Welcome to the Conservation Lecture Series

www.dfg.ca.gov/habcon/lectures

Questions? Contact margaret.mantor@wildlife.ca.gov

Lecture Schedule

Rare Plants in Pine Hill, Dr. Debra Ayres
January 22, 1:00-3:00, Sacramento
Bighorn Sheep, Dr. Jeff Villepique
February 4, 1:00-3:00, Ontario
Tricolored blackbird, Dr. Robert Meese
February 4, 1:00-3:00, Sacramento
Invasive Watersnakes, Dr. Brian Todd
March 12, 1:00-3:00, Sacramento
White-nose Syndrome in Bats, Dr. David Wyatt
April 14, 12:00-1:30, Sacramento

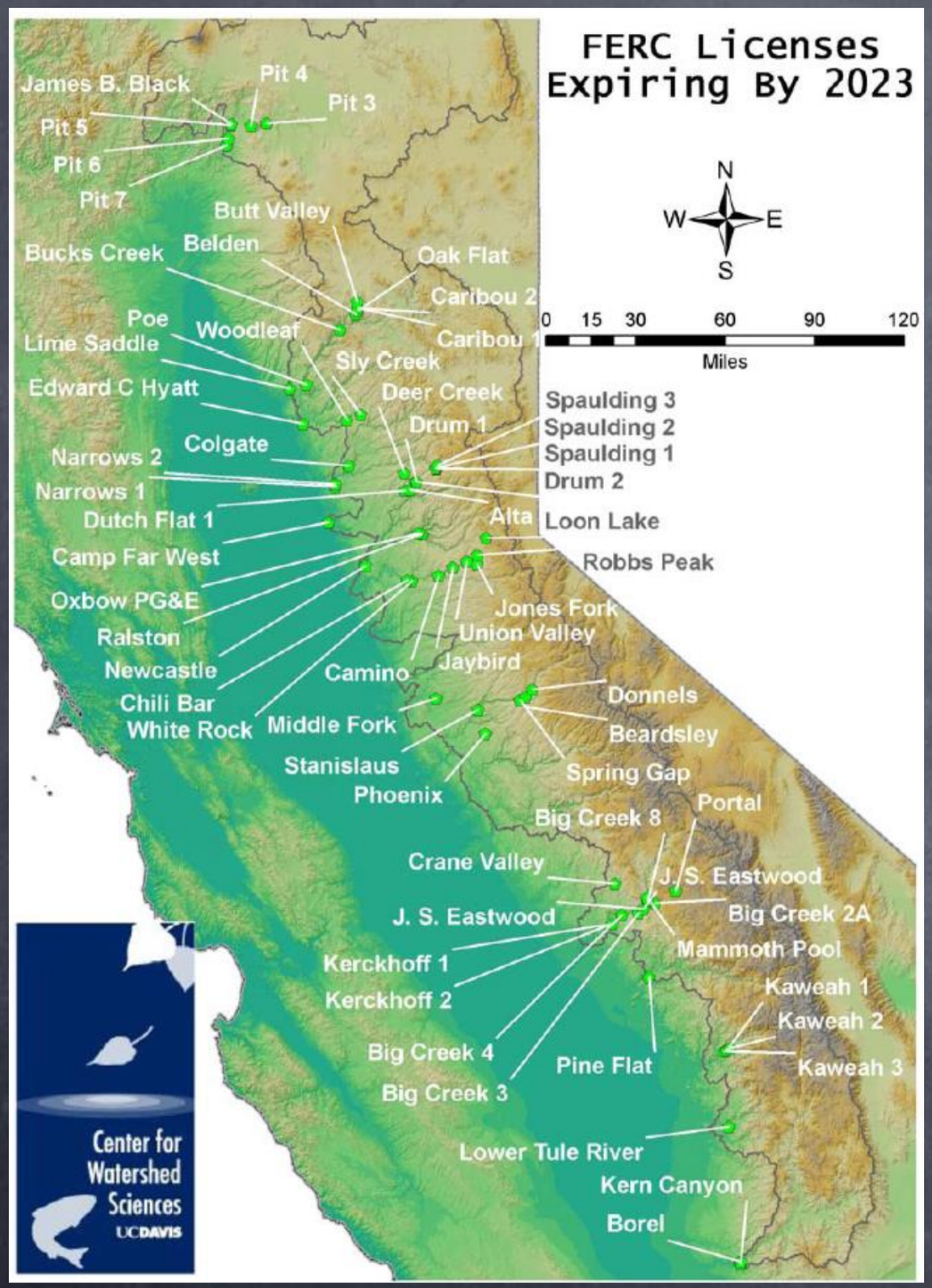
From algal food-web ecology to dam management: Connecting the dots one tadpole at a time

Sarah Kupferberg, McBain Associates

Scott McBain, Steve Bobzien, Alessandro Catenazzi, Joe Drennen, Paula Furey
Amy Lind, Wendy Palen, Mary Power, Sarah Yarnell
SFPUC, California Energy Commision


• 15% of California’s electricity from hydropower
• CA >2x the dams of any other state
• Highest biodiversity in the US
• Mediterranean climate supply in winter, demand in summer

Water-power-environment conflicts

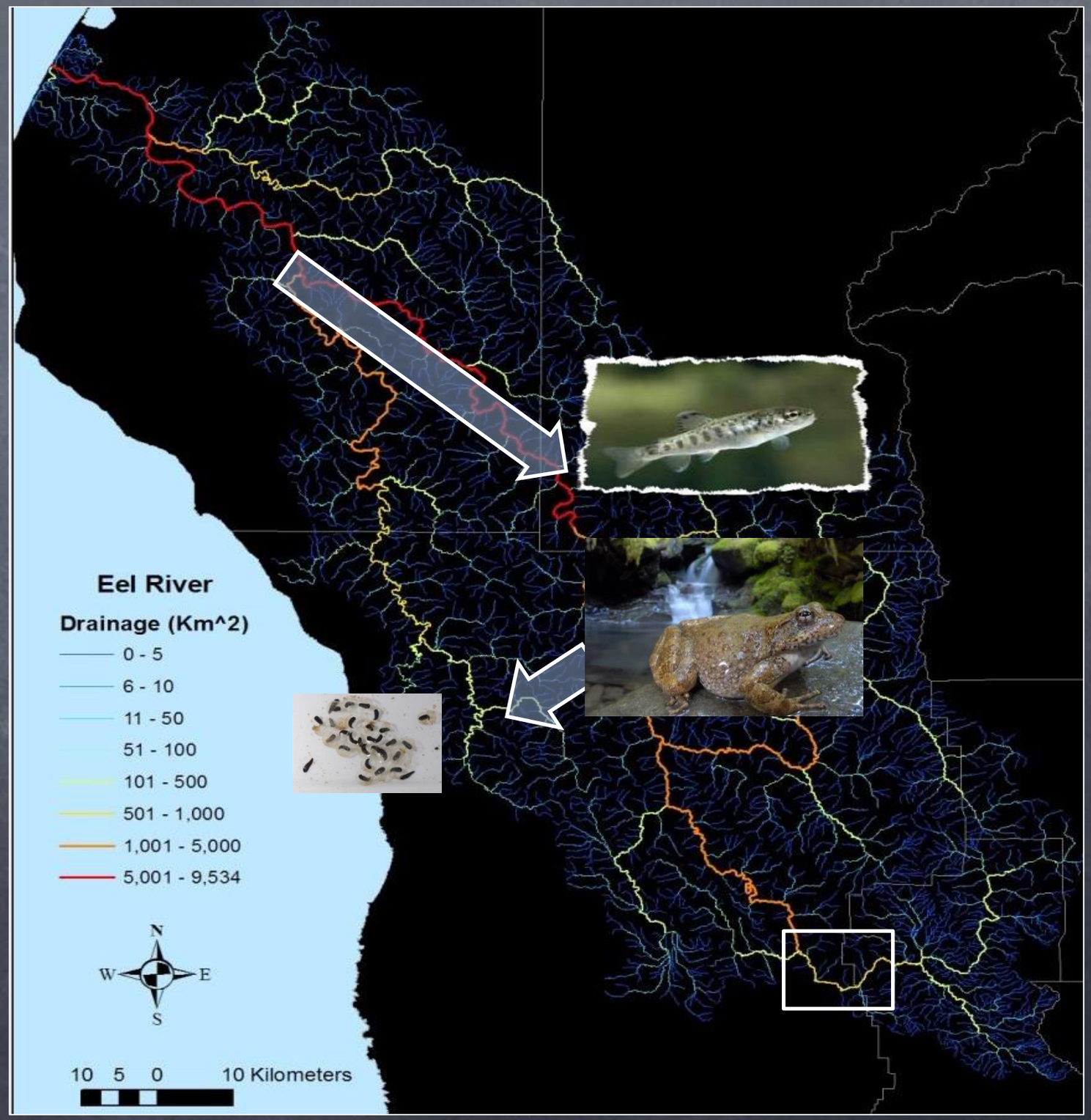


Viers et al. 2007

- Many large projects being relicensed
- Competing demands for water
  - Utilities, municipal water districts, agricultural users, recreational boaters, sport fishers, commercial and native salmon fishers, wildlife
- Opportunity for science to inform
  - Large-scale water policy
  - Long term 30+ yrs impact

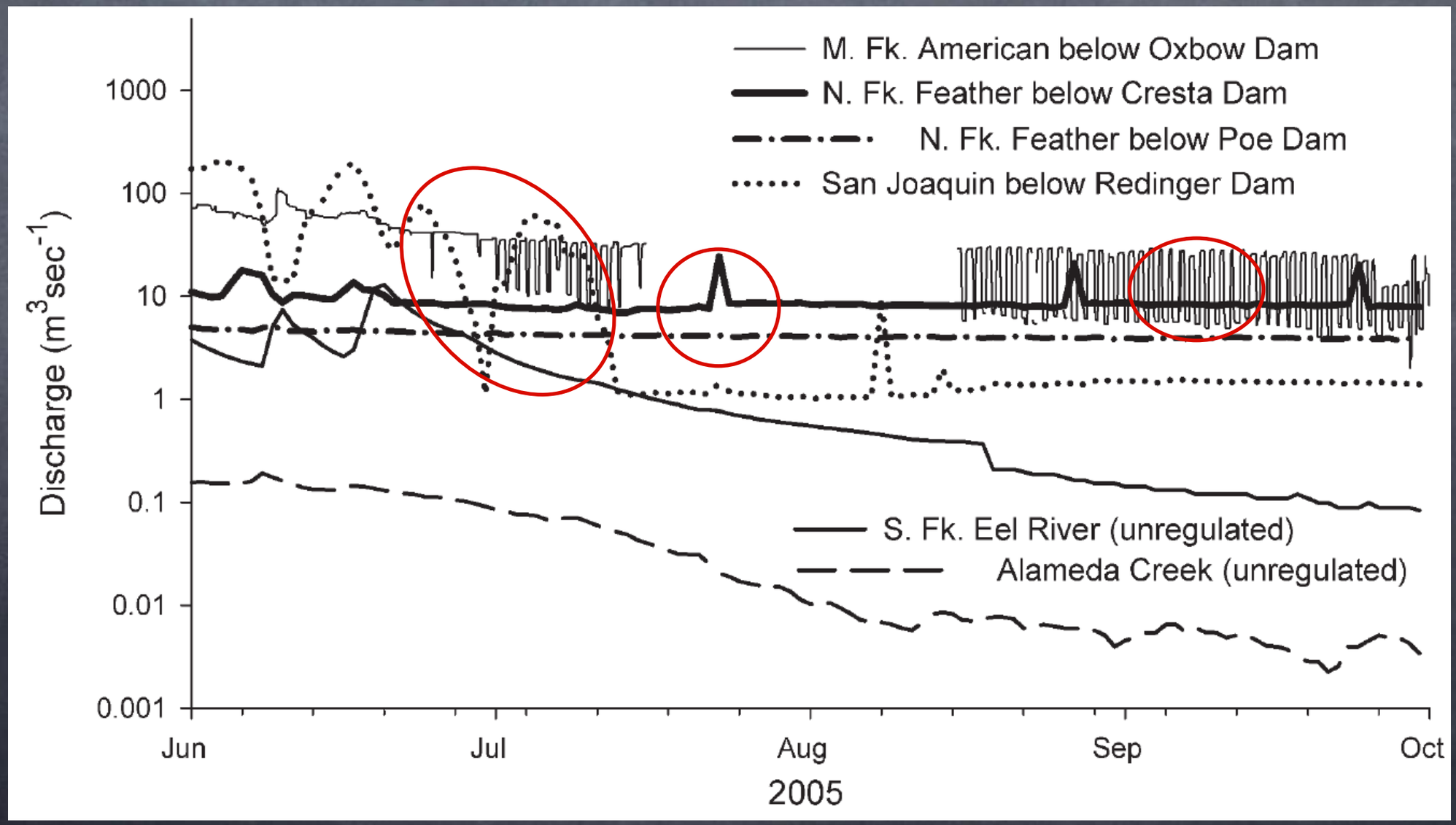
Example of conflict: dams block fish migration

- frogs move opposite direction of salmonids
- Frogs vs. fish when migration blocked



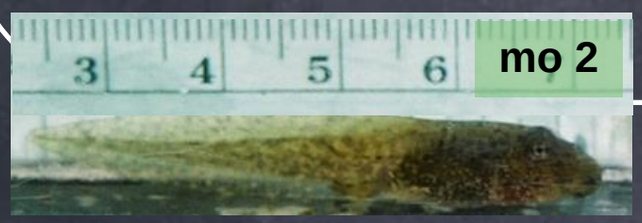
Altered versus natural flow regime

- flat line
- pulsed flows for boating
- power peaking
- rapid cessation of spill



MISMATCH impaired conditions / adaptations

Aquatic, vulnerable to flow fluctuation



Amphibious, Resistant

Recapture of NF Feather female by Garcia & Assoc indicates **longevity ≥ 12 yrs**

Initial Capture 5/29/2004

3/1/2005

4/20/2007*

5/21/2008

6/28/2009

5/10/2012

Hydrologic alteration has impacts across scales

small ⟷ large

Spatial Scale

Stage-based hydro impacts
(minutes -months - yrs)

Individual population trajectories (5-20 yrs)

