



# Otoliths: The Keystone to Biomarker and Fish Health Studies

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# Overview

- Ecological framework for biomarker research
- What's otoliths got to do with it?
- Otolith biomarker applications.
  - Growth
  - Habitat residency
  - Heavy metal exposure
- Otoliths: The keystone to biomarker and fish health
- Conclusions/closing remarks

# Why Biomarkers?

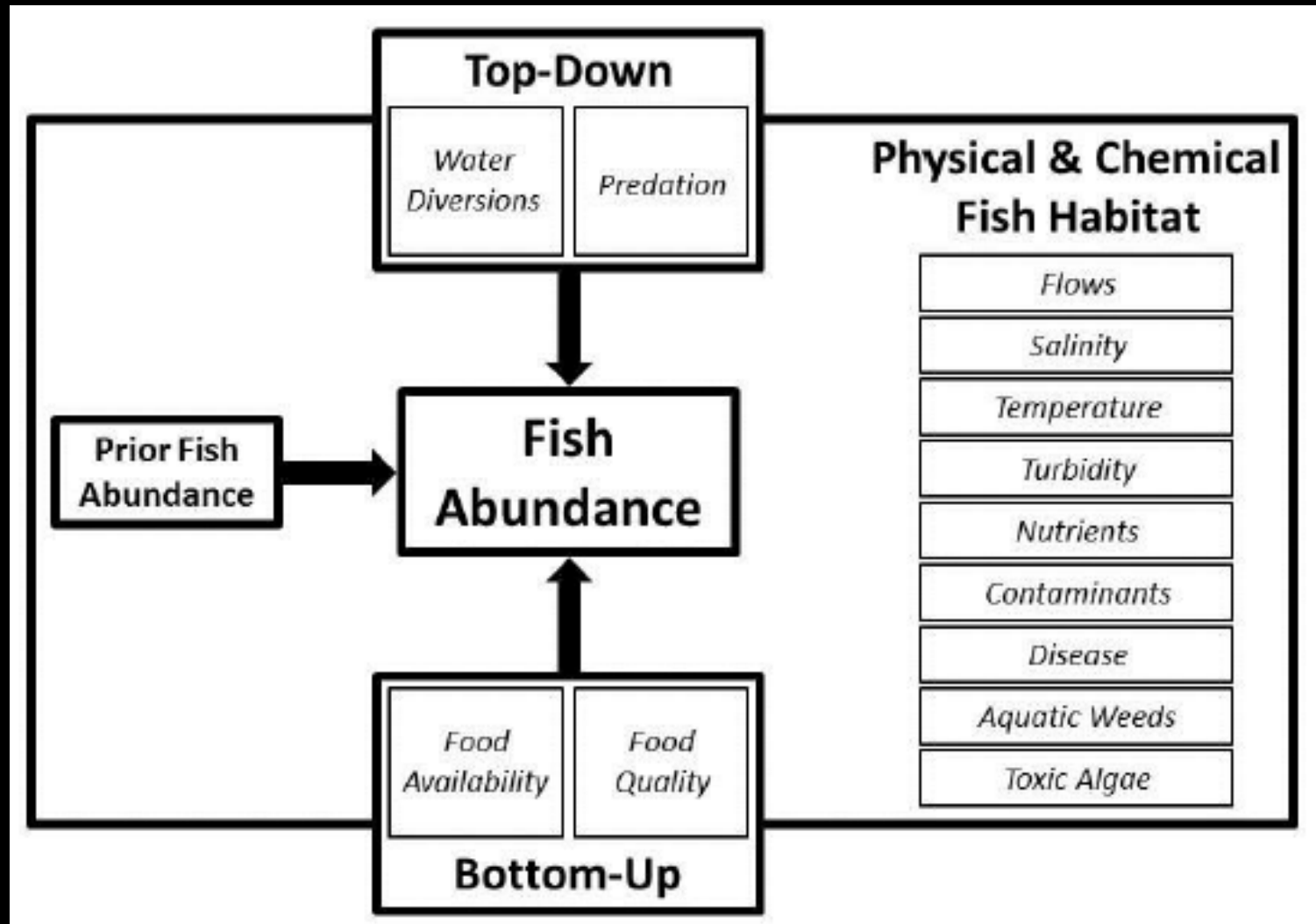
- Tracking fish abundance through time is REALLY HARD!!!

*“It’s not rocket science, It’s fisheries science, it’s much harder”*

*-Bob Hughes- AFS President*

- Can take a really long time to understand the drivers of fish populations
  - » *Management can’t really wait that long*

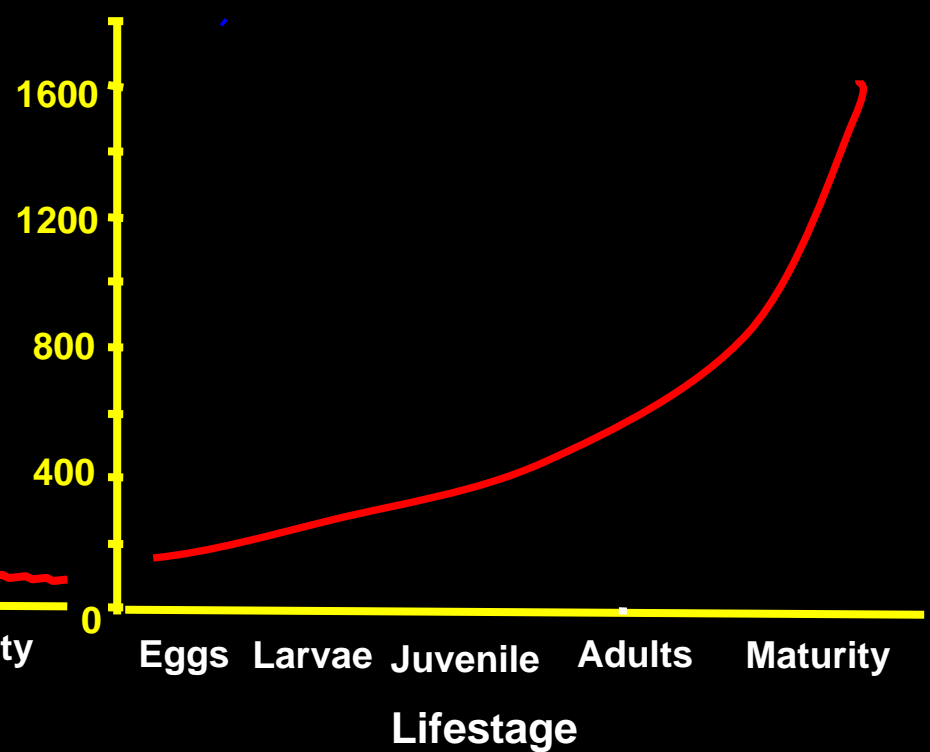
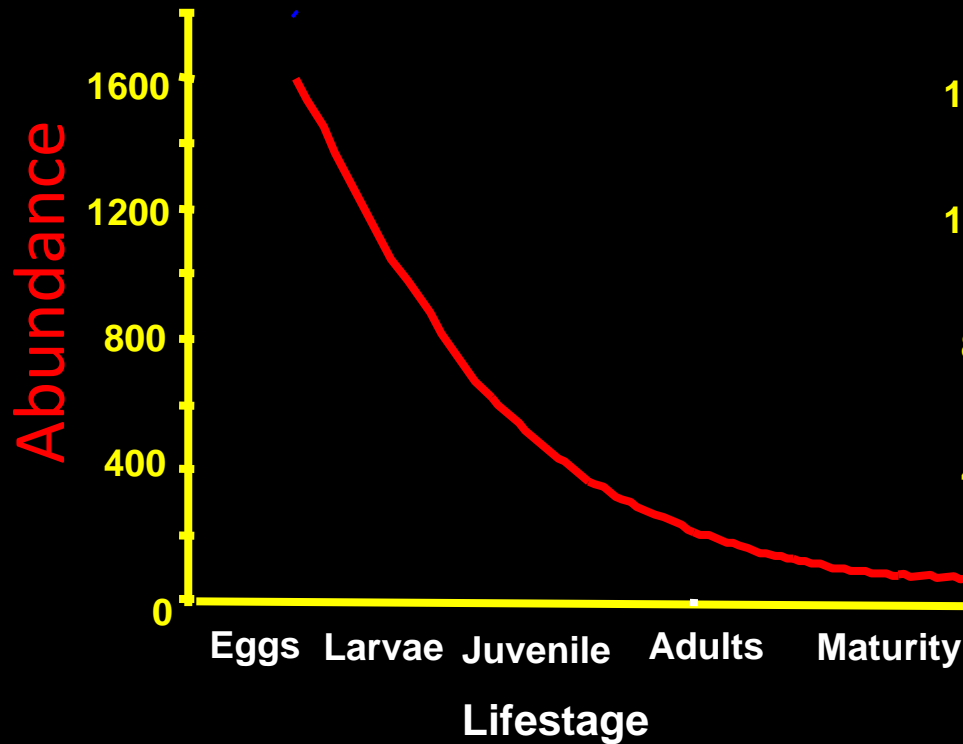
# Drivers and Stressors of Fish Populations



