



Smelts, smolts & splittail: declines, drought & the Delta

Peter Moyle

Center for Watershed Sciences

UC Davis

Calhoun Cut, April 2013



Take-home messages

- Native fishes adapted for droughts
- CA in perpetual drought for native fishes
- ‘Natural’ drought makes things worse.
- Delta is increasingly a hostile environment for native fishes, but not all.
- Big problems require big solutions.

Native fishes are drought adapted

- Physiological tolerances
- Life history adaptations
- Mobile (many)
 - Salmon
 - Sturgeon
 - Lampreys
- Use refuges
 - Spring-fed streams
 - Upstream reaches
 - Large rivers

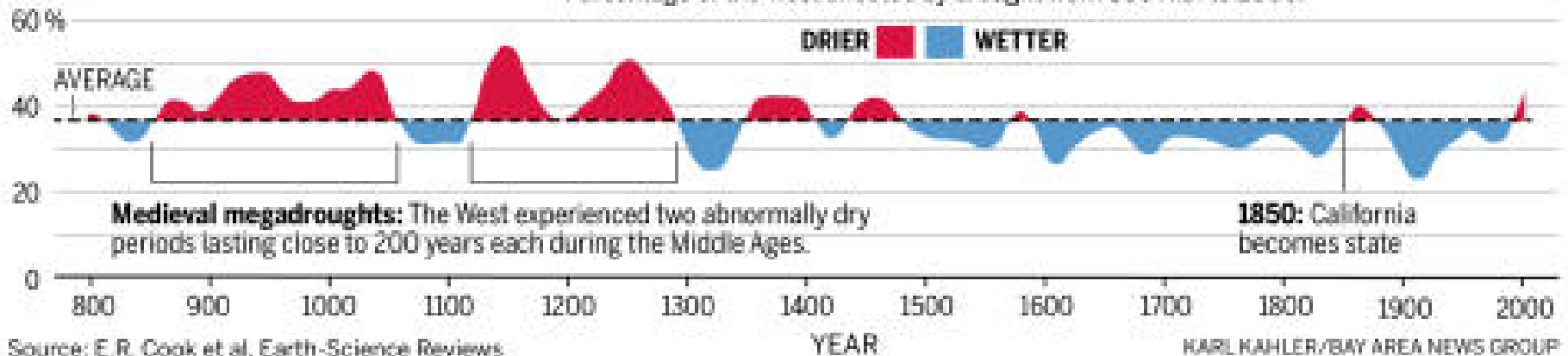


See Moyle 2002

Native fishes have survived long-term droughts

A 200-year drought?

Evidence from tree rings shows that drought was historically much more widespread in the American West than now, while the 20th century was wetter than normal. Percentage of the West affected by drought from 800 A.D. to 2000:



Ingram and Malmud-Roam 2013. West without Water, UC Press

California is in perpetual drought from native fish perspective

- Streams dewatered, warmer
- Dam block access to refuges
- Competition from alien species
- Real drought makes conditions worse



Native fishes in decline statewide

63 species

“Fish Species of Special Concern in California.” 2015 CDFW

30 species

listed under state and federal ESAs

93/122 extant species need

protection

General Causes of Decline

- Habitat alteration
- Alien invasions
- Natural environmental variation
 - Drought



=



Native Delta Fishes

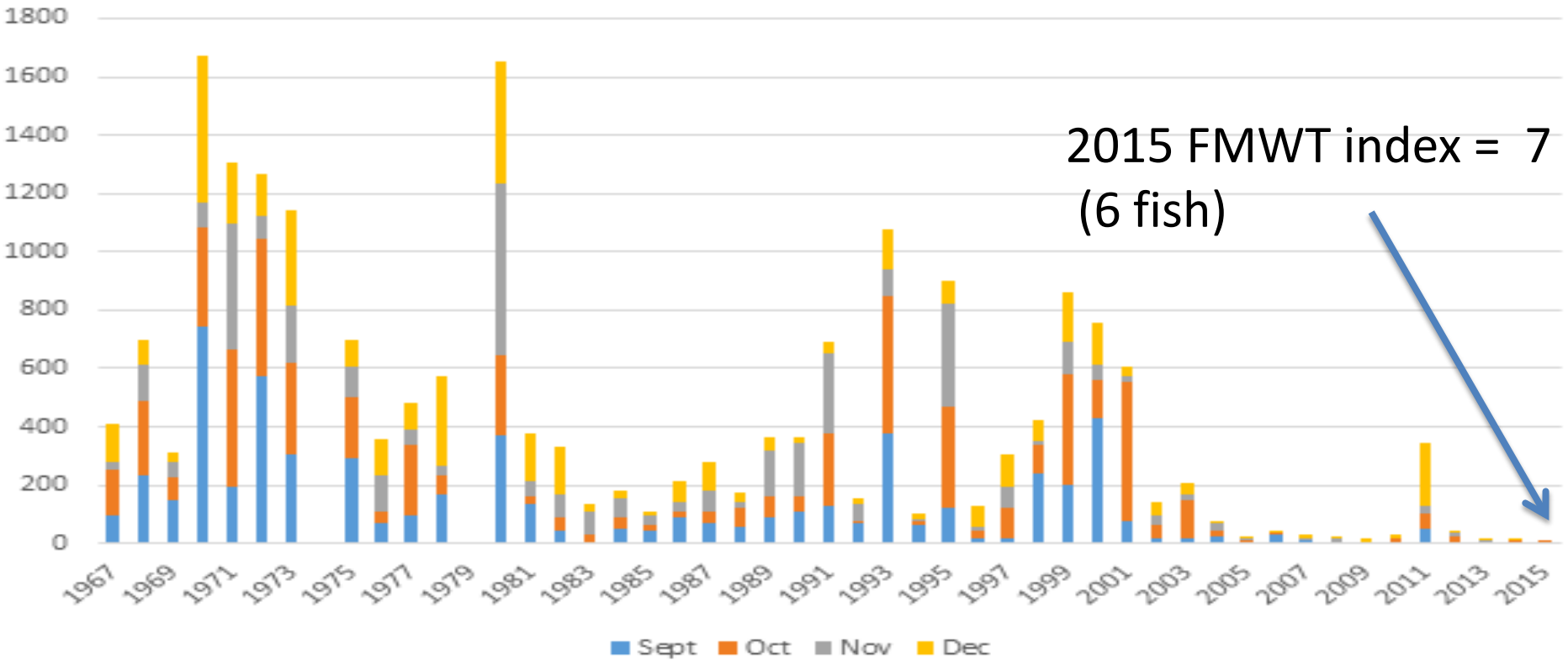


Delta smelt: extinction in wild is likely



Graph by Tom Cannon

Delta Smelt Midwater Trawl Survey



Thicktail chub

Globally extinct 1950s



EXTINCTION in Delta

Sacramento perch

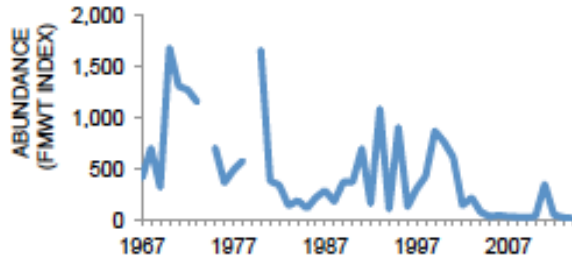
Extinct in Delta,
Native Range 1970s



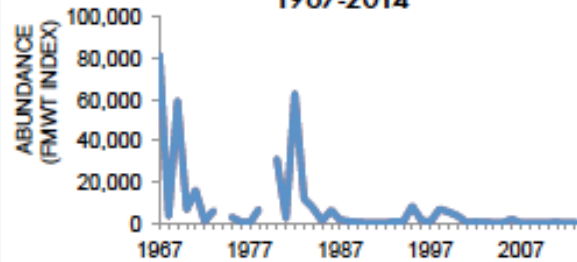
So why are so many species in trouble, especially in Delta