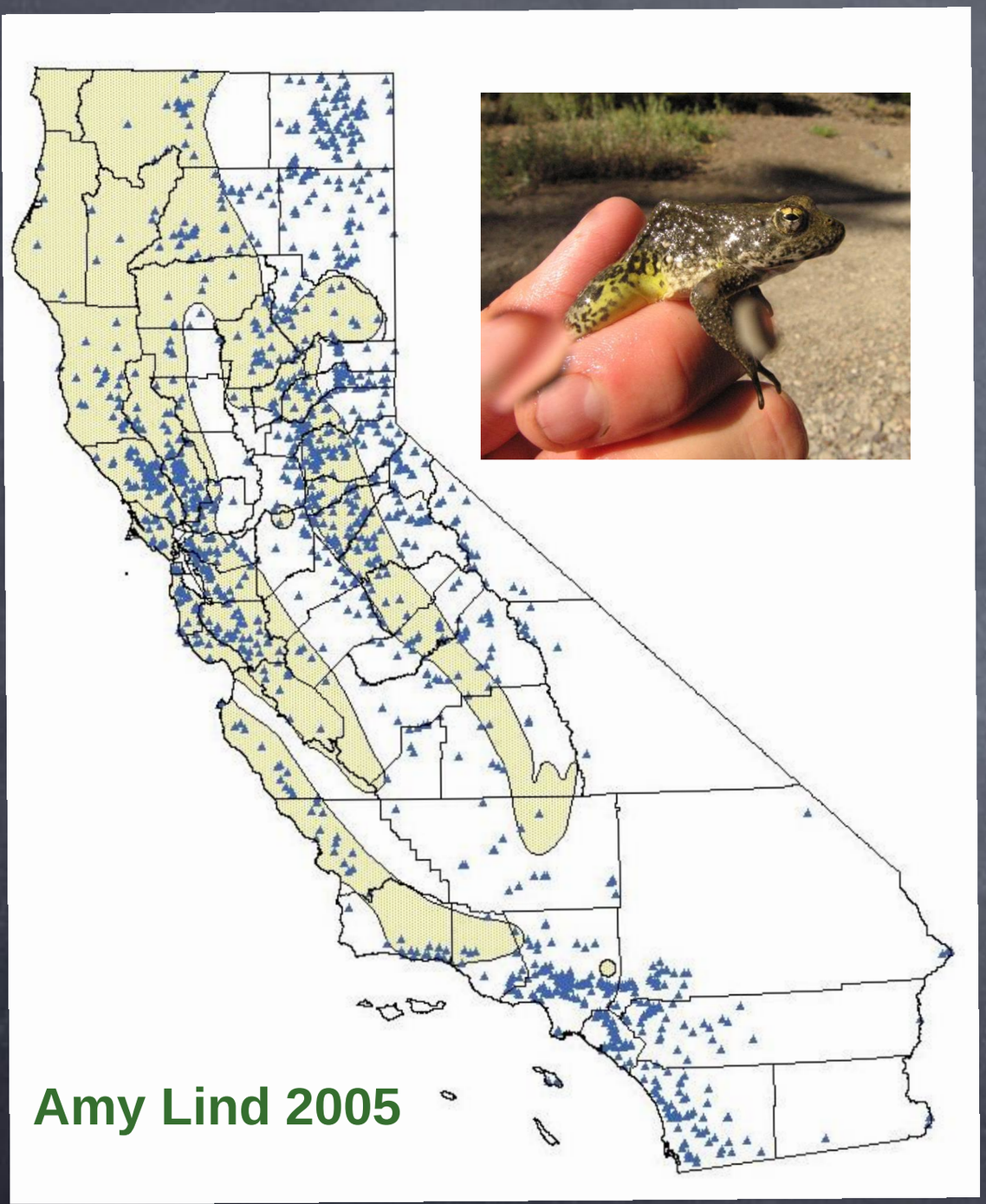
- time series analysis

Range-wide changes (25-50 yrs)

- historic vs. modern status

- average density reg vs. unreg

Range-wide changes over 50 yrs.



Amy Lind 2005

Evaluated modern status compared to known historic locations

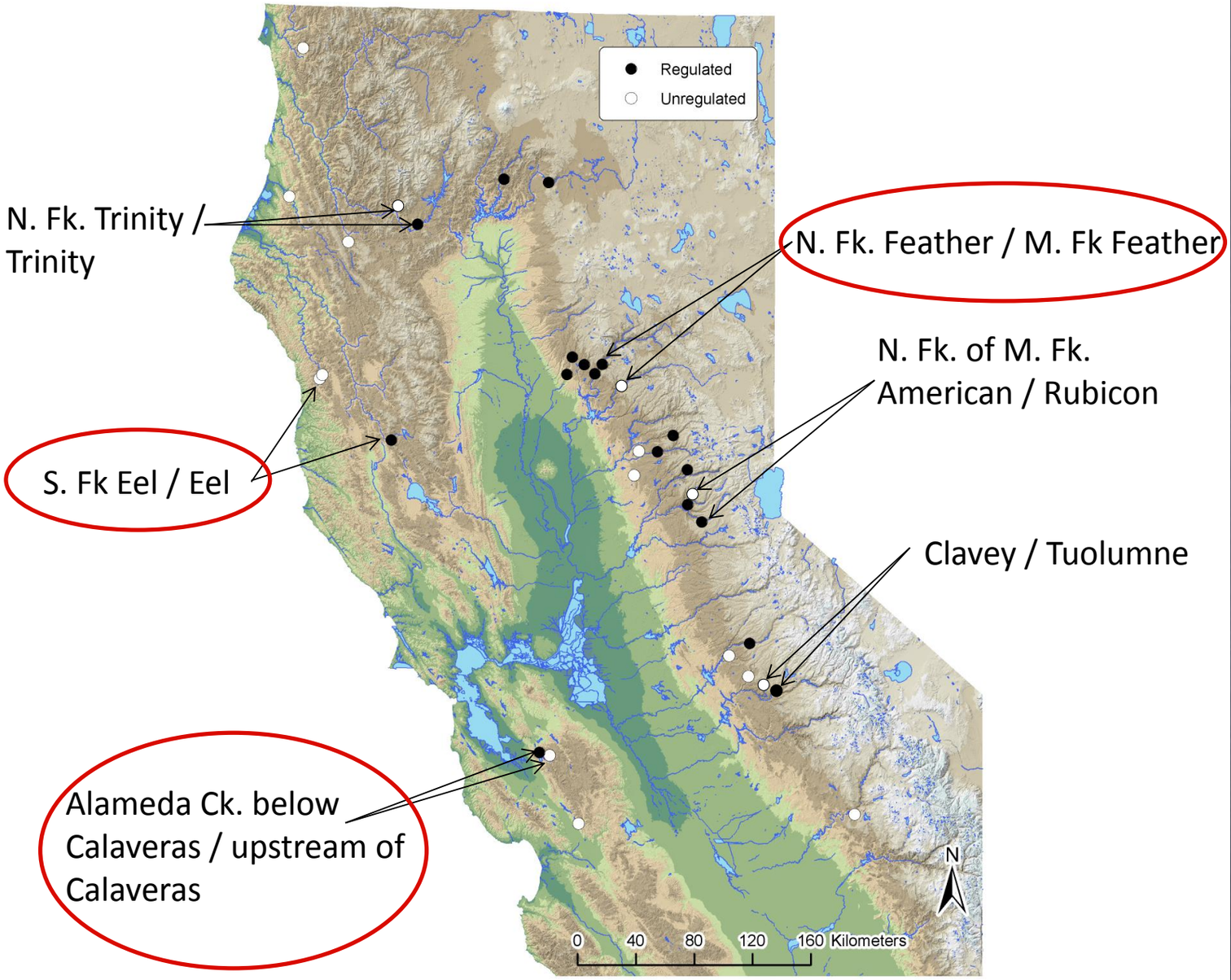
- -Landscape features
- -Dam attributes (e.g. size, distance, number)

Absent from >50% of historic sites

Absent localities had:

- **more large dams upstream ($p<0.1$)**
- **greater height of dams ($p<0.05$)**

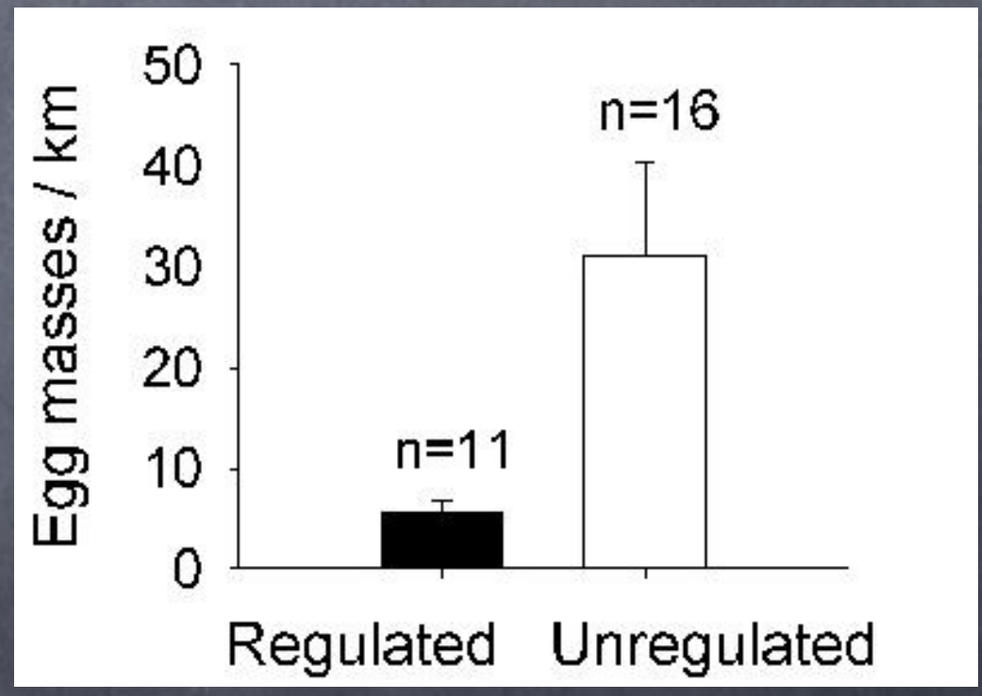
Population density and trends
Regulated vs Unregulated



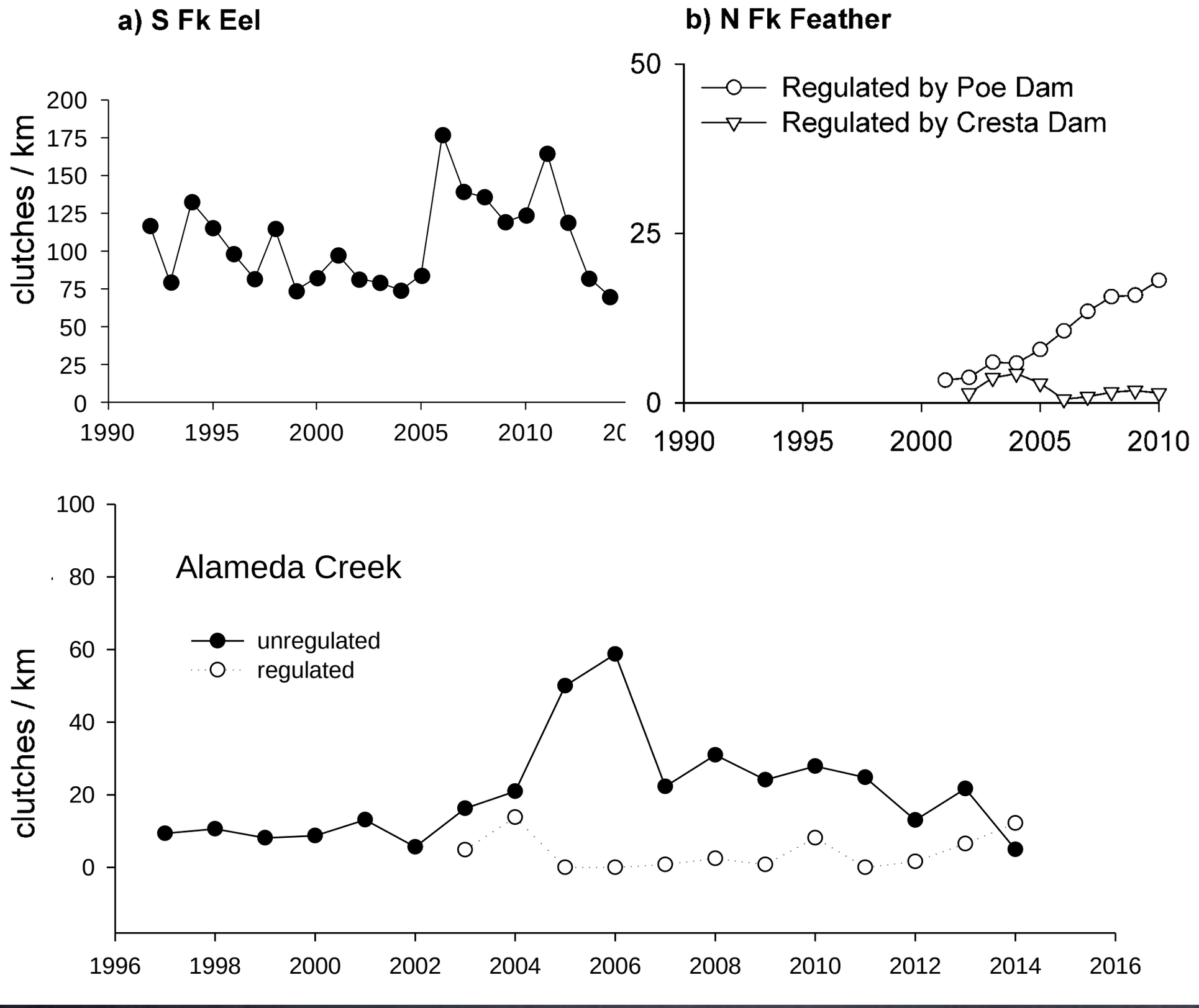
Compiled breeding survey records for 27 populations

