

# A 3-Year Study of Environmental Stress on Health of Endangered Delta Smelt

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Aquatic Health Program





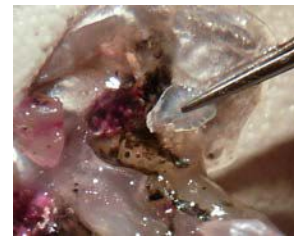
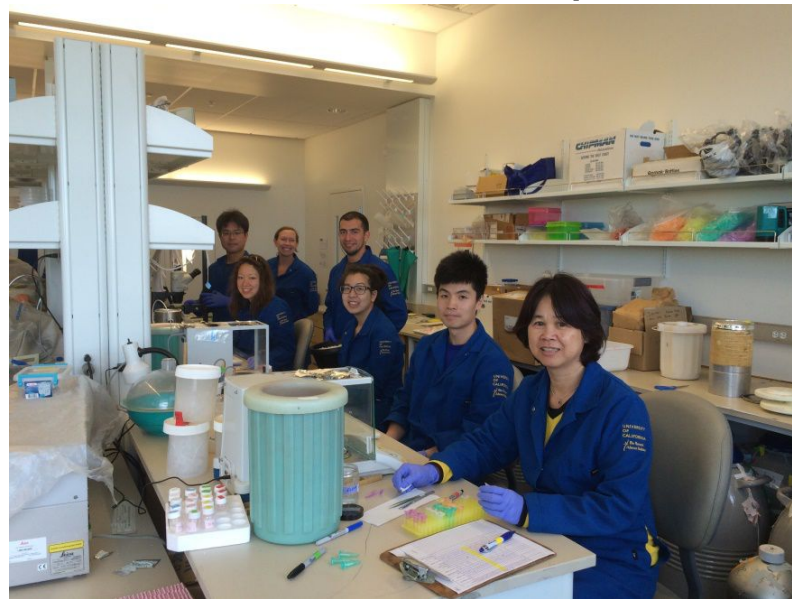
# Acknowledgements



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- Field Samplings and gut content data from Randy Baxter, Steve Slater, Dave Contreras, Bob Fujimura, Julio Adib-Samii, Lauren Damon, Tricia Bippas, Katie Osborn, Burris, Zair, La Luz Felipe, Finstad Sarah, Avila Michelle, and Morris Trishelle of CDFW
- Scientific Support of scientists and managers of Interagency Ecology Program.



# FISH HEALTH STUDY, AQUATIC HEALTH PROGRAM, UC DAVIS



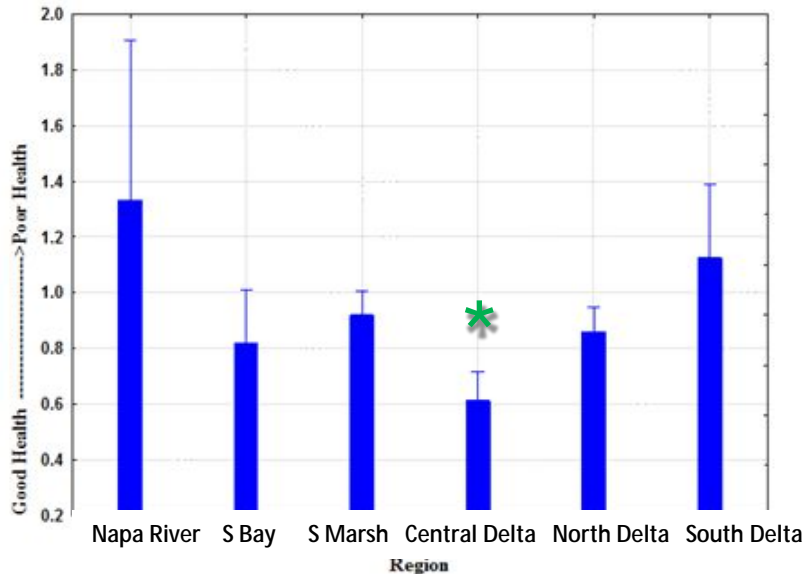
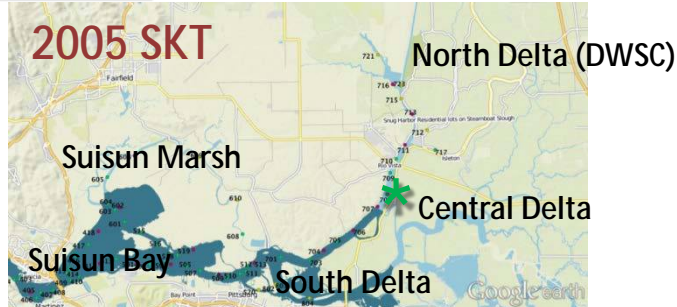
Teh et al 2016. A novel and versatile flash freezing approach for evaluating the health of Delta Smelt. *Aquatic Toxicology*



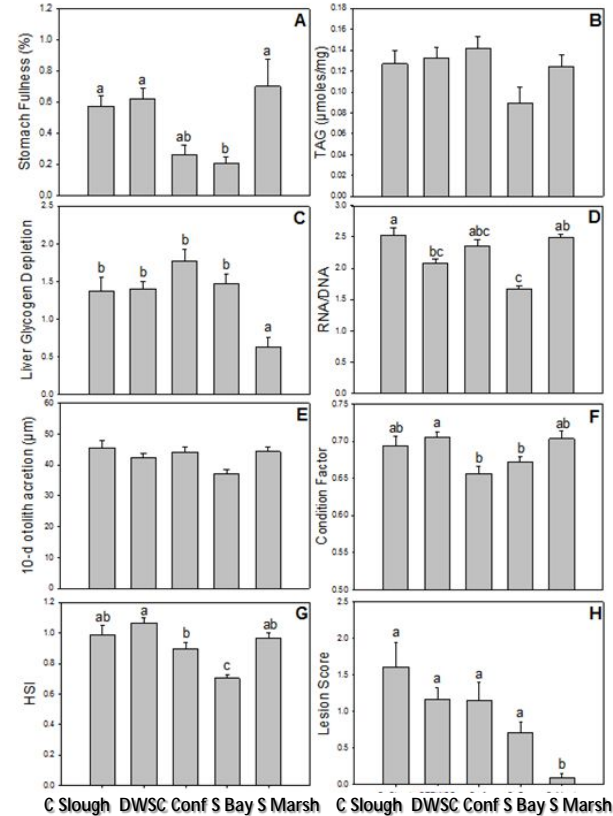
# Background

2005 Spring Kodiak Trawl (January-March)  
Mature Adult Delta Smelt (N=385)

2012-2013 Summer Towntnet (June-August)  
Juvenile Delta Smelt (N=176)