COLLAPSE OF SPECIES ACROSS MULTIPLE TROPHIC LEVELS

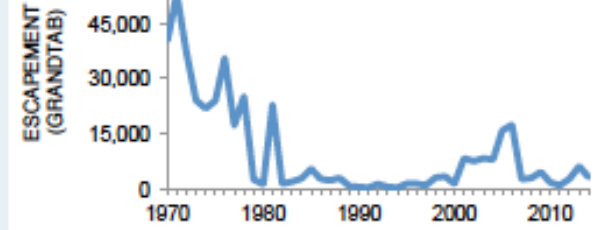
**DELTA SMELT
1967-2014**



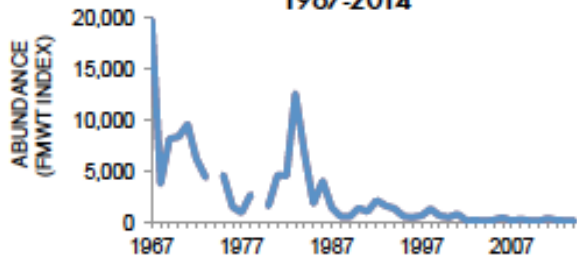
**LONGFIN SMELT
1967-2014**



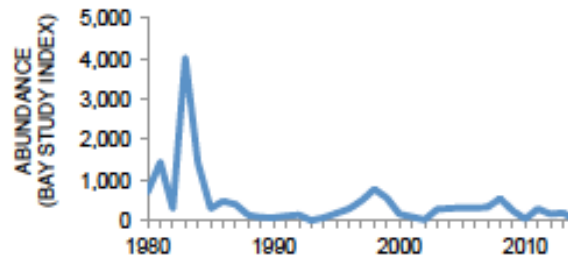
**WINTER RUN CHINOOK
1970-2014**



**STRIPED BASS, AGE 0
1967-2014**



**STARRY FLOUNDER, AGE 1
1980-2014**



**HIGH VALUE ZOOPLANKTON
1974-2013**

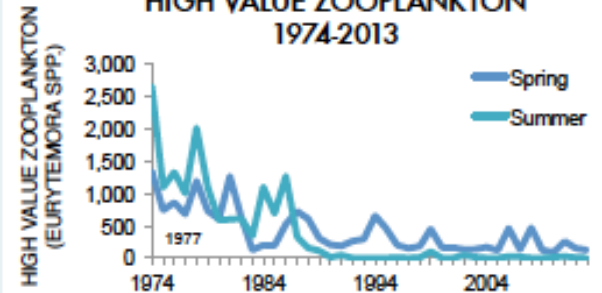


Figure 10: Abundance trends of several populations that serve as key indicators for the health of the San Francisco Bay estuary and its watershed. Data sets and length of data time series differ across species.

1440

'large' dams
(1.8+ m)

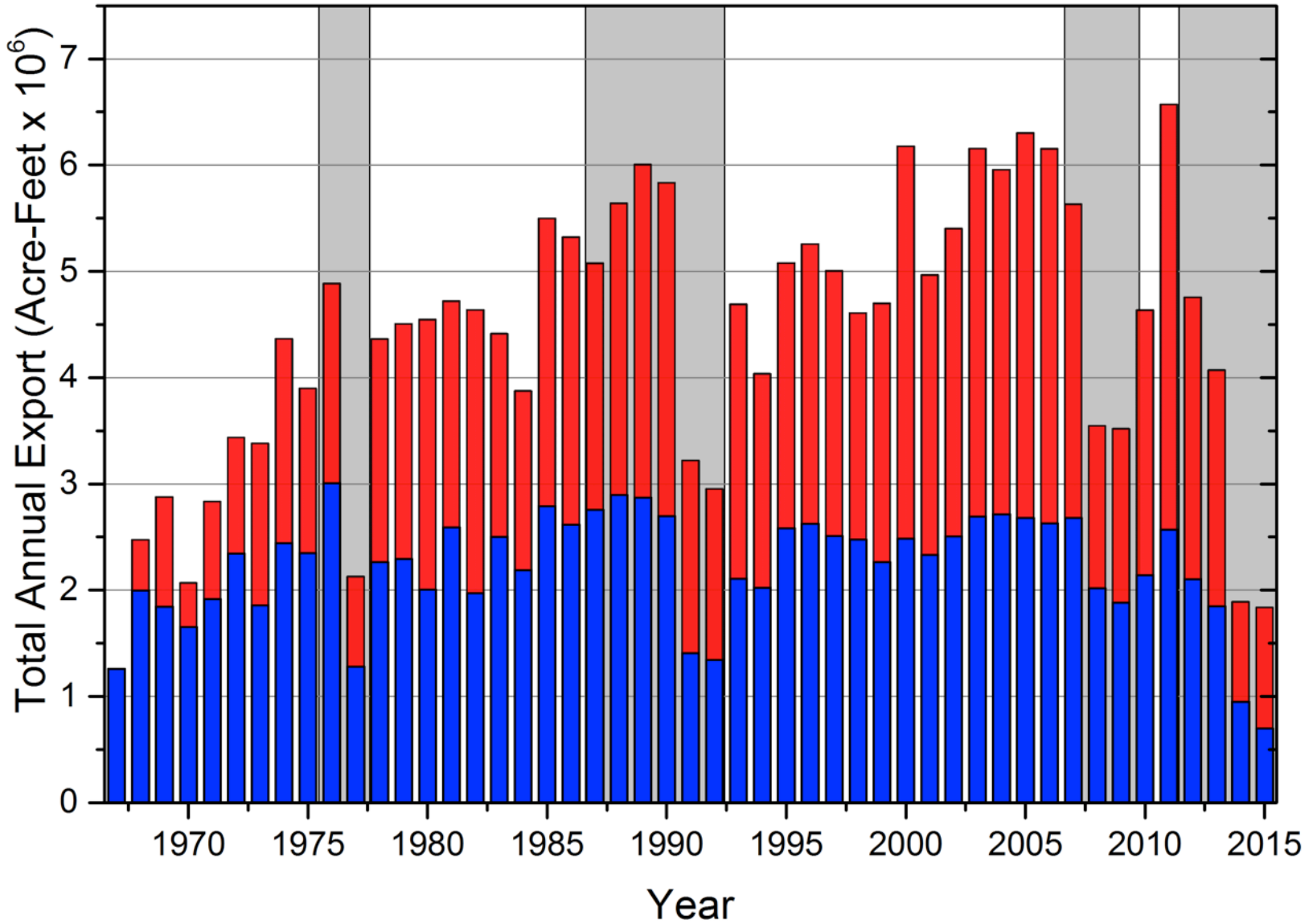
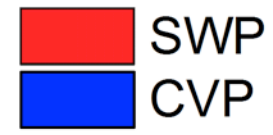
INFLOWS REDUCED

Grantham et al. 2014

Figure 1.1 Dams in the state of California.