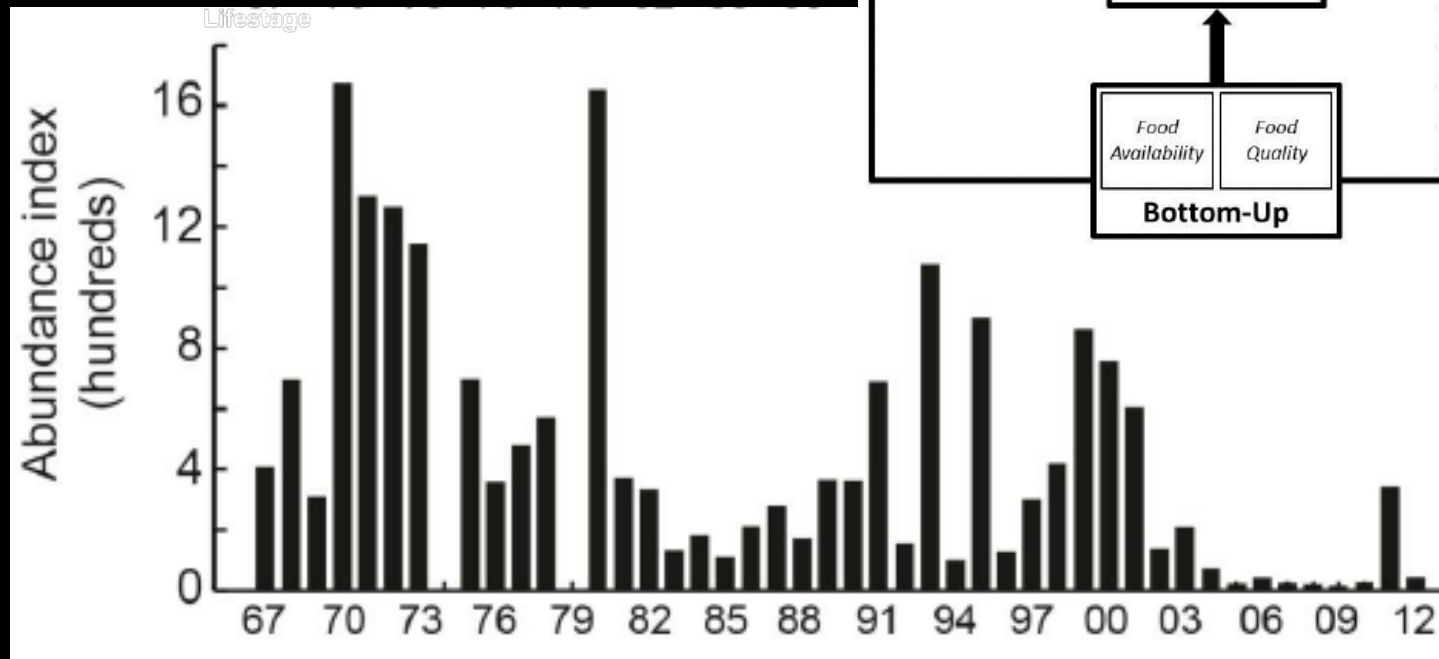
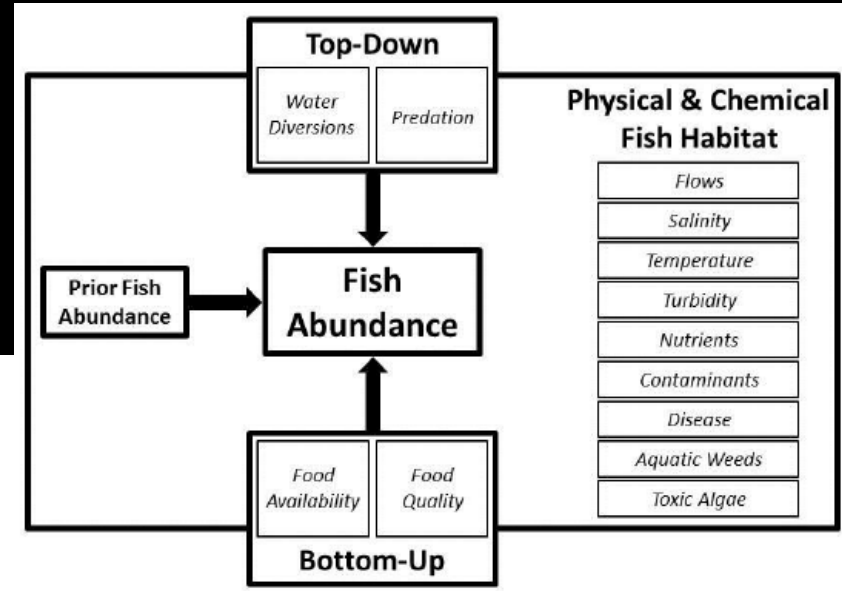
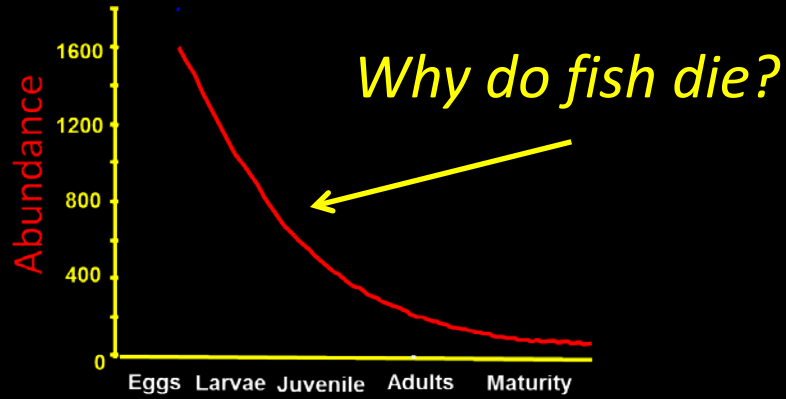
# Did I mention fisheries is hard?

