



# Integrating land, ocean, and atmospheric processes through threatened and economically important fish species—the case of Central California salmon

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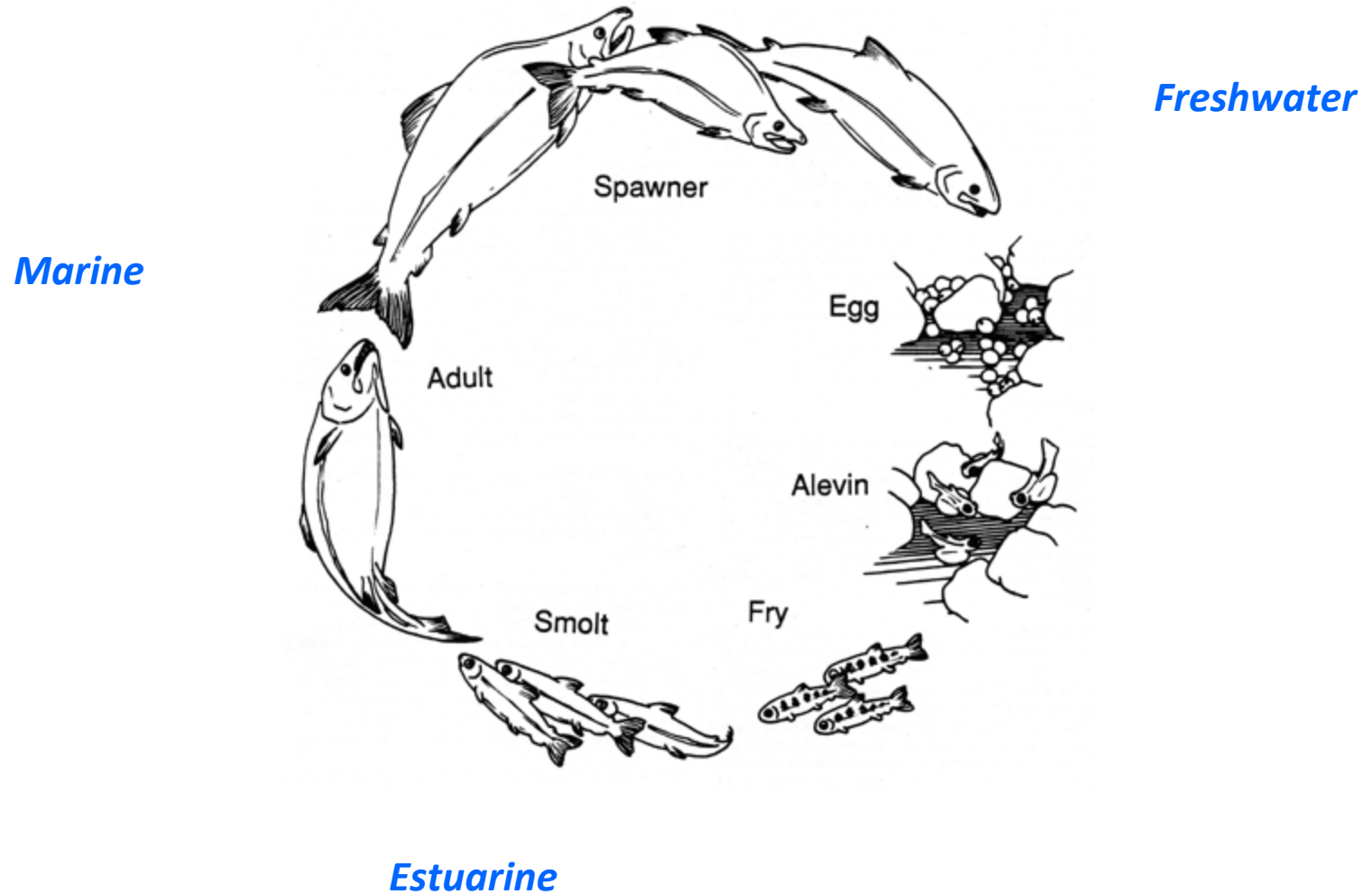
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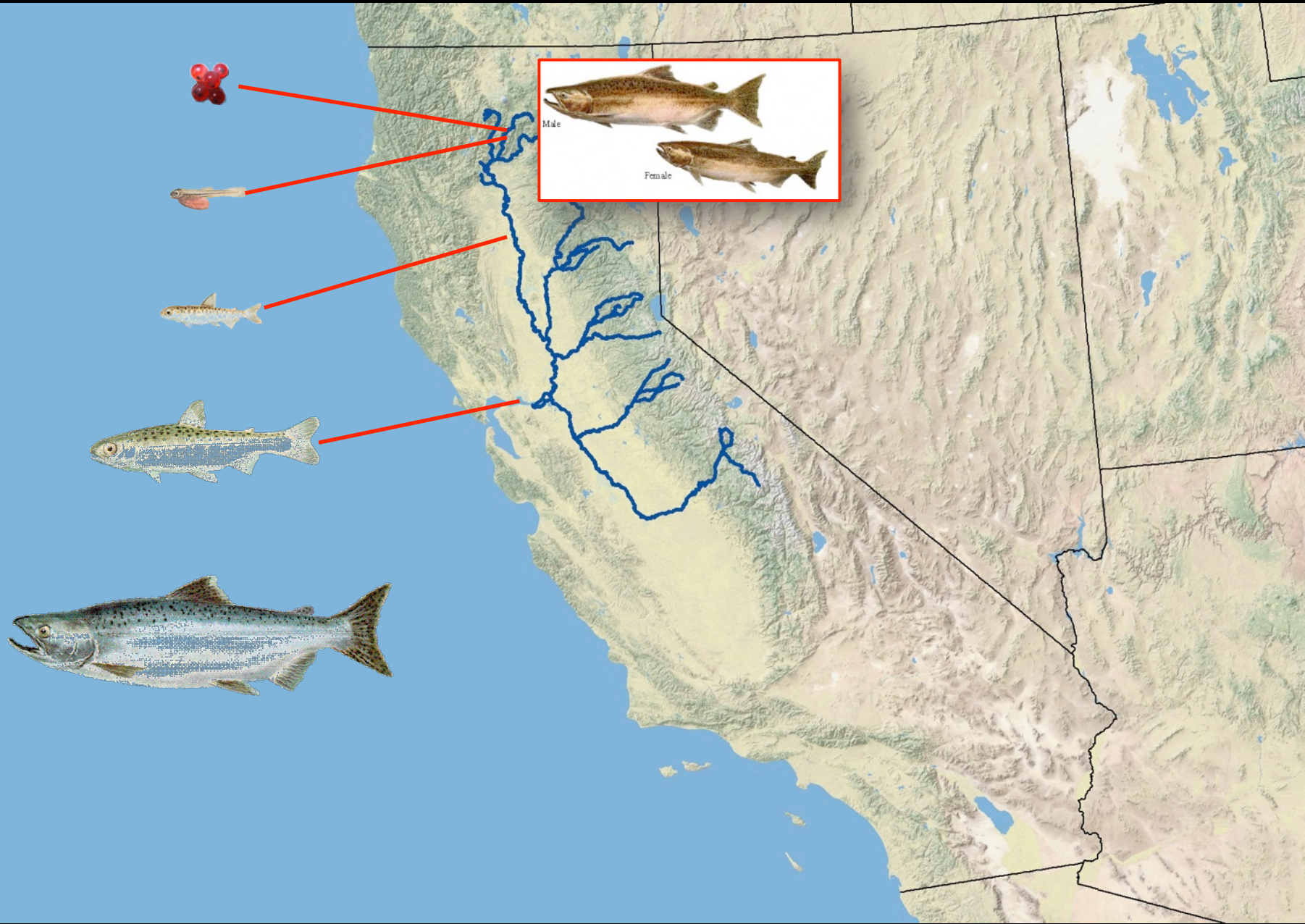
Morgan Hocking