-compared average #/km

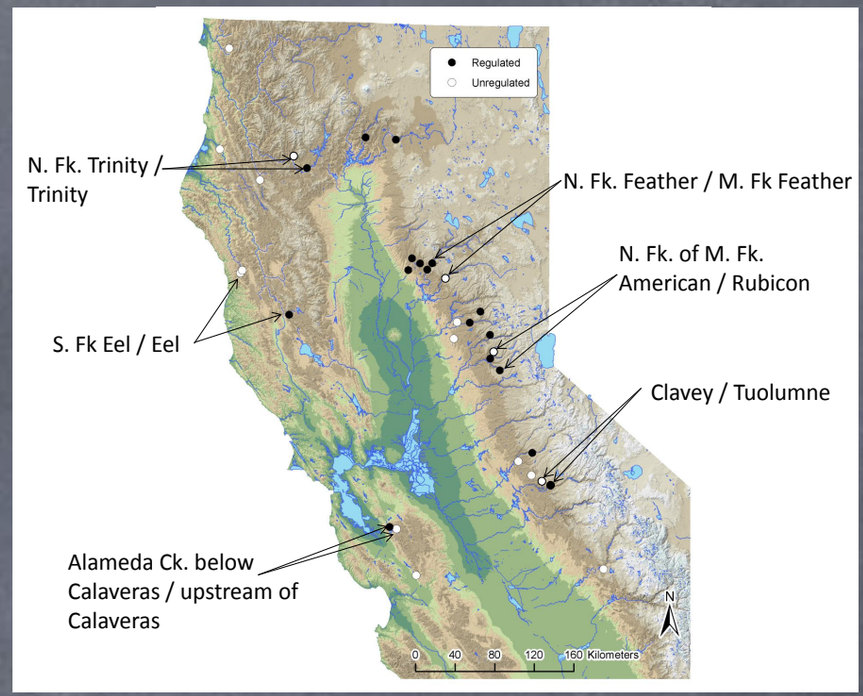
-monitored temperatures in 6 locales



Population trends in relation to multiple stressors

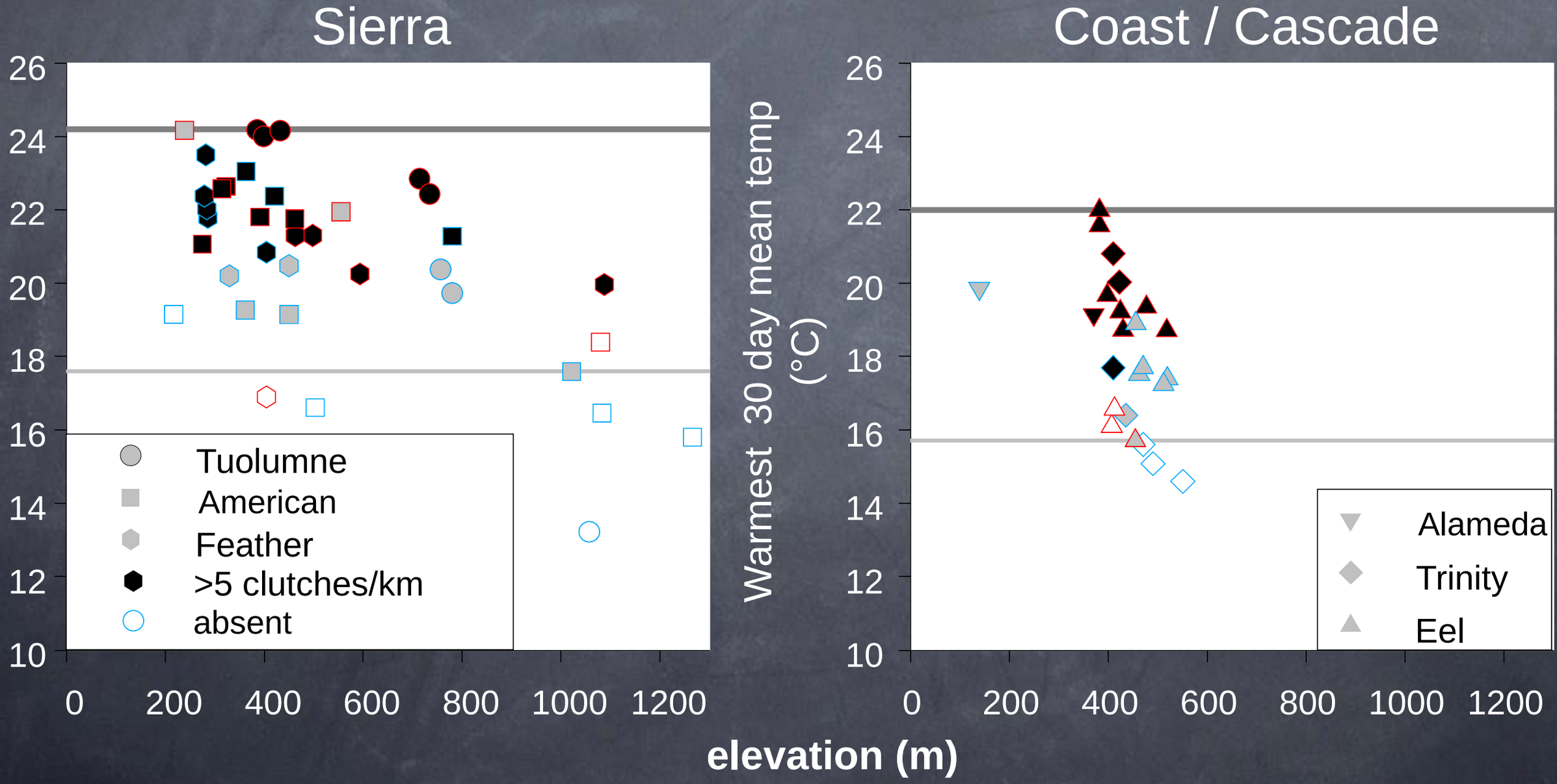


Hypolimnetic releases



Realized thermal niche

Regulated vs Unregulated



Hydrologic alteration has impacts across scales

small ⟷ large

Spatial Scale

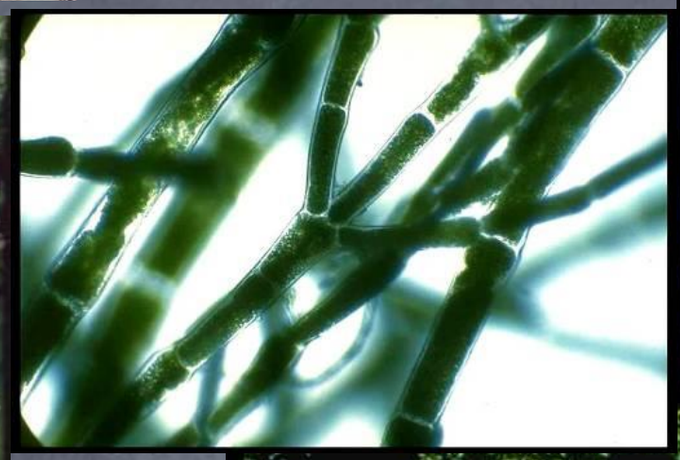
Stage-based hydro impacts (minutes -months - yrs)

Rearing experiments
- Thermal performance
- Growth / food quality

Population and range wide status

Decades

Algal succession during summer low-flow



Cladophora with heavy epiphyte load

Often “rusty-red” in the field

Rhopalodia

Epithemia

Cyanobacteria endosymbionts

Epithemia adnata

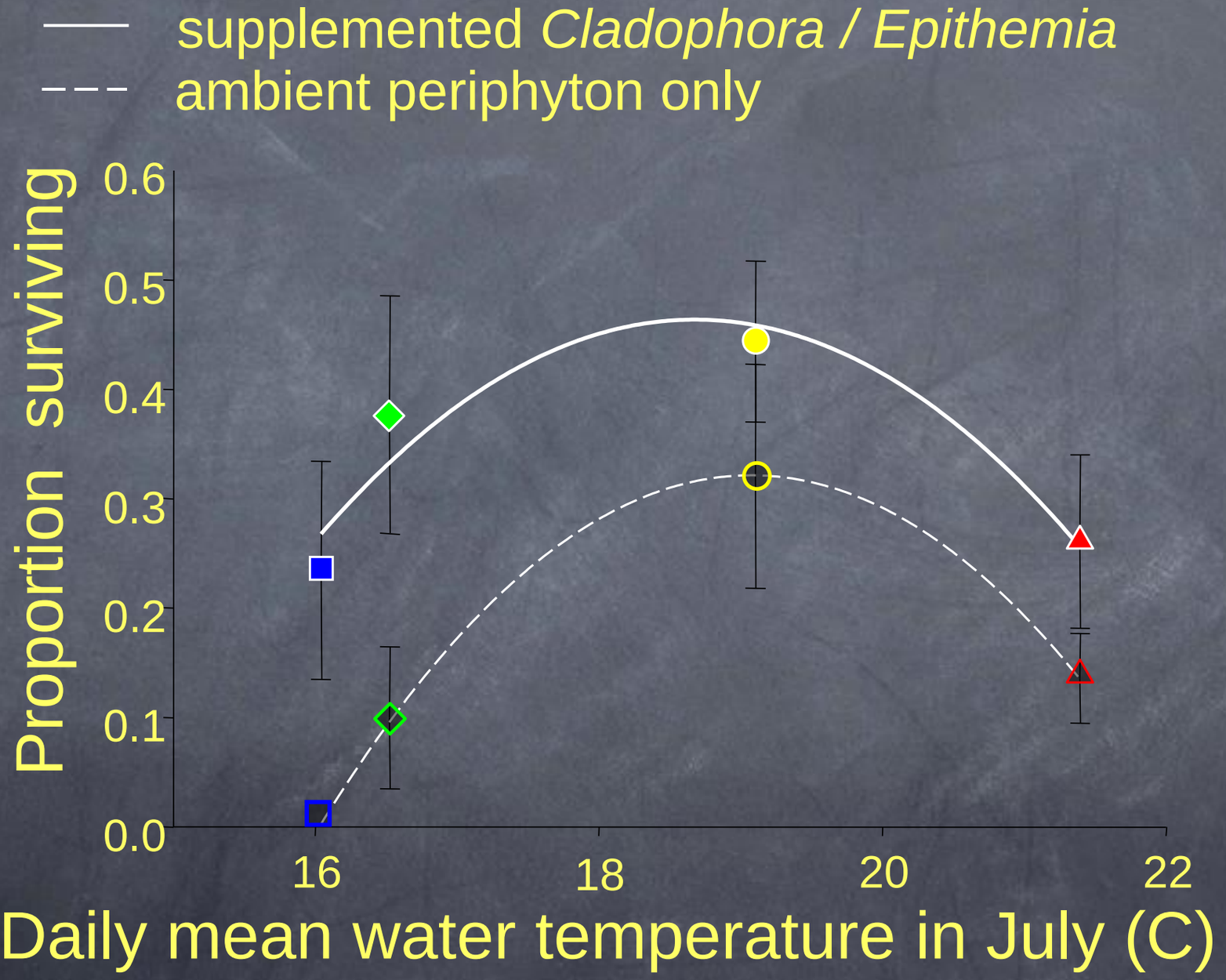
50µm

Foothill yellow-legged frog tadpoles are incredible periphyton scrapers

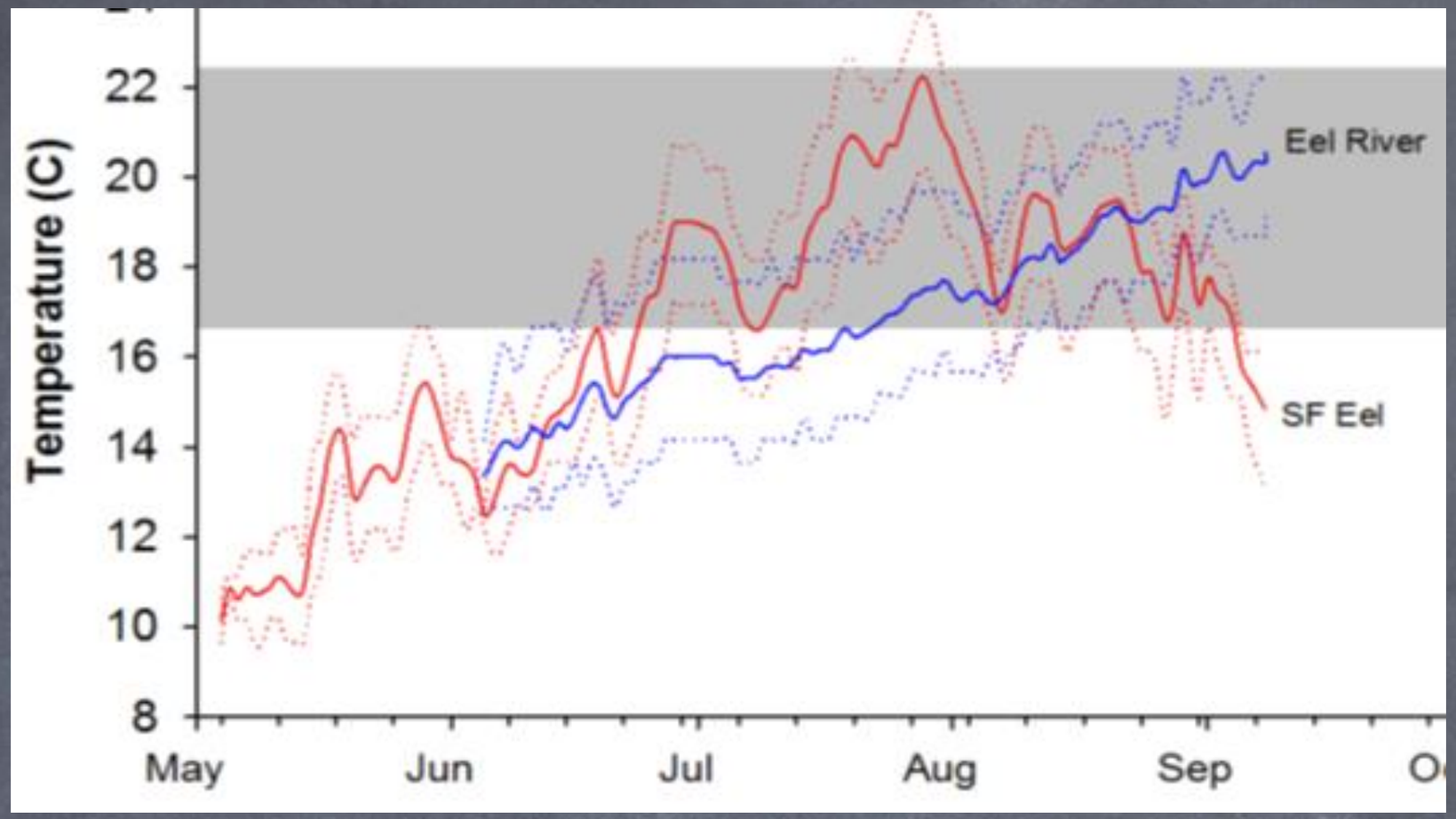
Convert algae
into snakes
and other consumers