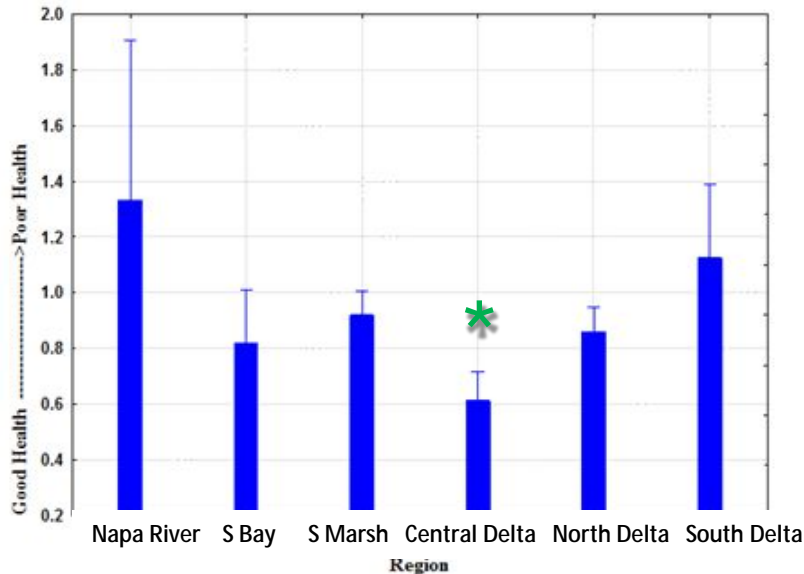
\* Central Delta had lower lesion scores



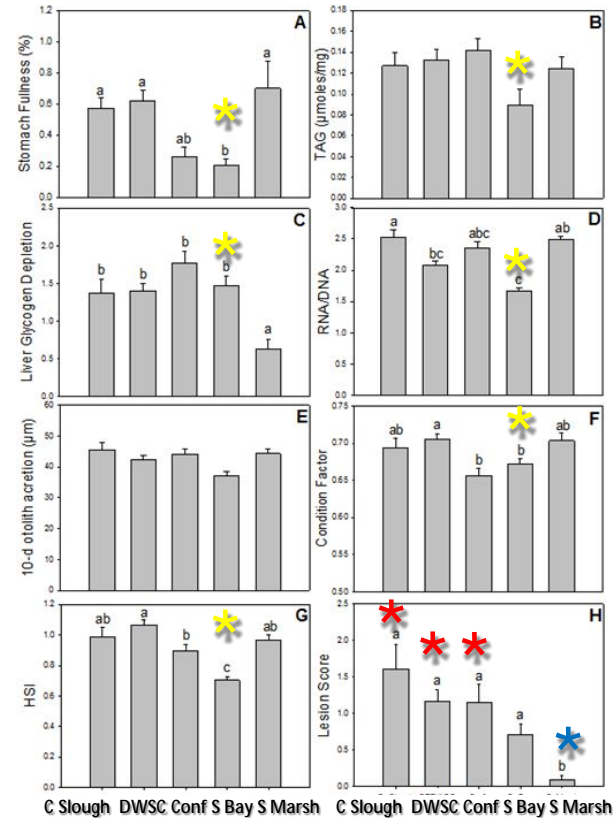
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\* Central Delta had lower lesion scores



- \* Suisun Bay had poorer condition status and food limitation
- \* Suisun Marsh had better condition and nutrition status
- \* Cache Slough, DWSC, and Confluence had higher lesion scores

Final Report by S Teh. 2007. Histopathological Evaluation of Starvation and/or Toxic Effects on Pelagic Fishes.  
 Funded by Interagency Ecology Program

Hammock et al. 2015. Contrasts in Health Indices of Delta Smelt Reared in the Low Salinity Zone and Cache Slough Regions in Summer 2012-2013.  
 Funded by Dr. Erwin Van Nieuwenhuys, USBR

# Goals

- Integrate biomarkers of Delta Smelt health at multiple levels of biological organization in the Fall of 2011, 2012, and 2013
- Assess regional differences in summer and fall
- Test the hypothesis that regional differences in summer health persist into fall



# Indicators of health of Delta Smelt

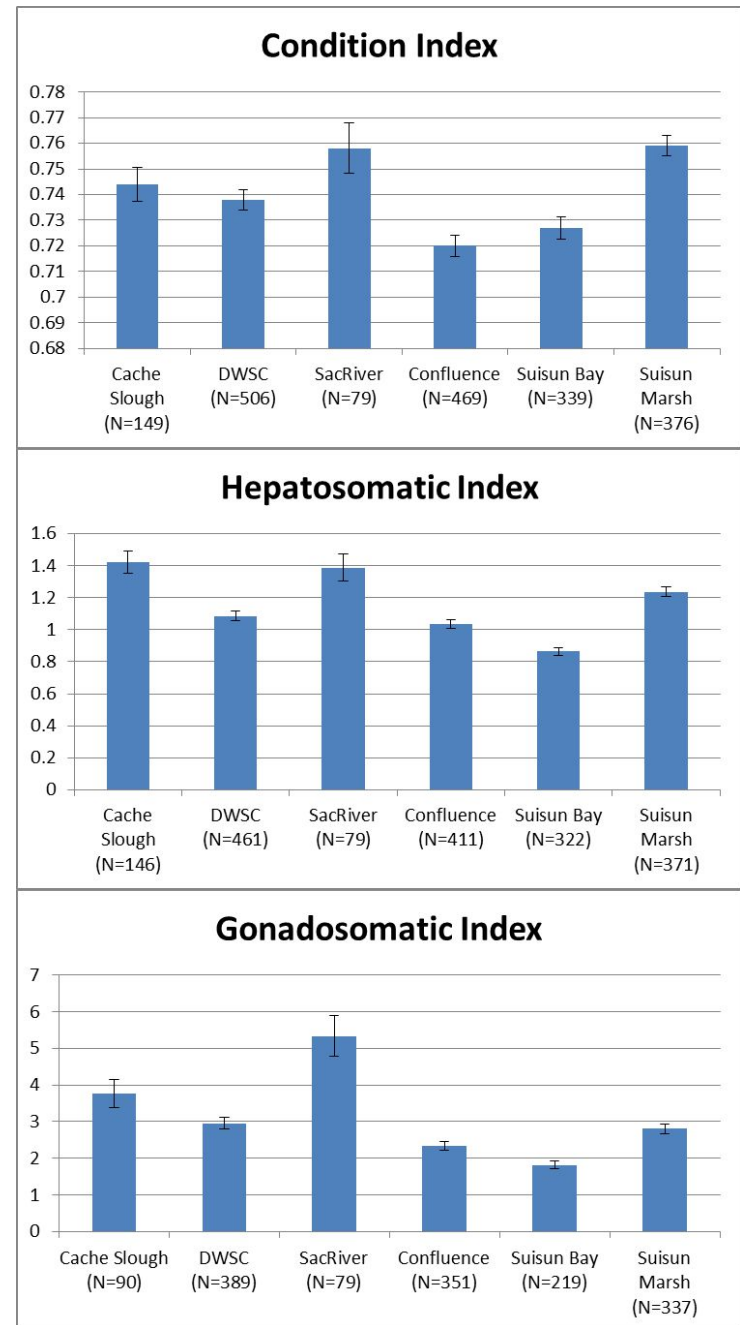
- Indicator of general condition
  - Length-weight (condition factor), liver-weight (hepatosomatic index), and gonad-weight relationships (gonadosomatic index)
- Indicator of short-term growth, energy reserve, and food consumption status
  - RNA-DNA ratio, liver glycogen depletion, triglycerides, stomach fullness
- Indicator of environmental and contaminants stress
  - Histopathology

# Indicator of general condition

- Condition and hepatosomatic index
  - As indicative of metabolic condition
- Gonadosomatic index
  - As indicative of sexual maturation