# Salmonid Life Cycle



# Salmon Life Cycle



# Ecosystem Roles



# Environmental Influences

Cold, flowing water  
in streams and rivers

Flow, salinity, and  
temperature

Gulf of  
Farallons

Oceanographic conditions



# Anthropogenic Influences

Loss of habitat: logging

Major water projects

Fishing

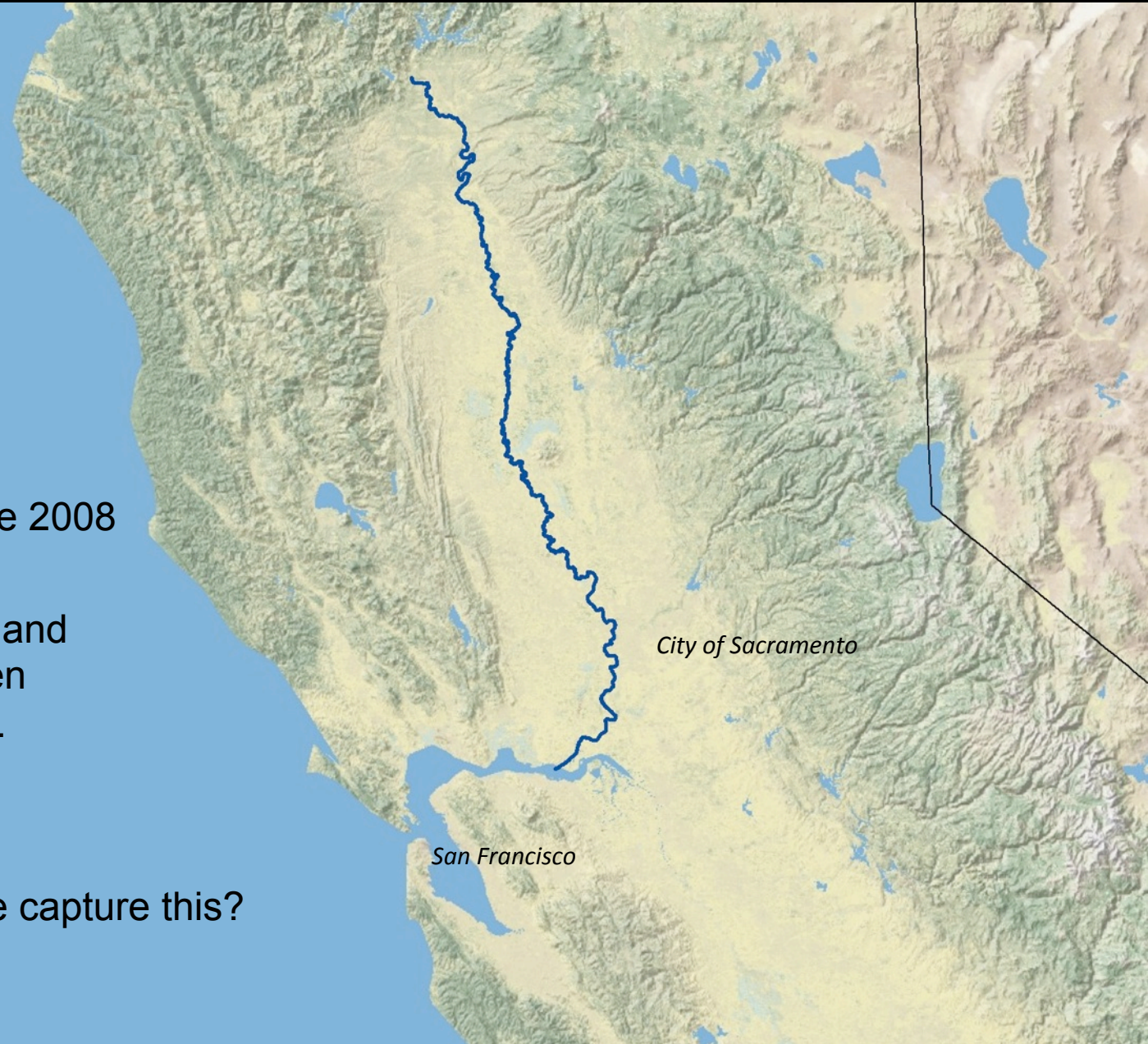