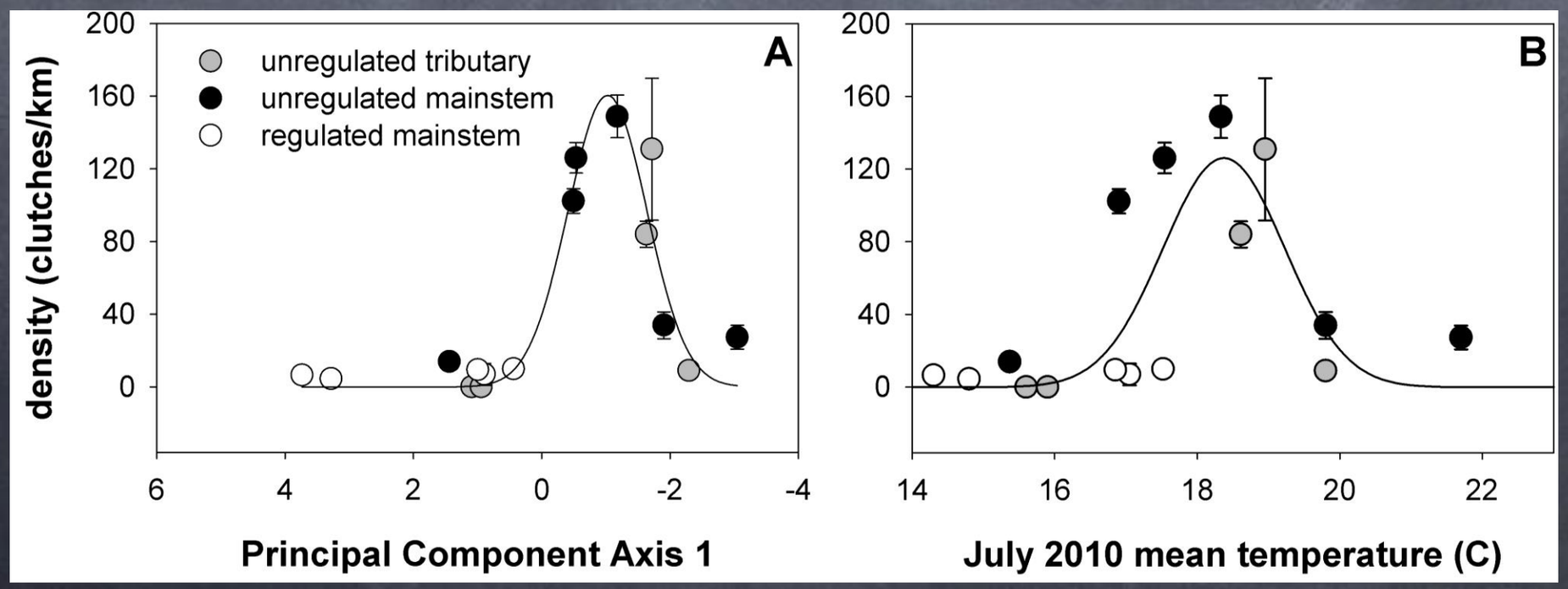
Reared tadpoles at different temperatures

Water temperature x food quality

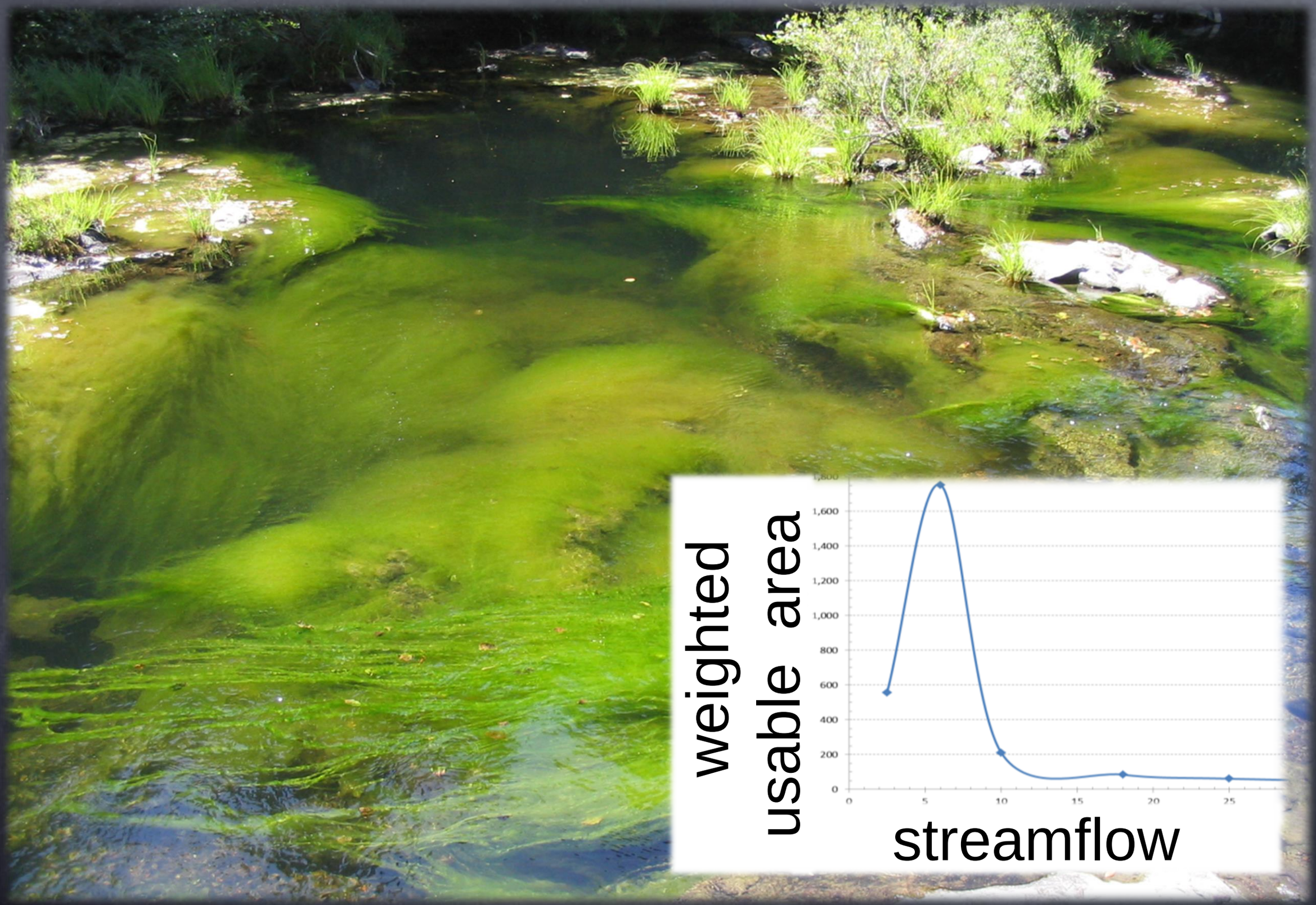


Thermal preference, performance, population abundance aligned





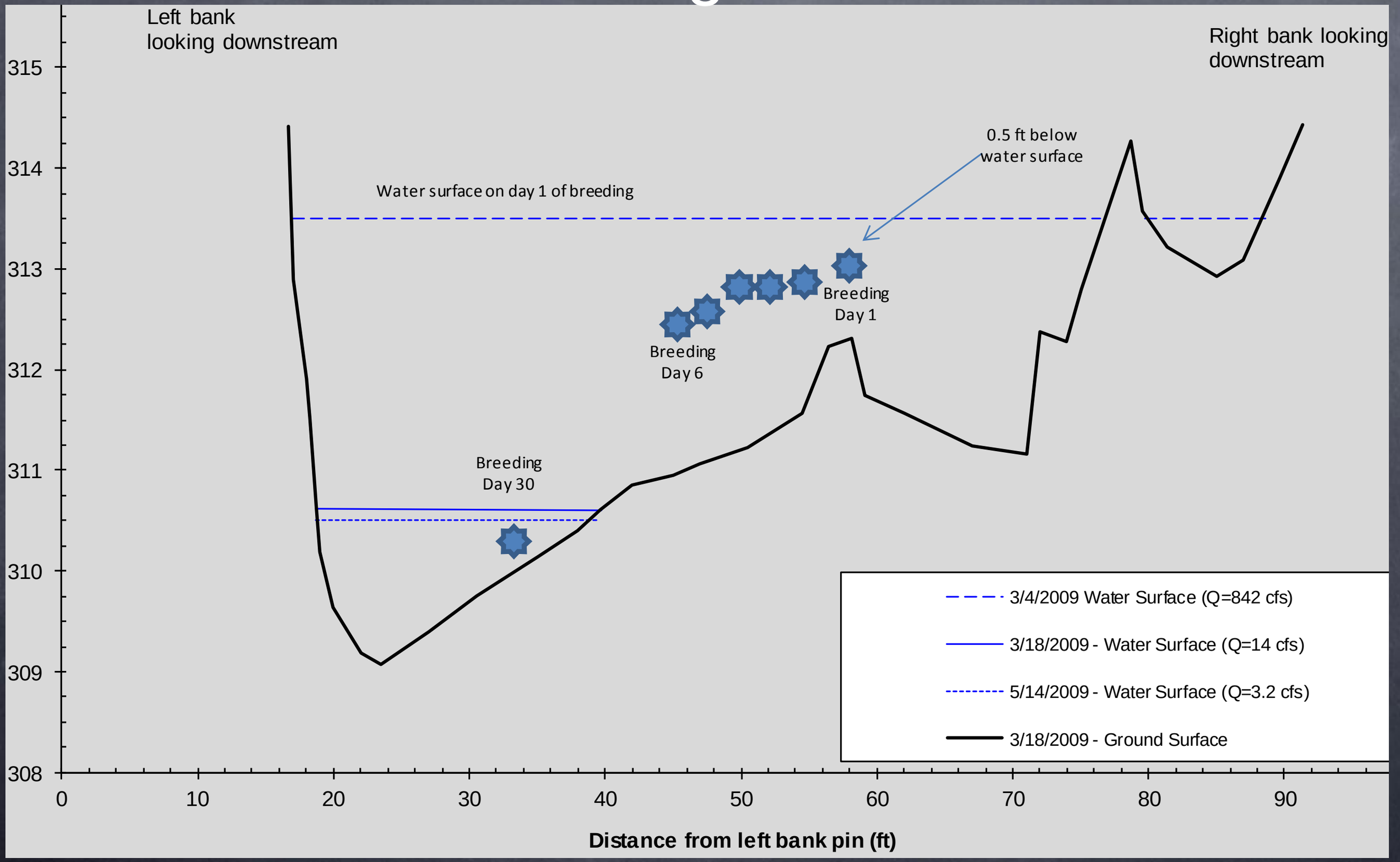
Mechanistic approach to determine model reproductive success rather than habitat



