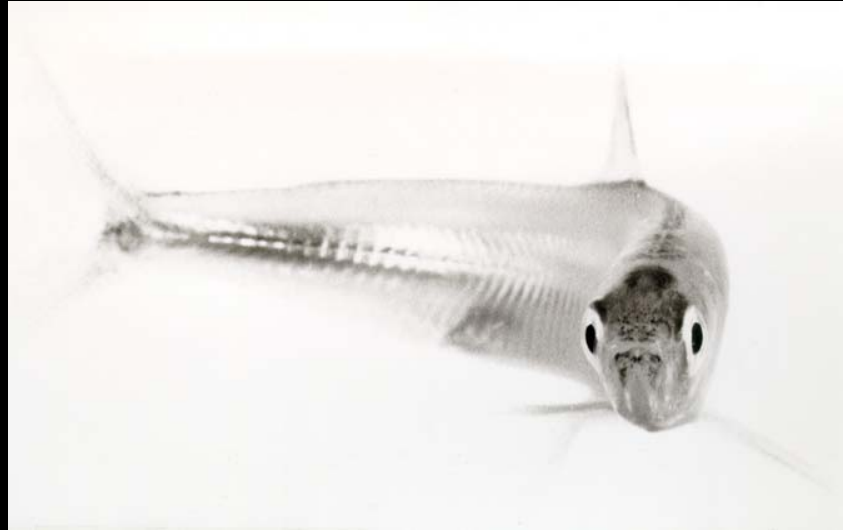
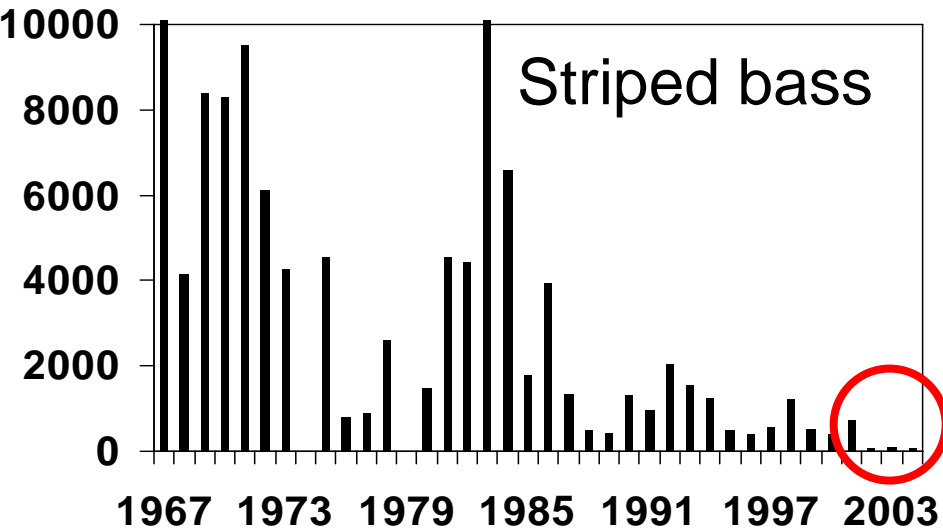
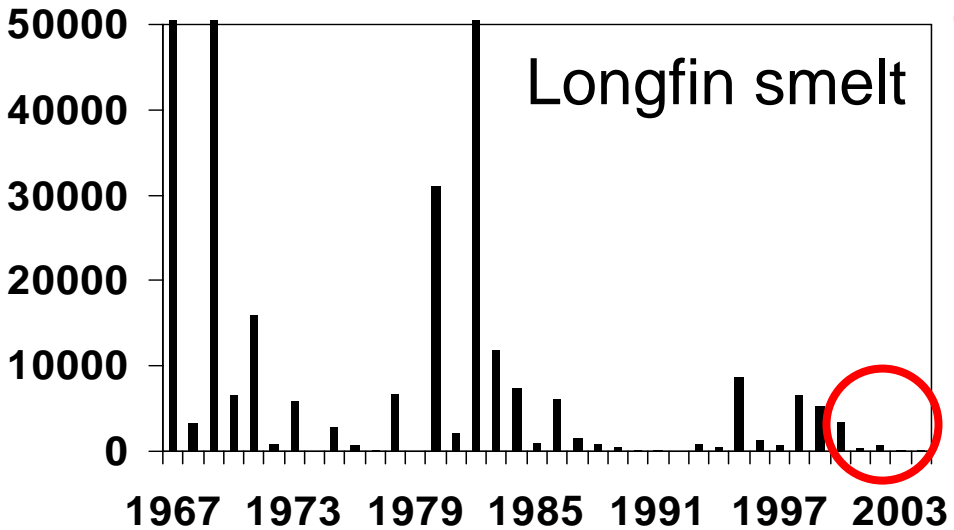
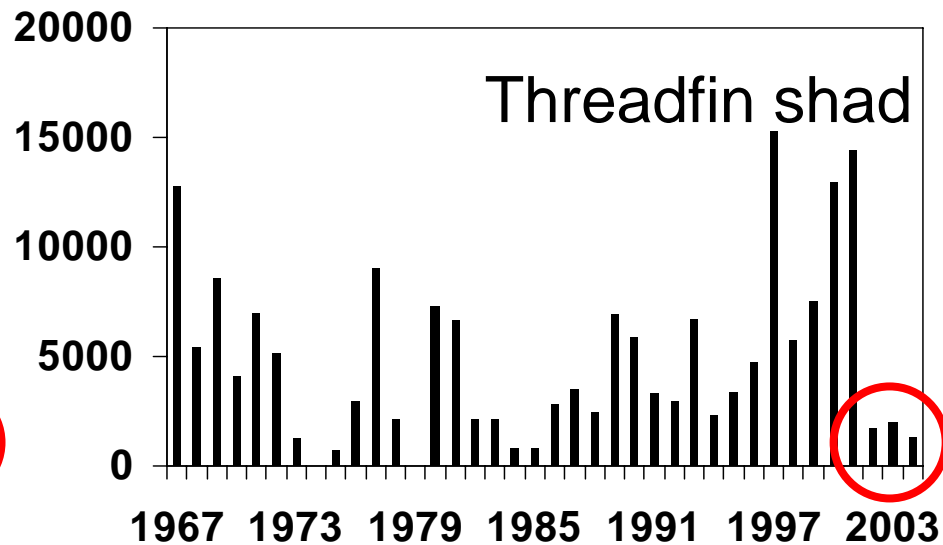
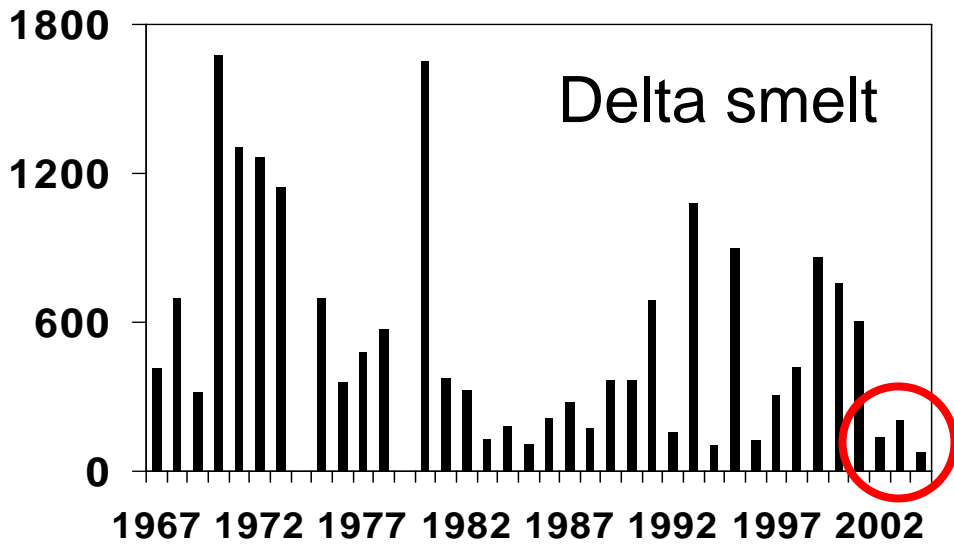