# Complex Landscapes

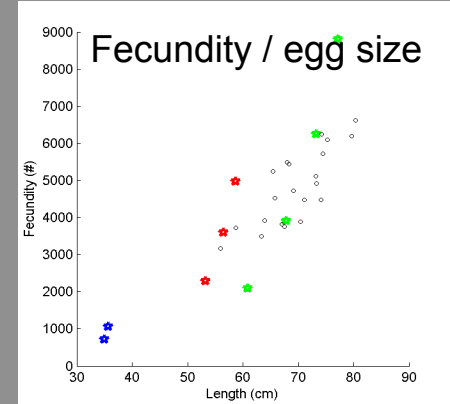
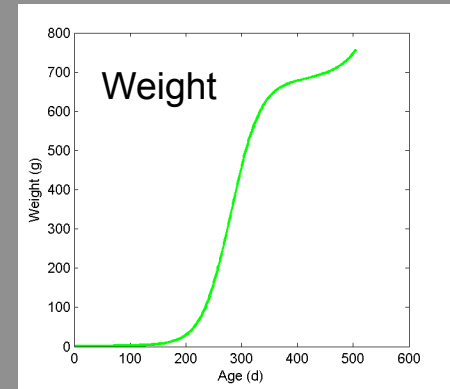
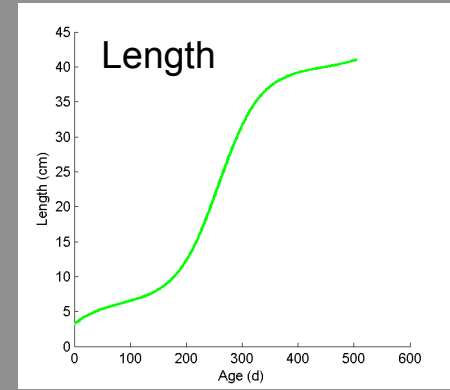
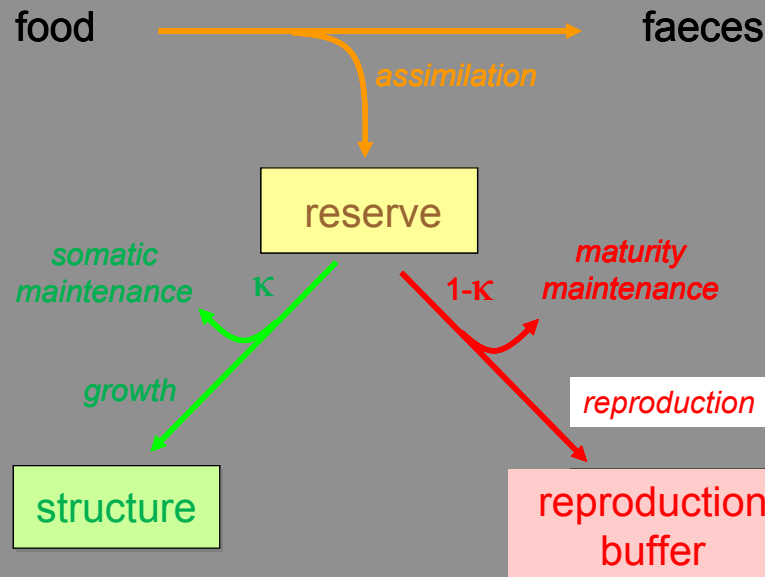
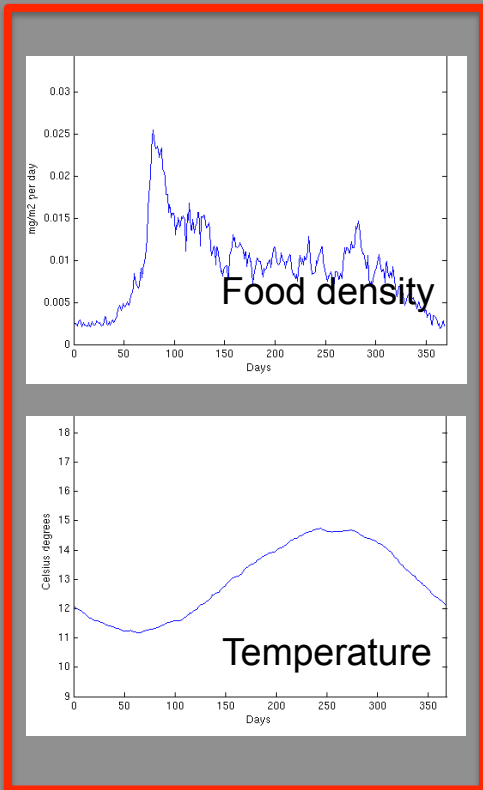
Salmon in decline,  
unprecedented closure 2008

Freshwater dynamics and  
the movement between  
complex landscapes...

...how can we capture this?