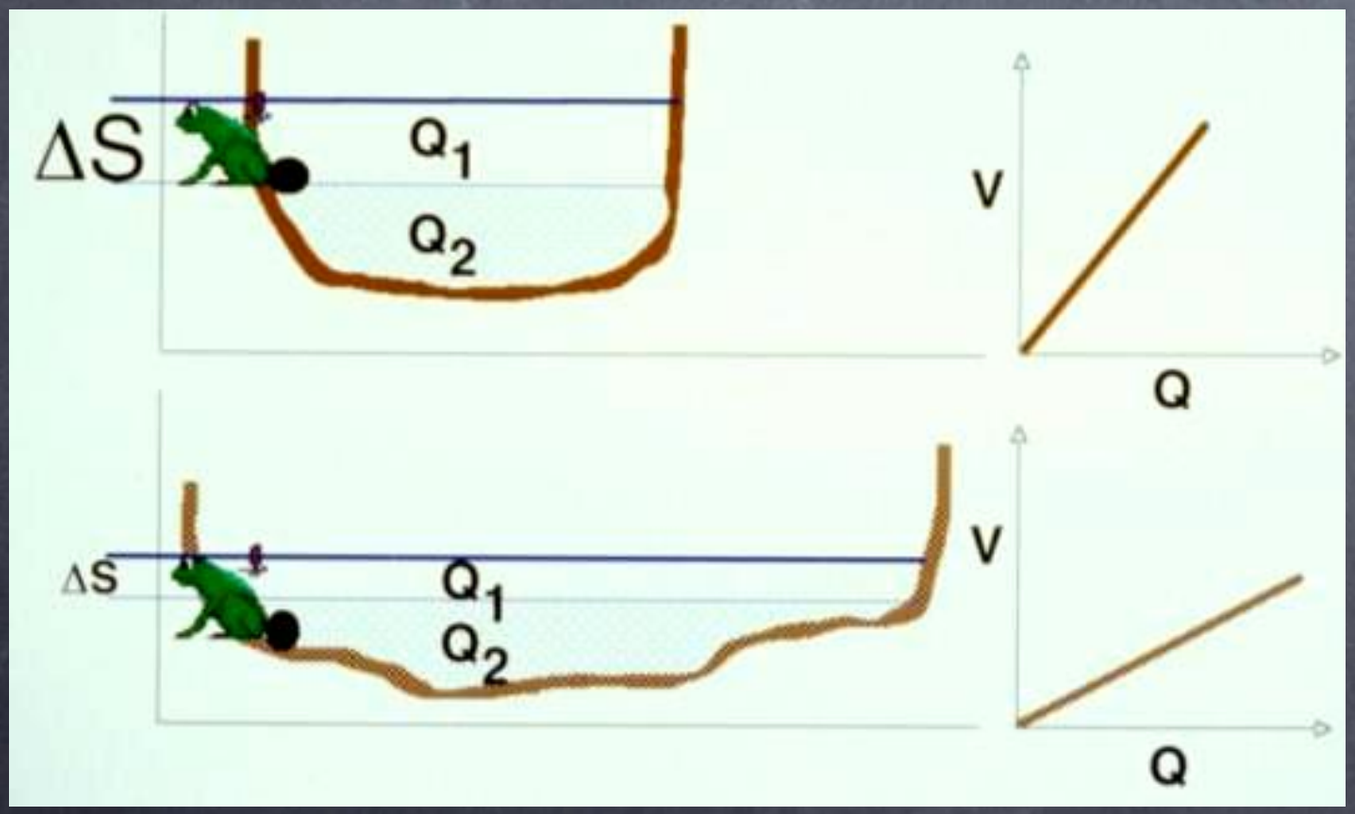
Frog Reproduction Model-what it is

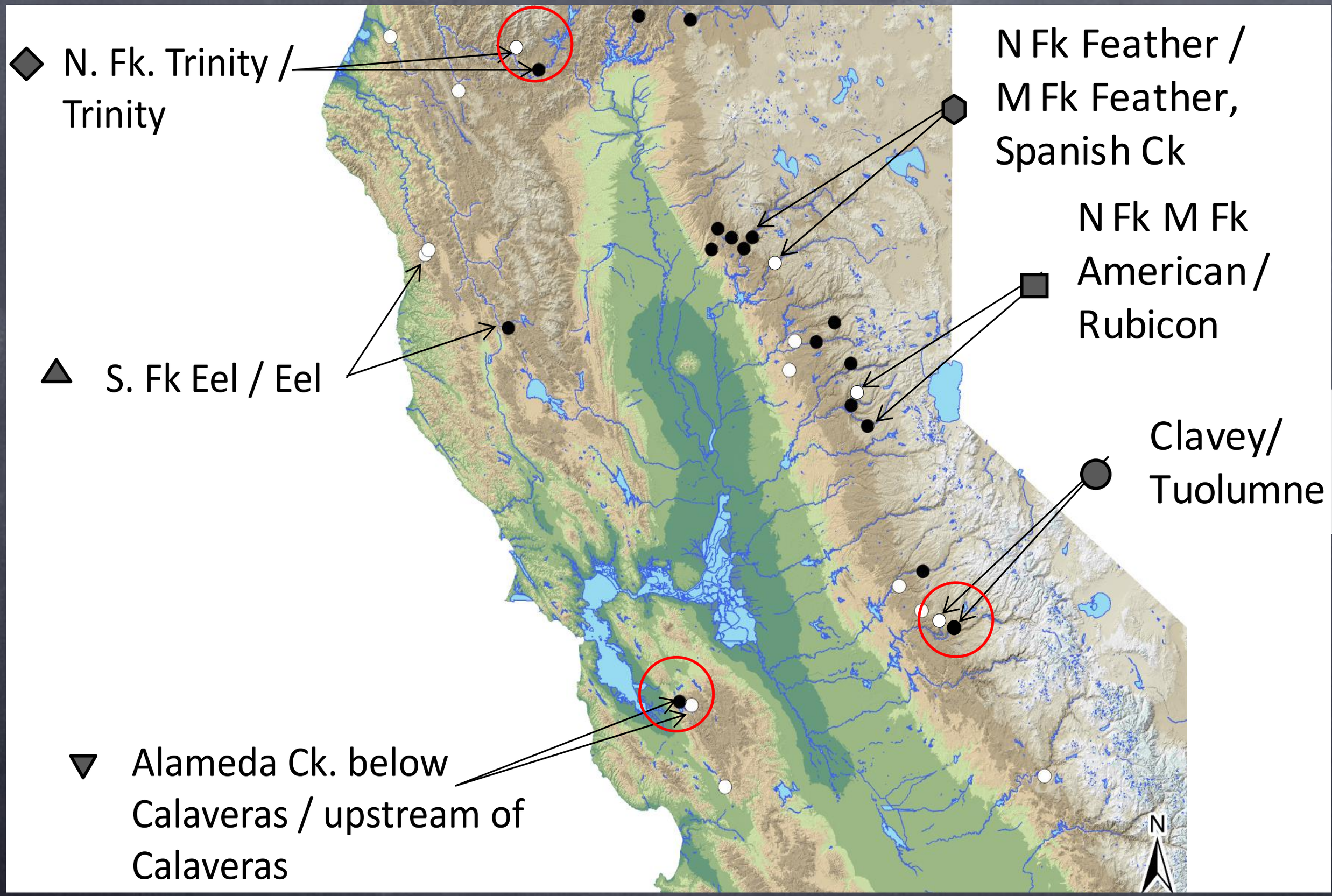
- Excel spreadsheet
- Cross section based, 1-dimensional
- Daily time step
- Start at breeding, end at overwintering
- Uses multi-yr time series of daily data
- Assesses fate of eggs and tadpoles each year
- Predicts changes in reproduction success as function of:
  - discharge
  - water temperature
  - channel geometry
  - egg laying depth
  - breeding dates ...and other parameters

Computational process for immobile stages

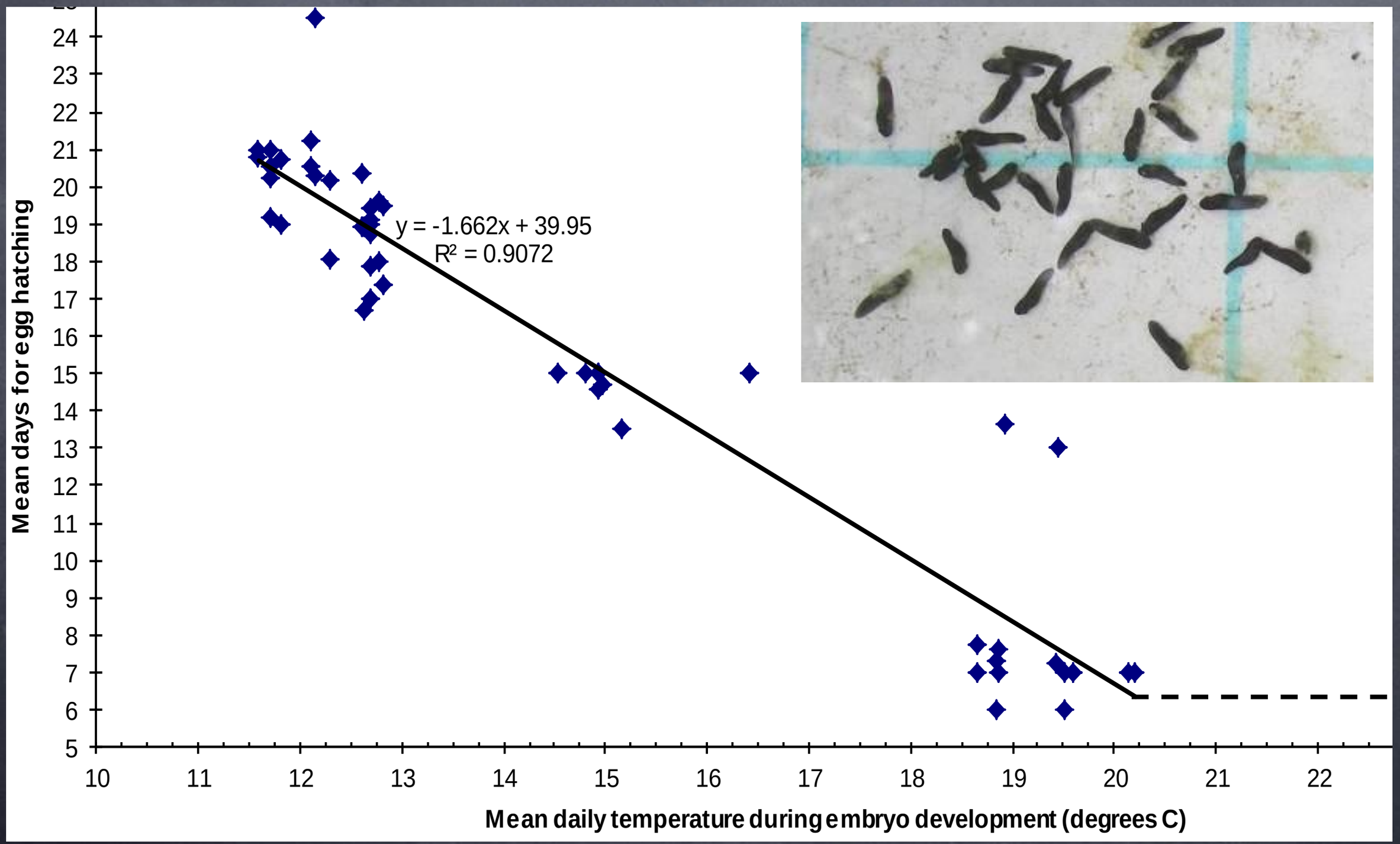


- Simplified channel shape ⇩ topographic diversity
  - Less habitat for breeding
  - Less lateral warming
  - Steeper stage-discharge rating curves

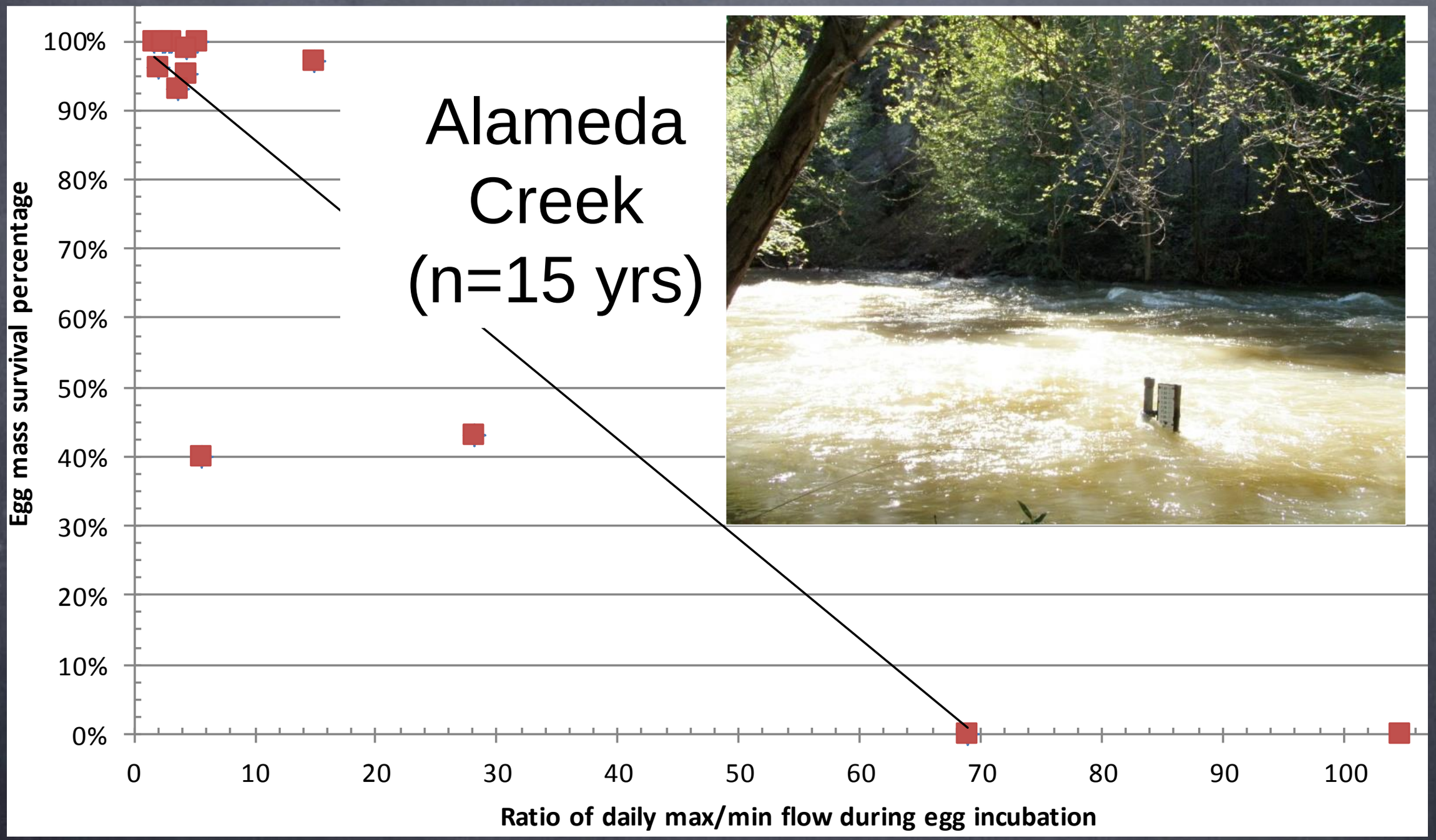



N. Fk. Trinity / Trinity
S. Fk Eel / Eel
Alameda Ck. below Calaveras / upstream of Calaveras
N Fk Feather / M Fk Feather, Spanish Ck
N Fk M Fk American / Rubicon
Clavey/ Tuolumne
N