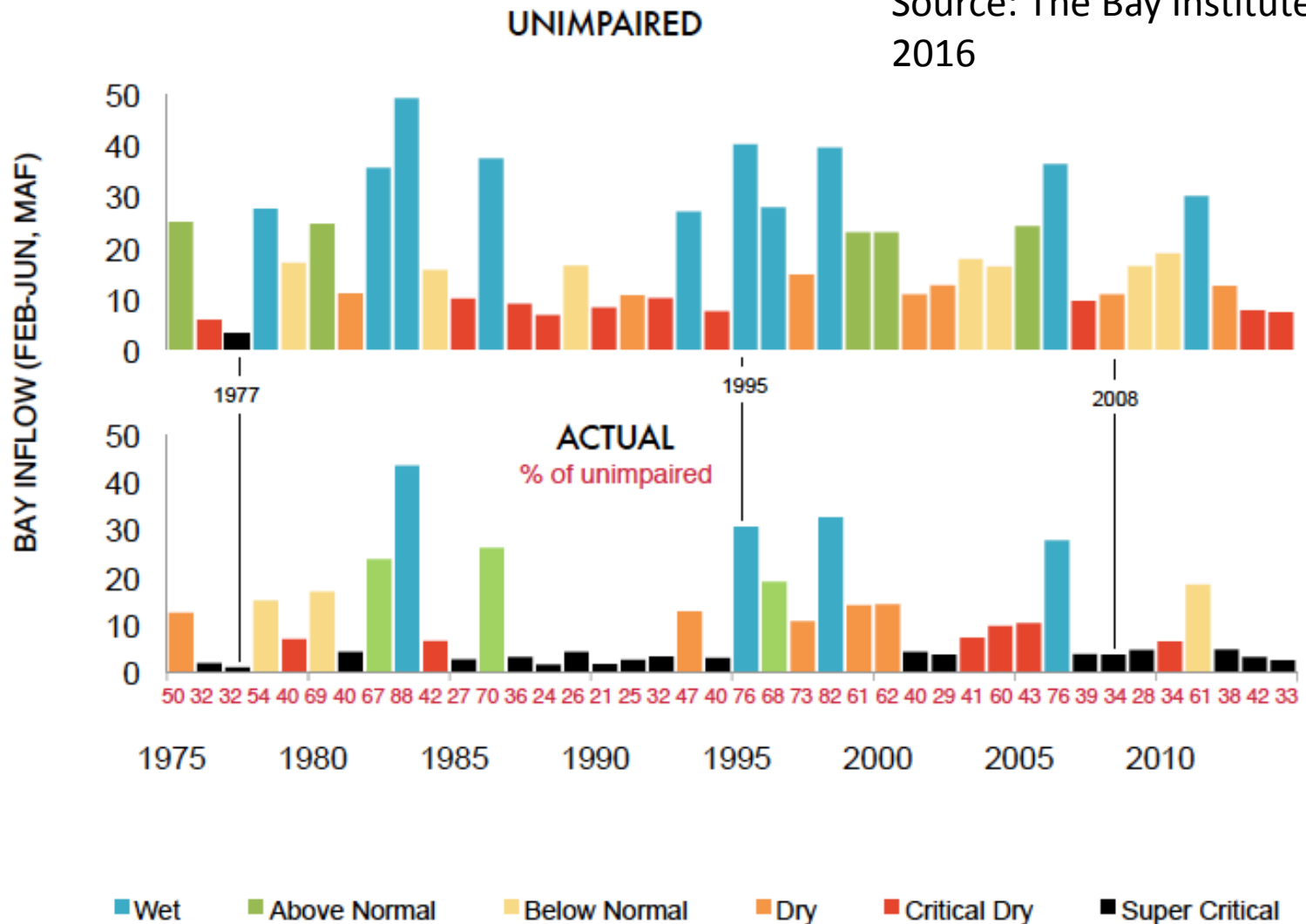


Exports from South Delta



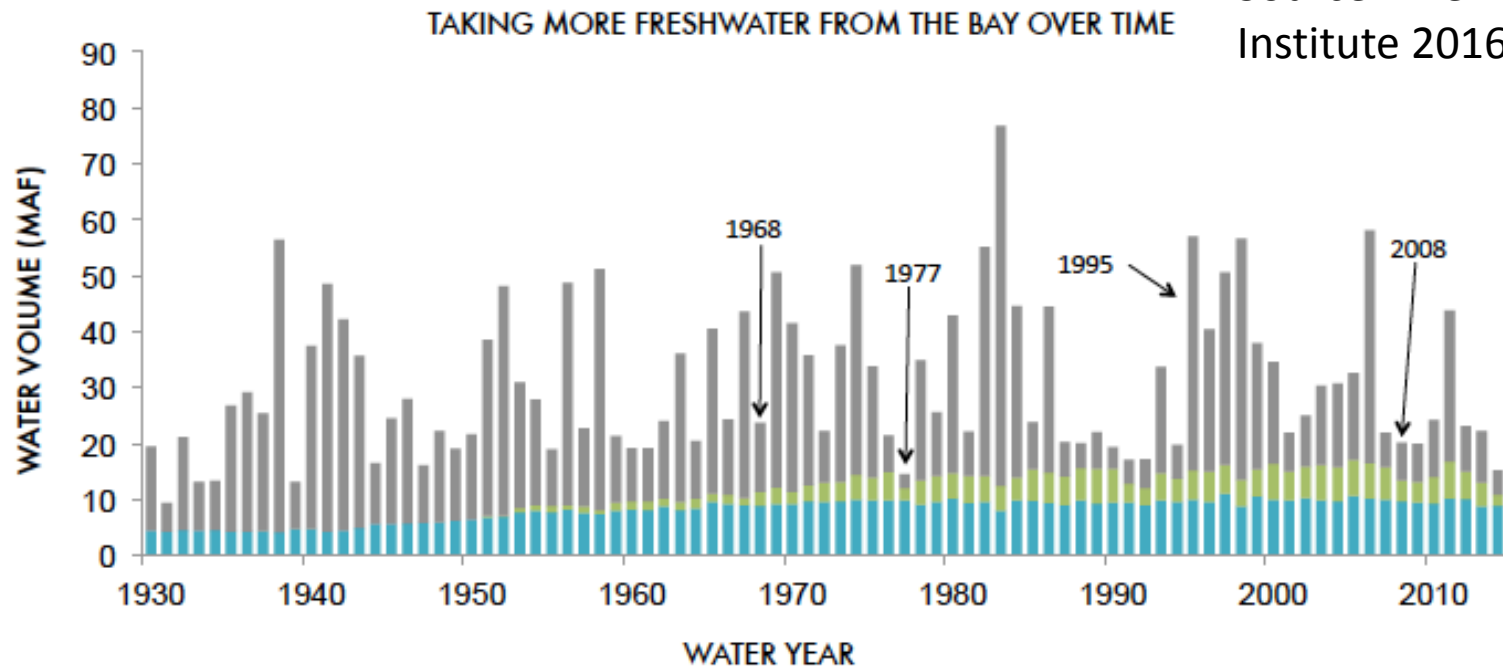
Delta outflows greatly reduced: More drought conditions

Source: The Bay Institute
2016

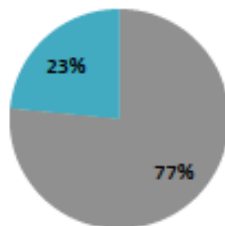


Reduced freshwater outflows

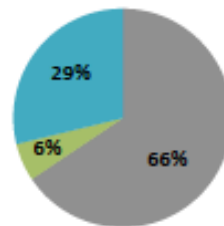
Source: The Bay Institute 2016



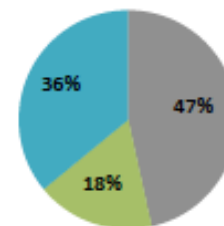
1930 - 1949



1950 - 1974



1975 - 2014



- Bay Inflow
- Delta Exports
- Upstream Diversion

Drought in Delta: making existing conditions worse

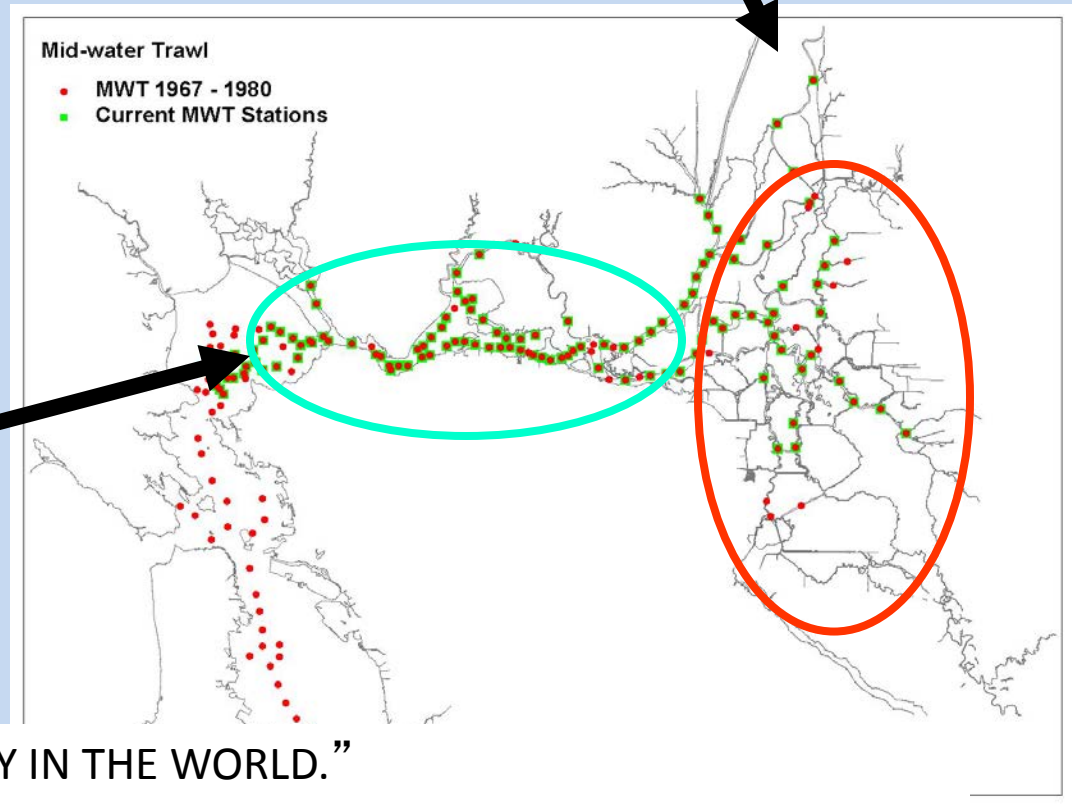
- Less fresh water in system (mostly)
- Changed hydrology
 - Cross Delta 'flows'
- Changed water quality
 - Higher clarity
 - Less food
 - Saltier in places
 - Warmer
- Spread of non-native species

