

# Drought: the Final Straw for Delta Smelt?



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Department of Water Resources

*Delta and Longfin Smelt: is Extinction Inevitable?*

*March 29, 2016*

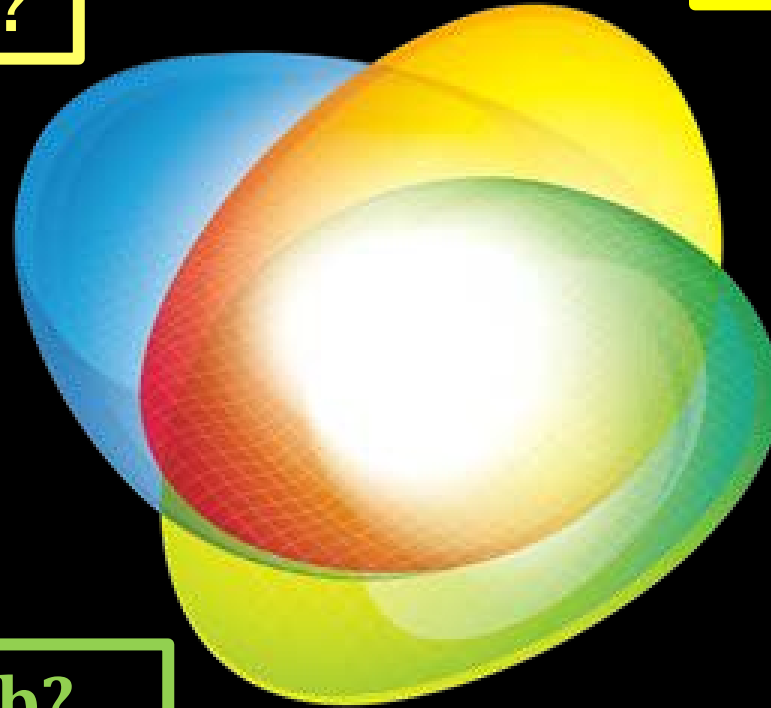
*UC Davis*

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# *Ecosystem Drought Effects?*

**Water Quality?**

**Delta Smelt Responses?**



**Food Web?**

**Clams and Invasive Fish?**

**Tier 1 - Landscape Attributes**



Erodible Sediment Supply, Proximity to Ocean, Proximity to Discharges, Proximity to Diversions, Bathymetry (Proximity to and Extent of Shallow Areas)

**Tier 2 - Environmental Drivers**

Air Temperature, Flows, Turbidity, Contaminant Loading, Water Diversions

Weather, Exports, Hydrology, Turbidity, Contaminants

**Tier 3 - Habitat Attributes**

Food, Predation, Temperature, Entrainment, Toxicity

Food, Predation, Temperature, Transport, Entrainment, Toxicity

**Tier 4 - Delta Smelt Responses**

**Adults**

Spawning

**Eggs & Larvae**

Survival

**Tier 5 - Life Stage Seasons**

December-May  
(Winter)

March-June  
(Spring)

Growth

September-December  
(Fall)

June-September  
(Summer)