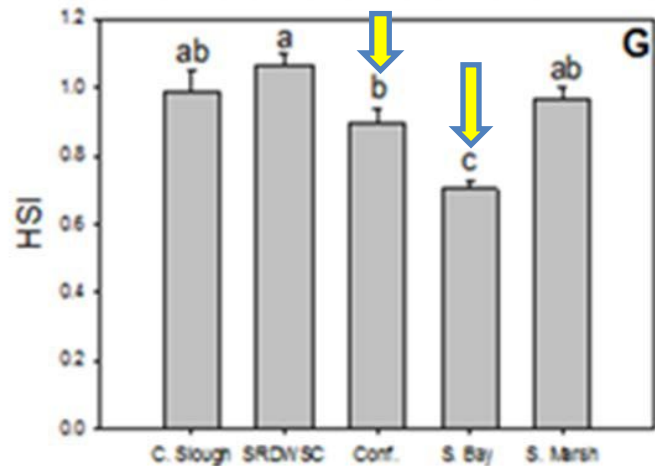
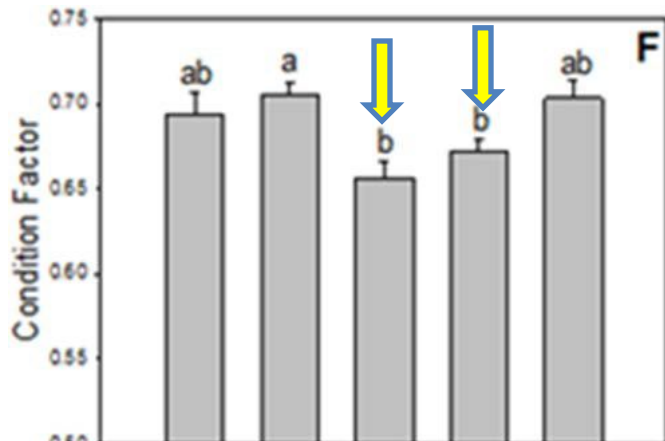
## 2011-2013 FMWT



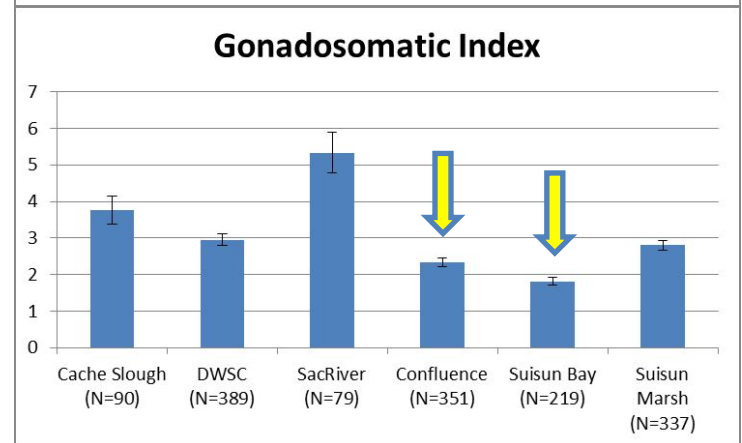
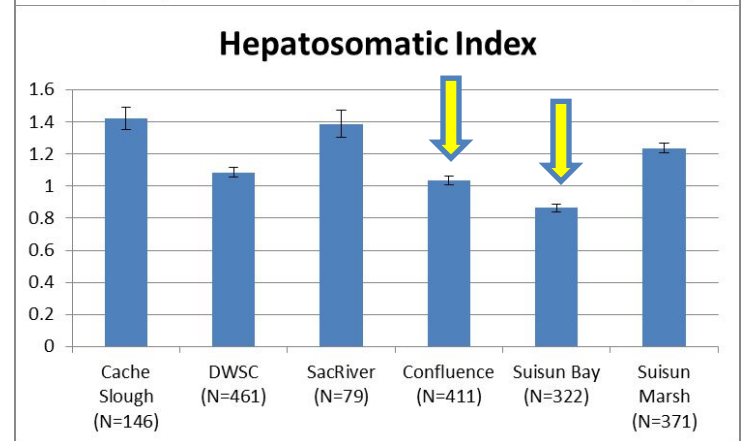
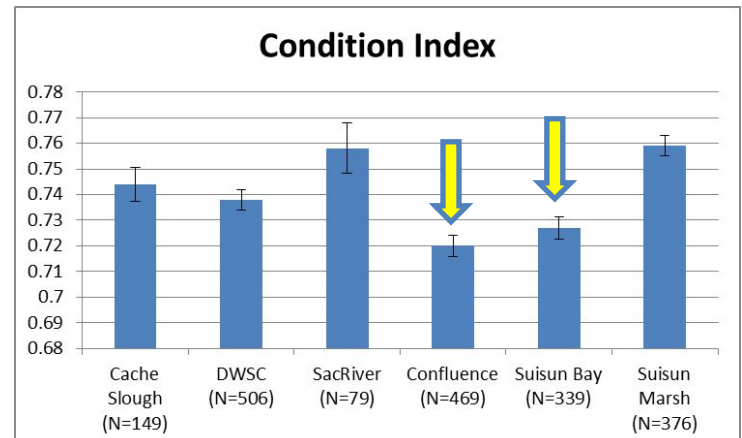




2012-2013 STN (N=176)

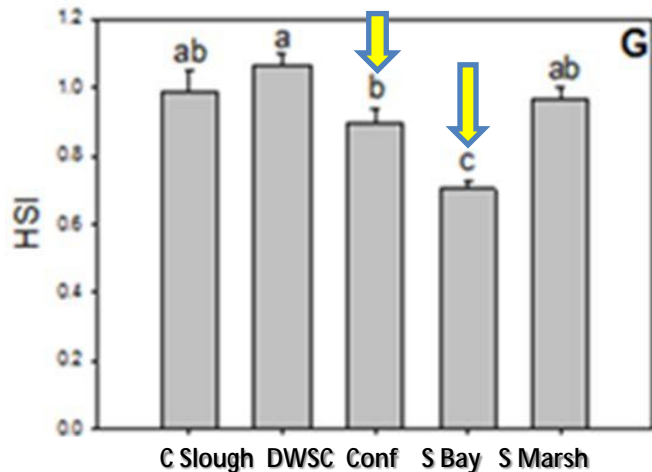
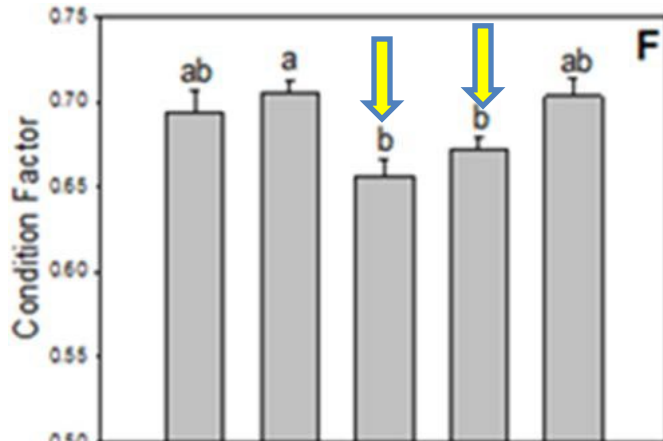


2011-2013 FMWT (N~1500)