The Decline of Pelagic Fishes in the San Francisco Estuary: An Update



Dr. Ted Sommer

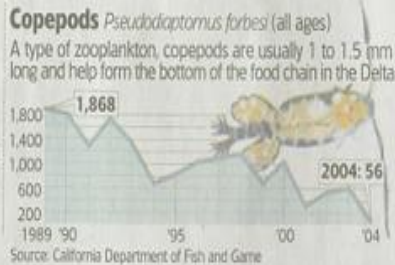
California Department of Water Resources



Pelagic Organism Decline ("POD")

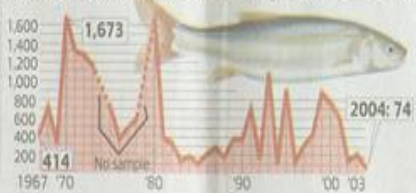
Fish survey

Each year, scientists survey dozens of locations along the Delta, using a trawl net to capture a sampling of fish. The numbers at right are calculations of population density based on the average number of fish caught in a specified volume of water.

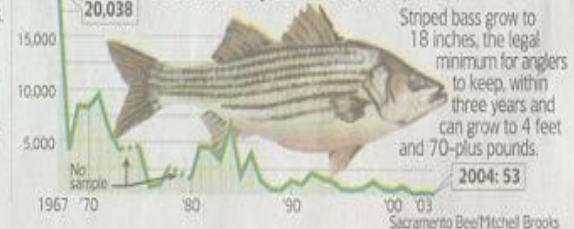


Delta smelt (all ages)

Typically living just one year, Delta smelt grow to about 4 inches.