Survival

**Subadults**

Survival

Growth

**Juveniles**

Food, Predation, Size and Location of LSZ, Toxicity


Food, Predation, Temperature Harmful Algal Blooms, Toxicity

Weather, Outflow, Turbidity, Clam Grazing, Nutrients, Contaminants

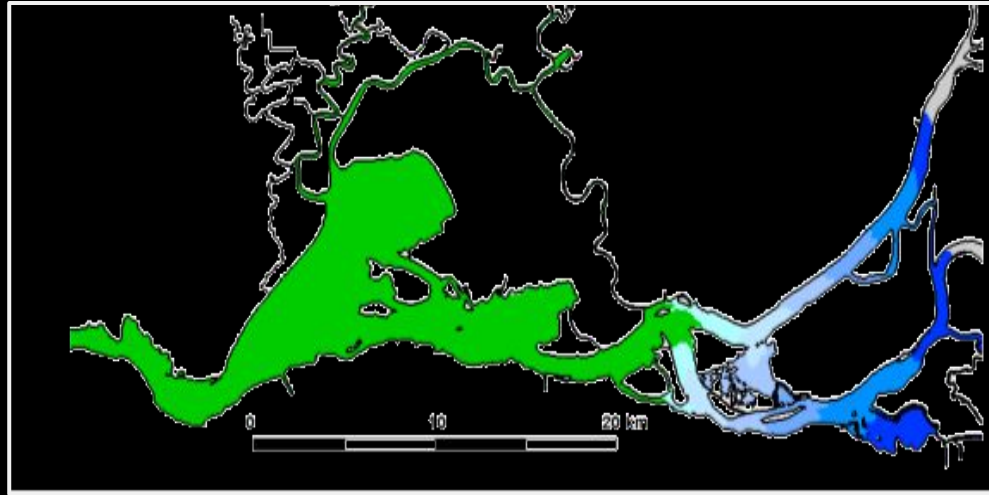
Weather, Hydrology, Turbidity, Clam Grazing, Nutrients, Contaminants



# Delta in Drought = Nitrogen, Weeds, Microcystis, Little Plankton

 **Low Salinity Zone**  
(0.5-6ppt)

 **High Salinity**  
(>6ppt)



Modeled Low Salinity Zone Area,  
Michael MacWilliams,  
Anchor QEA



Nitrogen Concentration  
Microcystis  
Aquatic Weeds  
Largemouth Bass, Silversides