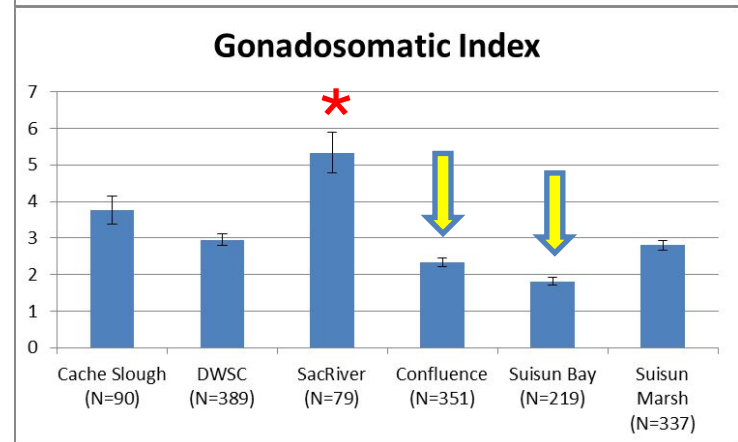
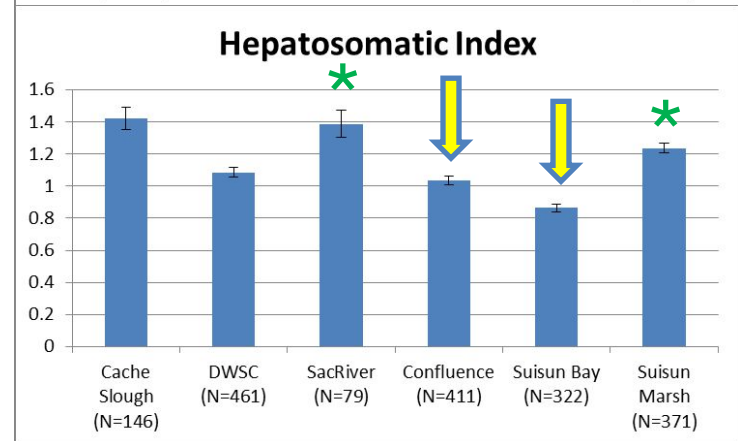
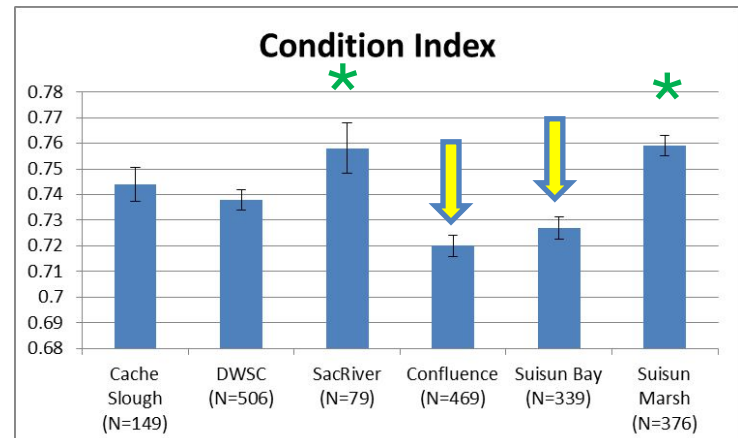




### 2012-2013 STN



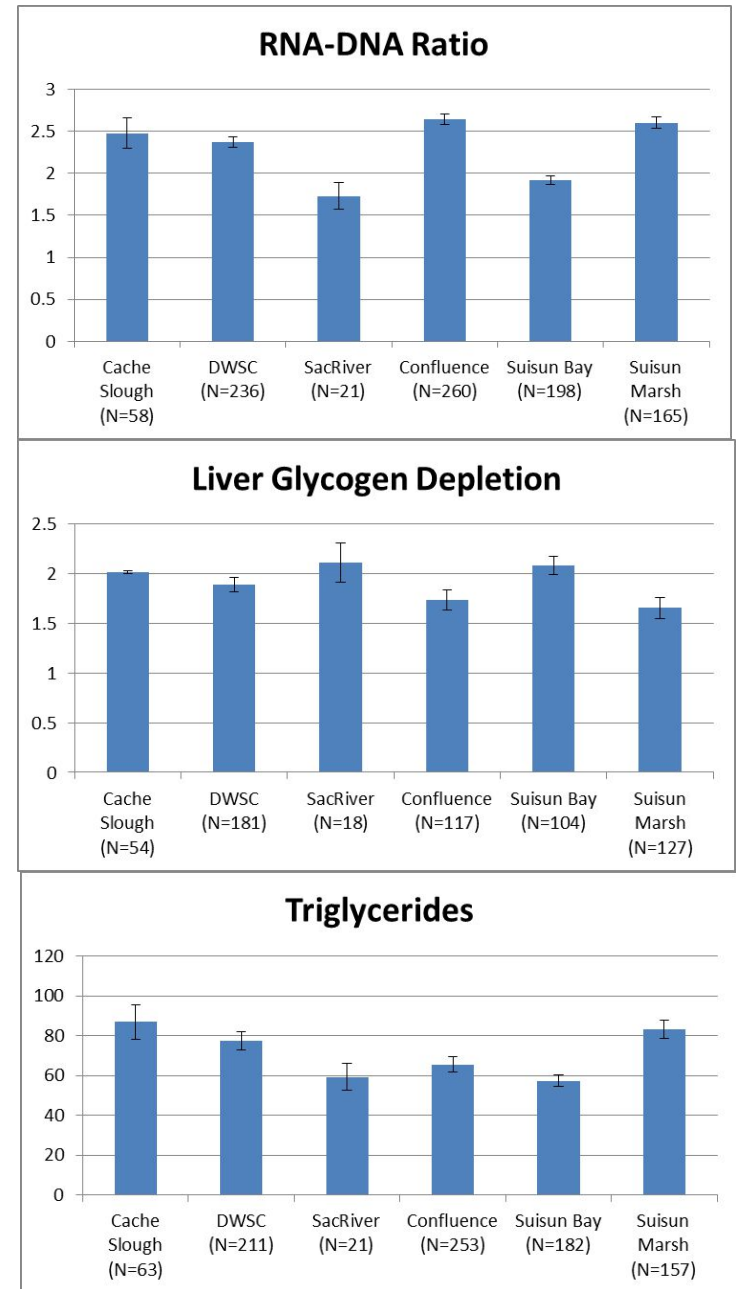
### 2011-2013 FMWT



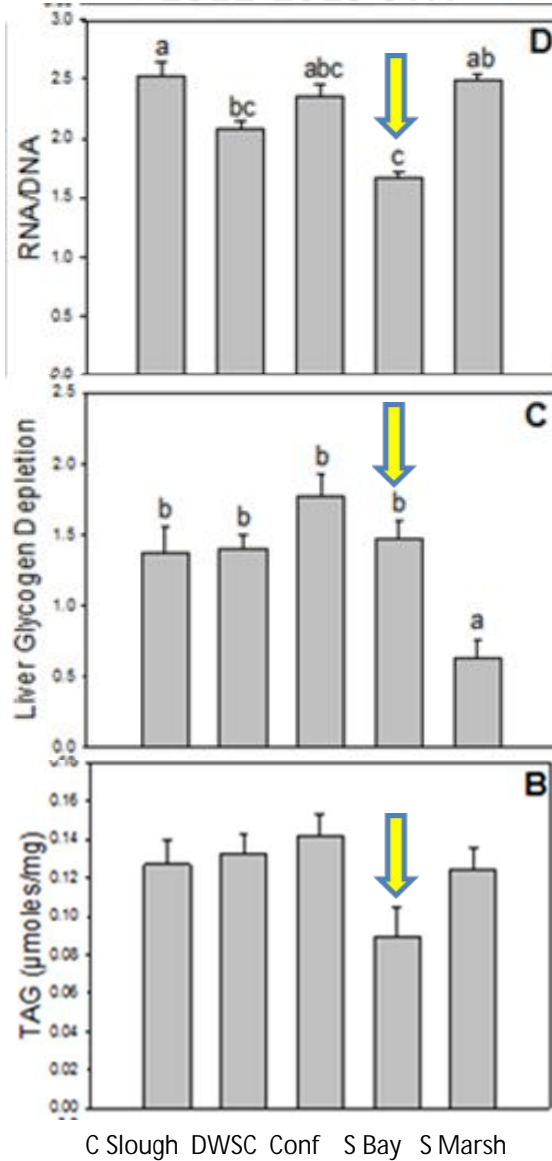
# Indicator of short-term growth and energy status