Juvenile striped bass (up to 1 year old)



DELTA DANGER

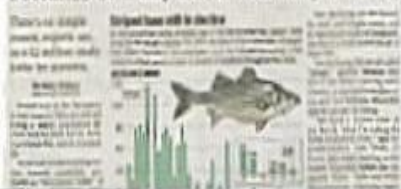
A decline in fish species and their food source is a reminder of a recurring worry in the West: A broad ecosystem collapse

By Matt Weiser
BEE STAFF WRITER

An unprecedented research effort is under way to make sense of an alarming plunge in the population of Delta fish species. But some observers worry it may be a case of "too little, too late."

The \$2 million research plan was pulled together in just five months by state and federal officials. It will be part of a routine survey in fall 2004 found

Fortunes of a key Delta fish keep sinking



Members of Congress Seek Answers on Delta Fish Decline
by Dan Bacher *Thursday, May 12, 2005 at 11:23 PM*
danielbacher@hotmail.com

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for not doing
it responding
began declin-

Veys also
zooplank-
fish.

Decline In Delta Forage Species Alarms Scientists

May 25, 2005
By Dan Bacher

WESTERN ROUNDUP - May 30, 2005

A massive restoration program may have nothing left to save
by Matt Weiser

Food chain collapsing in the California Delta

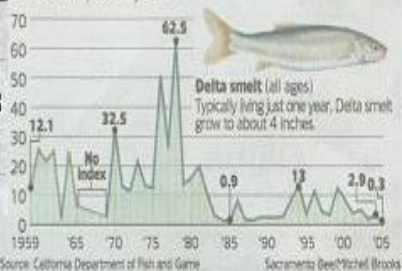
Officials challenged over Delta smelt deaths

By Matt Weiser
BEE STAFF WRITER

sion could be drawn that (the Department of Water Resources) has been acting out-

Delta smelt threatened

Delta smelt continue to decline, with the latest numbers from a June survey. The numbers are a measure of abundance relative to water volume, not an actual population count. The lowest numbers ever recorded for the native fish coincide with near-historic shipments of Delta water in three of the past five years.



The San Francisco Examiner

Opinion

Delta fish decline hints at water crisis

Viewpoint

By Los Angeles Times

Published: Wednesday, August 24, 2005 11:54 PM PDT

"There was nothing presented today that would support compliance with the California Endangered Species Act. The conclu-

listed as threatened under the California Endangered Species Act since 1993.

► SMELT, Page A4

Interagency Ecological Program

- Long-term monitoring program for SF estuary
- Nine member agencies



POD Principal Investigators

- Dept Fish and Game
 - Randy Baxter, Marade Bryant, Kelly Souza, Steve Slater, Lee Mecum, Russ Gartz, Kathy Hieb, Marty Gingras
- Dept Water Resources
 - Matt Nobriga, Fred Feyrer, Ted Sommer, Bob Suits, Marc Vaysierres, Heather Peterson, Zoltan Matica, Peggy Lehman, Lenny Grimaldo
- US Bureau of Reclamation
 - Mike Chotkowski
- USEPA
 - Bruce Herbold
- US Geological Survey
 - Joe Simi, Cathy Ruhl
- UC Davis
 - Bill Bennett, Swee Teh, Inge Werner, Dave Ostrach
- SF State University
 - Wim Kimmerer
- SF Estuary Institute
 - Daniel Oros, Geoff Siemering, Jennifer Hayworth
- Consultant
 - Bryan Manly

FISH
ABUNDANCE



Prior Fish
Abundance

PHYSICAL & CHEMICAL FISH HABITAT

FISH
ABUNDANCE

Prior Fish
Abundance

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graph BT; A[Prior Fish Abundance] --> B[FISH ABUNDANCE]
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PHYSICAL & CHEMICAL FISH HABITAT

MORTALITY

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graph TD; Mortality[MORTALITY] -- red arrow --> FishAbundance[FISH ABUNDANCE]; PriorFishAbundance[Prior Fish Abundance] -- yellow arrow --> FishAbundance;
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FISH
ABUNDANCE