Zooplankton

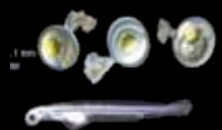


# ***Delta Smelt Drought Response Predictions:***

*Fewer fish, distributed more upstream*

*Constrained life history*

*Poor growth & fecundity*



**Jan - Mar**

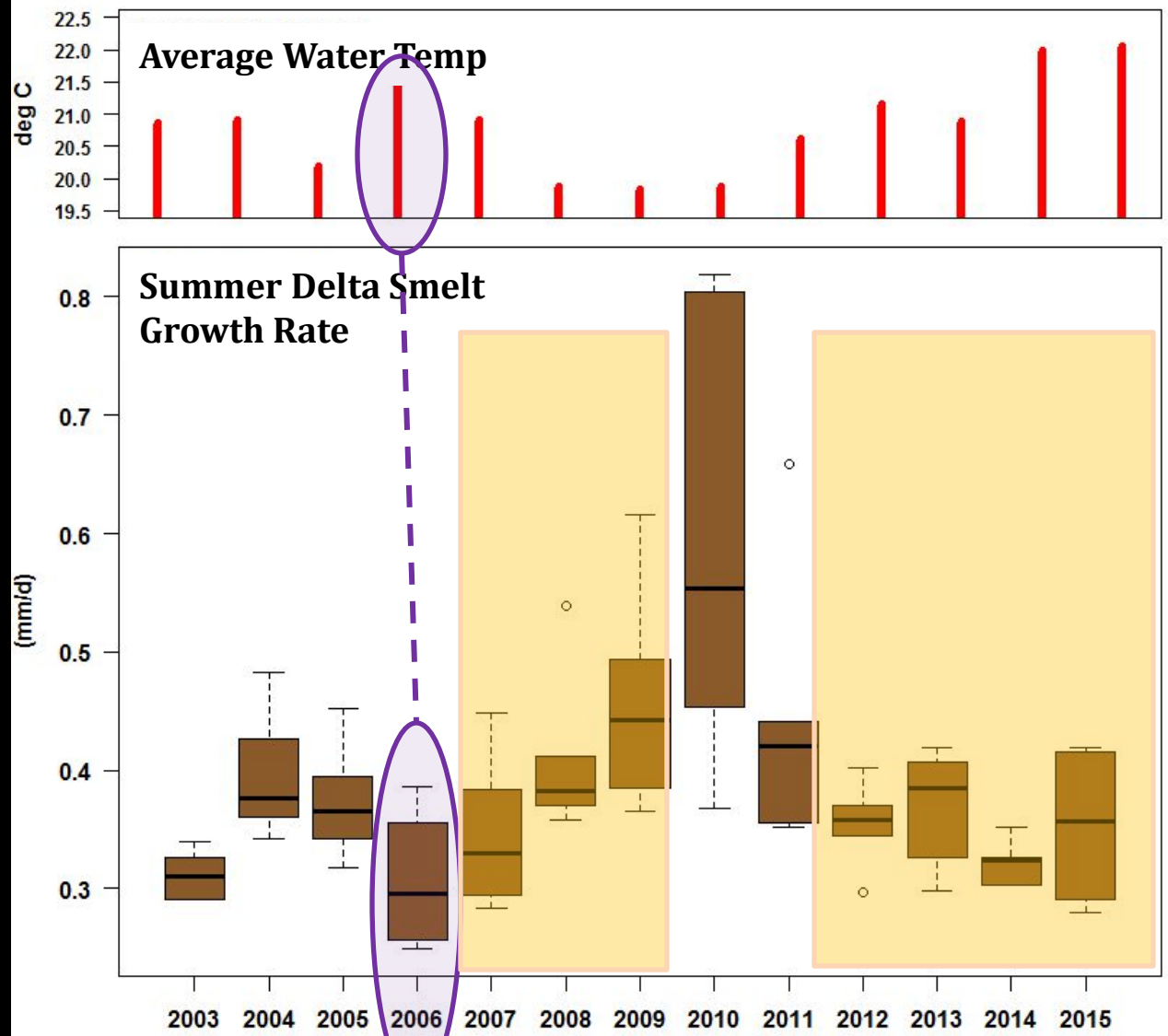