# Dynamic Energy Budget (DEB) models



INPUTS

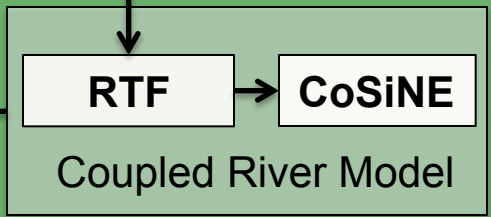
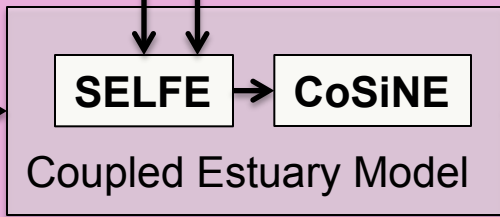
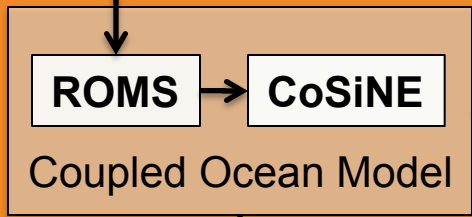
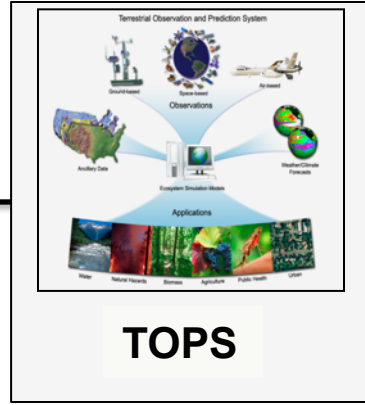
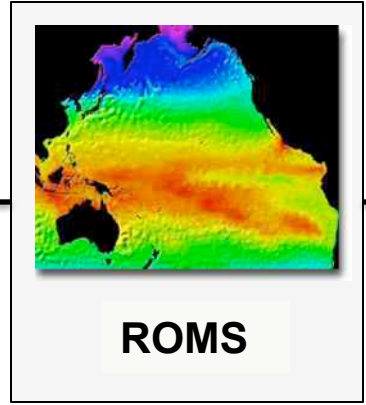
DEB MODEL

OUTPUTS



# Oceans

# Atmosphere & Land



3D temperature and salinity, water level, tidal fluxes

Water temperature and flow

*Coastal Ocean*

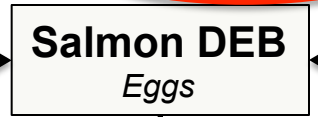
*San Francisco Estuary*

*Upper Sacramento River*

Water temperature  
Food

Water temperature  
Food

Water temperature  
Food

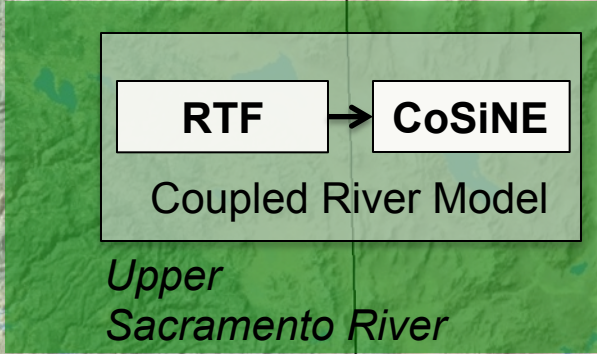


salmon growth and maturation

salmon growth and maturation

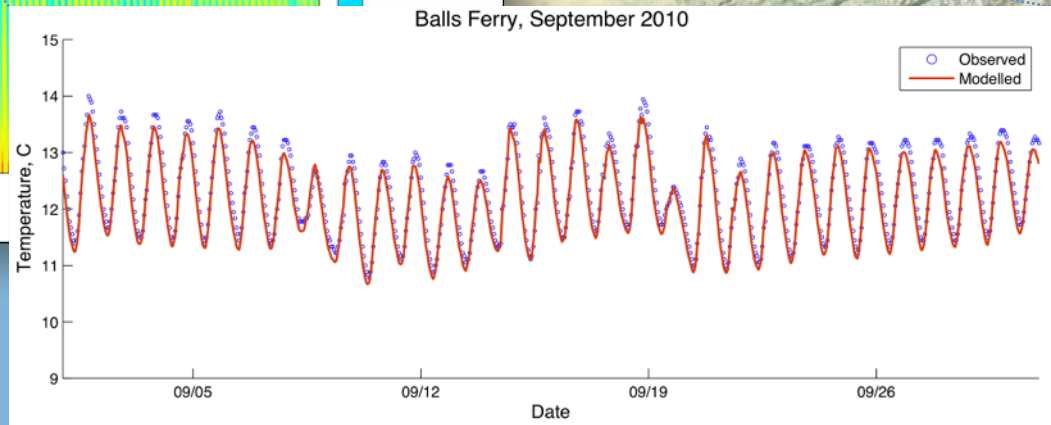
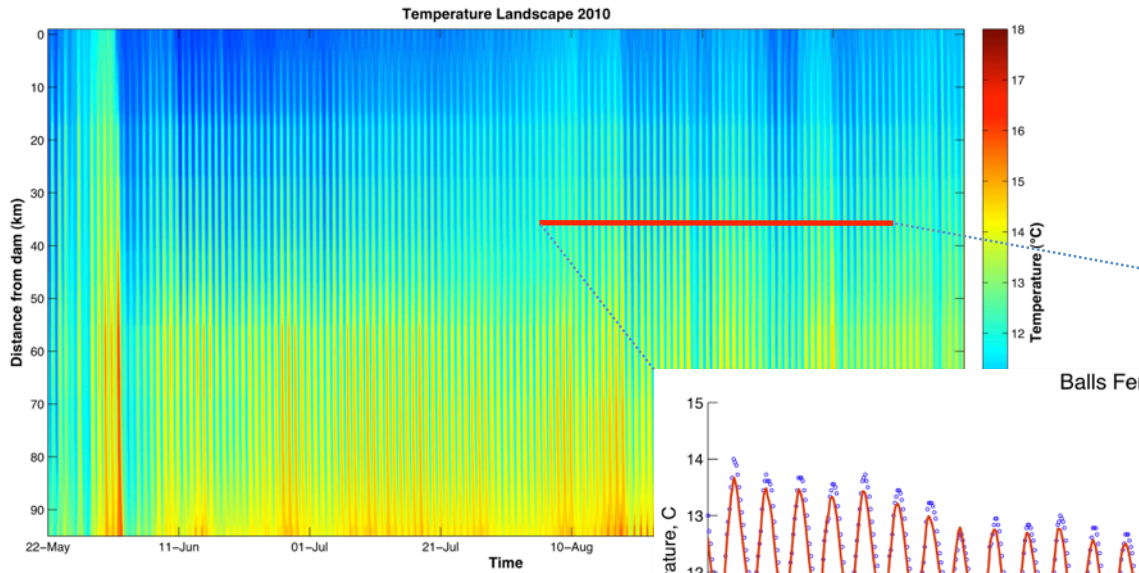
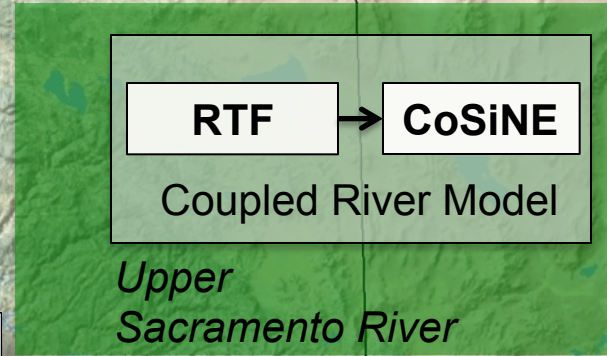