Prior Fish
Abundance

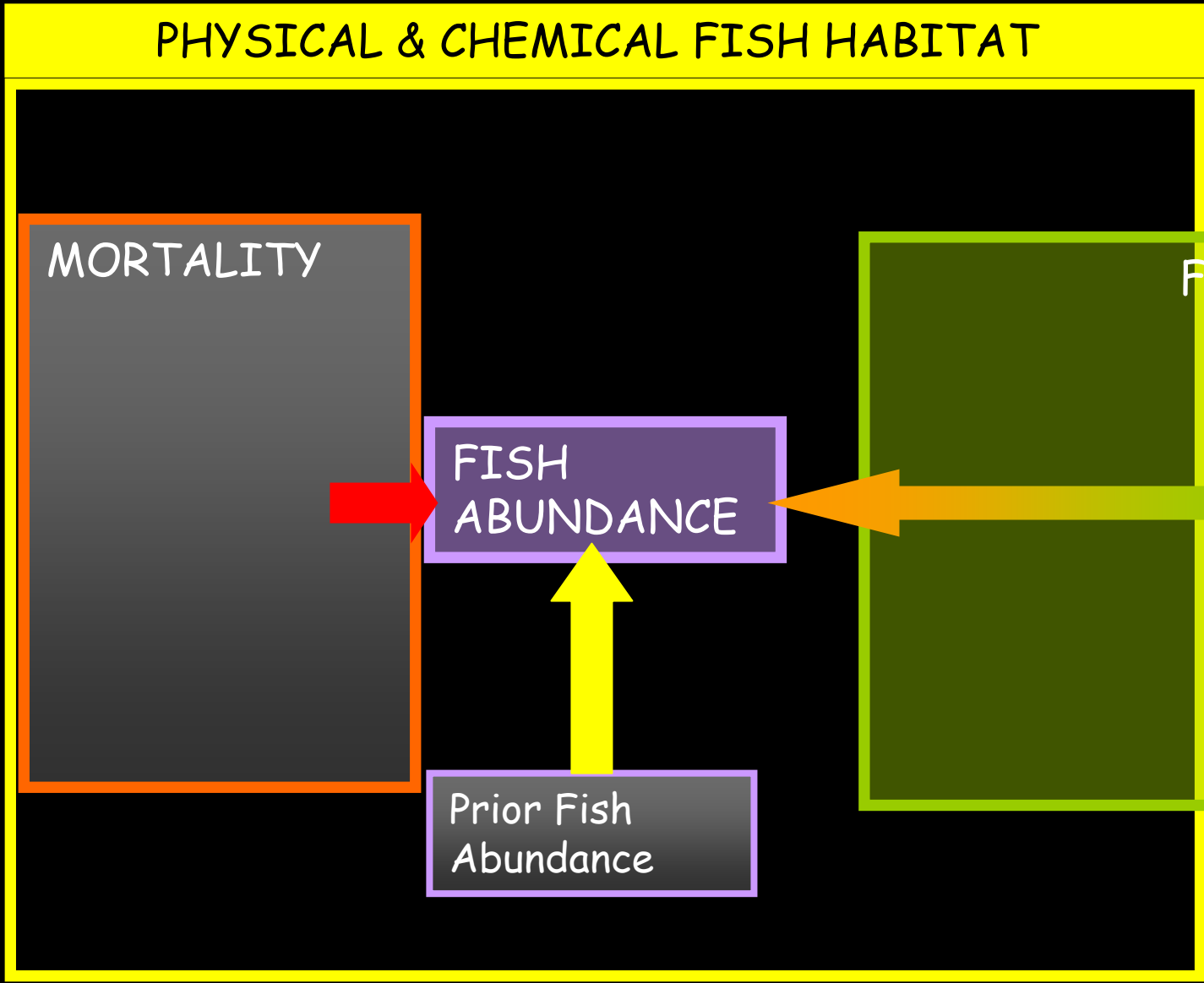
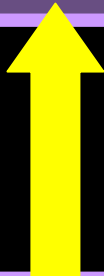
PHYSICAL & CHEMICAL FISH HABITAT