Theoretical Catch-Curve

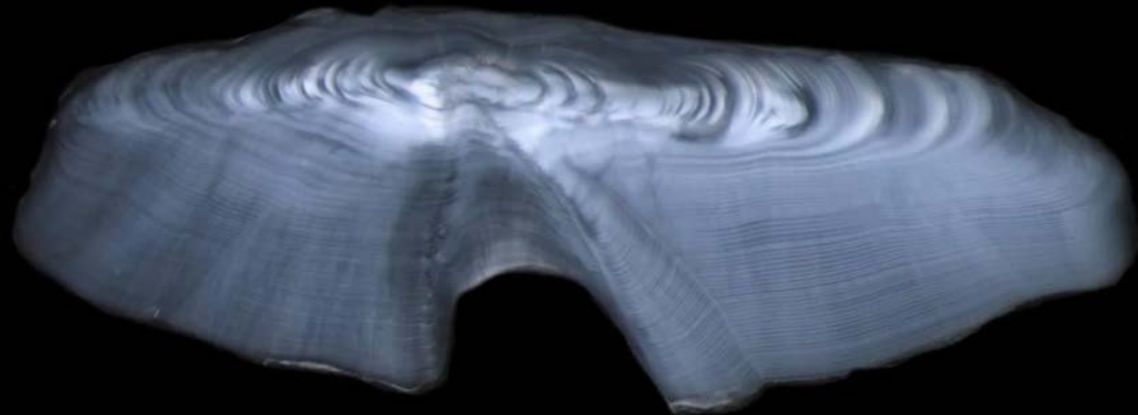
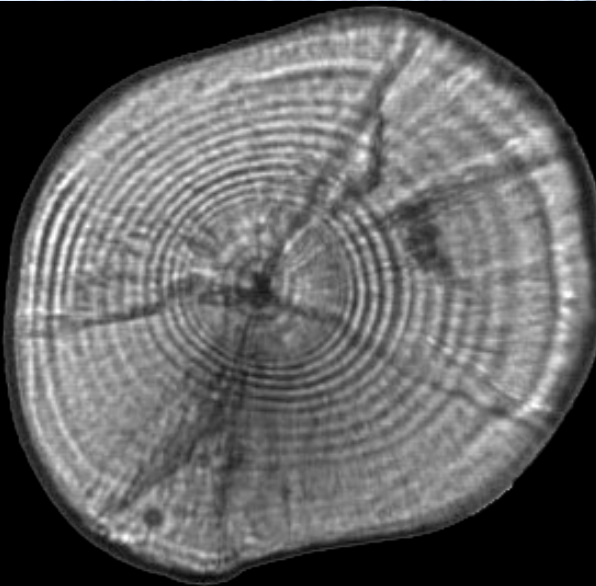
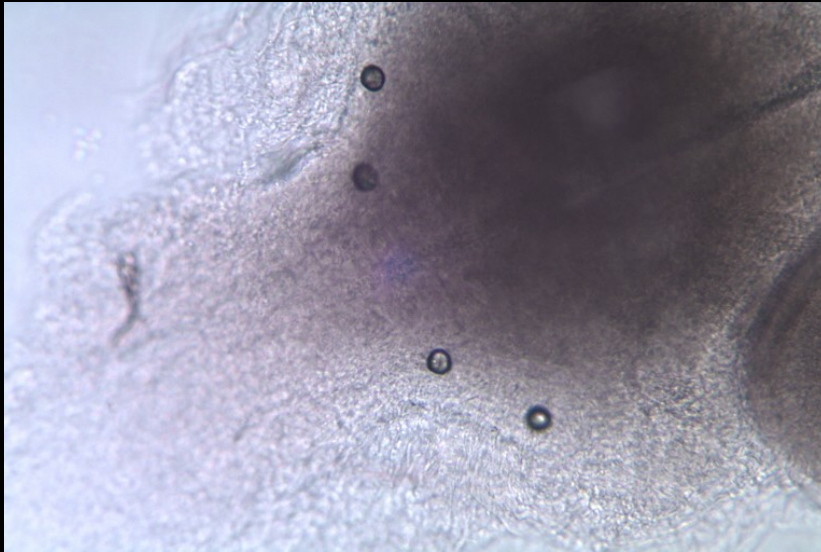
Realistic Catch-Curve



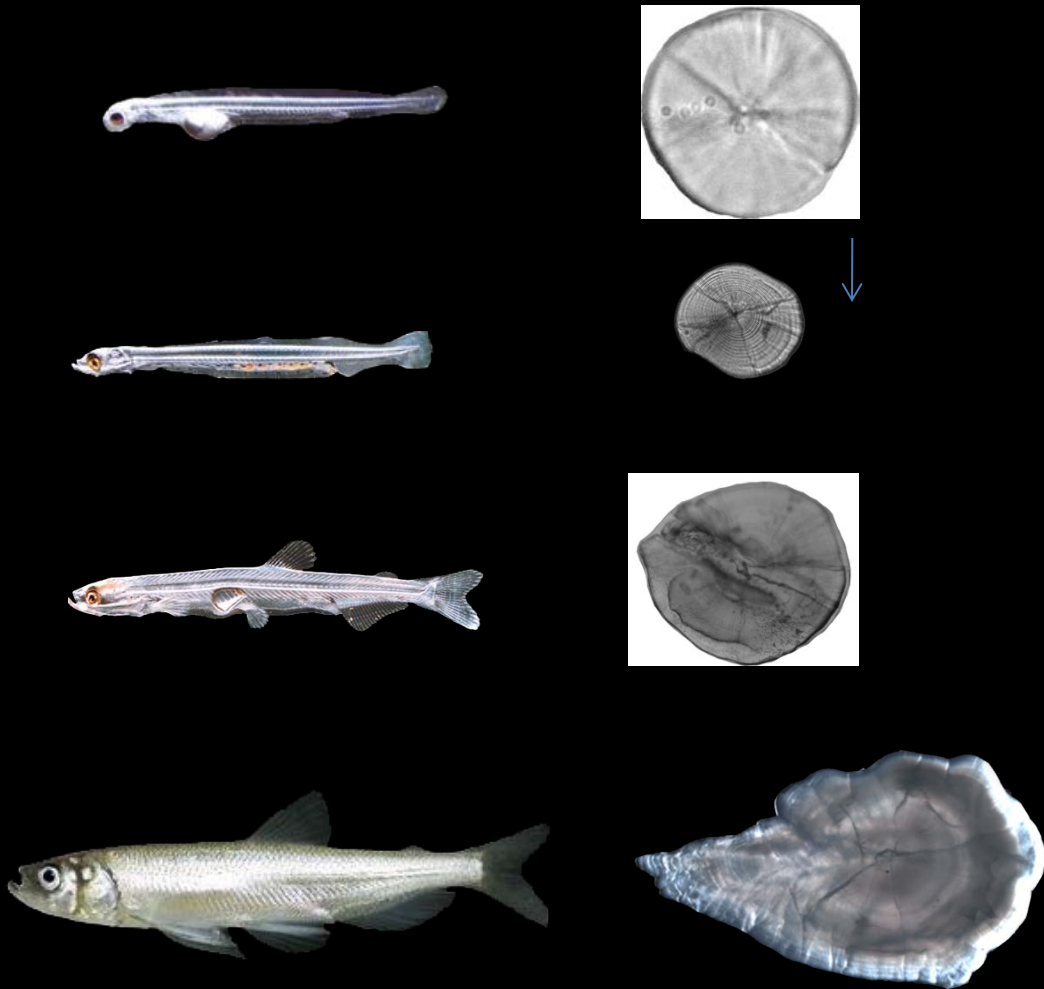
# Why does fish abundance go up and down?