# River Models

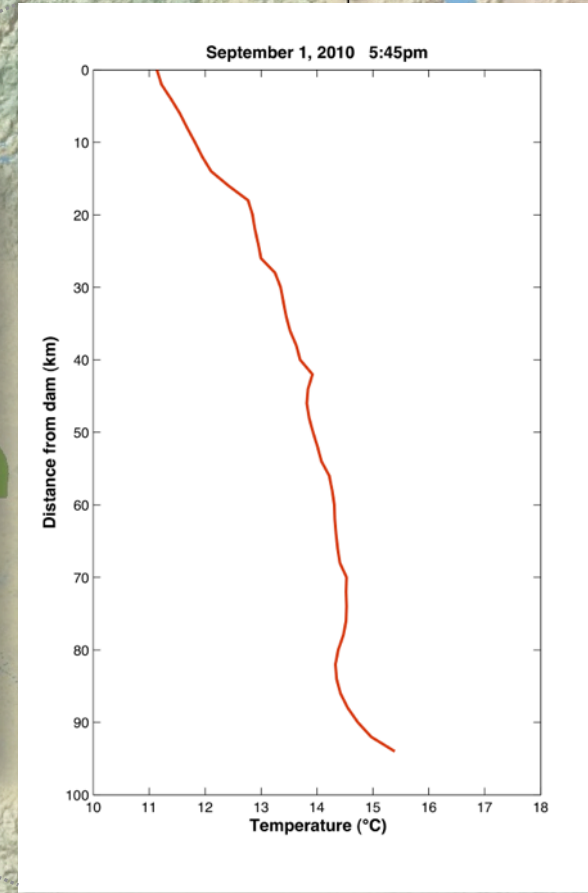
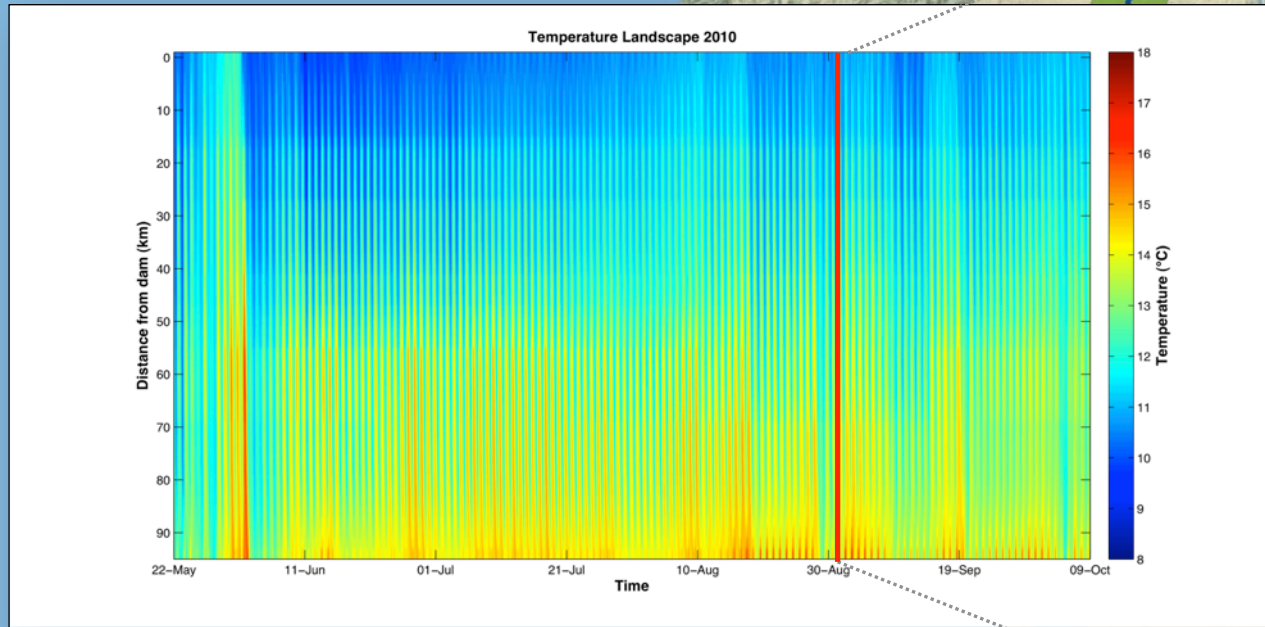