**Apr - Jun**

**Jul - Aug**

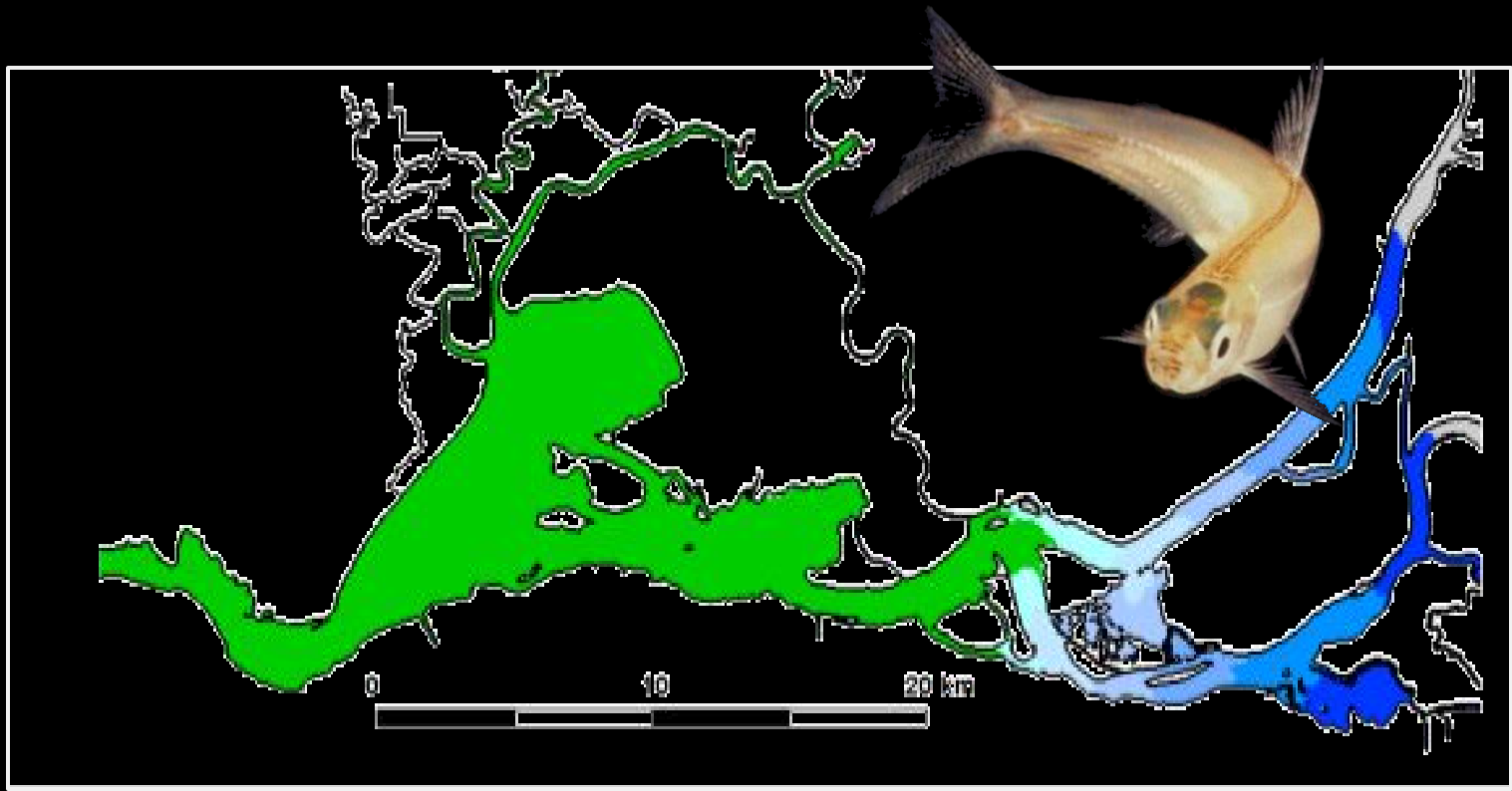
**Sept- Dec**

<b><i>Delta Smelt Responses</i></b>				
<i>Abundance</i>	↓	↓	↓	↓
<i>Distribution</i>	↑ Or ↓	↑	↑	↑
<i>Growth</i>	↓	↓	↓	↓
<i>Fecundity</i>	↓			