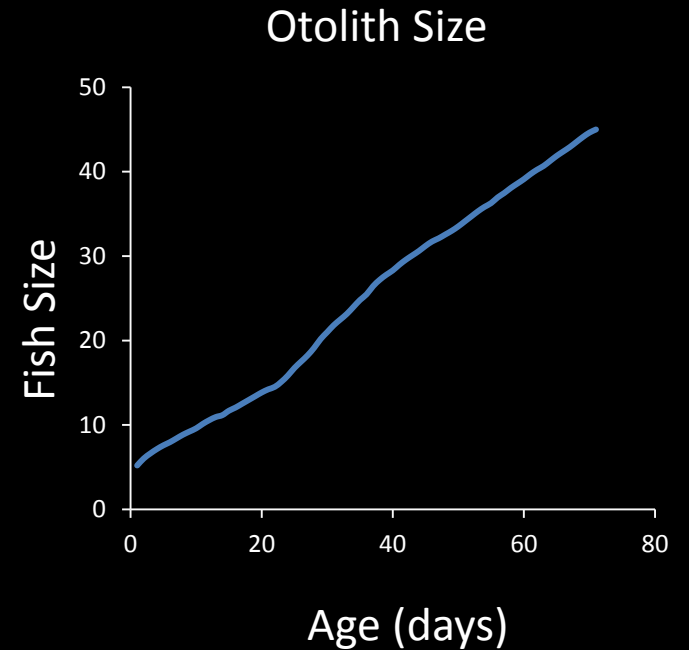
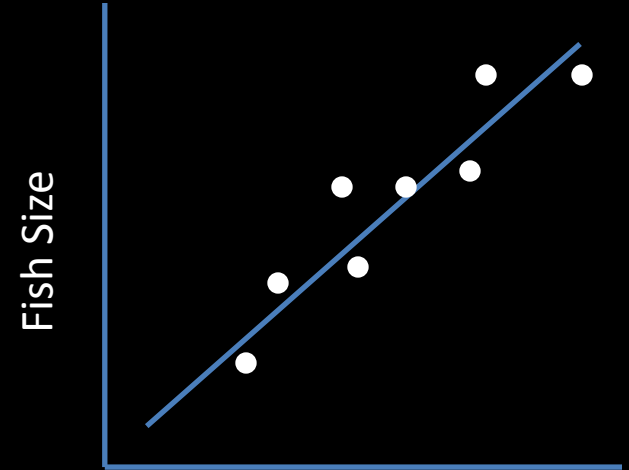
# What's otoliths got to do with it?



# Otolith-Fish Size Chronology

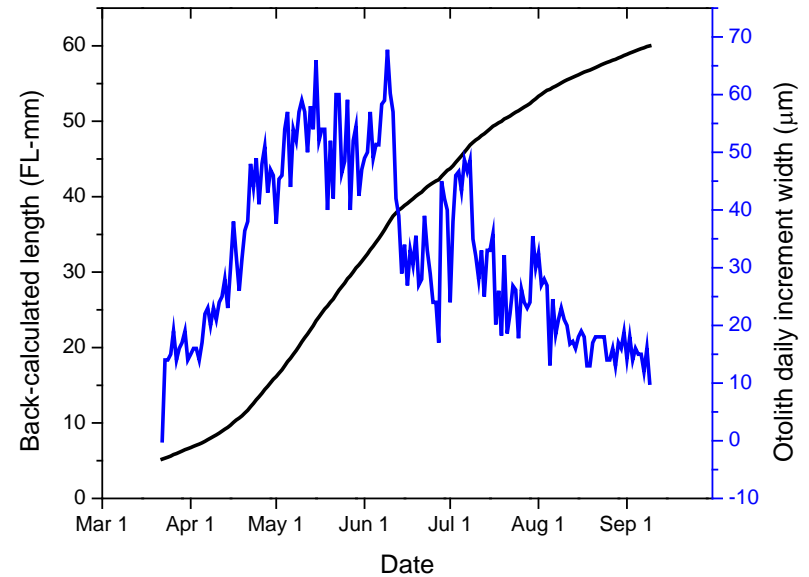
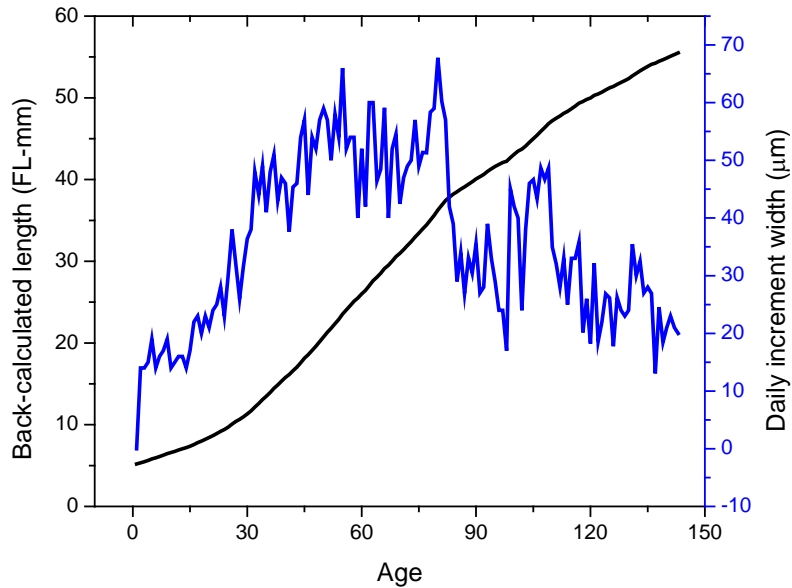
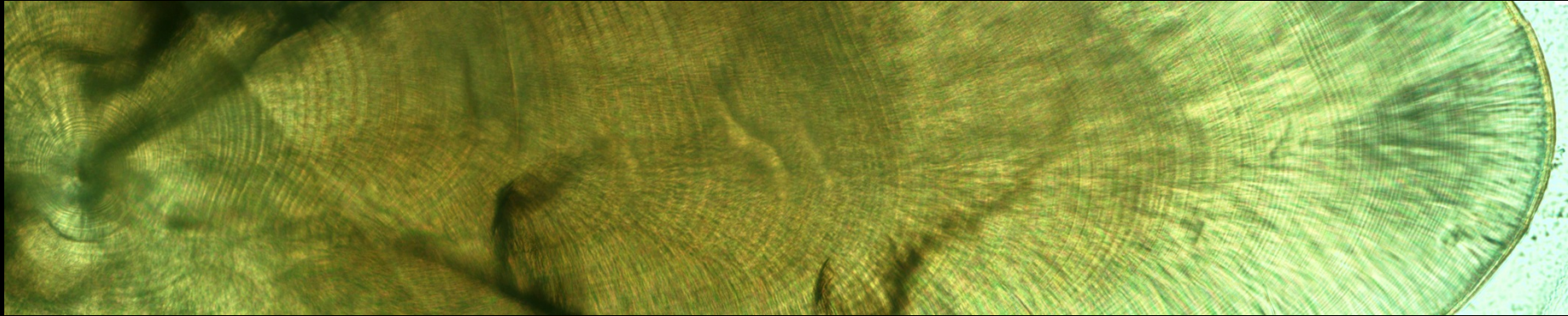