Drought spreads alien invaders

Brazilian waterweed



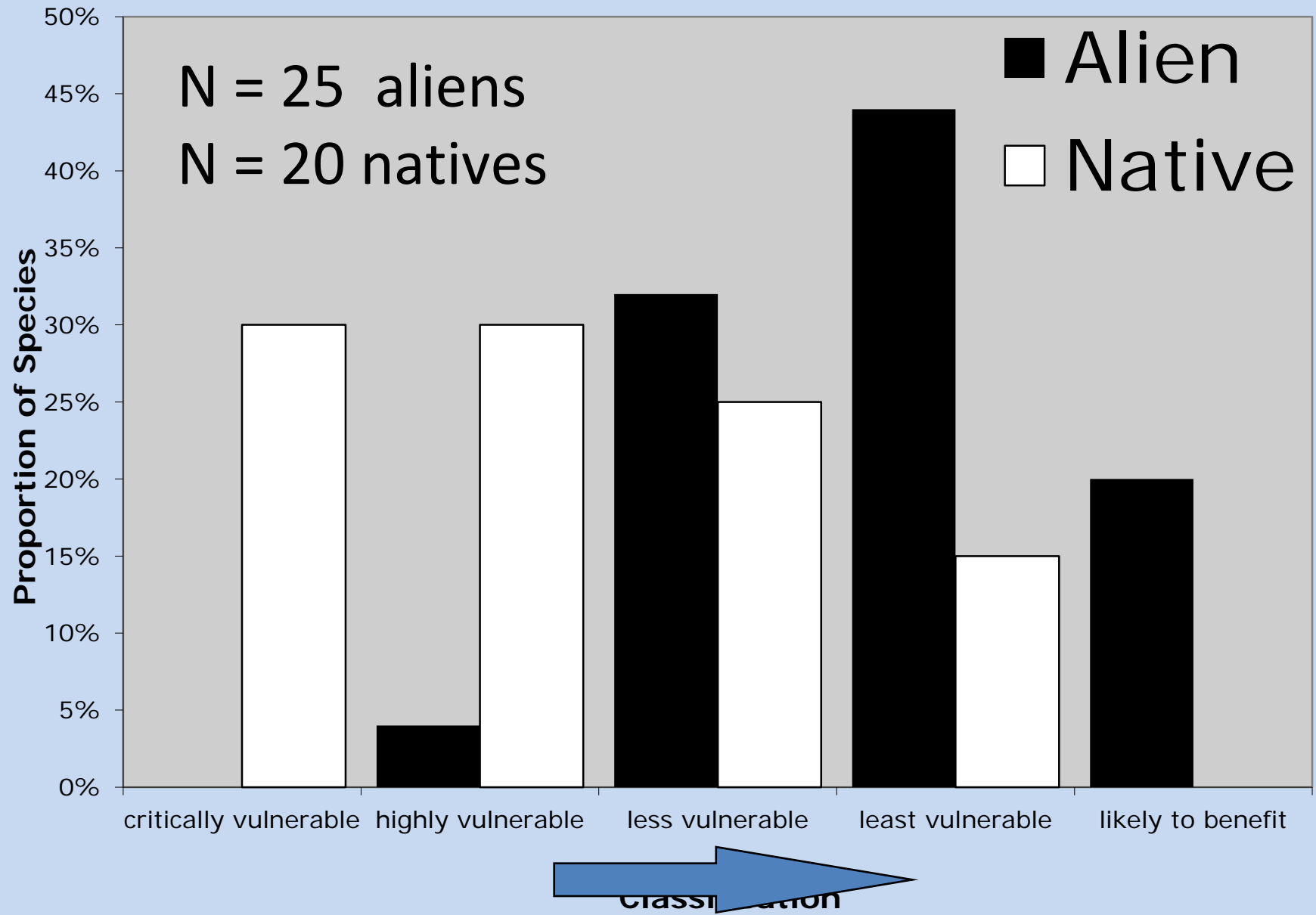
Overbite clam



“MOST INVADED ESTUARY IN THE WORLD.”

Climate change vulnerability: Delta fishes

Drought hastens this change



What can we do?

- Provide more fresh water
- Habitat restoration/improvement
- Manage Suisun Marsh as refuge?
- Rethink the Delta

Provide More Fresh Water?

Headlines

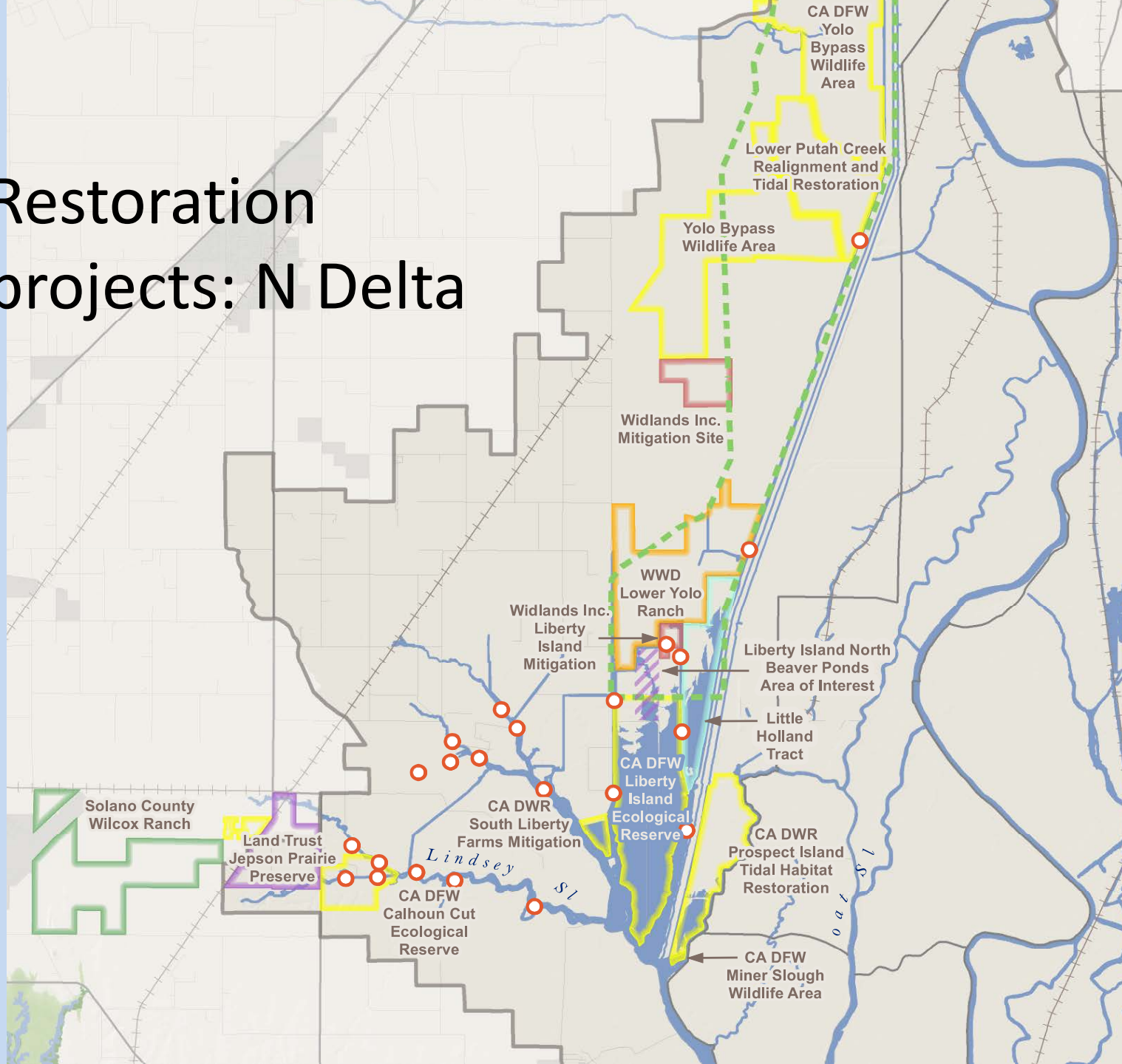
- California River will begin flowing year around for the first time in 60 years - LA Times 10/20/16
- First step taken on setting Sacramento River flows - Chico Enterprise 10/21/16
- Regulators propose leaving more water in California Rivers SF Chronicle 10/23/16

An aerial photograph of a tidal marsh restoration project. The landscape is dominated by brown, textured vegetation, likely marsh grasses, interspersed with a network of winding, light-colored waterways. The waterways are irregular and meandering, creating a complex pattern across the terrain. In the upper left corner, there is a distinct, rectangular area of greyish-brown, possibly a different type of vegetation or a cleared area. The overall scene depicts a natural, restored wetland environment.

Habitat restoration

Tidal marsh 'restoration' is important but not a panacea for native fish recovery.