- RNA/DNA Ratio
  - Indicative of feeding conditions and growth (1-2 days)
- Liver glycogen depletion
  - Indicative of metabolic condition
- Triglycerides
  - Indicative of energy reserve

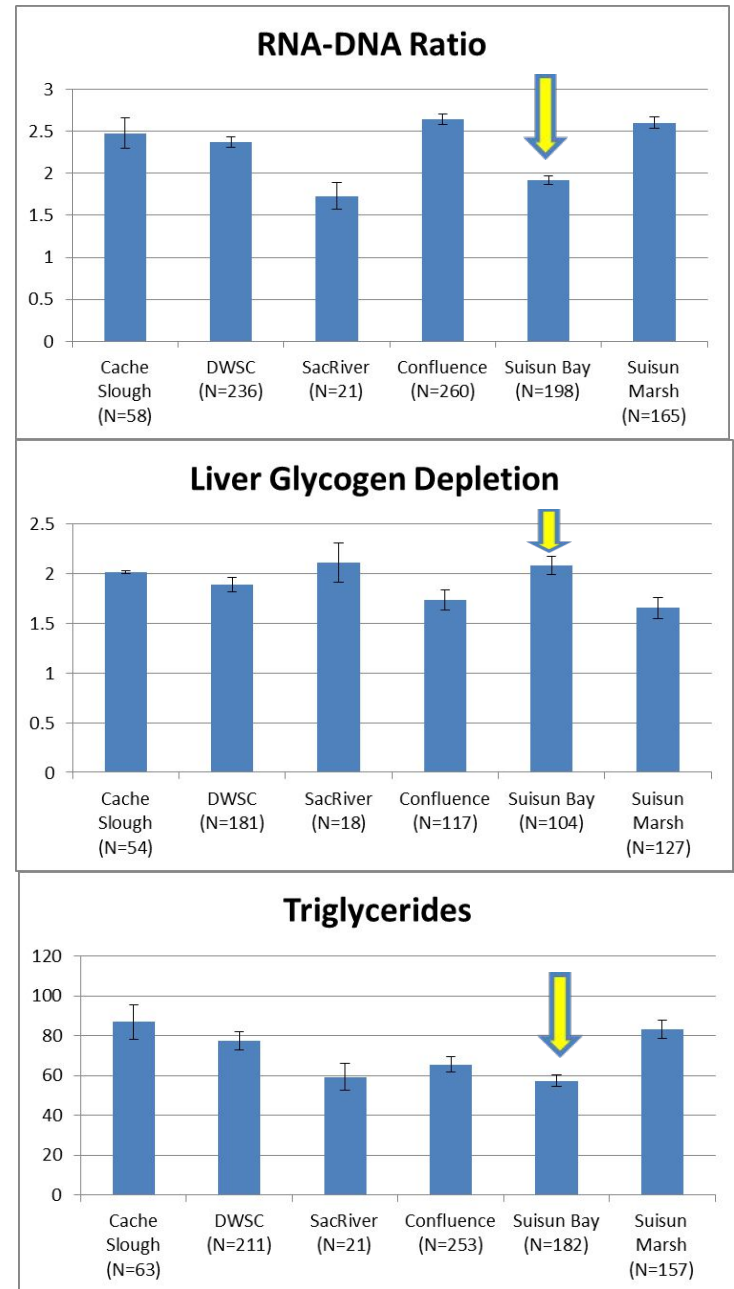
## 2011-2013 FMWT



## 2012-2013 STN



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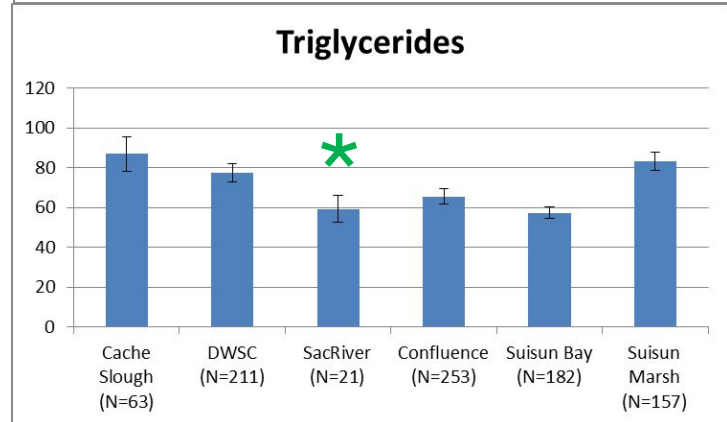
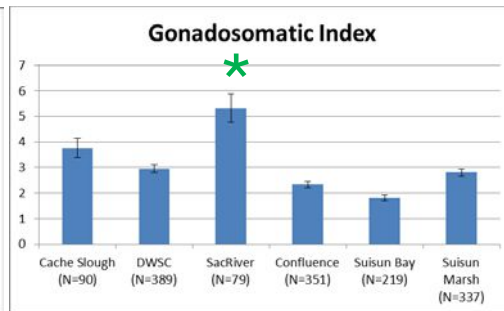
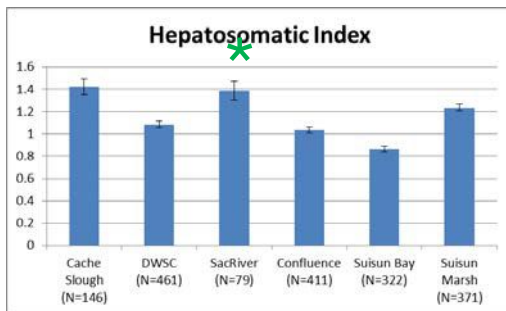
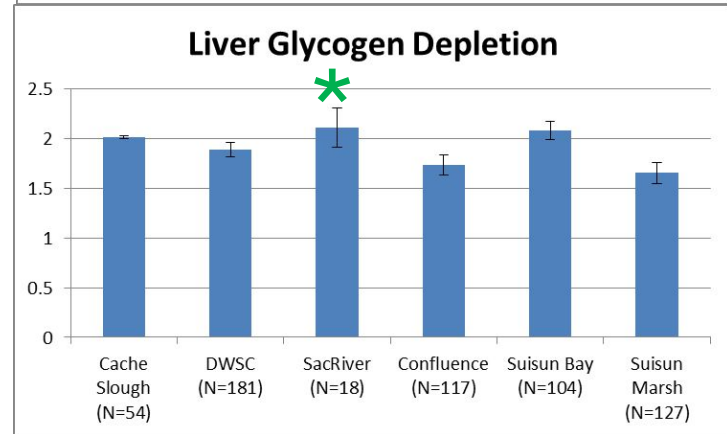
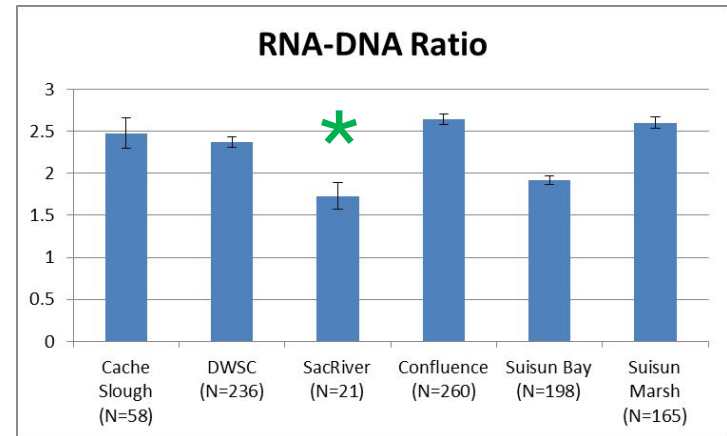
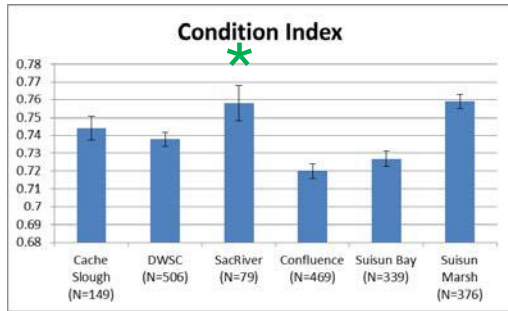