MORTALITY

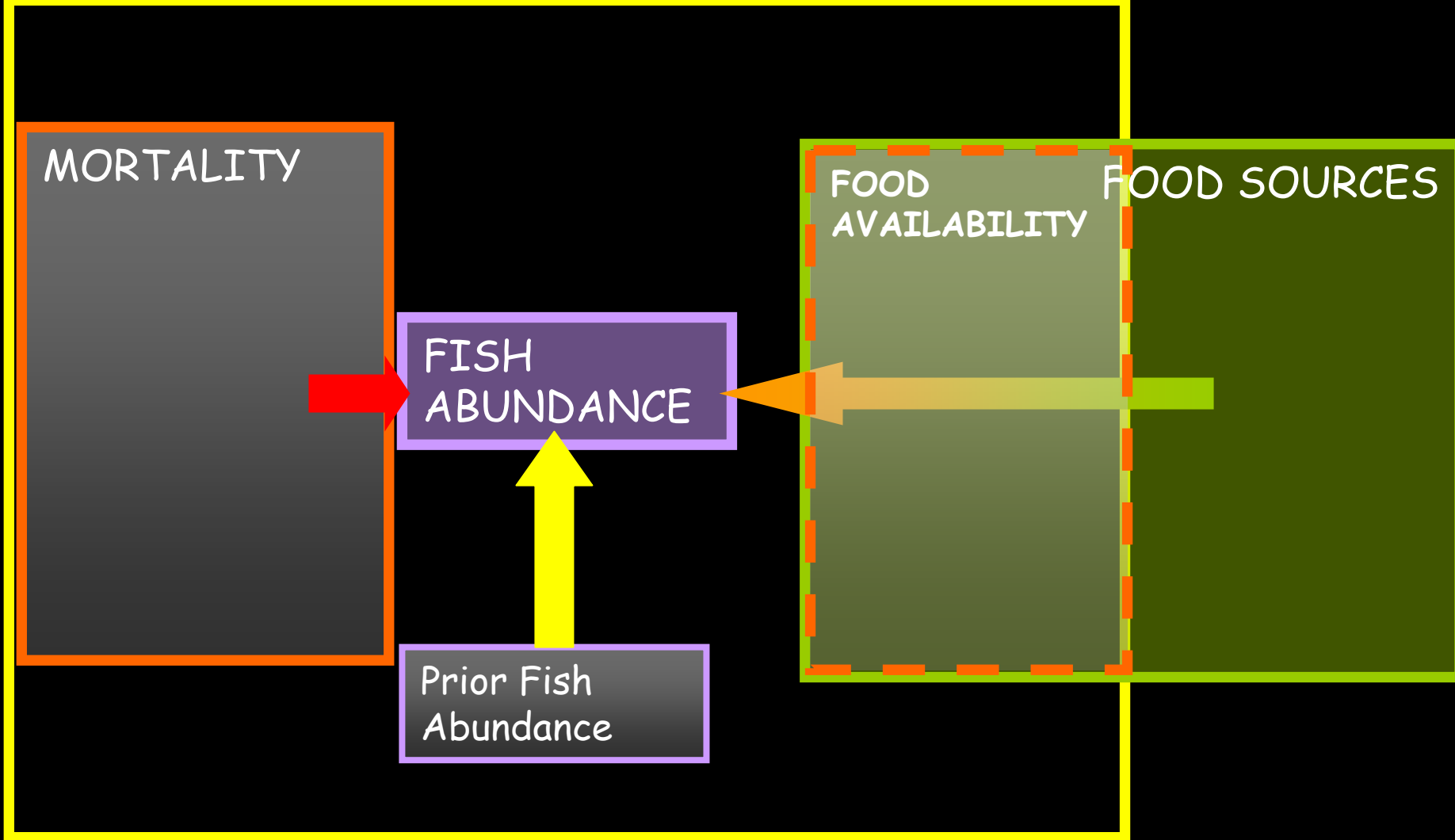
FISH
ABUNDANCE

FOOD SOURCES

Prior Fish
Abundance



PHYSICAL & CHEMICAL FISH HABITAT



PHYSICAL & CHEMICAL FISH HABITAT

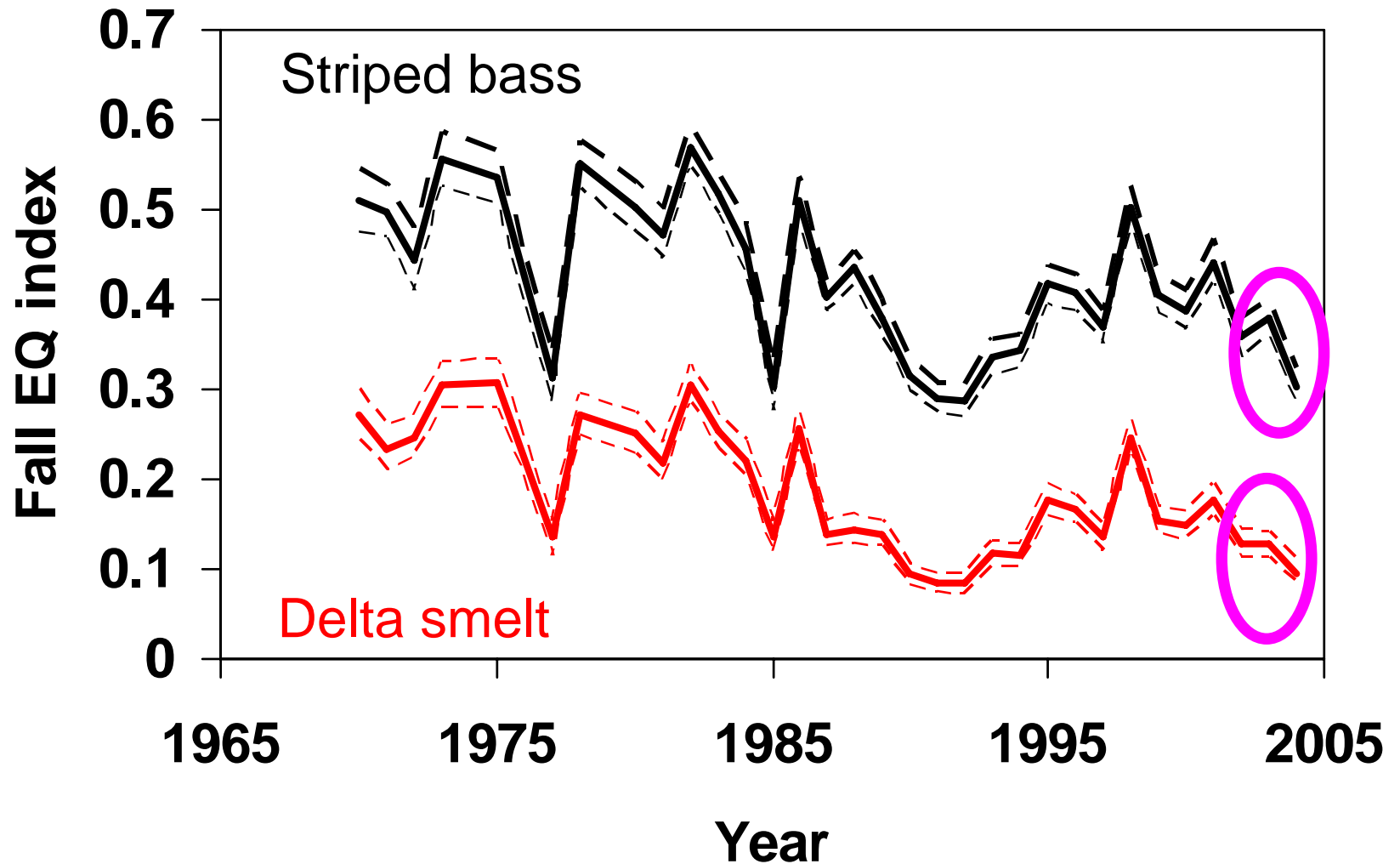
FISH
ABUNDANCE

PHYSICAL & CHEMICAL FISH HABITAT

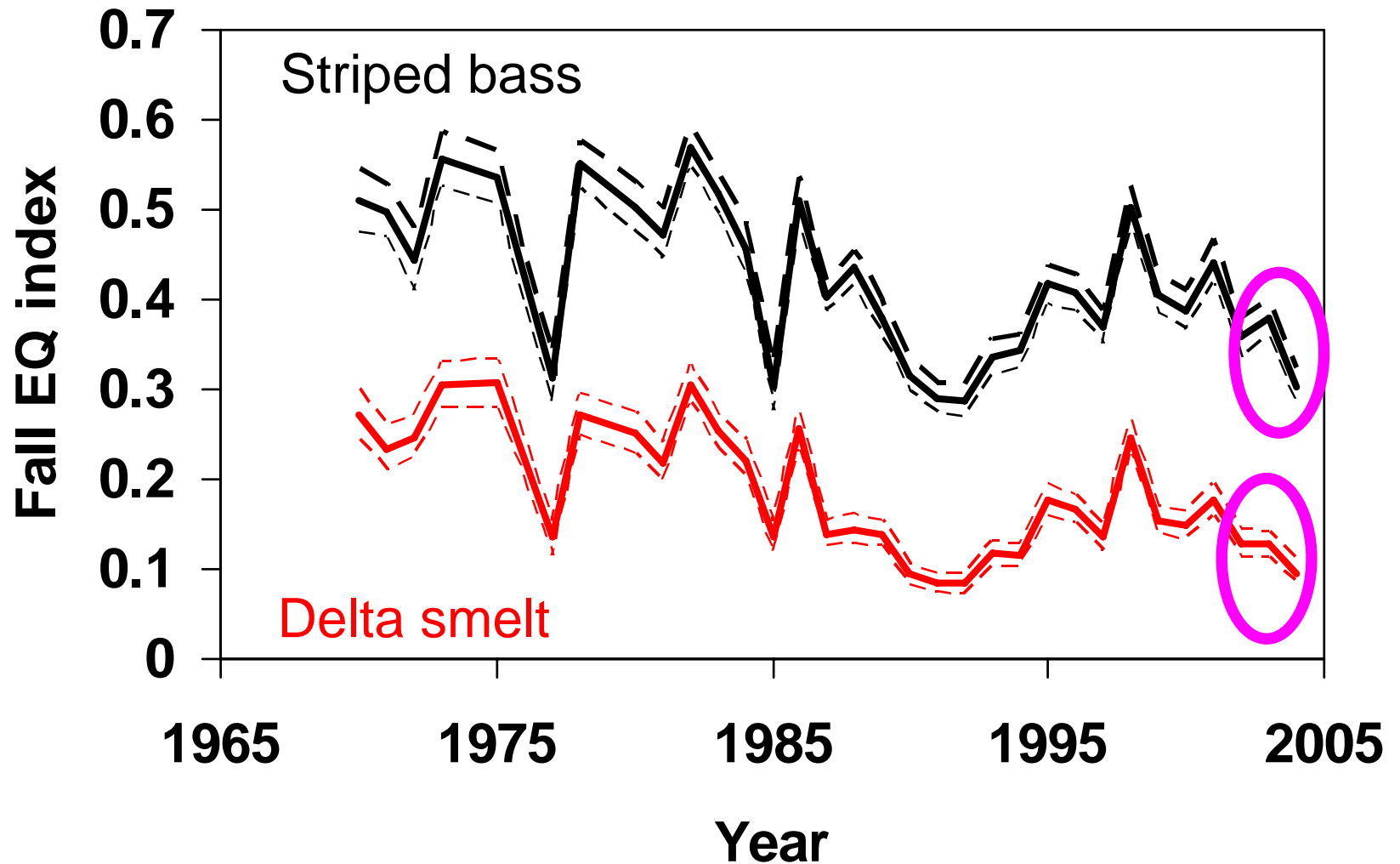
Salinity Turbidity Contaminants Toxic Algae

FISH
ABUNDANCE

Fall “habitat quality” has deteriorated



Fall “habitat quality” has deteriorated too



Fall EQ Correlated with juvenile production

Major Habitat Questions

- Why did habitat area change?
- What is the mechanism for population-level effects?
- What about contaminants and toxic algae?