Correlation of fish and otolith size





# Otoliths as Biomarkers: Growth



# Otoliths as Biomarkers: Habitat

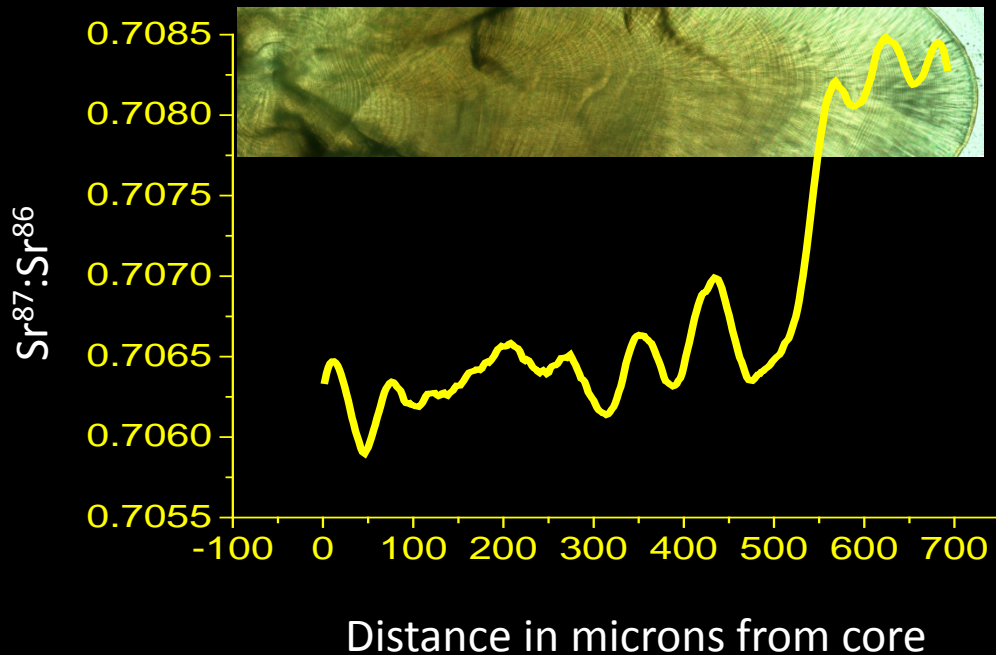
*Laser ablation micro-chemistry*

Freshwater

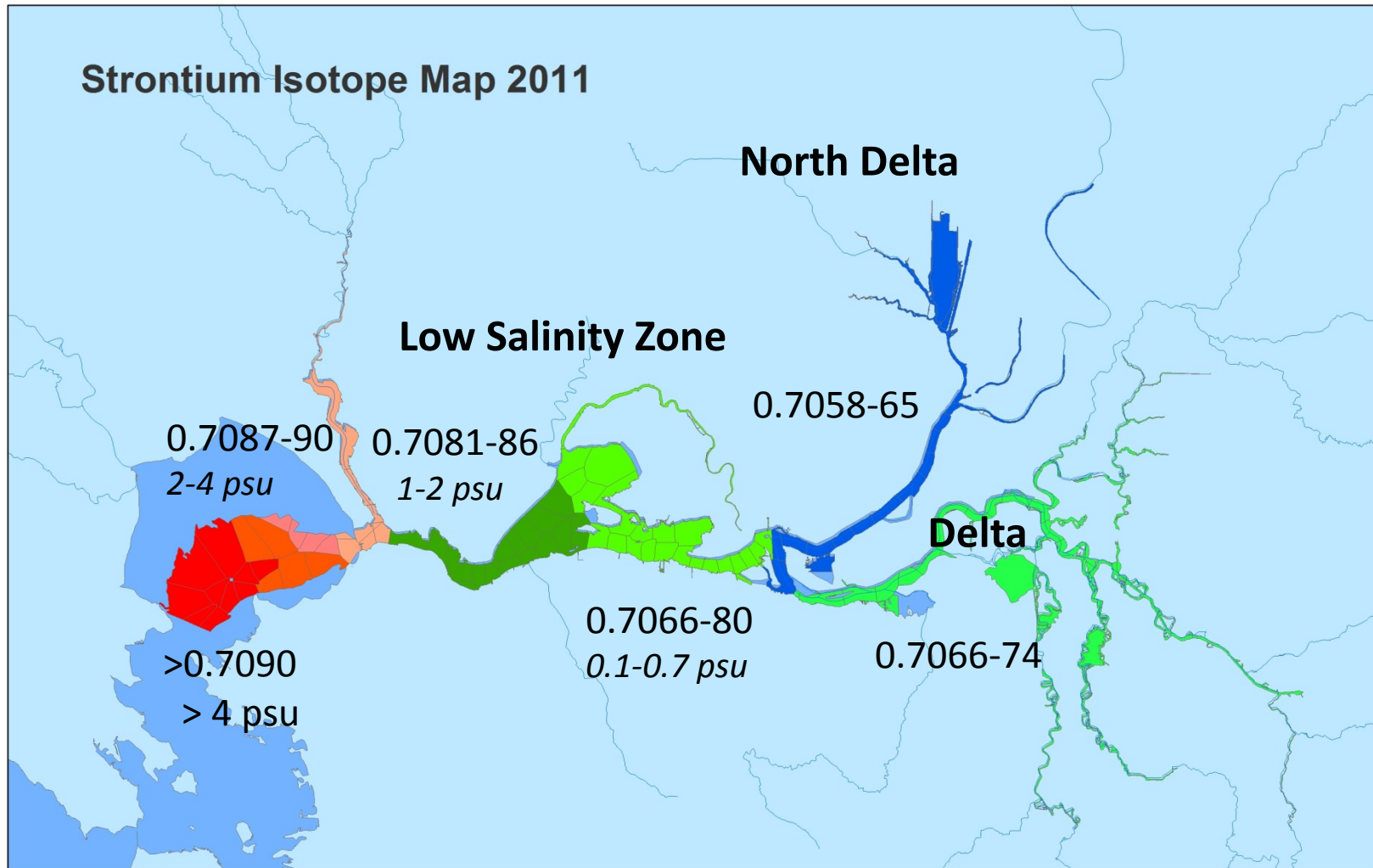
Brackish-water

↓ Sr