↓ = Suisun Bay has lower growth rate and reserve energy and higher glycogen depletion





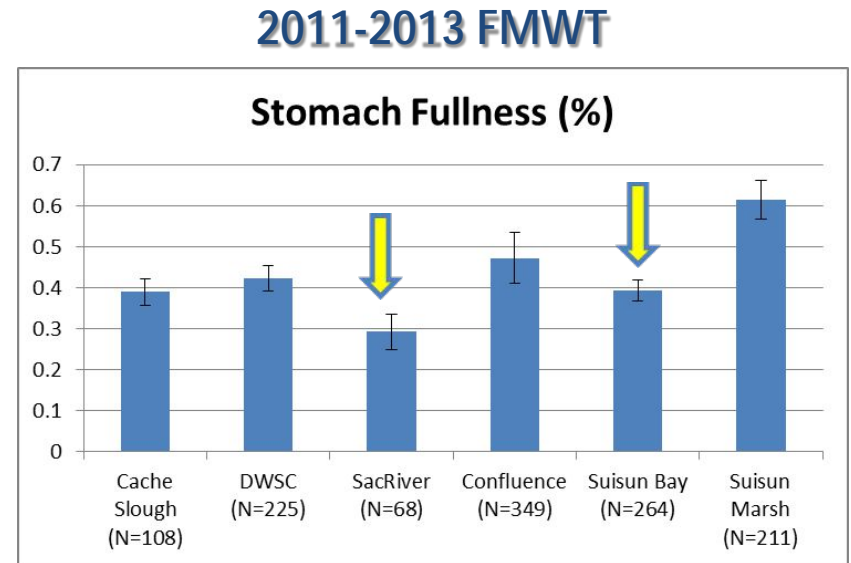
## 2011-2013 FMWT



\* Reduce growth (RNA/DNA) and energy reserves (TAG) and higher glycogen depletion in Sacramento River may be related to sexual maturation (increase liver and gonad weight). I.e., higher metabolic demand for mature fish

# Indicator of food consumption status

- Stomach fullness (Gut content weights / Body weight) \* 100
  - Indicative of success foraging or food availability

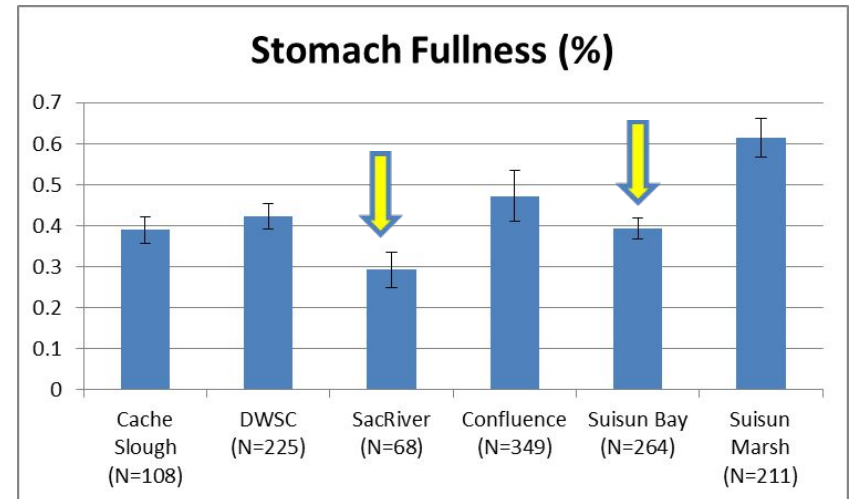


Data provided by Steve Slater and Randy Baxter (CDFW)

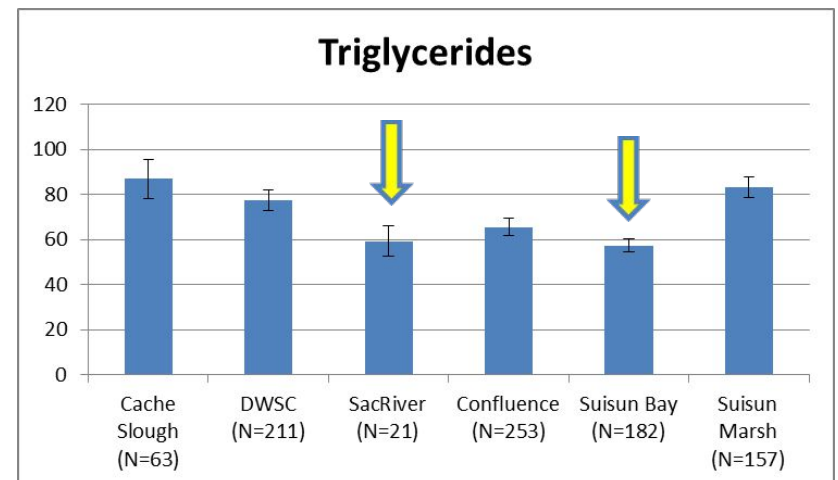
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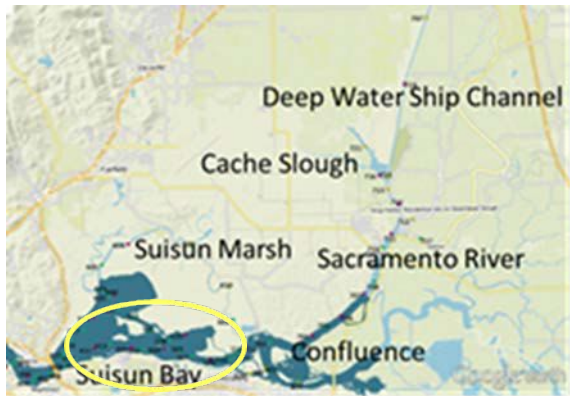
- Stomach fullness (Gut content weights / Body weight) \* 100
  - Indicative of success foraging or food availability
  - **Corresponding well with reserve energy (TAG)**