Restoration projects: N Delta



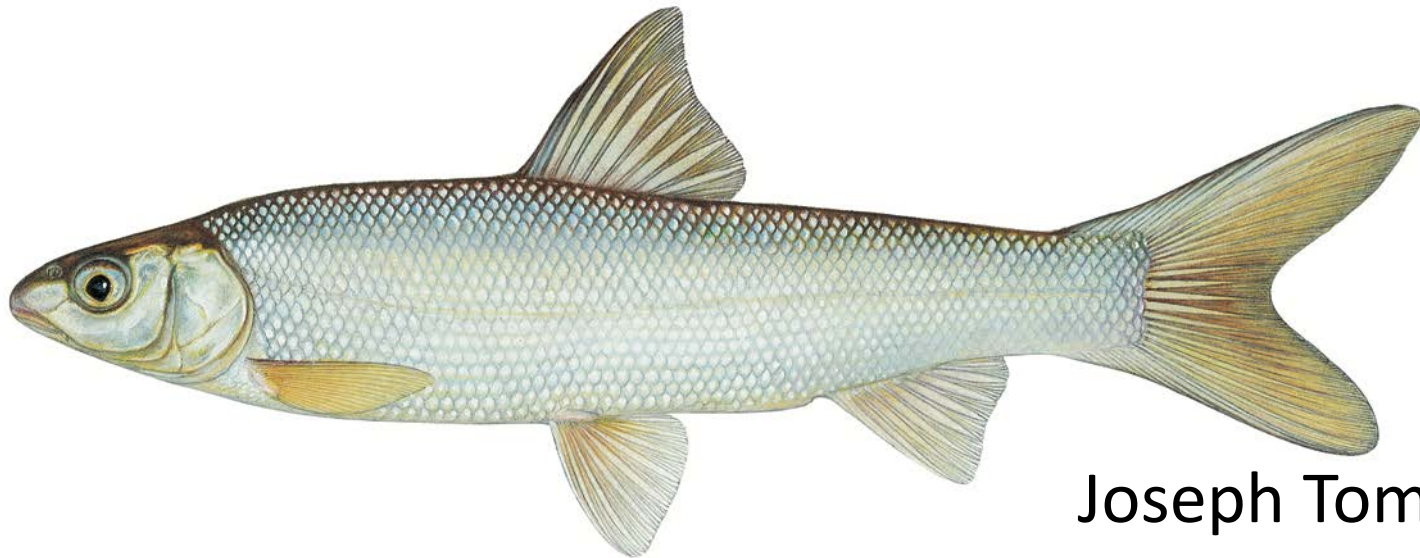
Integrate functional floodplains into the Delta