↑ Sr

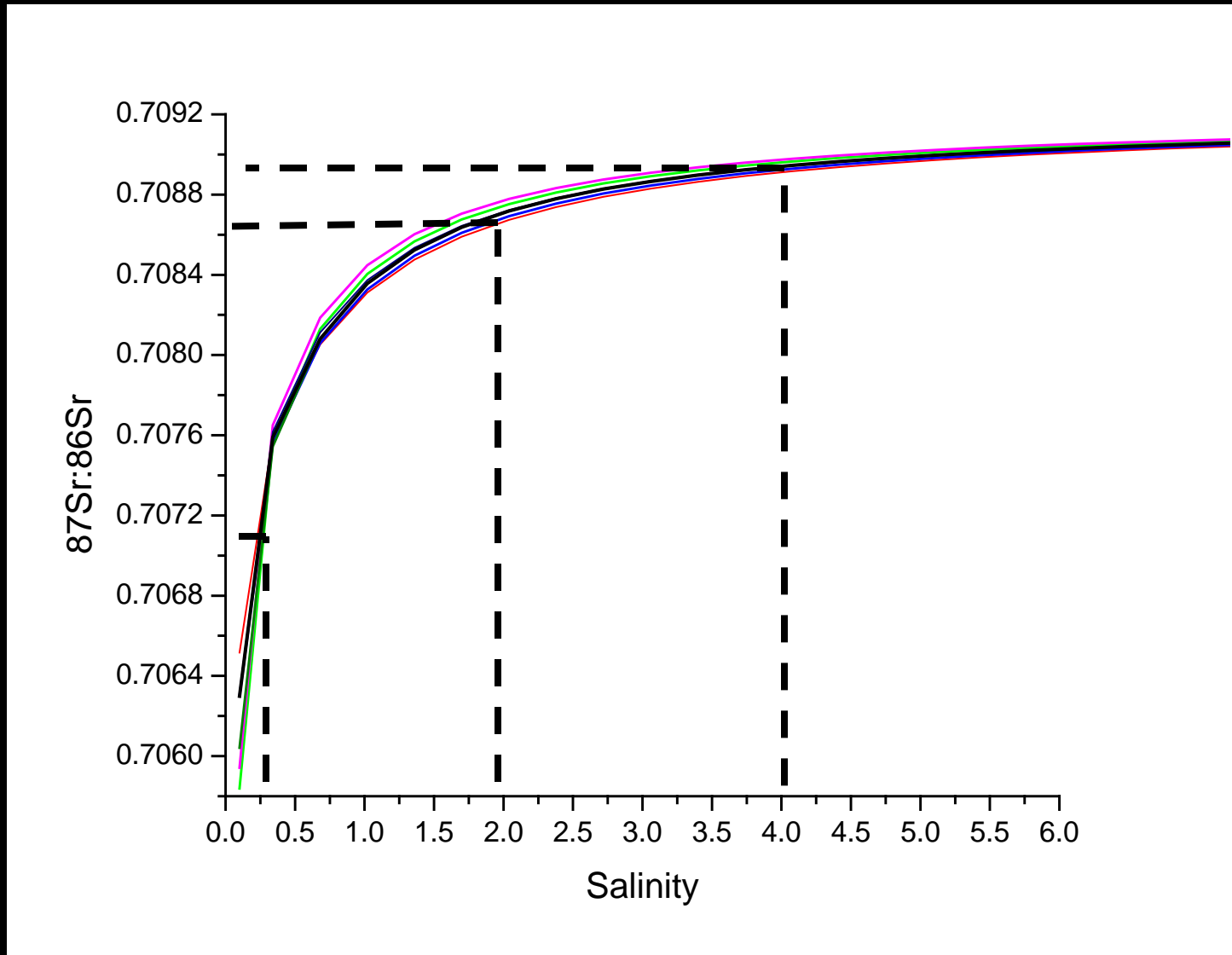


# Bay-Delta Isotope Map 2011

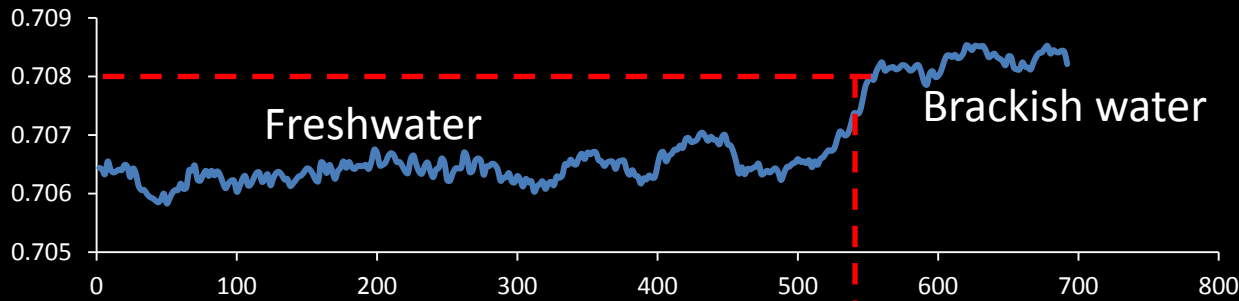


# Identifying fresh and brackish habitats

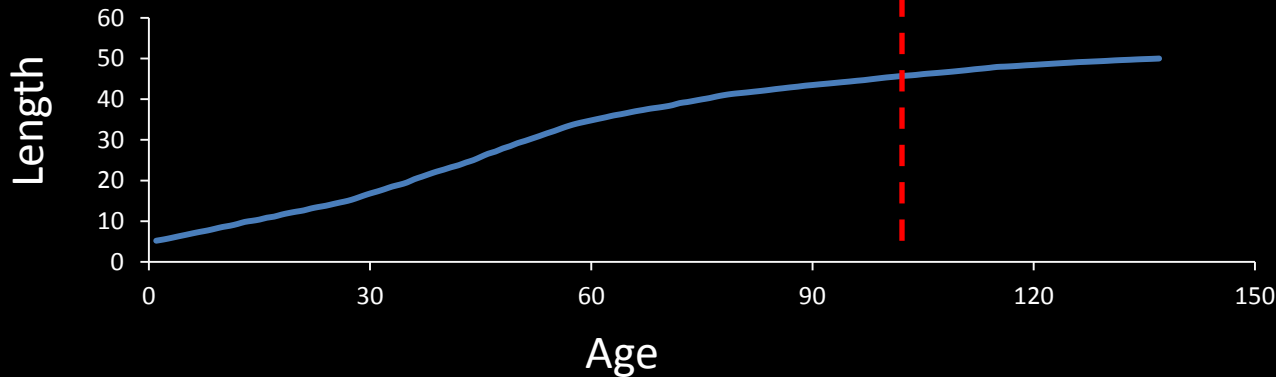
$^{87}\text{Sr}:^{86}\text{Sr}$  – Salinity Mixing Curve