## 2011-2013 FMWT

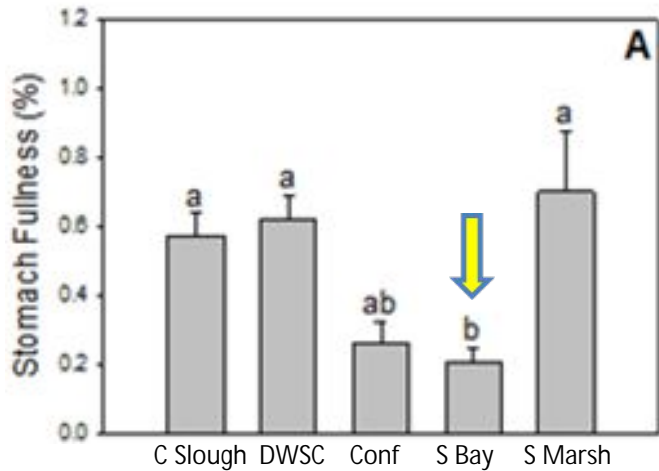


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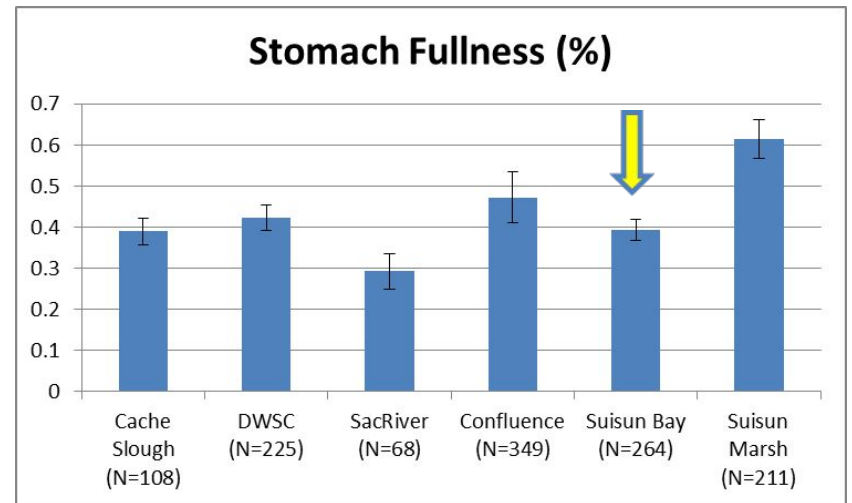




### 2012-2013 STN



### 2011-2013 FMWT



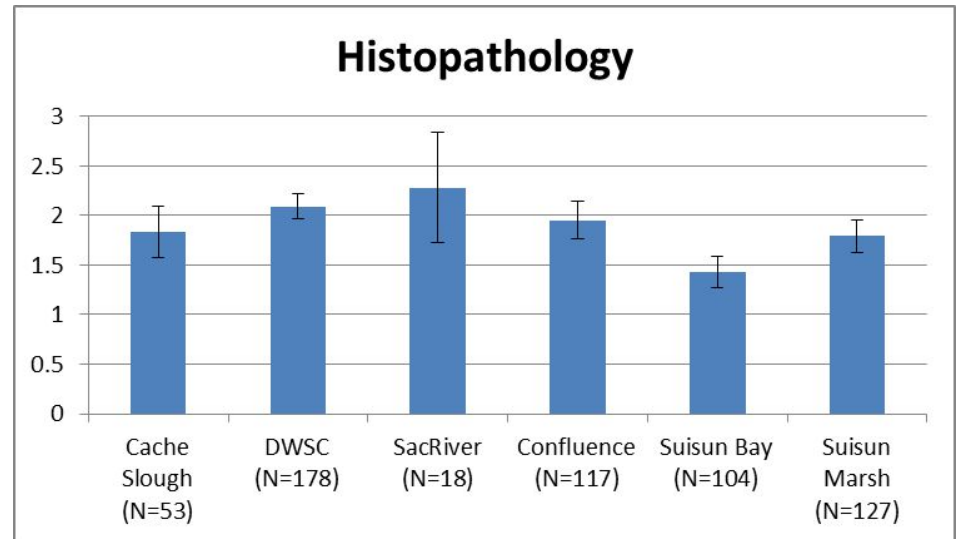
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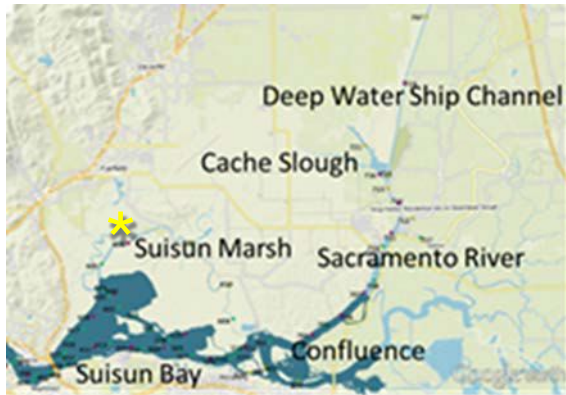


# Indicator of environmental and contaminant stress

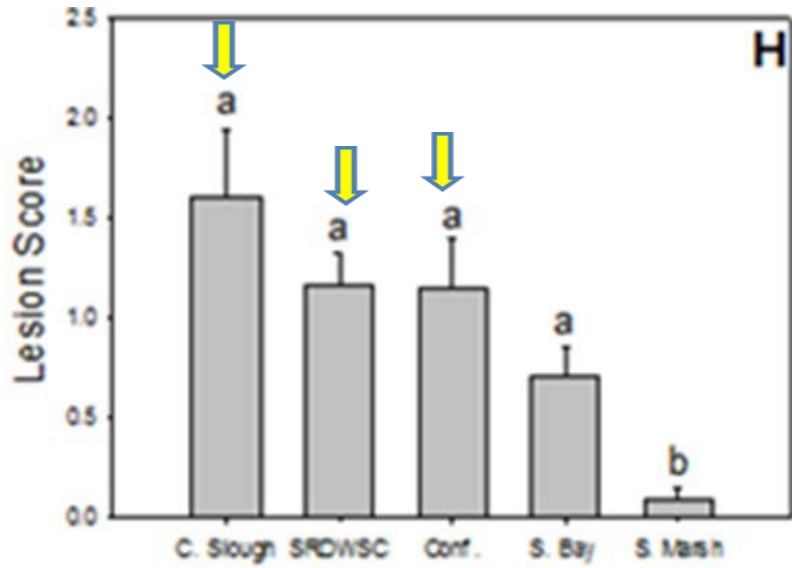
- Histopathology
  - Indicative of effects of exposure to environmental and contaminant stressors