Cosumnes River floodplain



Splittail: benefits of floodplain restoration



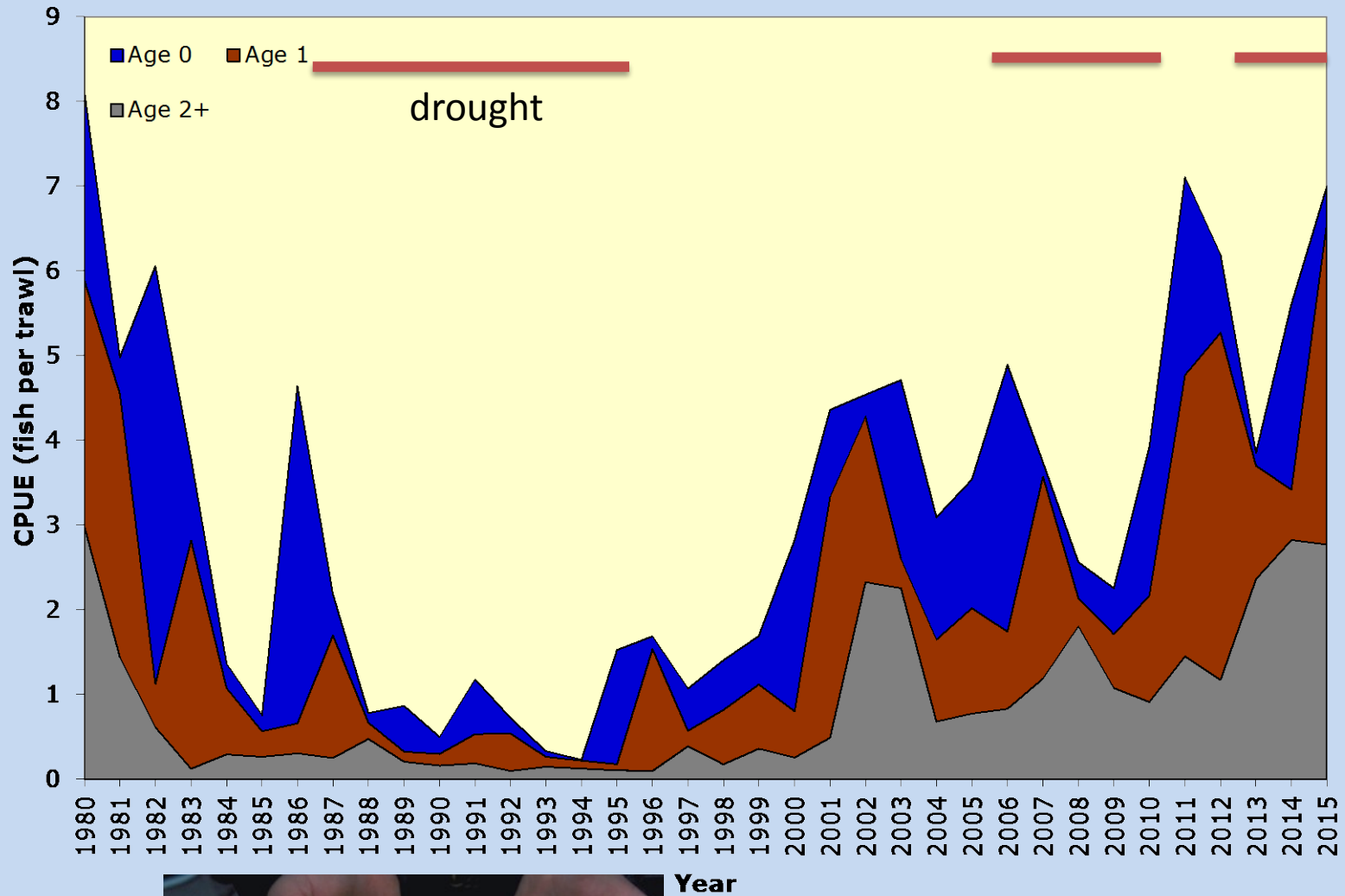
Joseph Tomelleri

Spawn on floodplains January- March

Juveniles carried downstream

Rear in Suisun Marsh

Splittail – Suisun Marsh



Year

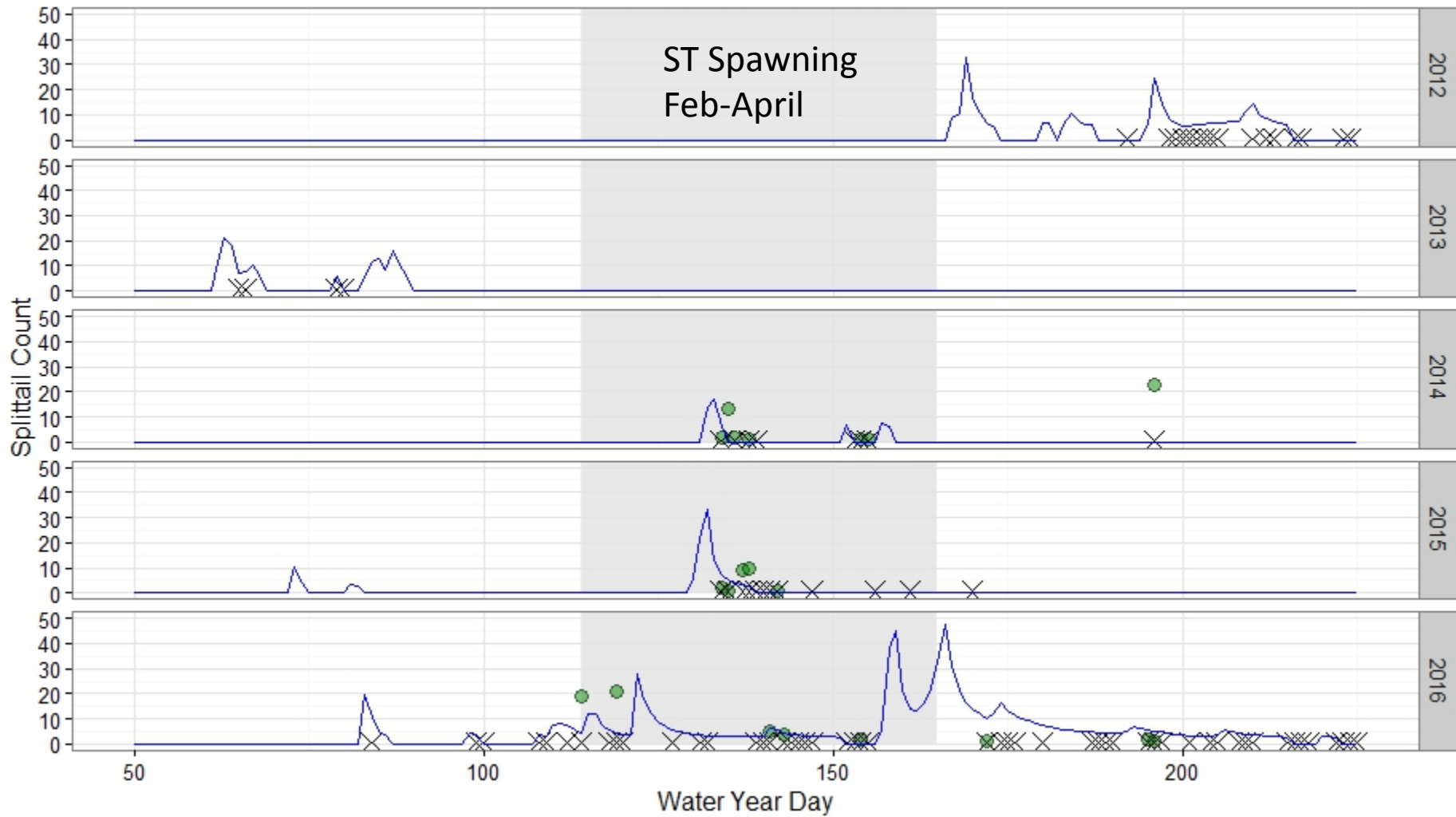


Cosumnes
River
Floodplain
January, 2016



Flooding during drought: Cosumnes River

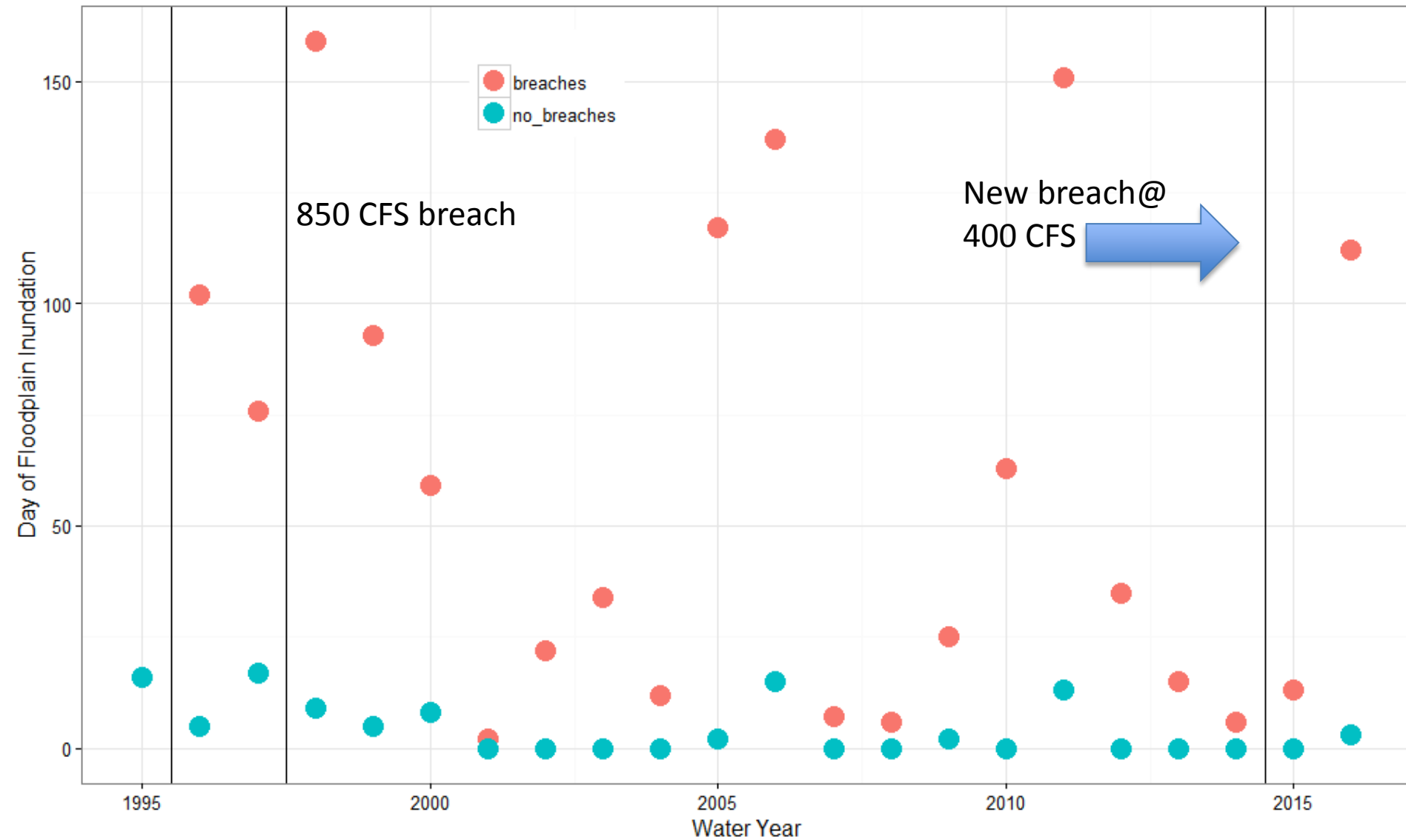
Splittail Daily Count on Floodplain



“Timing is everything” Carson Jeffres

Cosumnes River Floodplain: days of flooding

Flood Days With and Without Levee Breaches



Green dots: days of flooding if breaches not present

Integrating functional floodplains into the Delta in good for splittail and salmon!



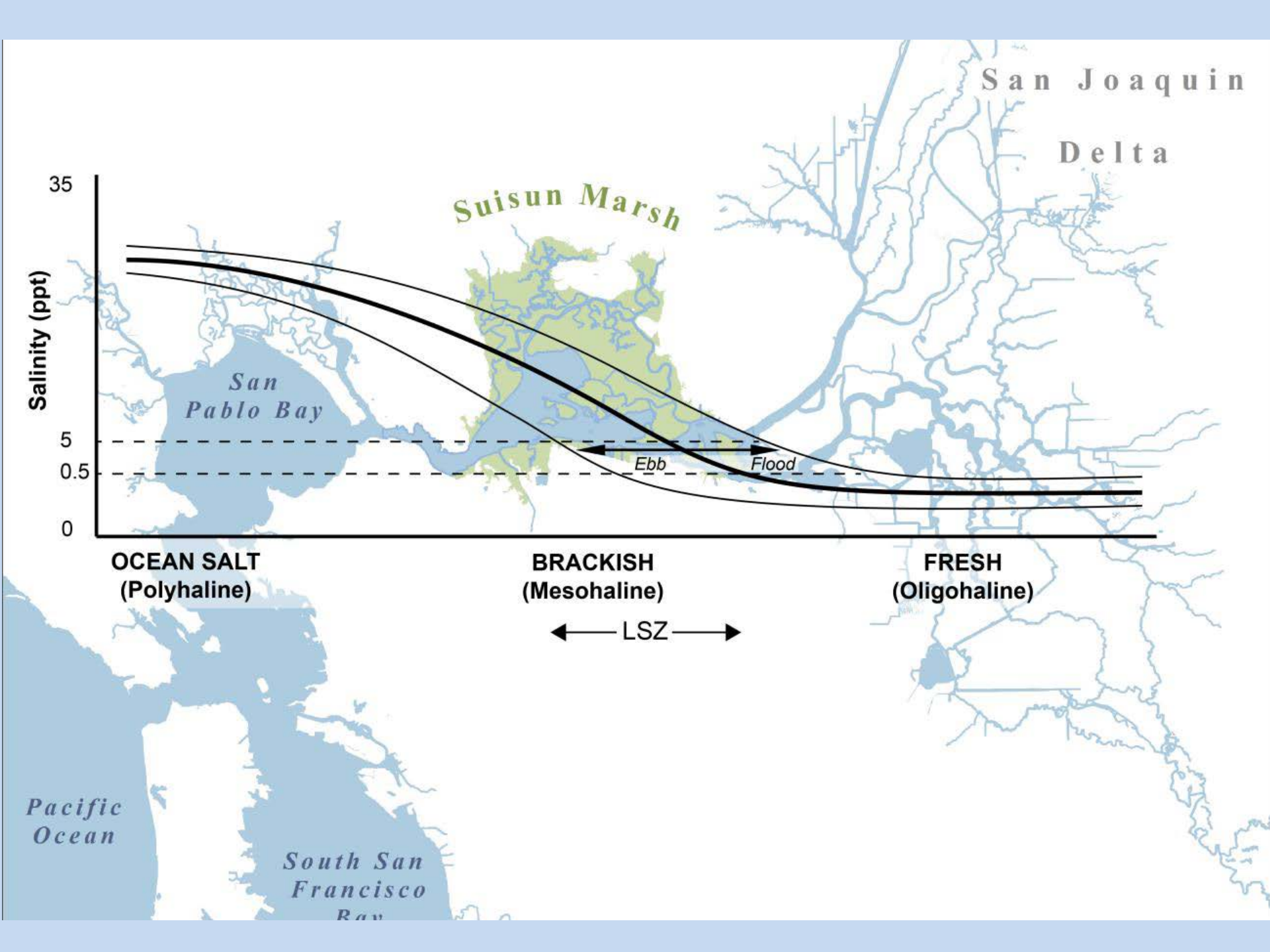
salmon!