# Life History Details

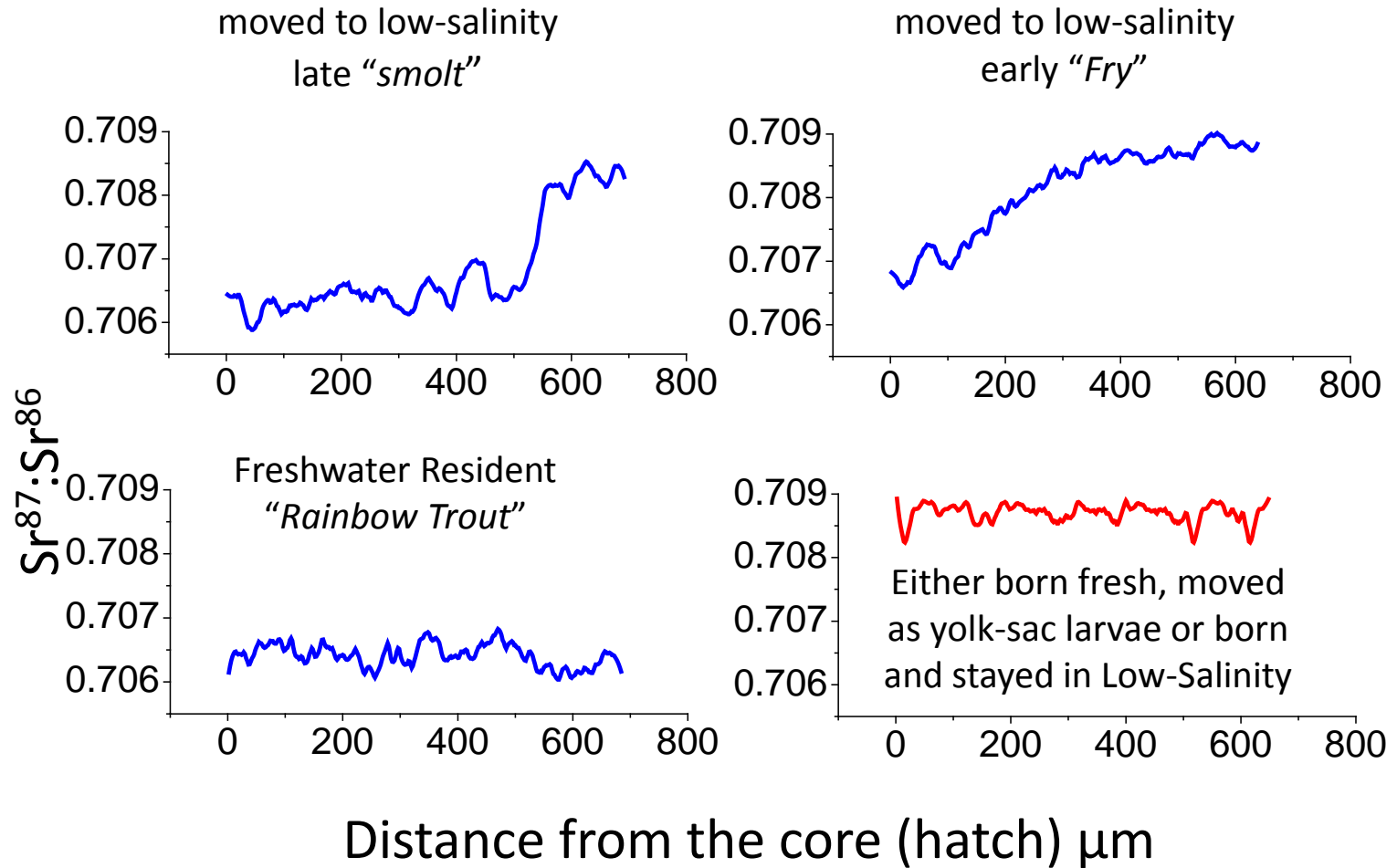


$^{87}\text{Sr}:^{86}\text{Sr}$  Profiles



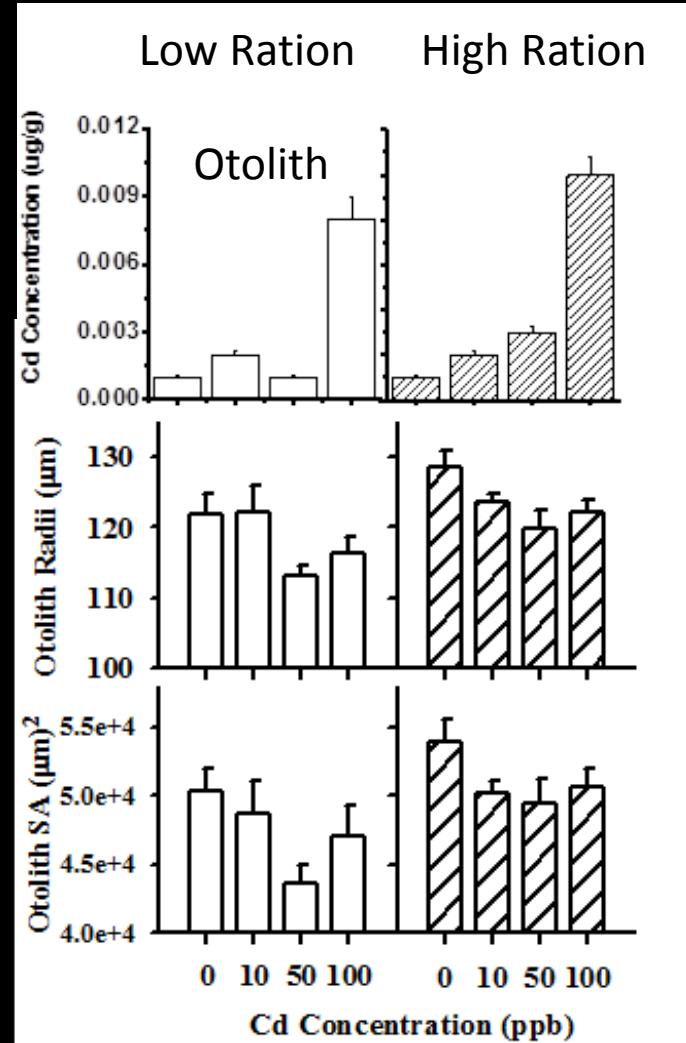
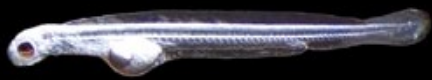
Back-Calculation  
of length-at-age

# Life History Diversity



# Otoliths as Biomarkers: Heavy metals

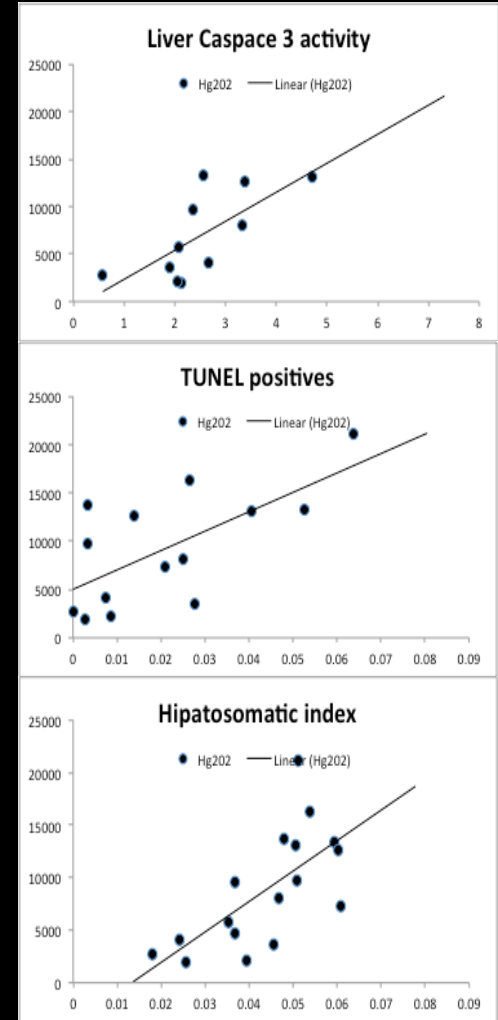
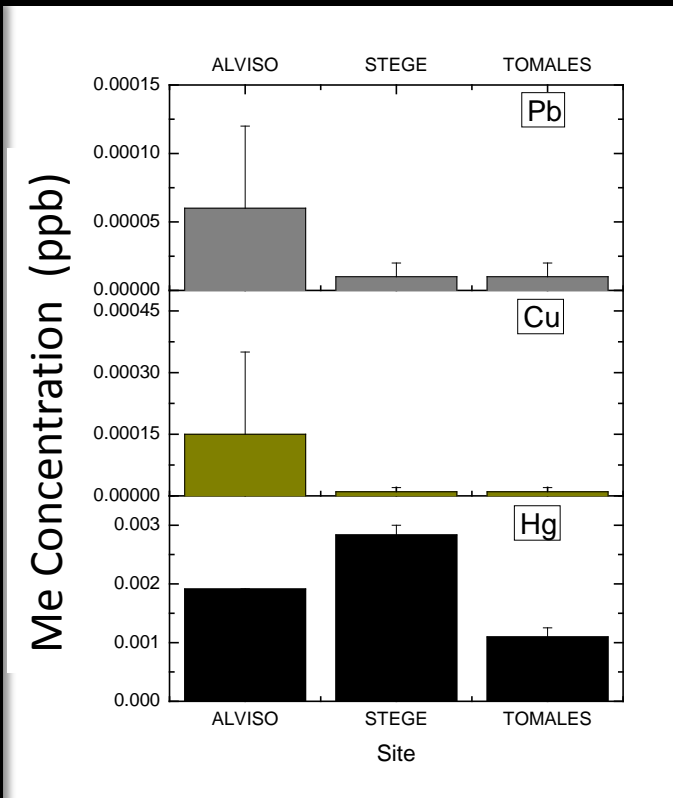
Cadmium effects on larval top smelt *Atherinops affinis*



<sup>b</sup>Rose, W.E., J.A.Hobbs, <sup>a</sup>R. Nisbet, <sup>f</sup>P.G. Green, <sup>a</sup>G. Cherr, <sup>f</sup>S. Anderson  
Validation of Otolith Growth Rate Analysis Using Cadmium-Exposed Larval Topsmelt. Environmental Toxicology and Chemistry, 2005, Oct. 5