2011-2013 FMWT

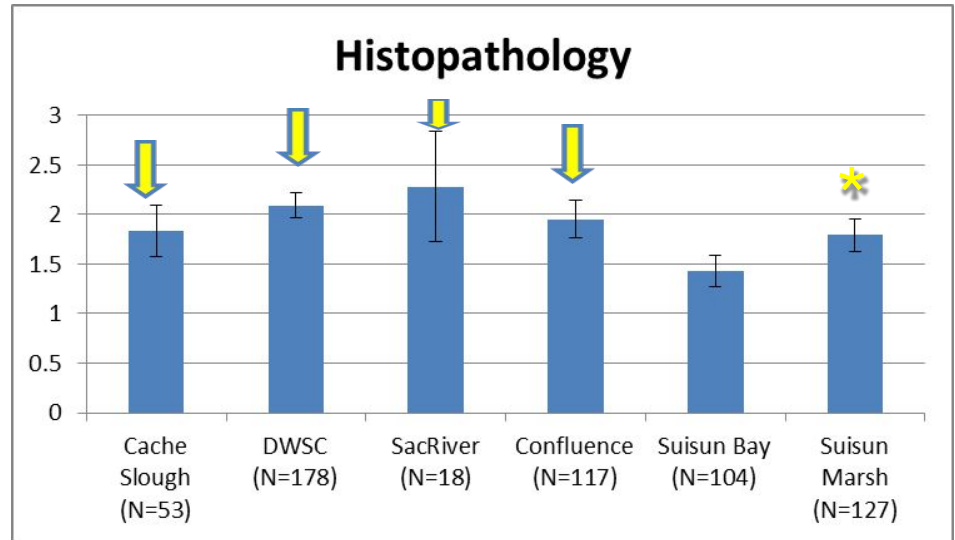




2012-2013 STN



2011-2013 FMWT



# Survivals of post-spawner or 1 year-plus fish

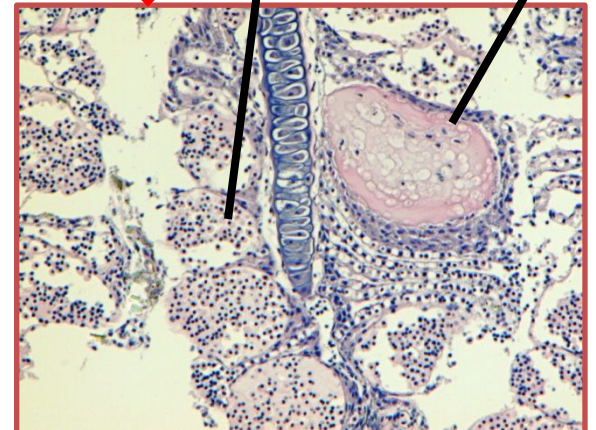
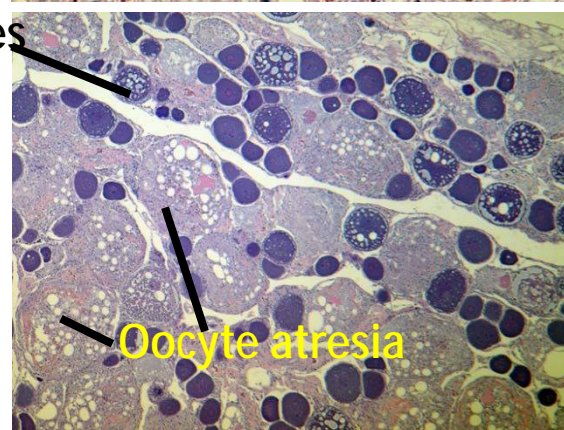
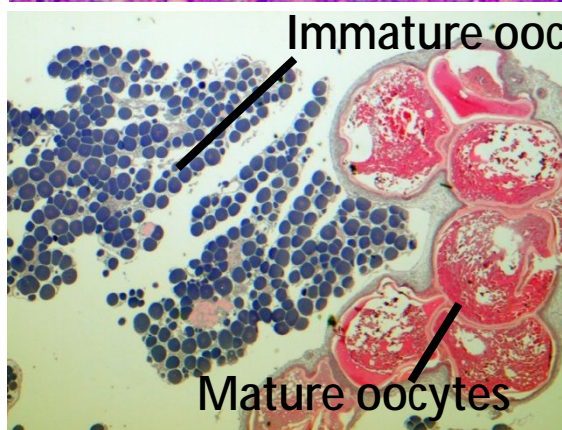
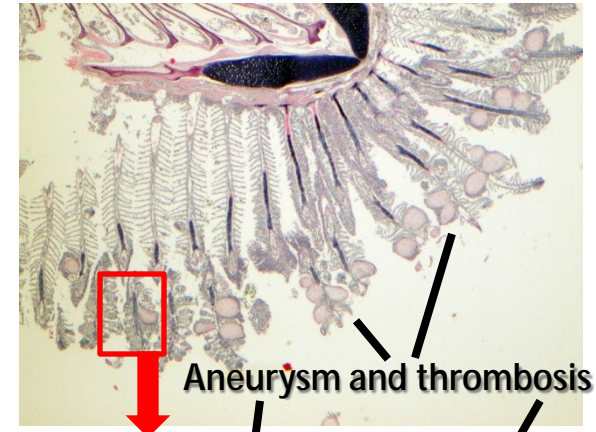
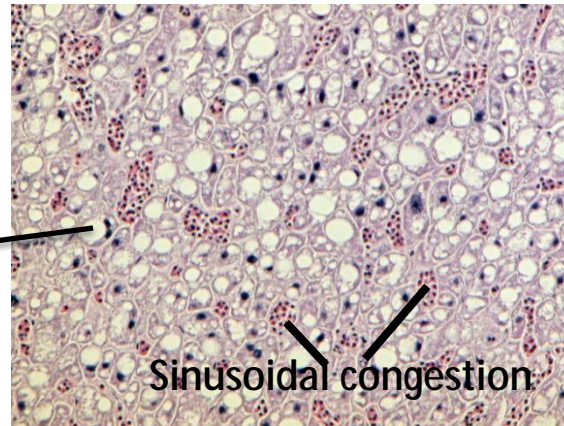
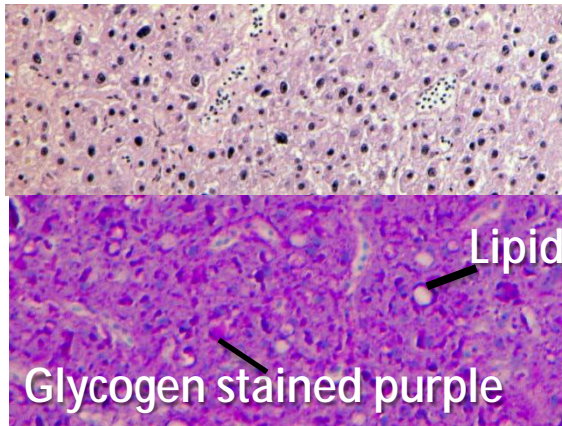
**FMWT** Sample date: **9/13/2011**  
 Honker Bay (site 507)  
 Body Weight: 4.40 g; Fork length: 78 mm;  
 Condition Factor: 0.93



**STN** sample date: **6/2/2014**  
 Deep water Ship Channel (site 719)  
 Body weight: 4.60 g; Fork length: 82 mm;  
 Condition Factor: 0.83



**FMWT** sample date: **9/17/2014**  
 Deep Water Ship Channel (site 719)  
 Body weight: 3.74 g; Fork length: 83mm;  
 Condition Factor: 0.66





# Summary

## FMWT results corresponded well with STN study

- ❖ Suisun Bay had poorer condition and food limitation
- ❖ Suisun Marsh had better condition and greater foraging success
- ❖ DWSC had better condition but appeared to have higher lesion scores
- ❖ Sacramento River had better condition and more sexually mature fish





# Future Study

- Test the hypothesis that regional differences in fall (FMWT) health persist into spring (SKT)
- Evaluate biomarkers in summer, fall and spring of 2014, 2015, and 2016
- Indicator species: Delta Smelt + 1-3 resident fish species (Sacramento Perch, Sacramento Splittail, Longfin Smelt, juvenile Salmon, etc)