Major Habitat Questions

- Why did habitat area change?
 - Hydrologic studies (USGS, CCWD)
 - Aquatic weed and turbidity studies (UCD, USGS)
- What is the mechanism for population-level effects?
 - Regional comparisons of fish health, growth and origin (UCD, DFG, FWS)
 - Population modeling (SFSU, UCD, LSU)
- What about contaminants and toxic algae?
 - Microcystis studies (DWR)
 - Bioassays (UCD)
 - Histology (UCD)
 - Contaminant modeling (UCD)

PHYSICAL & CHEMICAL FISH HABITAT

MORTALITY

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graph LR; Mortality[MORTALITY] --> Abundance[FISH ABUNDANCE]
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FISH
ABUNDANCE

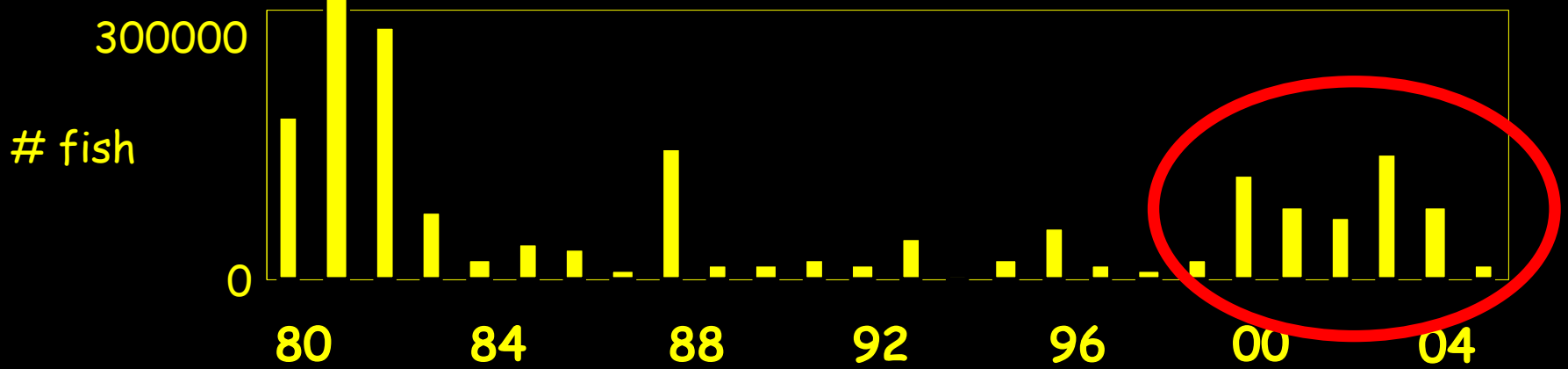
Water Diversions



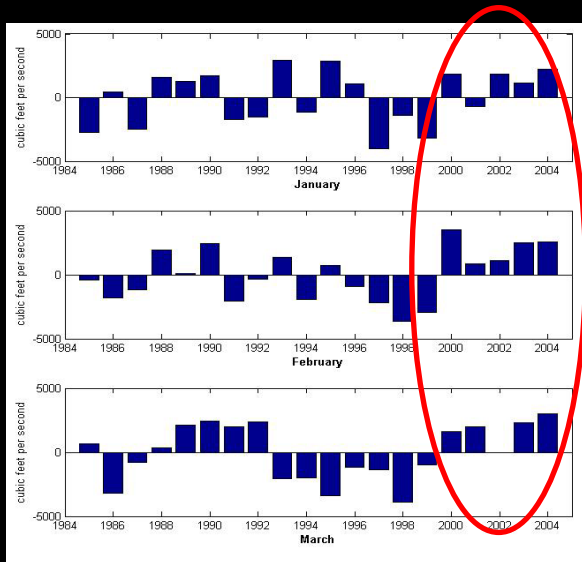
Trends in Fish Salvage



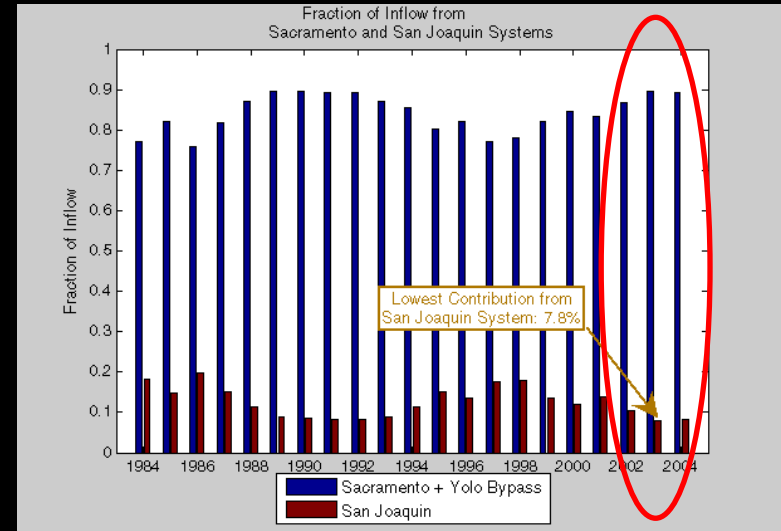
Winter Salvage of Delta Smelt (Nov-Mar)



Increased winter exports



Shifts in tributary flow



Entrainment
Increase in winter salvage.