# Otoliths as Biomarkers: Heavy metals

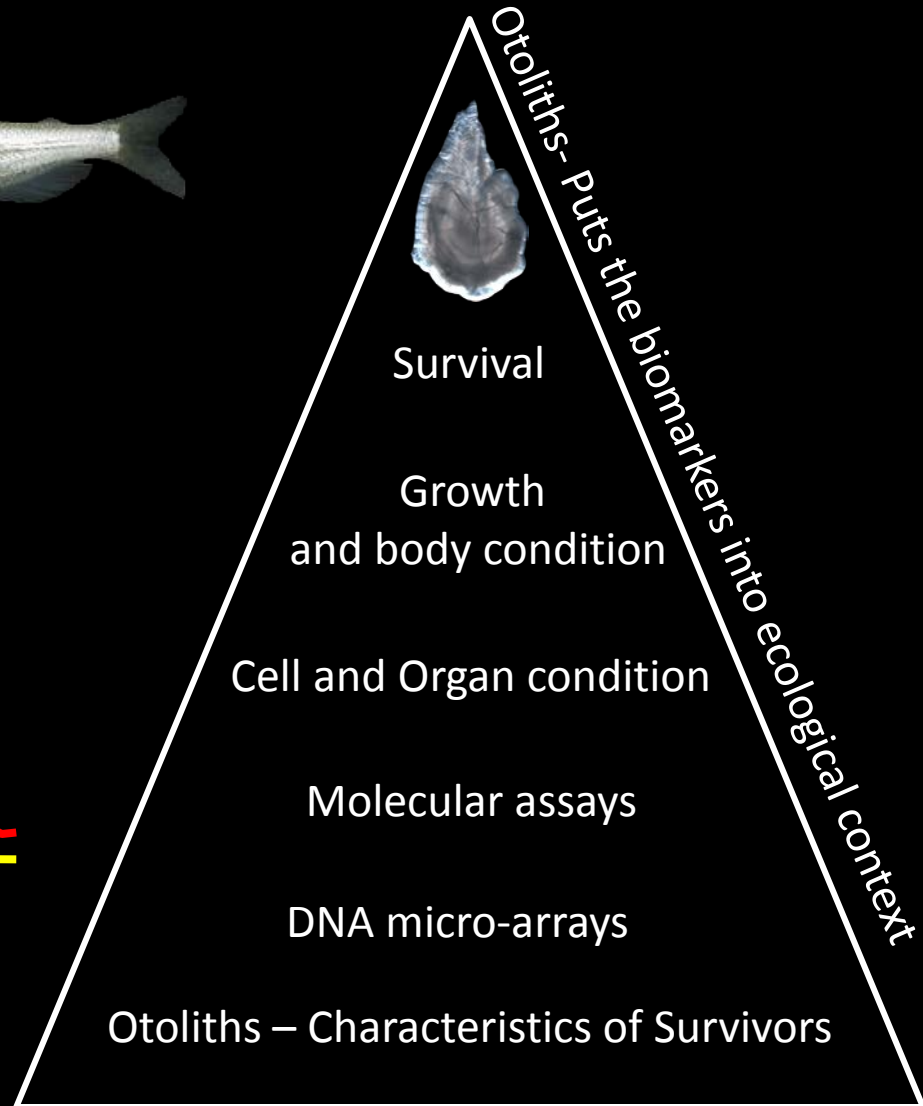
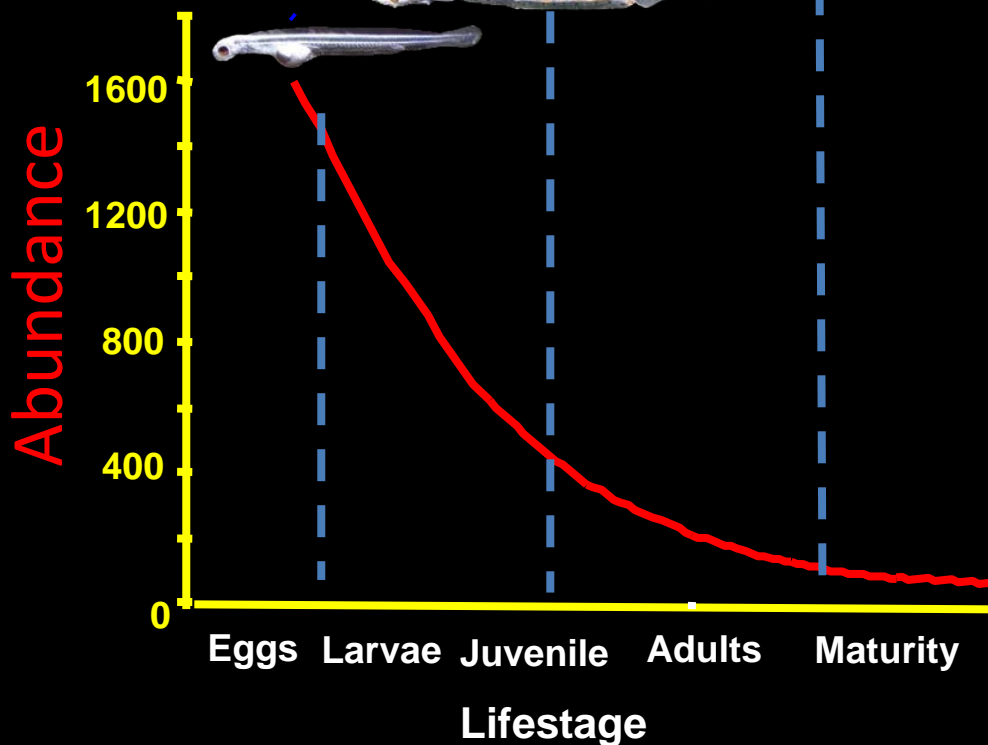
Toxic metals in *Gillichthys mirabilis* otoliths from site in SF & Tomales Bay



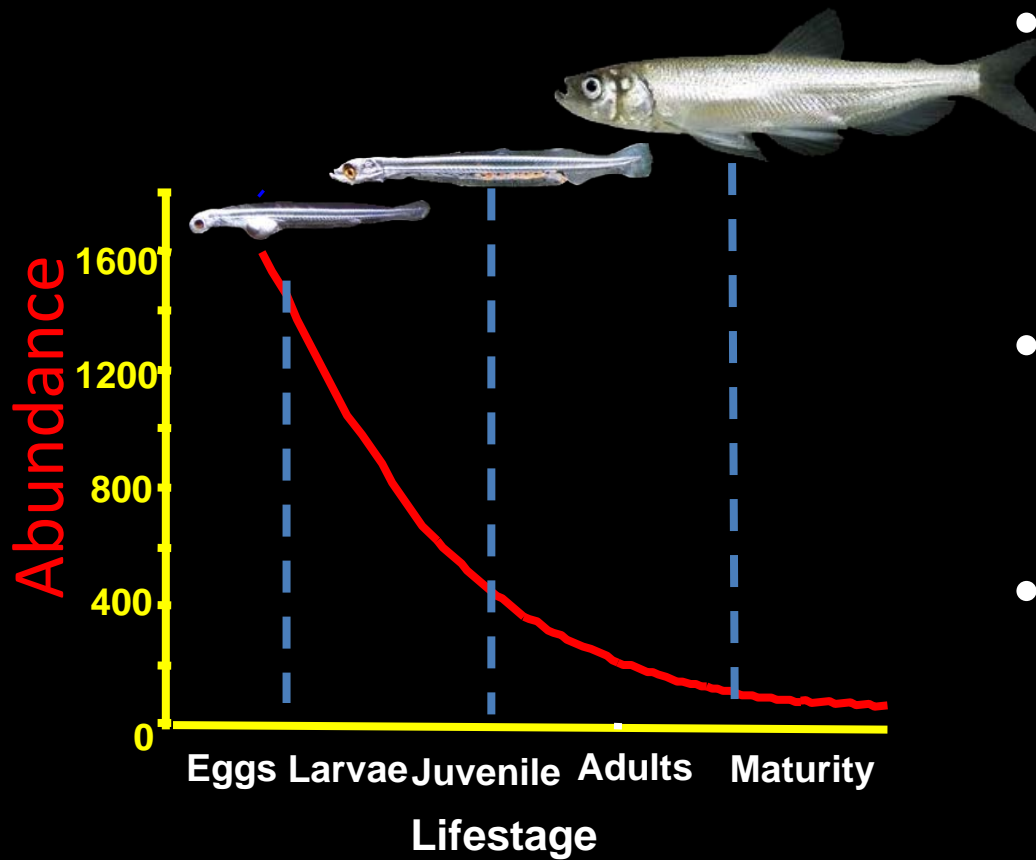


# Otoliths: The Keystone to Biomarker and Fish Health Studies

Snap shots in time  
of fish health



# Caveats to Biomarker Studies



- Biomarker assays are difficult to do on larvae, yet mortality is highest in this life-stage
- All too often we are examining fish that are the survivors
- Linking biomarkers to mortality in the field is impossible without an ecological framework

# Thanks for the Fishes

- The Ecosystem Restoration Program, Contract # E1183004
- IEP-BOR #R10AC20108,
- EPA-PEEIR Program #R828676
- The army of undergraduates of WFCB, Georgia Ramos, The Aquatic Health Program
- CDFG: Randal Baxter, Dave Contreras, Bob Fujimura, Julio Adib-Samii, Lauren Damon, Steve Slater, Tricia Bippas, Others