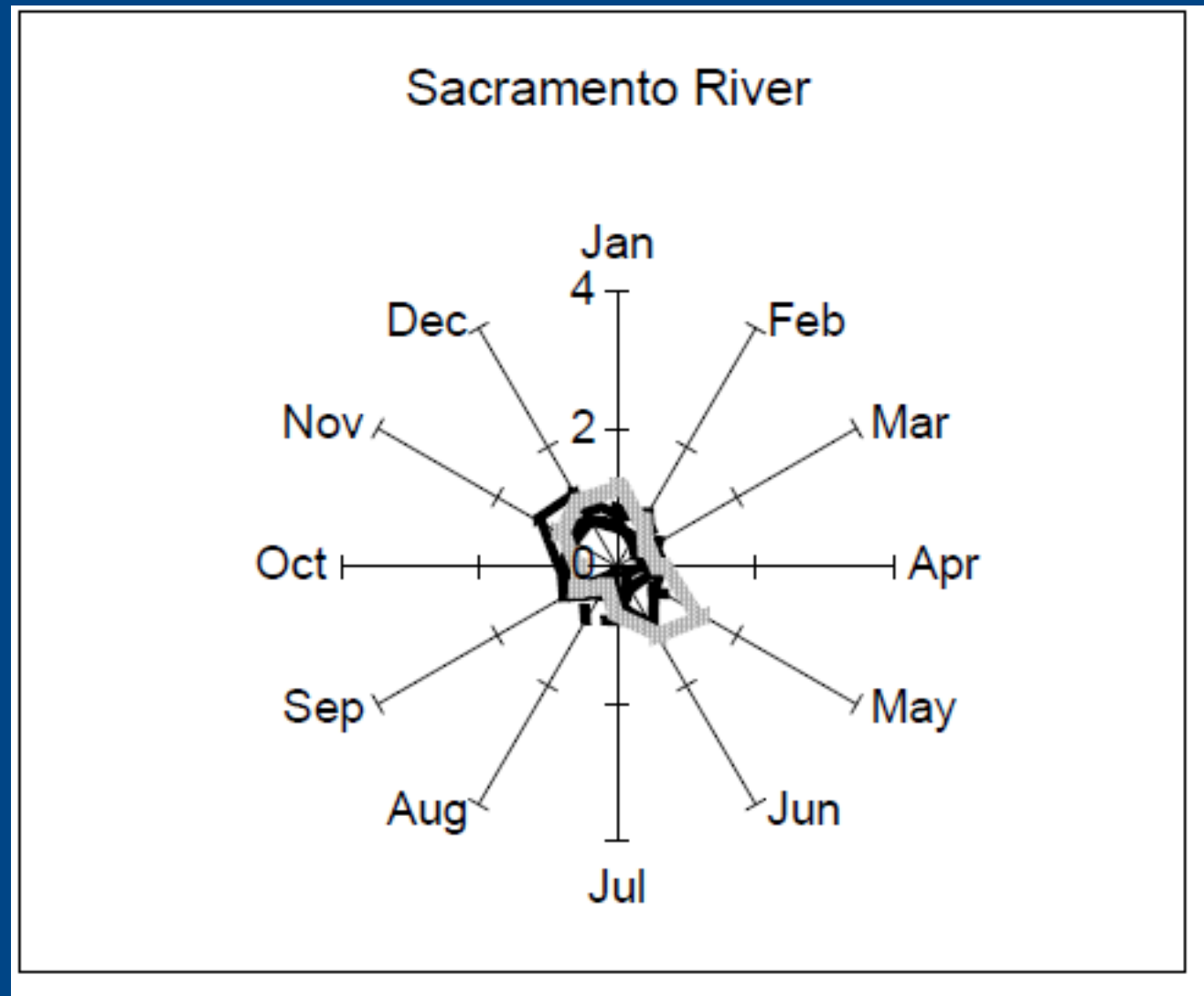
# *Toxic Algal Bloom Summary*

- Dense Microcystis blooms at Old River and Antioch
- Correlated with nutrient levels (total nitrogen) and increased water clarity
- May also be associated with low flows
- Cancer in juvenile Striped Bass thought to be associated with toxins in San Joaquin River