# Does drought = poor growth in the summer?



# *What to do if you are a Delta Smelt in DROUGHT?*



Modeled Low Salinity Zone Area, Michael MacWilliams, Anchor QEA



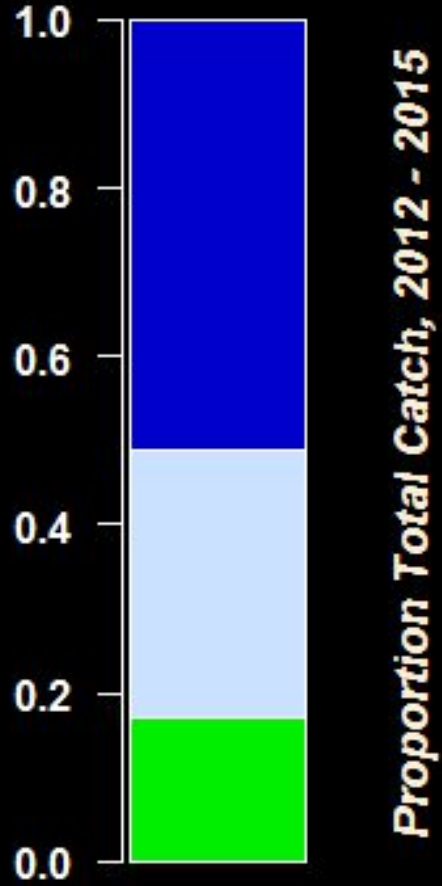
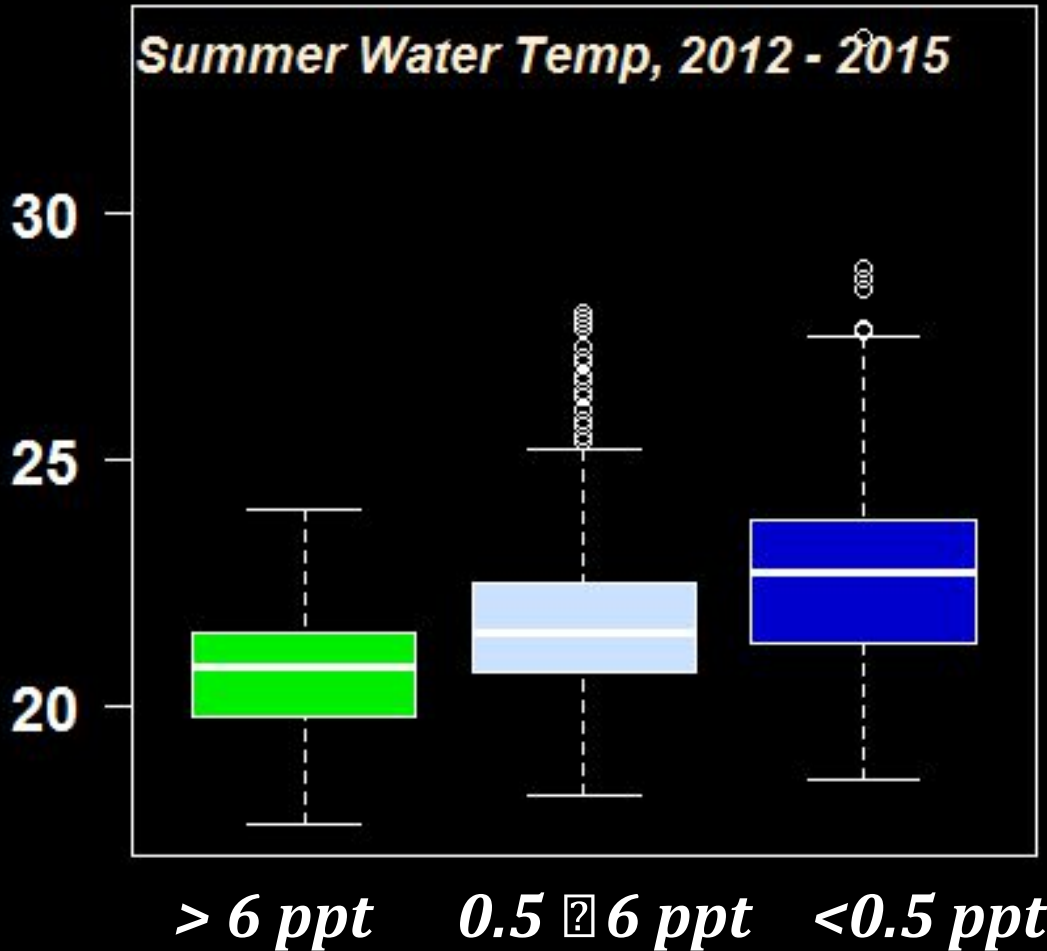
*Find cooler temps?*