*City of Sacramento*

# River Models



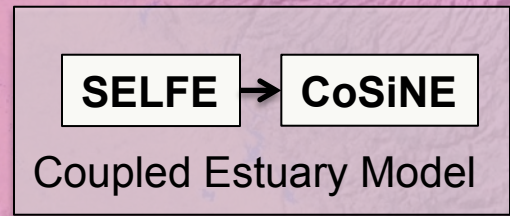
# River Models



# Estuarine Models



*City of Sacramento*



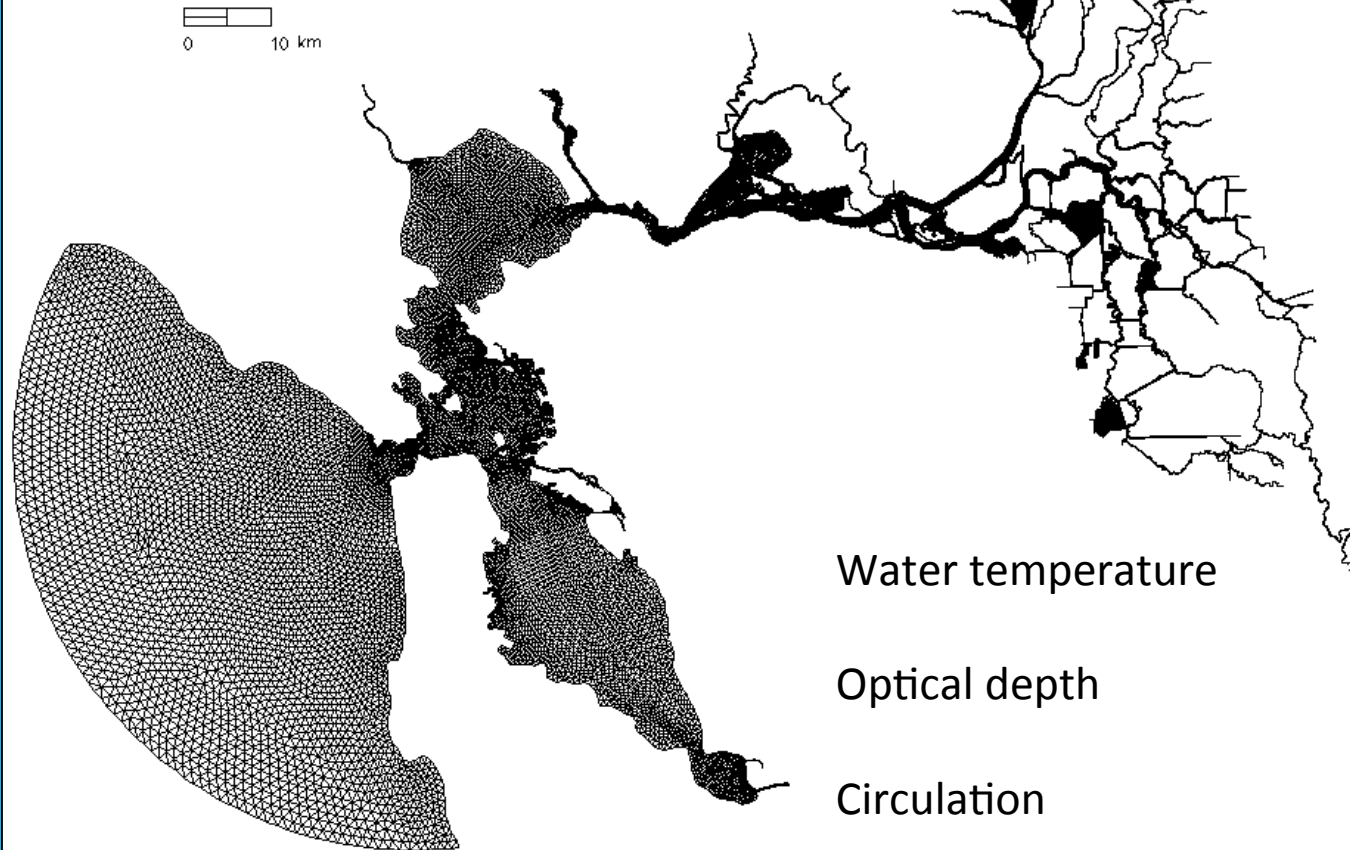
*San Francisco Estuary*

# Estuarine Models

Unstructured-grid model

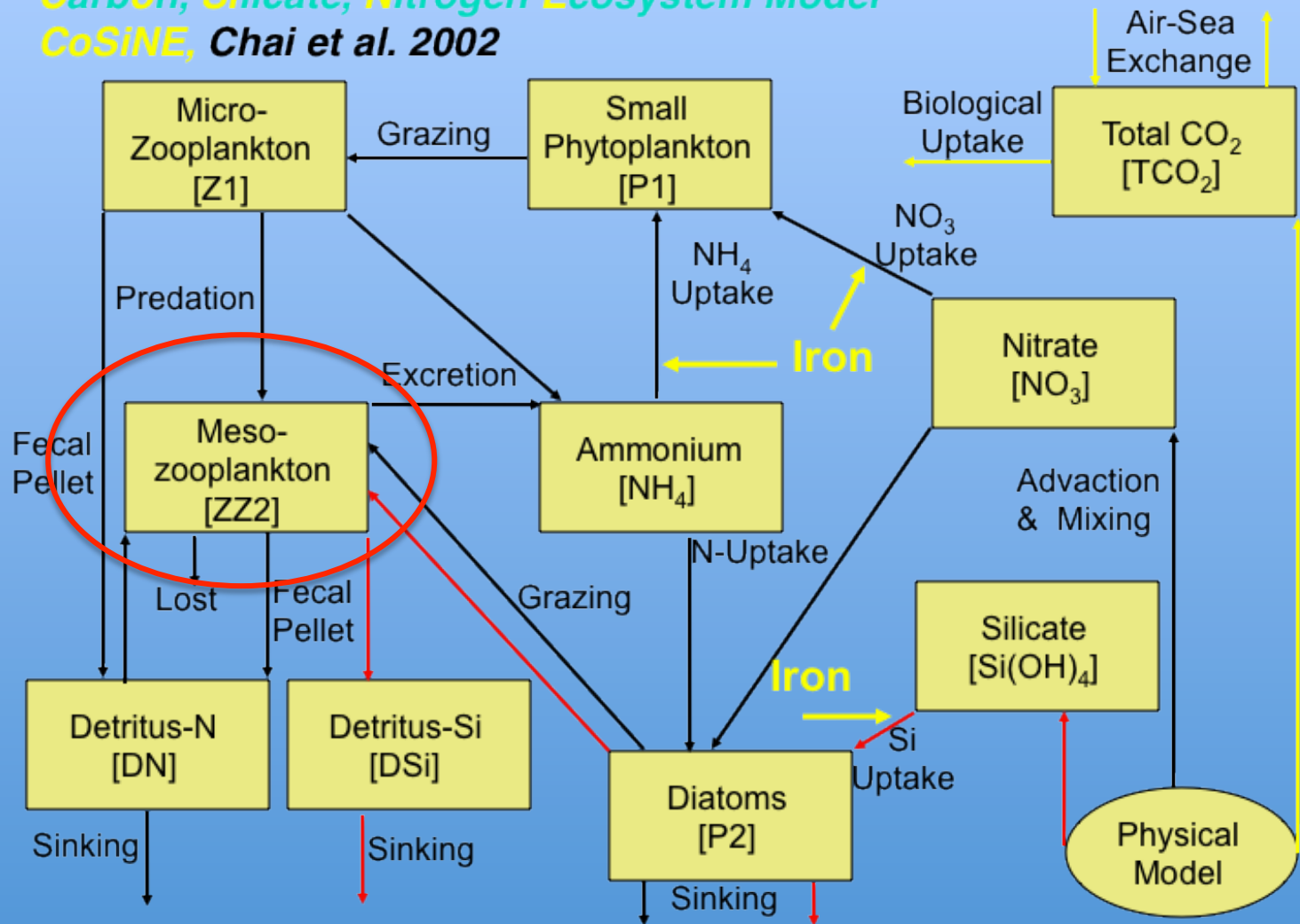
3-D baroclinic circulation

Forcings from TOPS: wind, heat flux and rainfall



# Modeling the estuarine environment (SELFE-COSINE)

*Carbon, Silicate, Nitrogen Ecosystem Model*  
*CoSiNE, Chai et al. 2002*

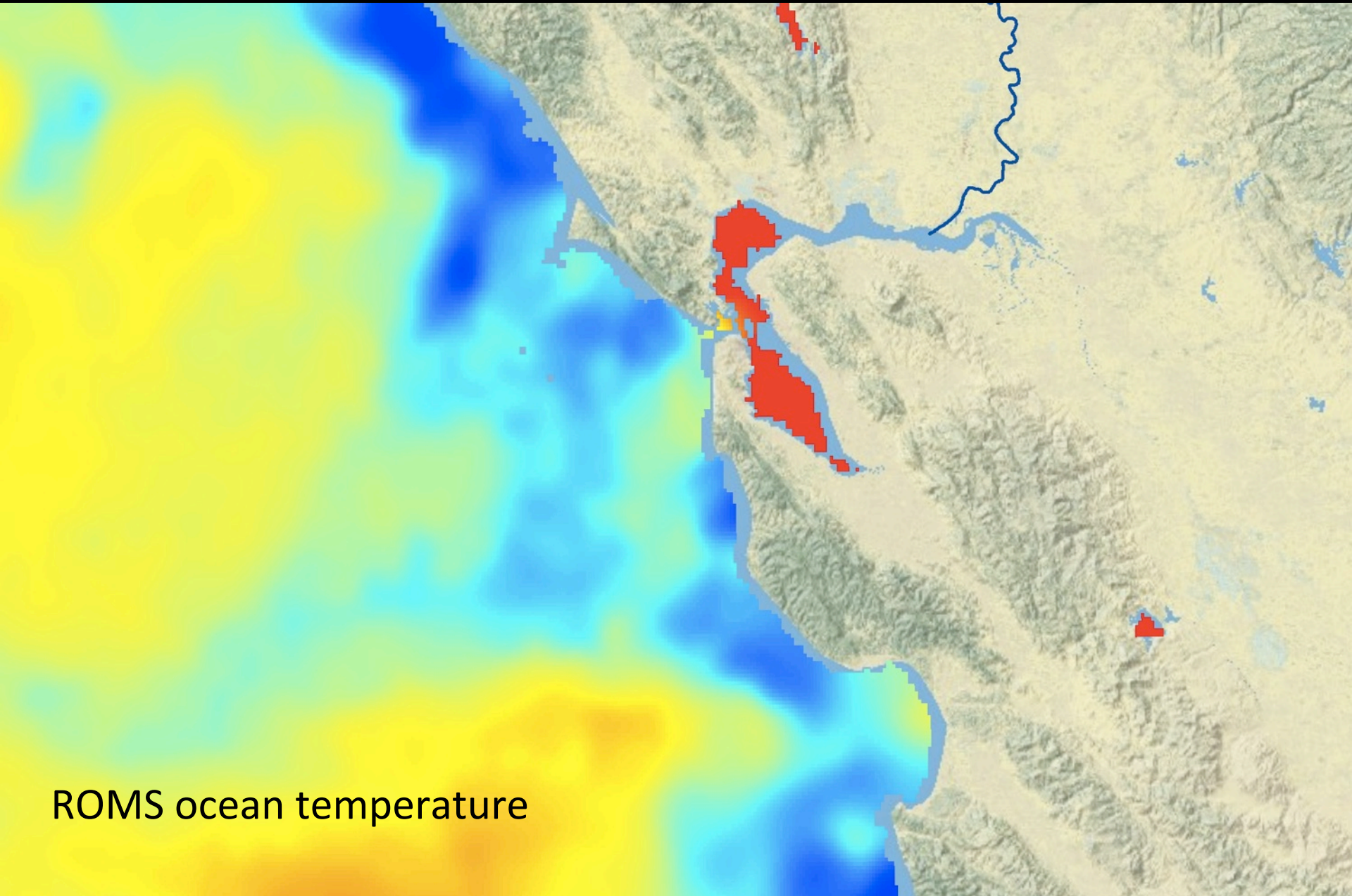