Cosumnes River floodplain



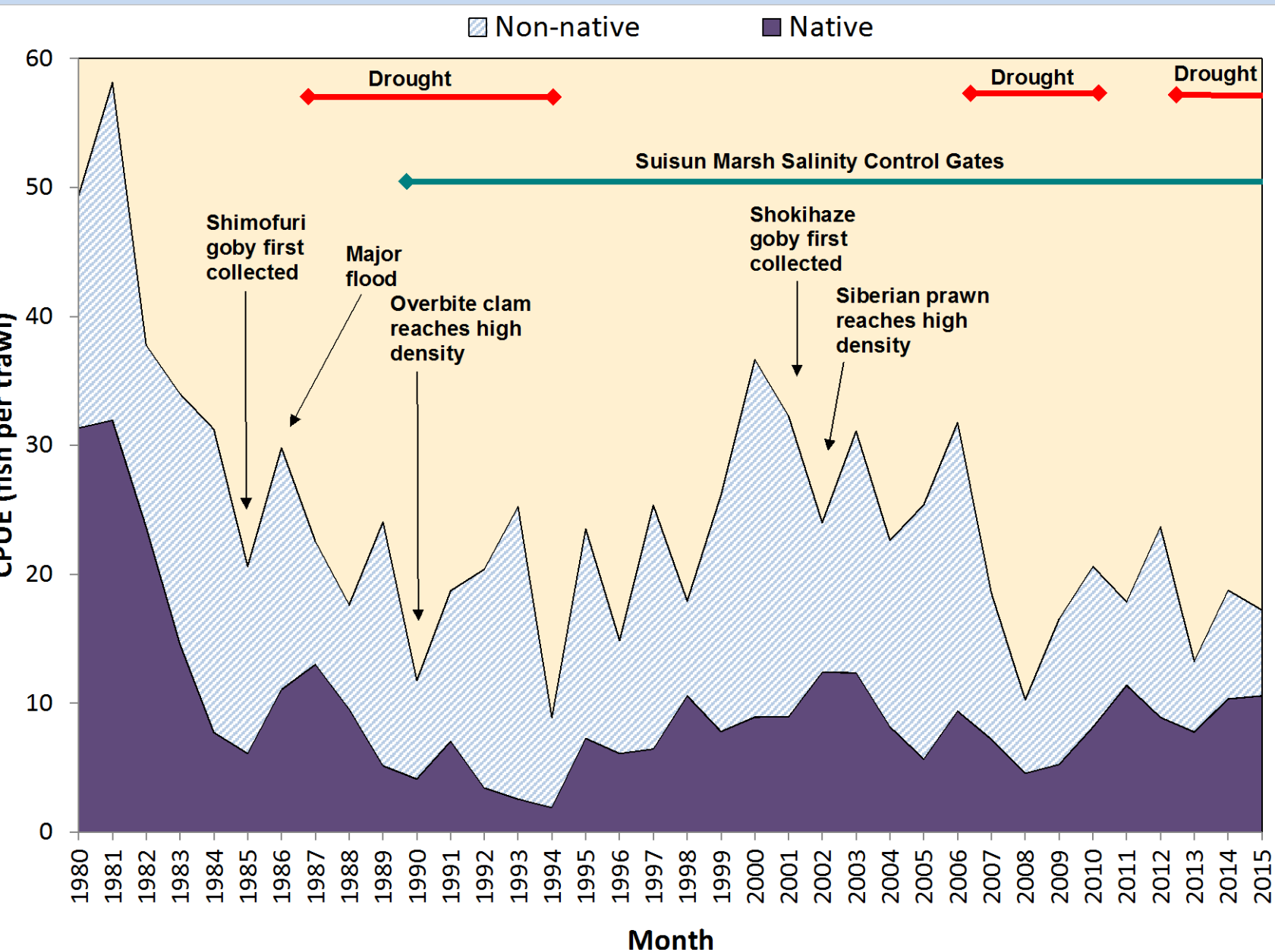
Suisun Marsh: refuge for desirable fishes?





Suisun Marsh: tidal gates



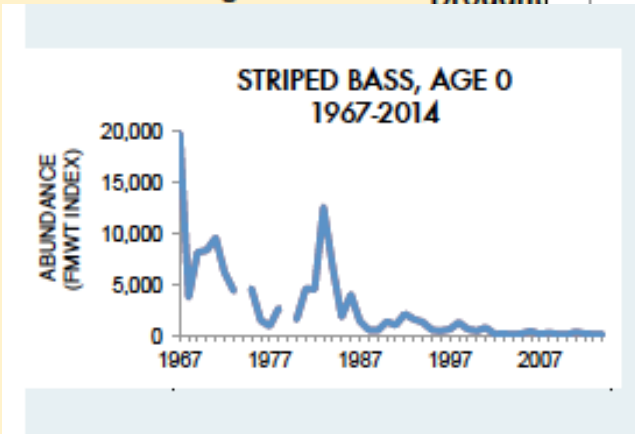


Striped Bass

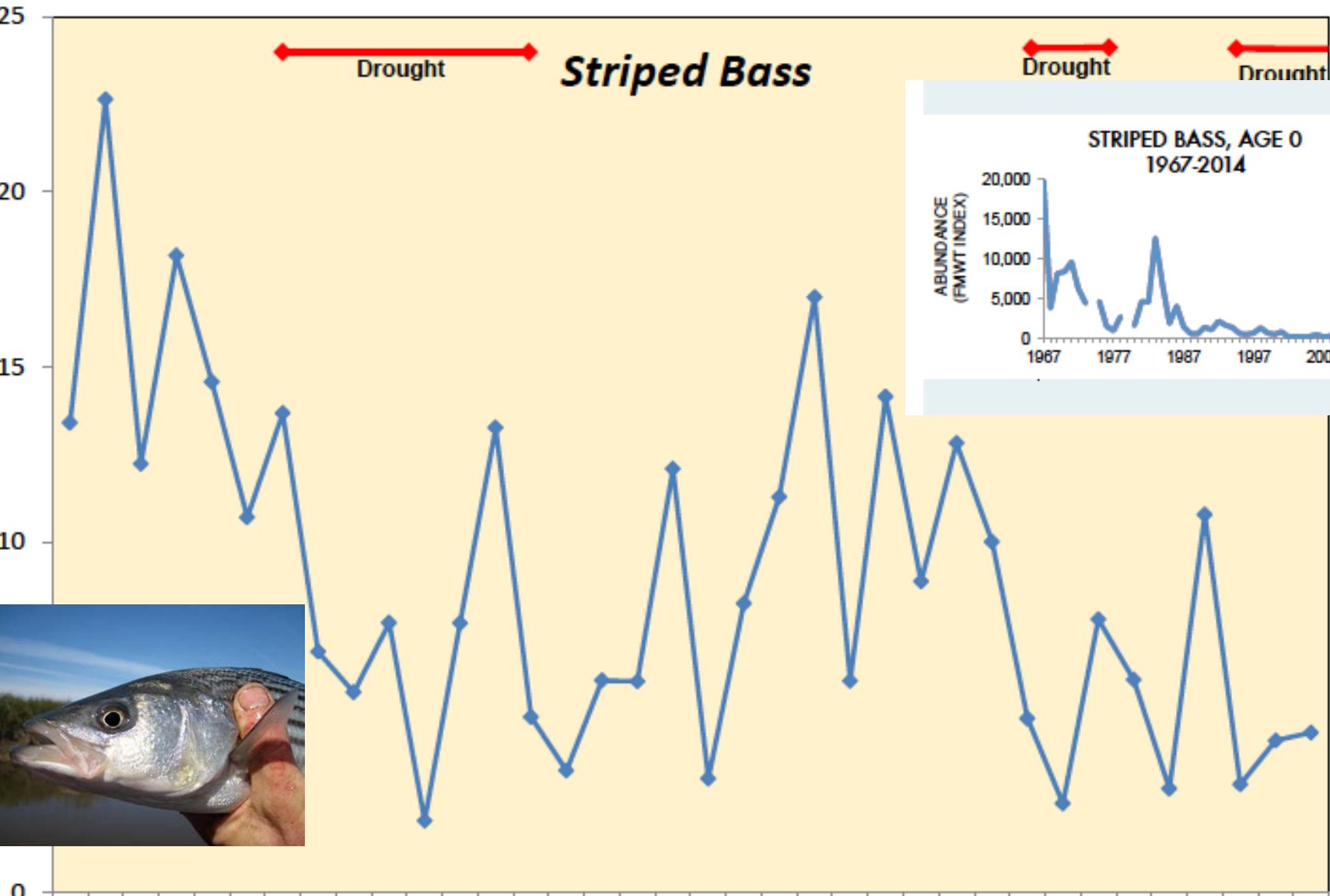
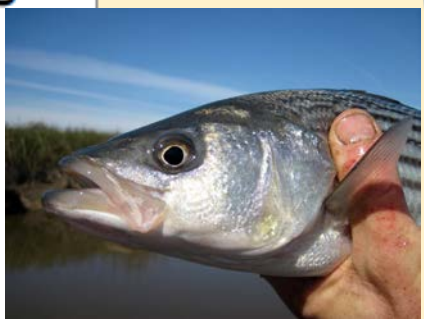
Drought