*Find refugia upstream?*

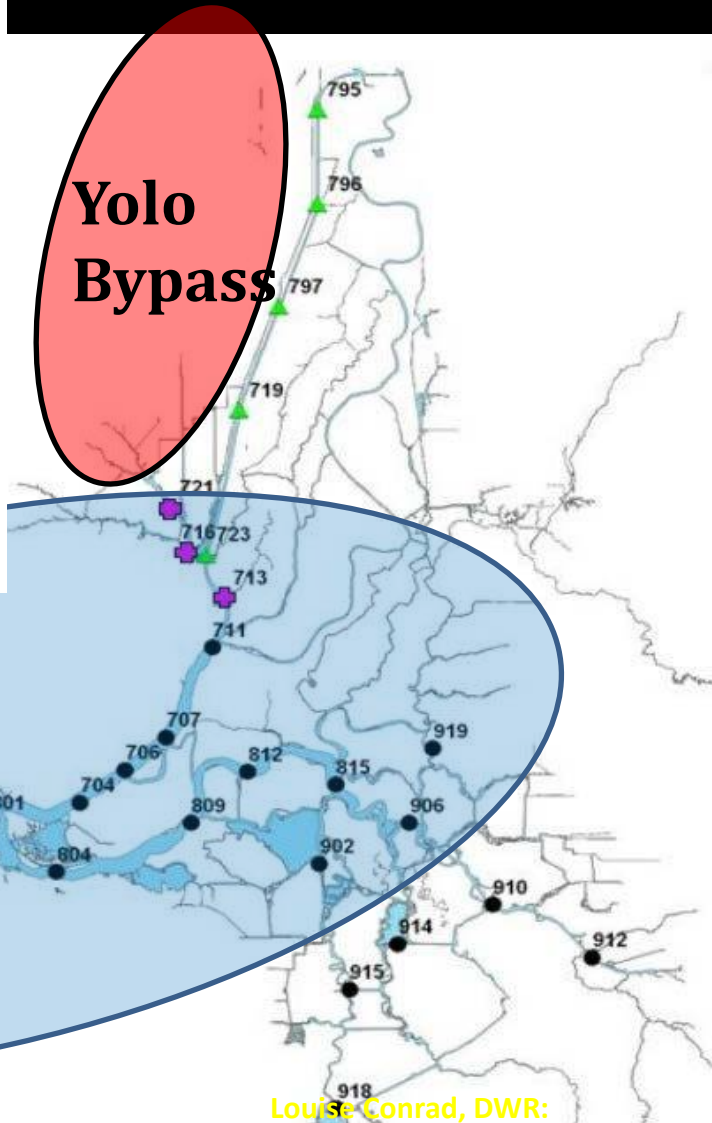
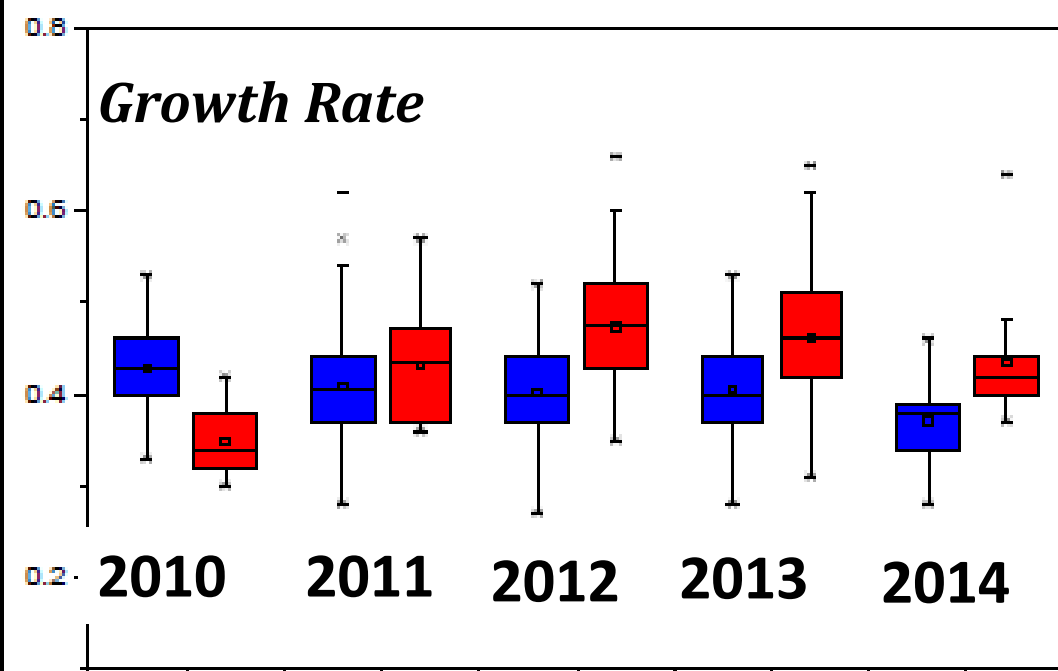