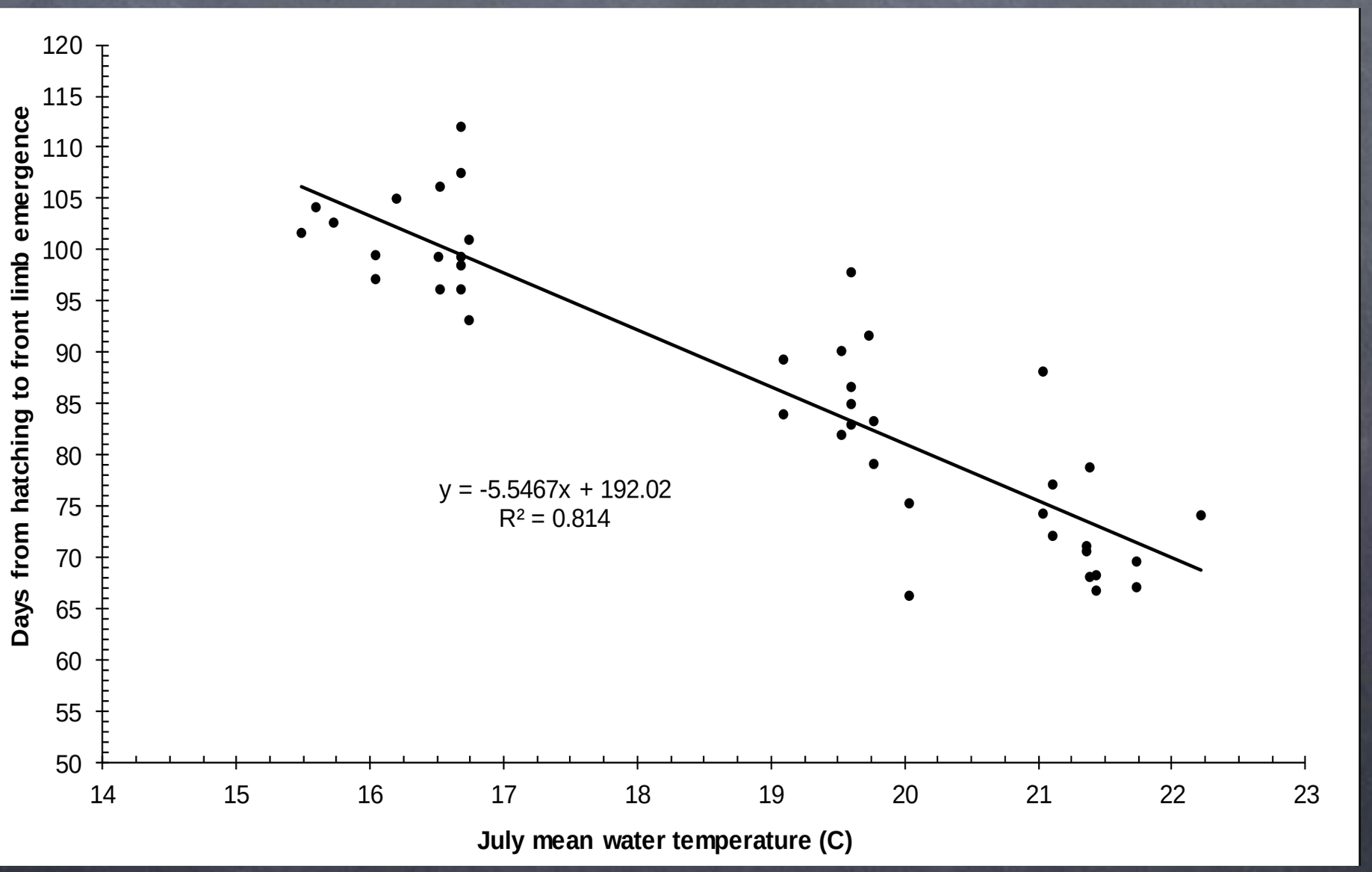
1. Model asseses if days of inundation > time needed for embryos to develop



2. Model assesses survival based on empirical scour relationship



3. Model assesses time to metamorphosis using field rearing experiments



Primary performance metrics

% of clutches avoiding desiccation

% avoiding scour (based on Q_{max}/Q_{min} relationship)

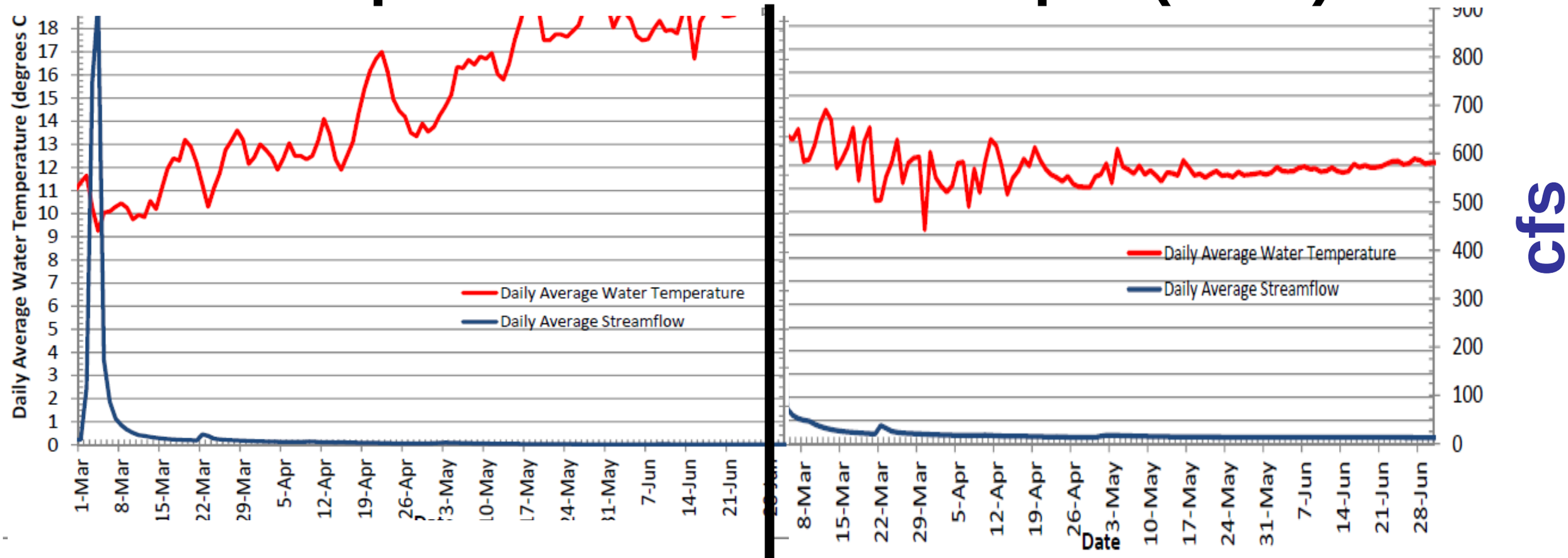
time for post-metamorphic growth

Site-specific Input variables

(default values)

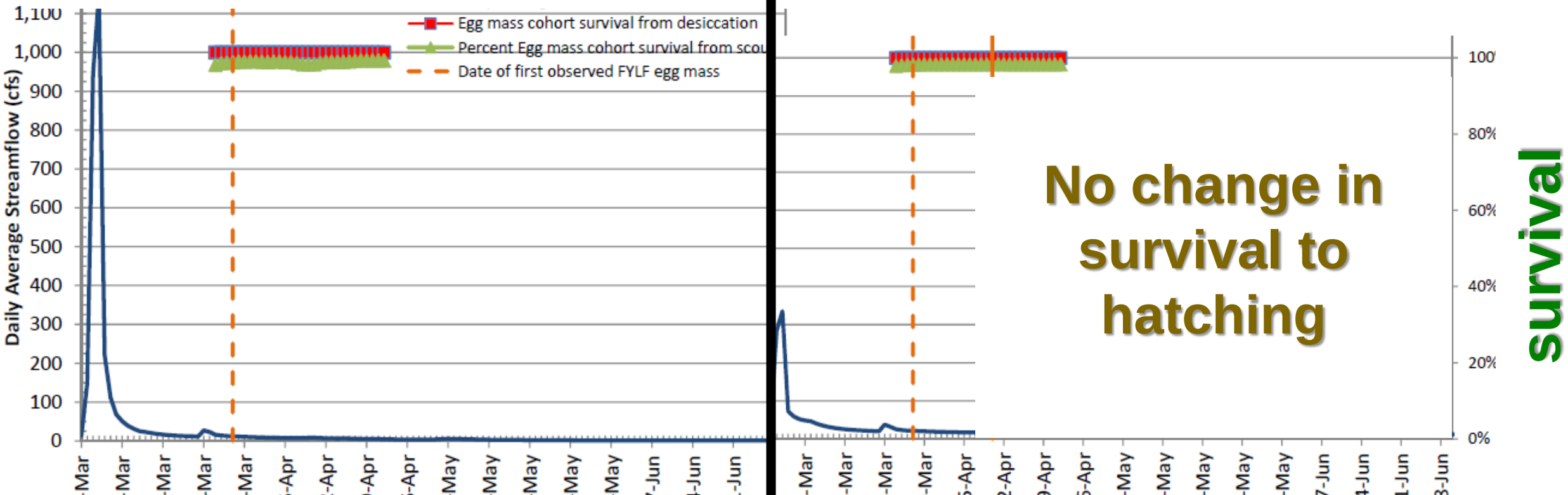
- Rating curve
- Daily average streamflows
- Daily average water temperatures
- Breeding trigger (11.5°C) and/or date
- Breeding season duration (30 days)
- Egg laying depth (0.5 ft)
- Duration of immobile tadpole (7 d)
- Duration front limbs to full metamorphosis (10 d)
- Lower limit of tadpole thermal niche (16.5°C)
- Onset of winter (November 15)

Example of Alameda Ck output (2009)