# *Deep Water Ship Channel*

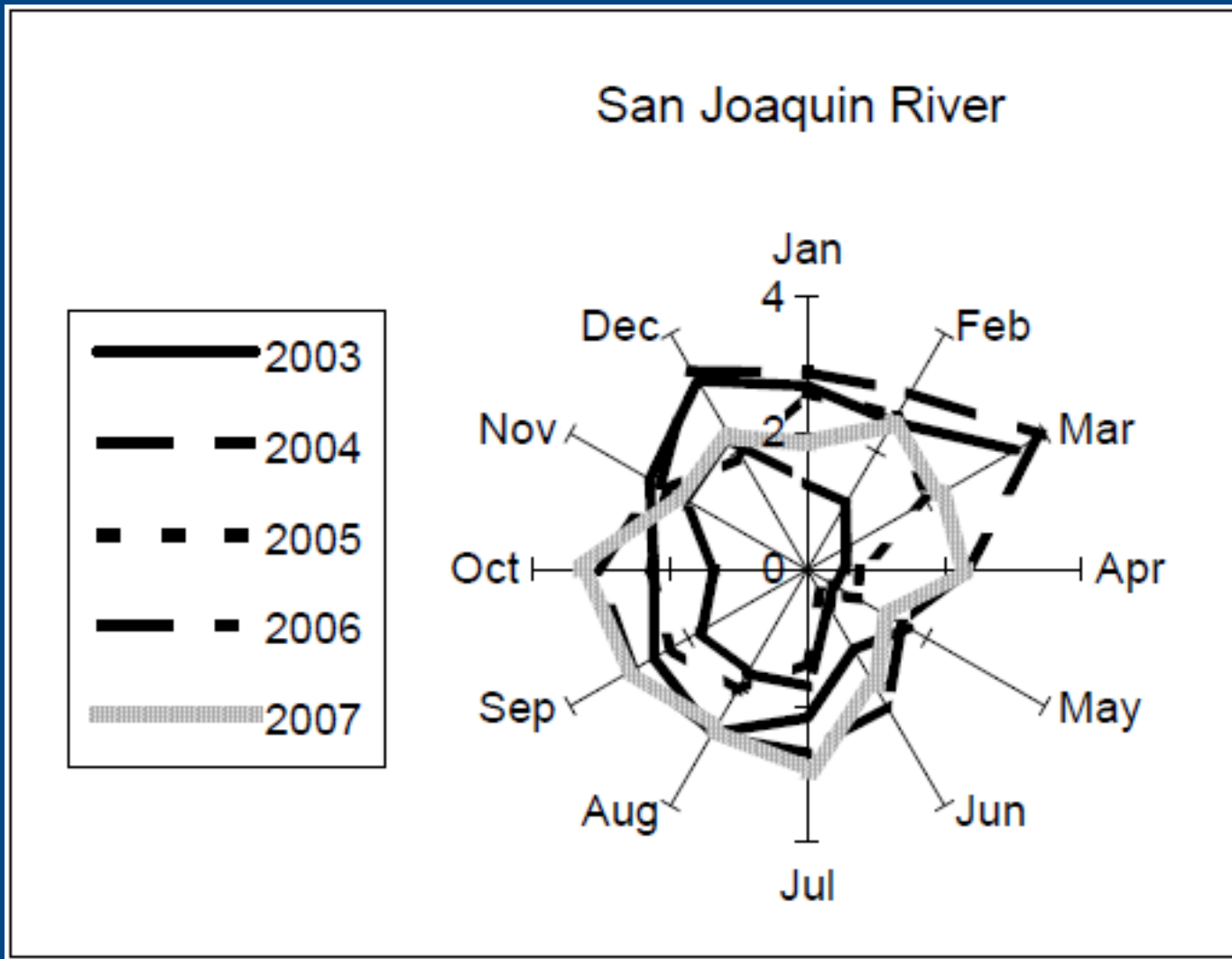
- San Joaquin River below Stockton, severe water quality problems
- Fish kills in 2003 and 2007, associated with low DO
- May be associated with upstream agricultural discharges as well as Stockton WWTP
- Modeling showed that flows of San Joaquin River above 2000 cfs will solve problem