# Delta Smelt in Freshwater despite Warm Temps



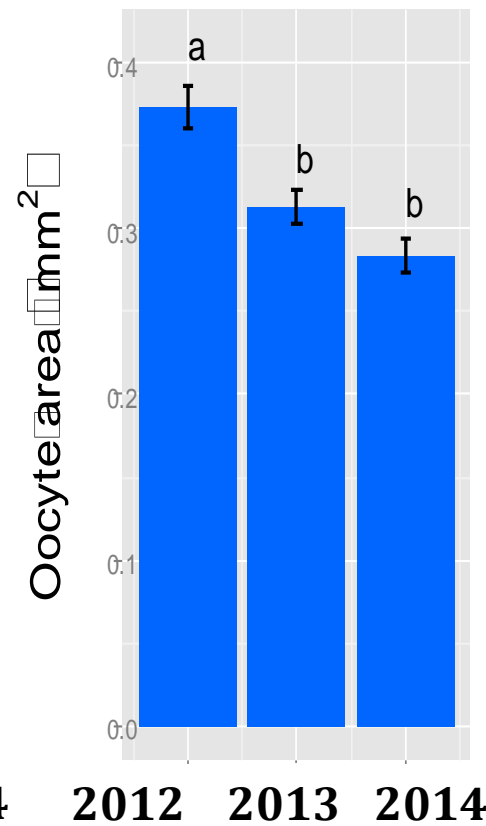
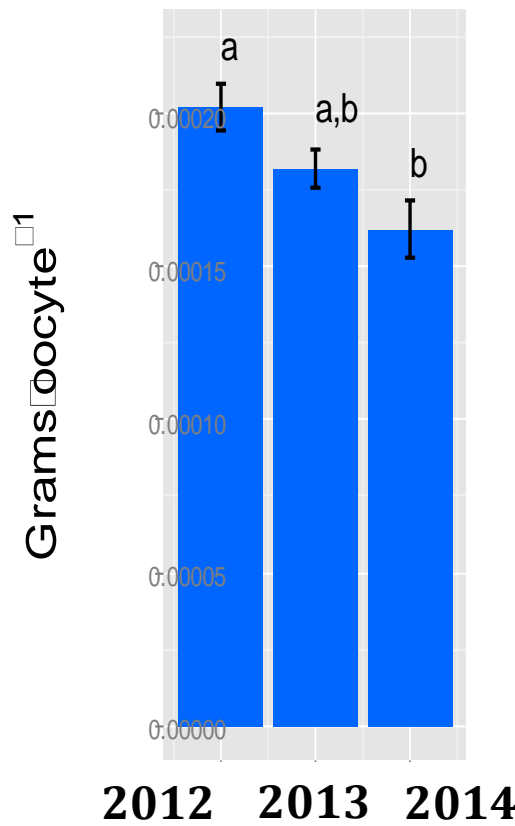
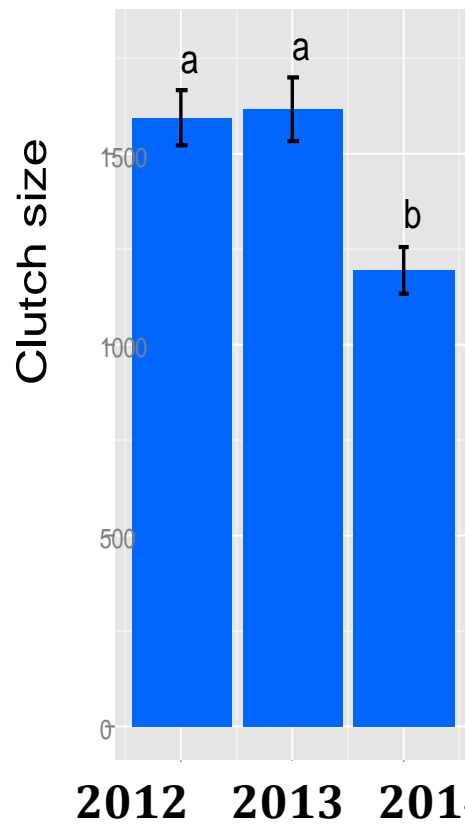
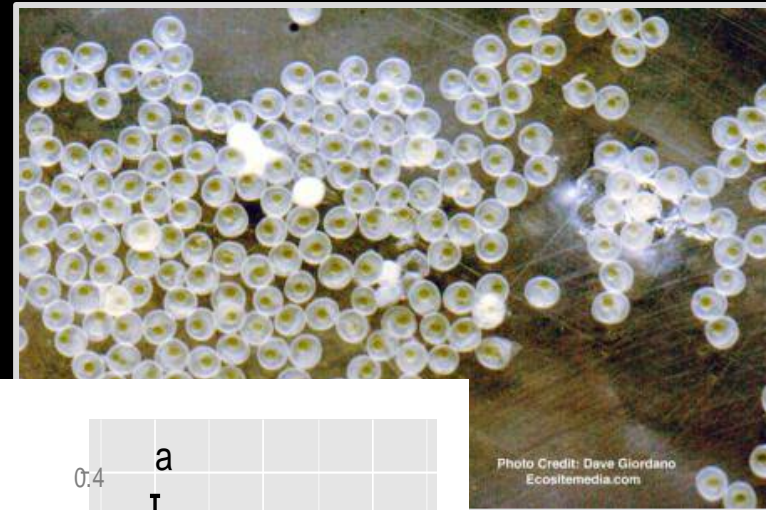