Major Entrainment Questions

 Why did entrainment increase?

 Do these changes have population-level effects?

Major Entrainment Questions

Why did entrainment increase?

Local effects?

- South Delta hydrodynamic studies (DWR, USGS)
- Particle tracking modeling (DWR, USGS, SFSU)

Regional effects?

- Trends affecting salvage (USGS, DWR)
- Regional comparisons of fish health, growth and origin (UCD, DFG, FWS)

Do these changes have population-level effects?

- Population modeling (UCD, SFSU, LSU)
- Statistical analyses (USBR, consultants, USGS)
- Entrainment "mass balance" (SFSU, USGS)

FOOD SOURCES

FISH
ABUNDANCE



Trends in the Pelagic Food Web

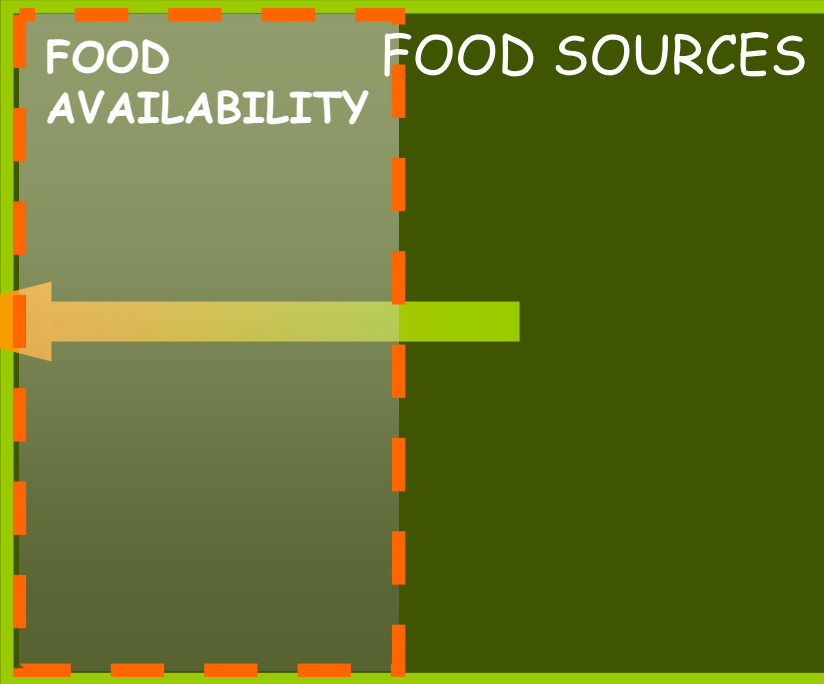
Phytoplankton

- Chlorophyll levels very low compared to other estuaries.
- Long term declines.
- But: No evidence of a recent decline in the Delta.

Zooplankton (fish food species)

- Plankton levels low compared to other estuaries.
- Long term declines.
- An apparent recent decline in key nursery region (Suisun Bay and the west Delta)

FISH
ABUNDANCE



Food Web Disruption Hypothesis

Recent Trends

Expansion in the range of the clam
Corbula



Food web
disruption



Decline in zooplankton
(calanoid copepods) in key
nursery habitat



Population Level Effects of Reduction in Food Supply

Kimmerer (2002)

Invasion of clam in 1987 led to step changes relationships between flow and fish abundance.

New analyses (Kimmerer, Miller)

- Prey occurrence is a good predictor of whether delta smelt survive from summer to fall.

Major Food Web Questions

 What are the major trends in the food web?

 What caused the food web effects?

 How big were the population-level effects?

Major Food Web Questions

- What are the major trends in the food web?
 - Clam biomass (DWR,USGS)
 - Zooplankton population trends (SFSU, DWR)
 - Phytoplankton trends (UCD, DWR, USGS, SFSU)
- What caused the food web effects?
 - Effects of species introductions and environment on food web (SFSU, UCD, USGS)
 - Clam salinity tolerance and grazing effects (SFSU)
- How big were the population-level effects?
 - Fish population modeling (SFSU, UCD, LSU)

Upcoming Major Reports

-  Agency Director Briefings (Continuous)
-  CALFED Science Conference (October 2006)
-  IEP Annual Meeting (February 2007)
-  American Fisheries Society National Meeting
(September 2007)
-  POD Synthesis Report (October 2007)

Questions?