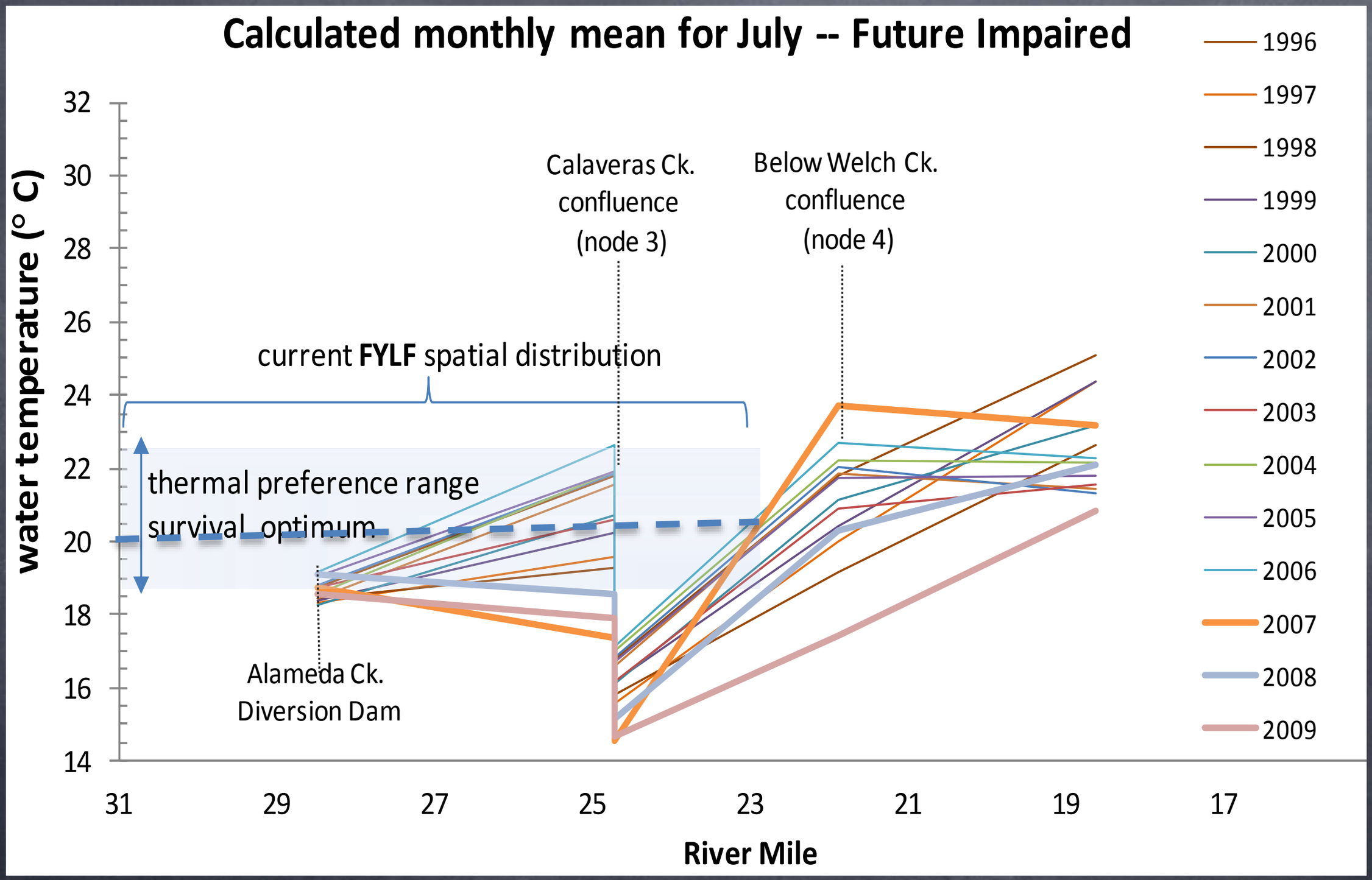
Observed

Proposed future flow



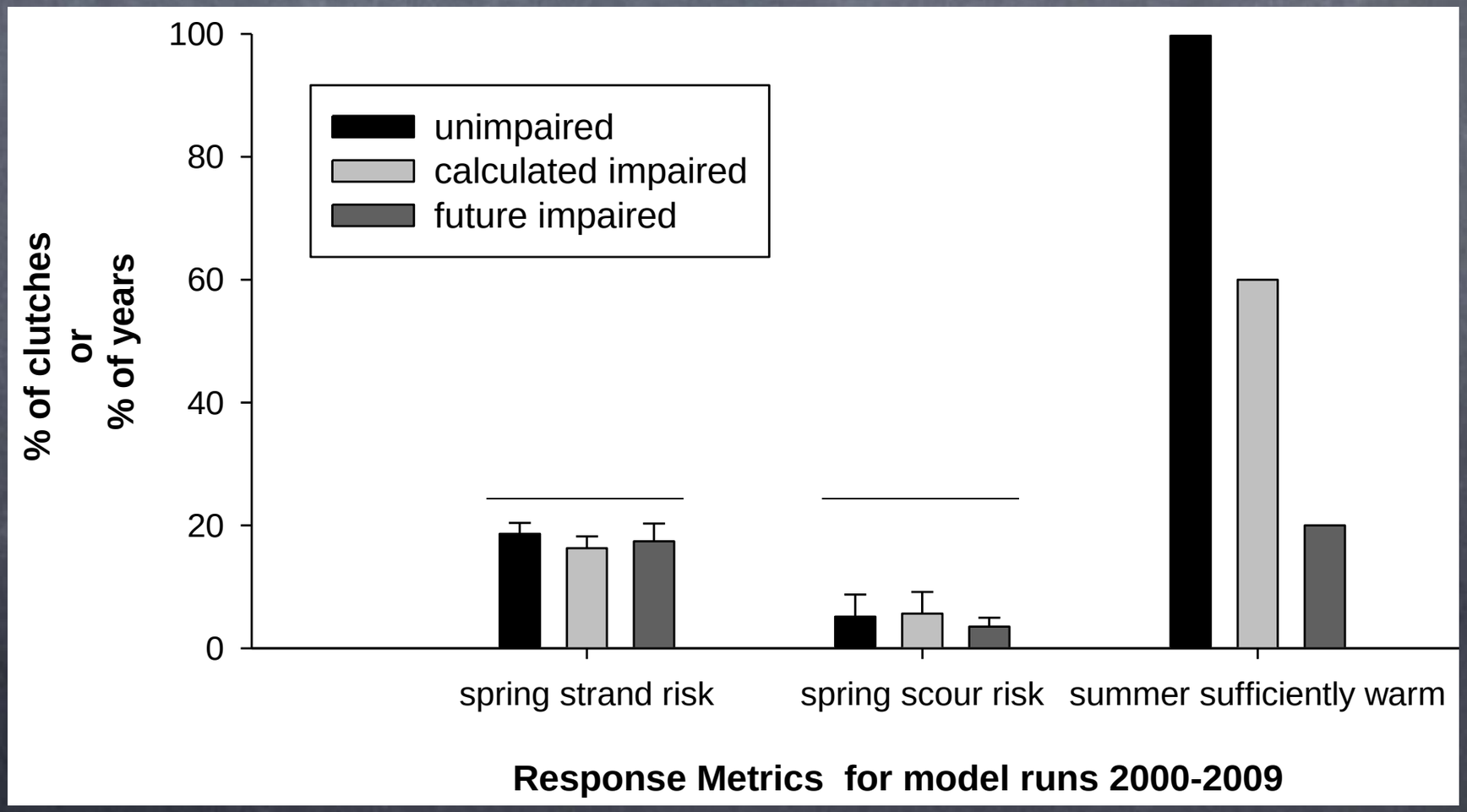
No change in survival to hatching

Cold water releases from Calaveras Dam

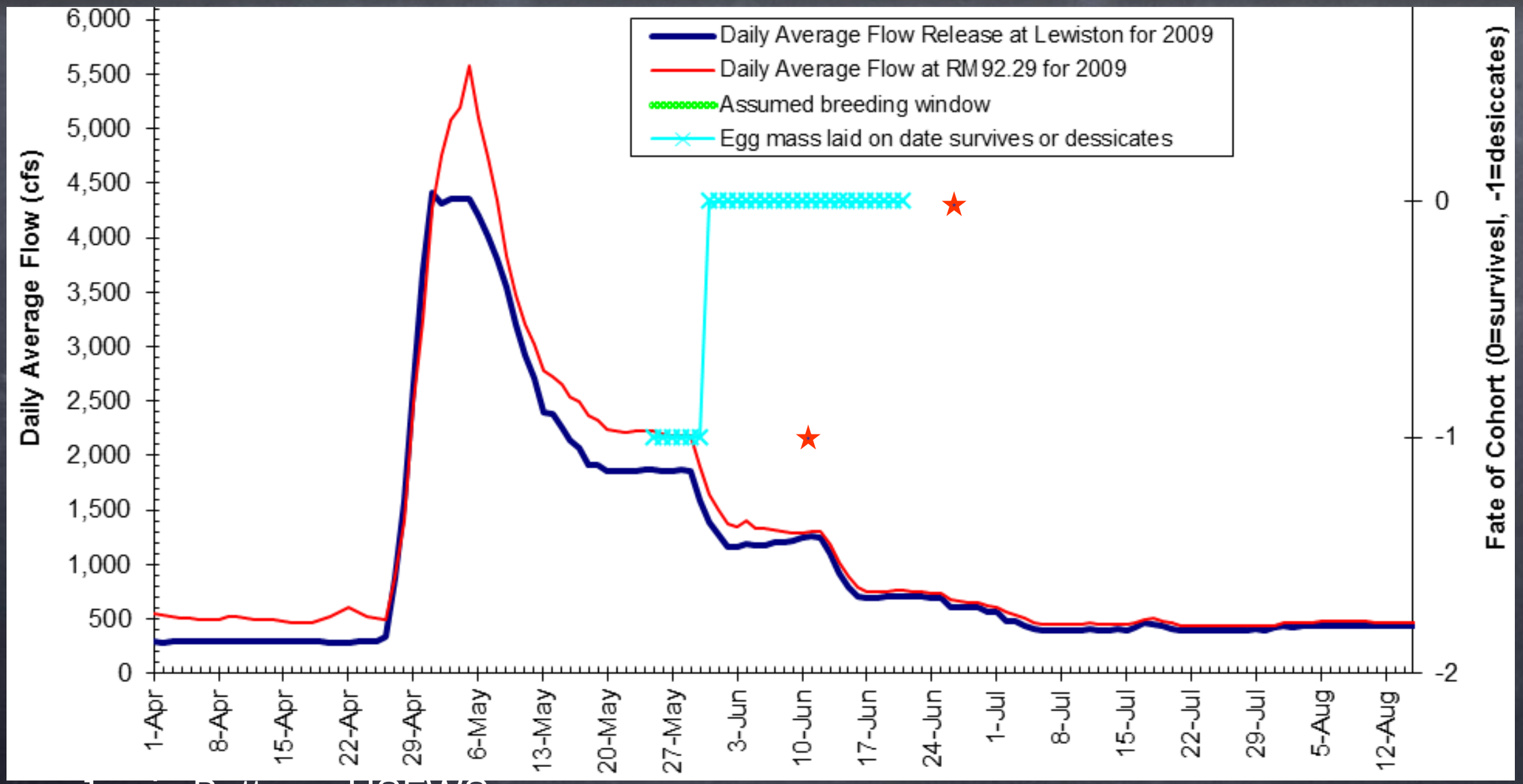


Alameda Ck predictions

- Avg. risk of strand and scour similar across flow scenarios
- future impaired flow regime may cause water temperature reductions that will be below the lower limit for tadpoles