# Nitrogen levels in Sacramento River



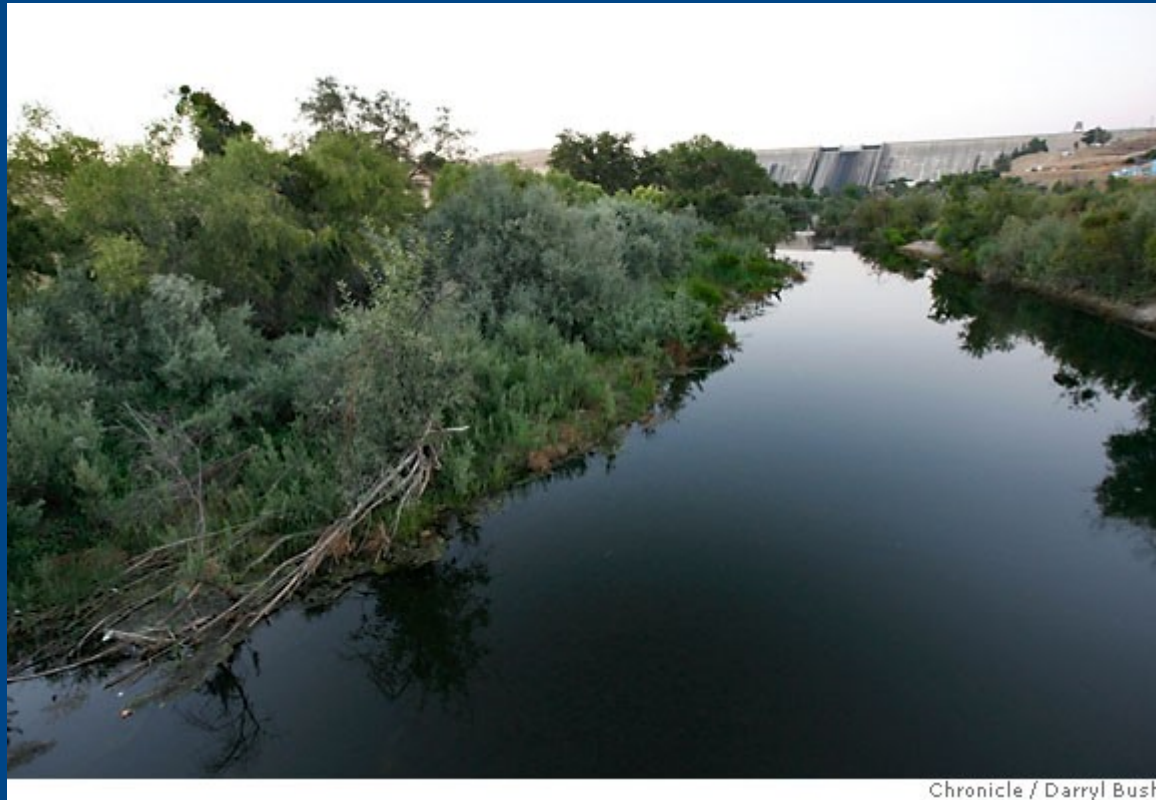
- Source: PPIC, Comparing Futures for the Sacramento-San Joaquin Delta, 2008

# Nitrogen levels in San Joaquin River



- Source: PPIC, Comparing Futures for the Sacramento-San Joaquin Delta, 2008

# *San Joaquin River*



Chronicle / Darryl Bush

- Restoration flows will help Delta water quality -- if they flow through the Delta
- Picture: San Joaquin River with Friant Dam in background. Photo by Darryl Bush, S.F. Chronicle