Drought

Drought

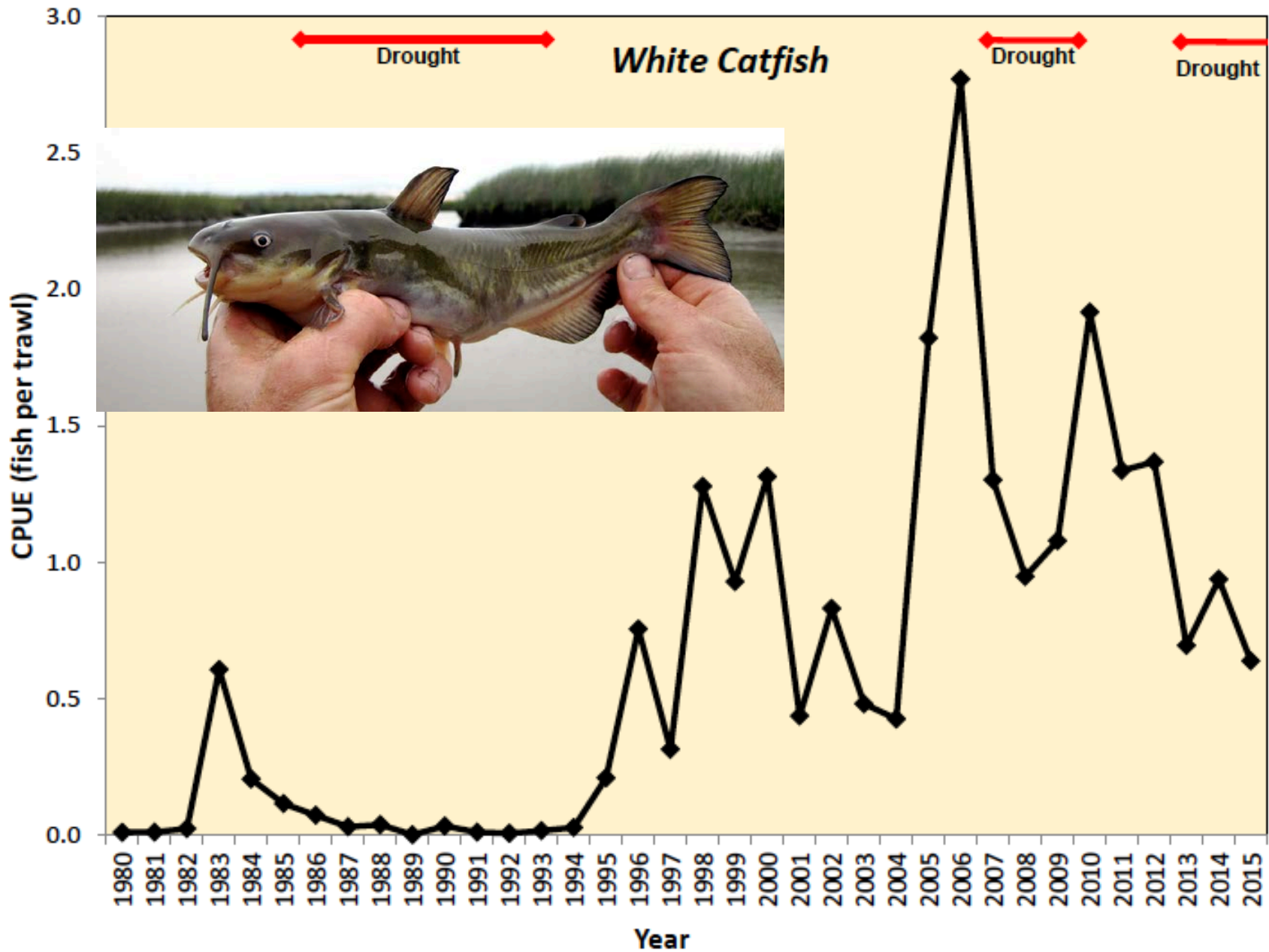


CPUE (fish per trawl)



Year

1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015





Suisun Marsh: Ecological History and Possible Futures

Peter Moyle
Amber Manfree
Peggy Fiedler

University of California Press 2014

Suisun Marshes
ca. 1900 William F. Jackson
Courtesy Crocker Art Museum

What can we do?

- Provide more fresh water
- Habitat restoration/improvement
- Manage Suisun Marsh as refuge?
- Rethink the Delta

Rethinking the Delta



North Delta Habitat Arc



Take-home messages

- Native fishes adapted for droughts
 - But need some good times as well
- CA in perpetual drought for native fishes
- ‘Natural’ drought makes things worse.
- Delta is increasingly a hostile environment for native fishes (but not all)
- Big problems require big solutions.
 - Suisun Marsh
 - North Delta Habitat Arc

Questions?





REALITY

No reductions in exports for smelt in 2013 or 2014

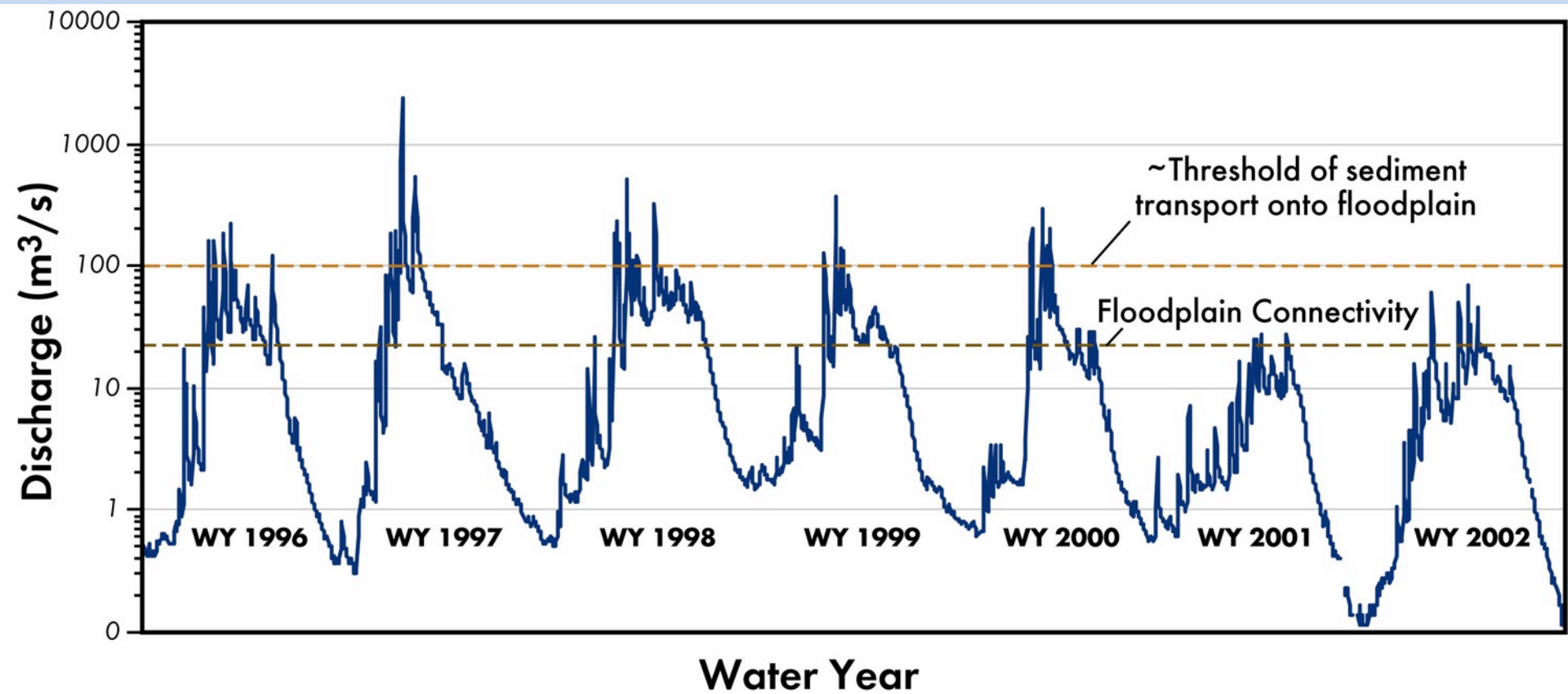
2012-2016 90 days of restrictions (7%)

2015-16 water year so far (9 mo.)

37% of natural runoff made it through the Delta to the sea

0.46% of natural run-off was used to protect delta smelt

1.2% of water entering Delta dedicated to smelt



Cosumnes River flows