# Some Refugia Upstream?



Data from  
J. Hobbs, UCD

# Reduced fecundity & egg size in drought



# Delta Smelt Drought Response:



Jan - Mar

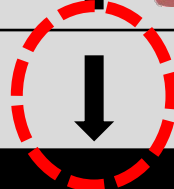
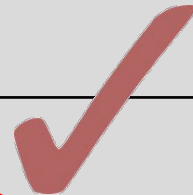
Apr - Jun

Jul - Aug

Sept- Dec

## Delta Smelt Responses

Abundance	↓	↓	↓	↓
Distribution		↑	↑	↑
Growth	↓	↓	↓	↓
Fecundity	↓			



- Temperature
- Location

# The Final Straw?

## Not the first drought for Delta Smelt? BUT

**Early**

**Early**

**Habitat Diversity**

- Water
- Freshwater w
- Willow thicke
- Riparian scrub
- Riparian forest
- Seasonal wet
- Vernal pool c
- Alkali season
- Dune scrub
- Grassland
- Oak woodland
- Agriculture
- Managed wetland
- Urban

**⌘ A Delta Transformed ⌘**  
**San Francisco Estuary Institute**  
[www.sfei.org](http://www.sfei.org)

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# Drought Synthesis Team:

## IEP-MAST &

## CDFW Drought Operation Plan Collaboration



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- Betsy Wells



- Michael MacWilliams
- Aaron Bever



- Larry Brown



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- Michael Eakin
- Randy Baxter
- Chad Dibble
- Gregg Erickson
- Ken Kundargi
- Steve Slater



- James Hobbs
- Swee Teh
- Bruce Hammock
- Tomofumi Kurobe



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- Steve Culberson
- Matthew Dekar
- Joseph Kirsch
- Susie Tharratt



- Jason Hassrick (now ICF)
- Josh Israel

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