# Ocean Models





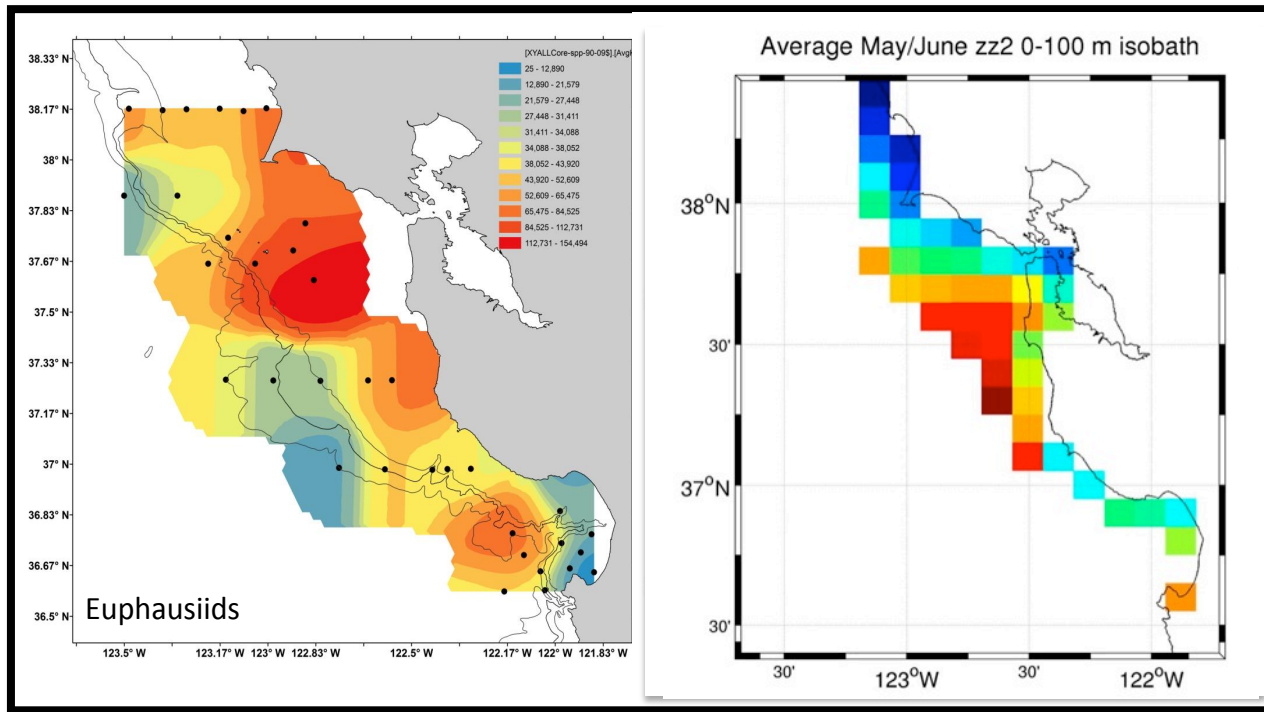
# Ocean Models



ROMS ocean temperature

# Food density – linking ROMS and CoSiNE

Relationship between mesoscale environmental forcing, krill and salmon



Observed

CoSiNE

# Summary

Salmon are important ecologically and economically, from rivers, estuaries, to the ocean - and carry the legacy of effects from system to system

Goal: improve our understanding of how salmon are affected by freshwater dynamics as they grow from eggs to mature adults while moving across these complex landscapes

DEB models integrate across variable environments

A tool to examine how salmon might respond to novel climate conditions

This project integrates data from two key NASA models, TOPS and ROMS, at the land-sea interface



Thank you.

**Improving Stream Temperature Predictions for River Water  
Decision Support Systems**

**Utilizing ecosystem information to improve the decision support  
system for central California salmon**

**From the watershed to the ocean: Using NASA data and models  
to understand and predict variations in central California  
salmon**