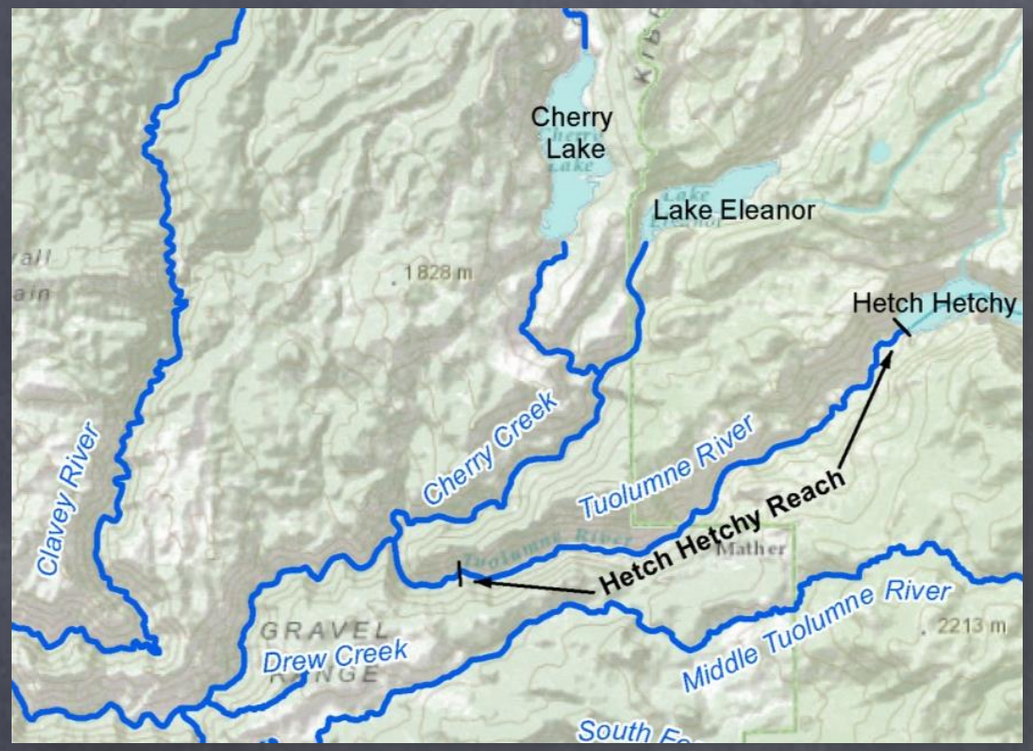


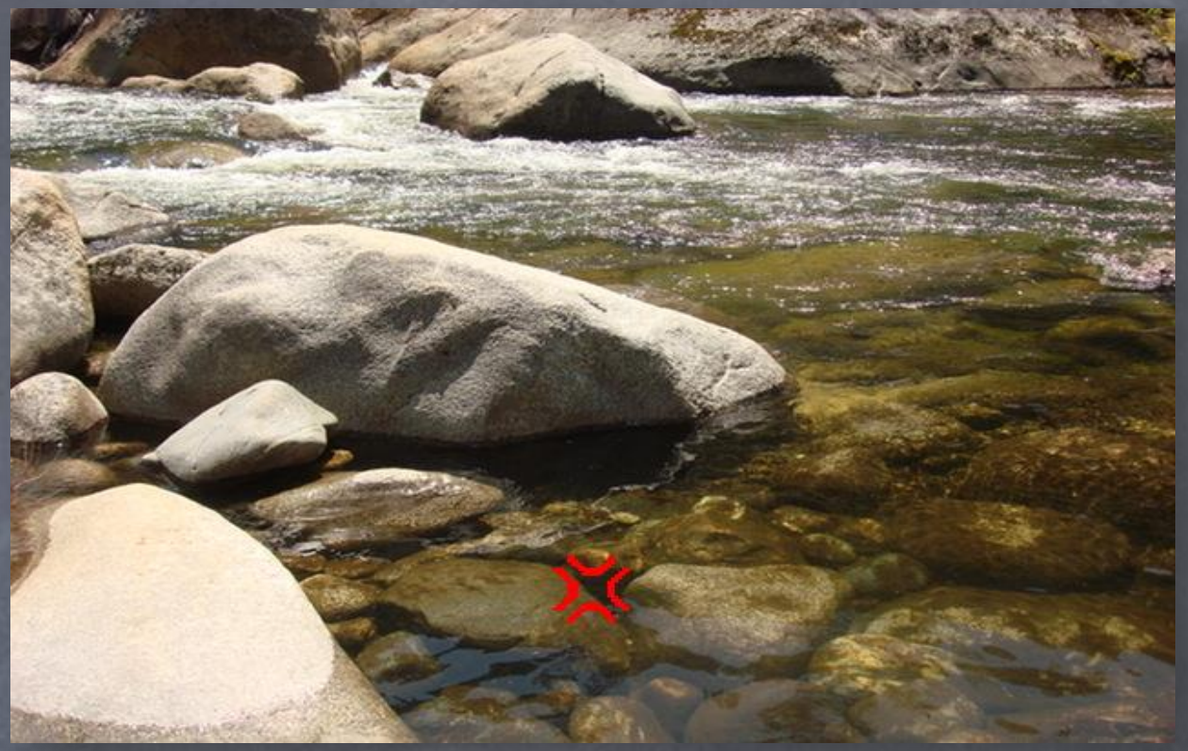
Contrast to Trinity desiccation



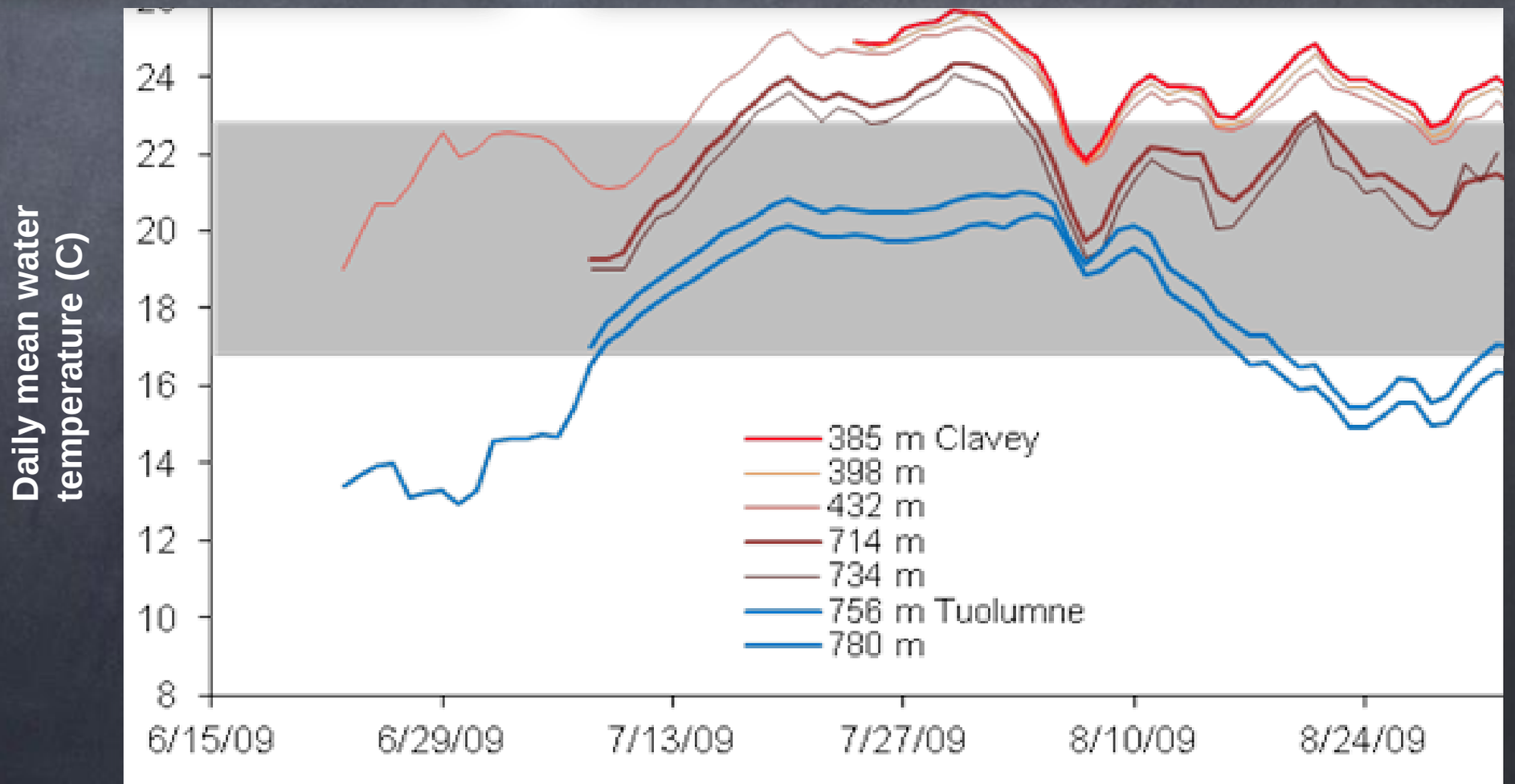
Jamie Bettaso, USFWS

Tuolumne River





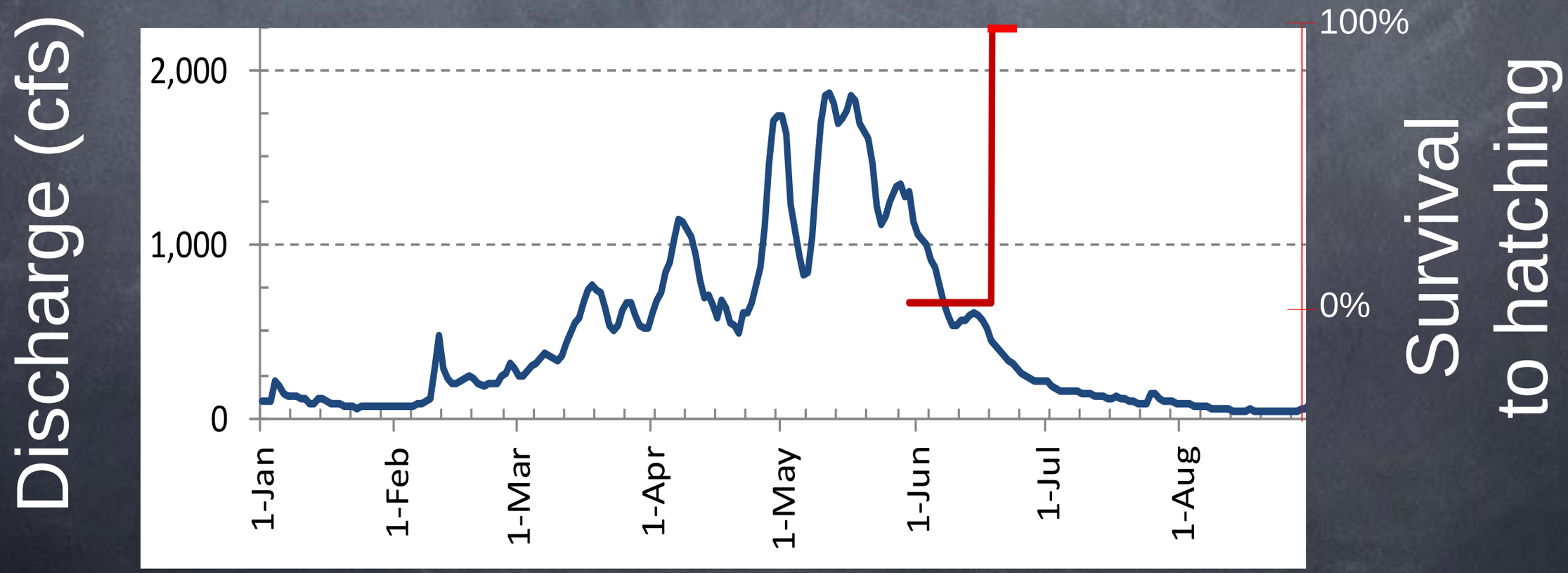
R. boylii rare relative to Clavey



Were historic conditions more favorable?

Existing to Calculated Unimpaired Comparison			
Water year type	Extremely Dry (2007)	Dry (2008)	Normal (2009)
# of days with survival to hatching	+20	+22	-6
Days of post-metamorphic growth	+61	+64	+57

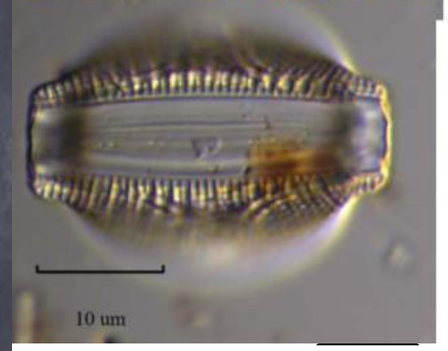
Unimpaired Snowmelt hydrograph → 20 days of stranding

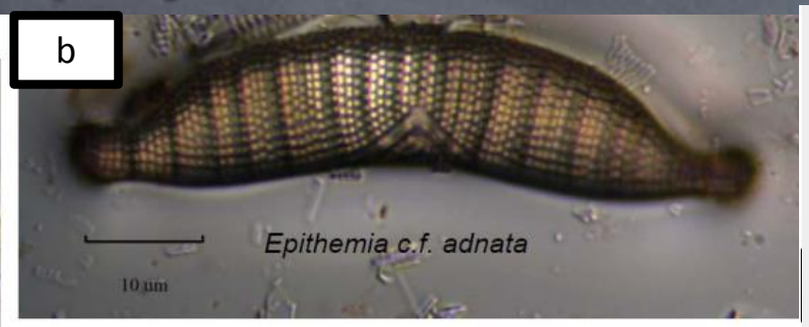


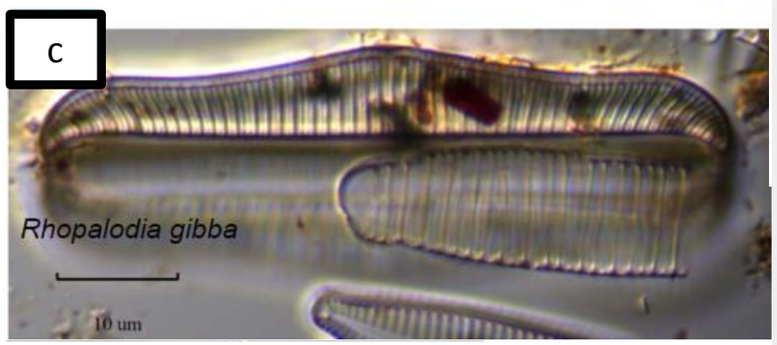
Summary of model uses

- Conduct gaming of alternate flow / thermal regimes
- Evaluate responses to change in channel geometry (i.e. restoration)
- Predict % of successful breeding years
- Use output as input for a population viability analysis
- Examine if unimpaired conditions would have been suitable
- Many opportunities to expand model
    - 2-D hydraulic model rather than 1-D cross section based
    - Incorporate physically-based egg mass scour thresholds
    - Incorporate site specific information about food quality

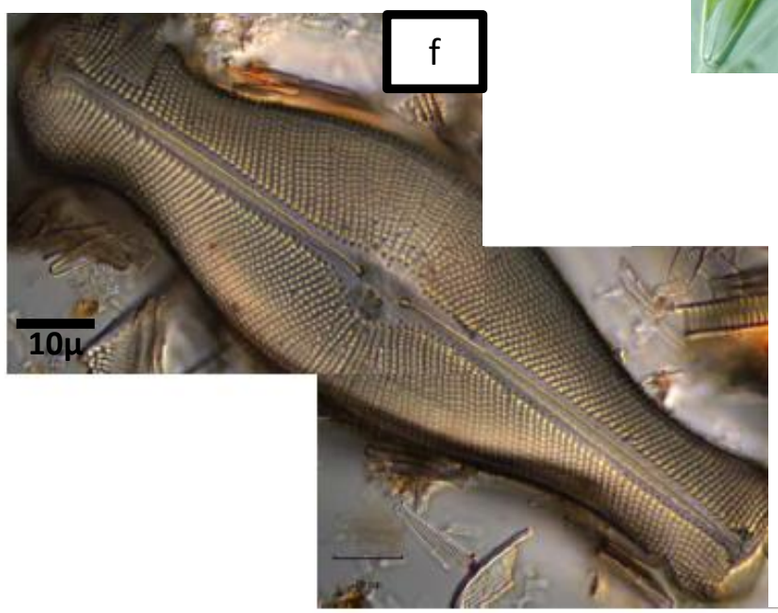
Connect hydrologically and thermally driven changes in periphyton to effects on tadpoles as grazers

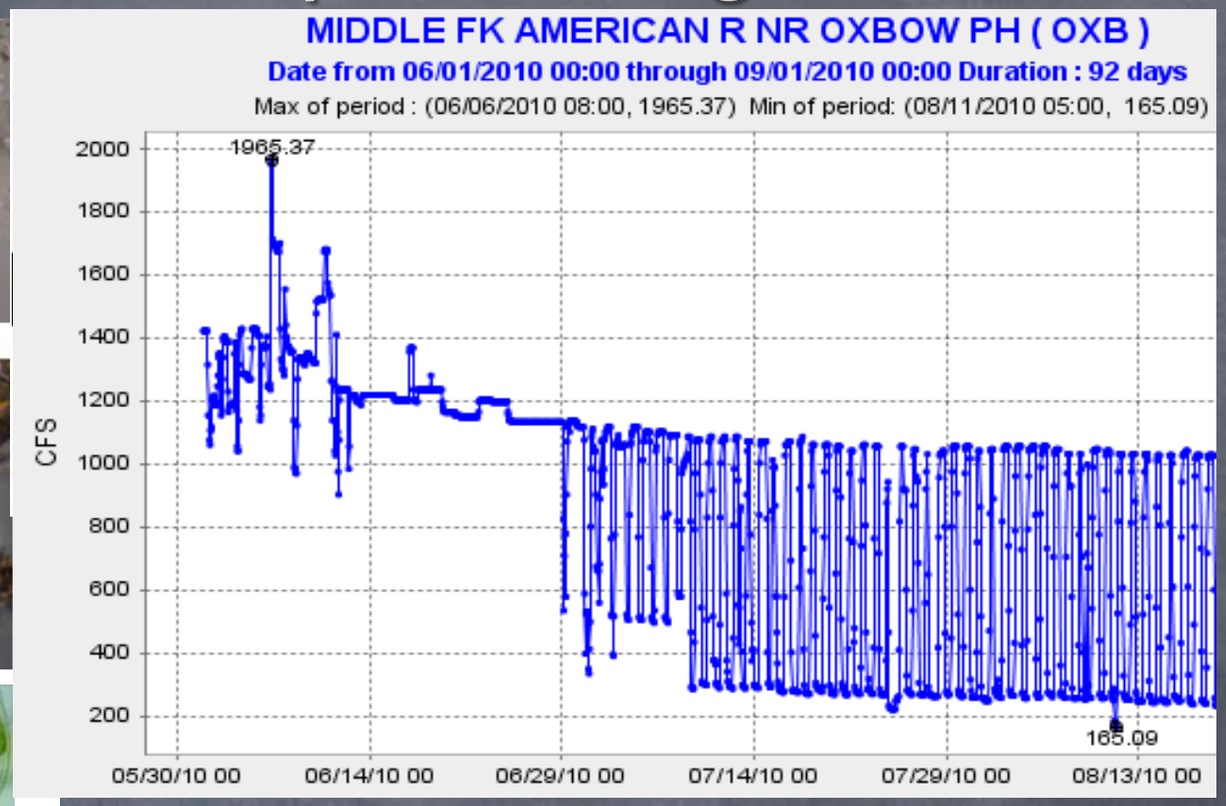


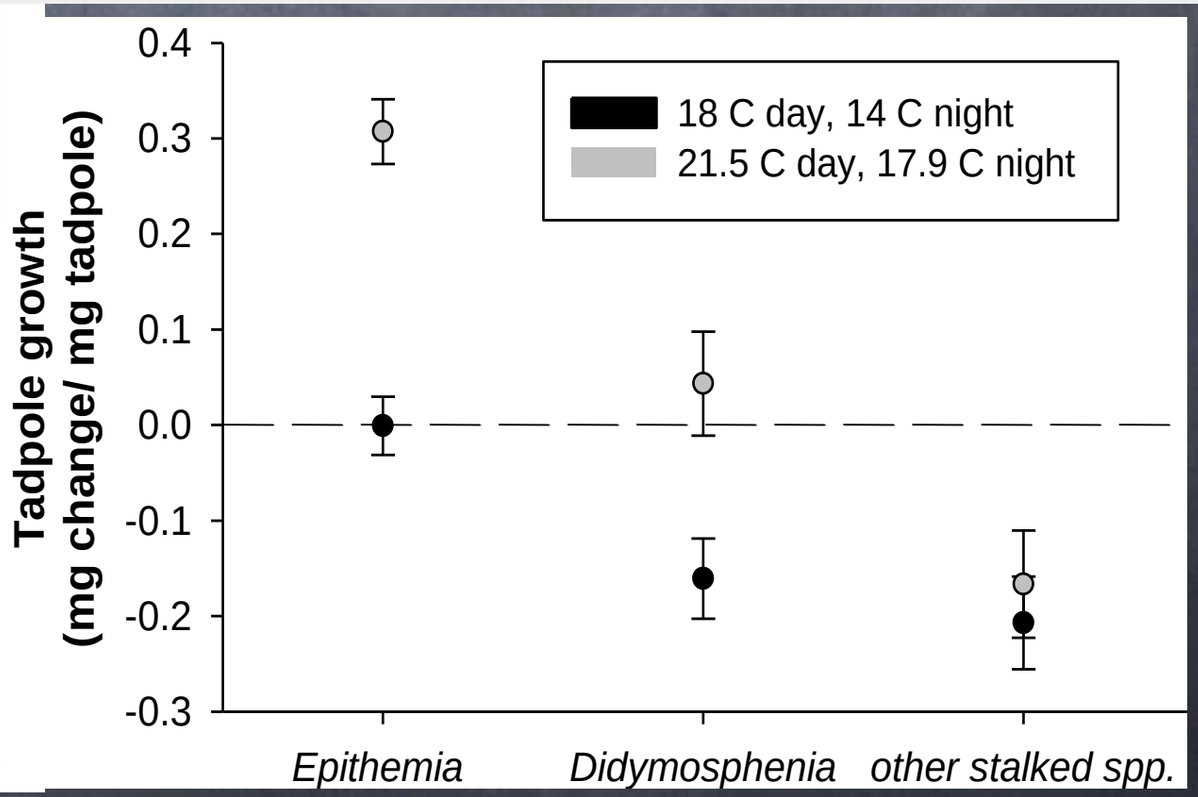




Didymosphenia geminata







Summary

small ⟷ large

Spatial Scale

Stage-based hydro impacts (mo - yrs)

Survival linked to hydrologic variability, temperature, food

Eggs & larvae most sensitive stages

Individual population trajectories (5-20 yrs)

Greater hydro. modification = declining/diverging population trends

Range-wide changes (25-50 yrs)

Absent from sites with largest influence by dams

Regulated sites generally colder and smaller frog populations


Questions?