Integration of Exposure and Effects in a Larger Watershed Scale

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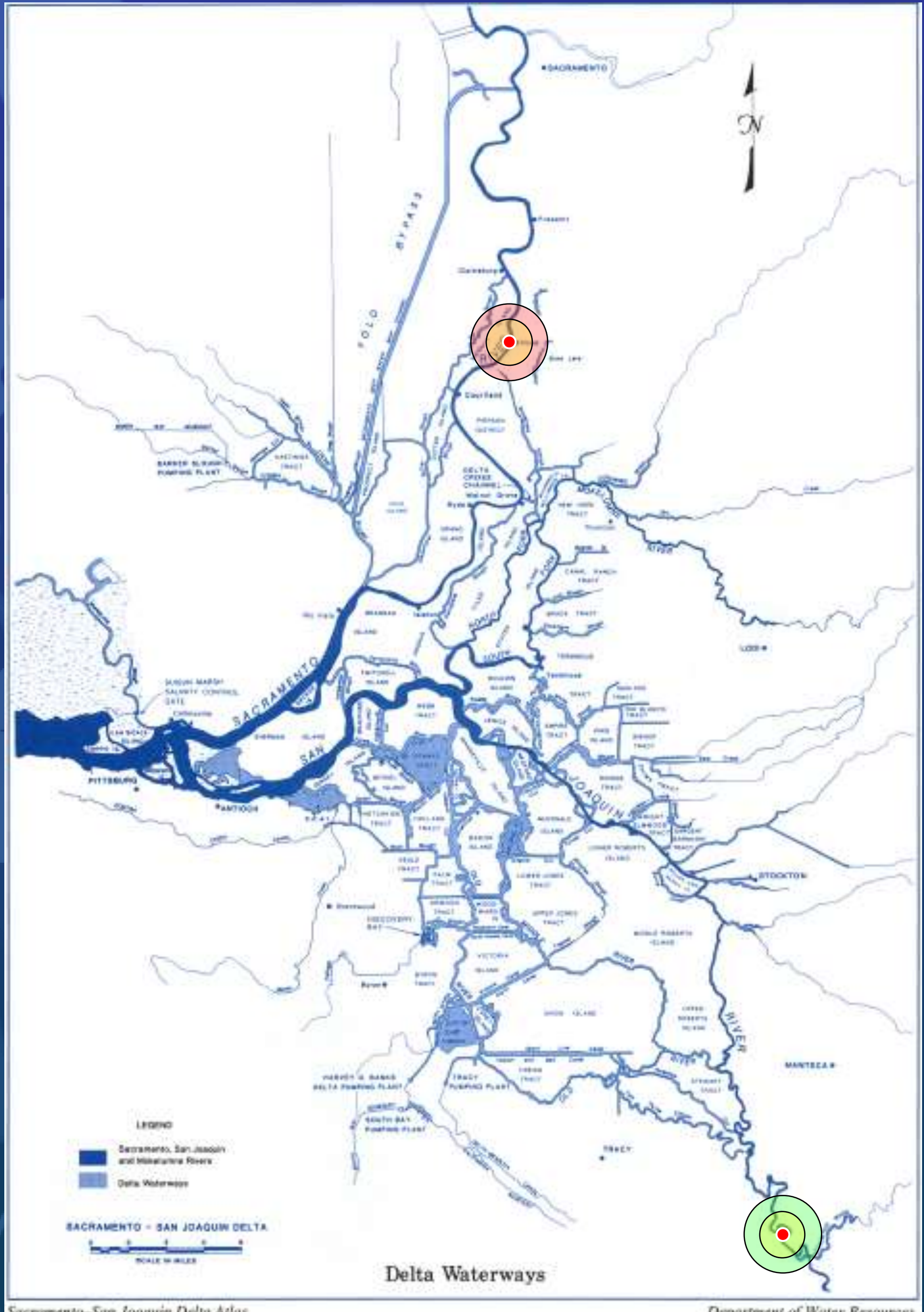
Making Connections

The Exposure-Effect Hierarchy

Biological Level	Biological Effect
Community	Bioassessment + Community Assessment
↑	↓
Population	Population Decline, Adaptation Population DNA Analyses
↑	↓
Organism	Toxicity Testing
↑	↓
Tissue/Organ	Histopathology
↑	↓
Cellular	Cell death/Mitosis/Activation
↑	↓
Subcellular	Molecular/RNA/Protein Changes

Two Studies

- Objective 1: Need to incorporate projects that measure multiple biological effects from cellular to whole organism
- Objective 2: Need to measure effects in lab and field exposures (ex-situ)
- Phase I Study (Biales et al., in review)
  - Molecular (ex-situ) and whole organism response (laboratory based)
- Phase II Study with UC Davis (Swee T, et al.)
  - Molecular and whole organism



Integrator Sites – important inputs to Delta –

Capture the Boundary conditions

Sacramento River at Hood

San Joaquin River River at Vernalis

Real-Time Monitoring Stations

Hood field station

Looking upstream from Hood

Vernalis field station

Looking upstream from Vernalis

Station Chamber – for Ex-situ Work

Exposure chamber and plumbing

Contact Linda Deanovic at ladeanovic@ucdavis.edu
Designer of exposure chambers and Lab Manager

Flow meter at input

Hood Larval Fish Exposures

- **Water collection:**
  - 25L in 1L bottles per collection
  - shipped frozen to St. Cloud State University overnight
  - 2-3 Events per Study

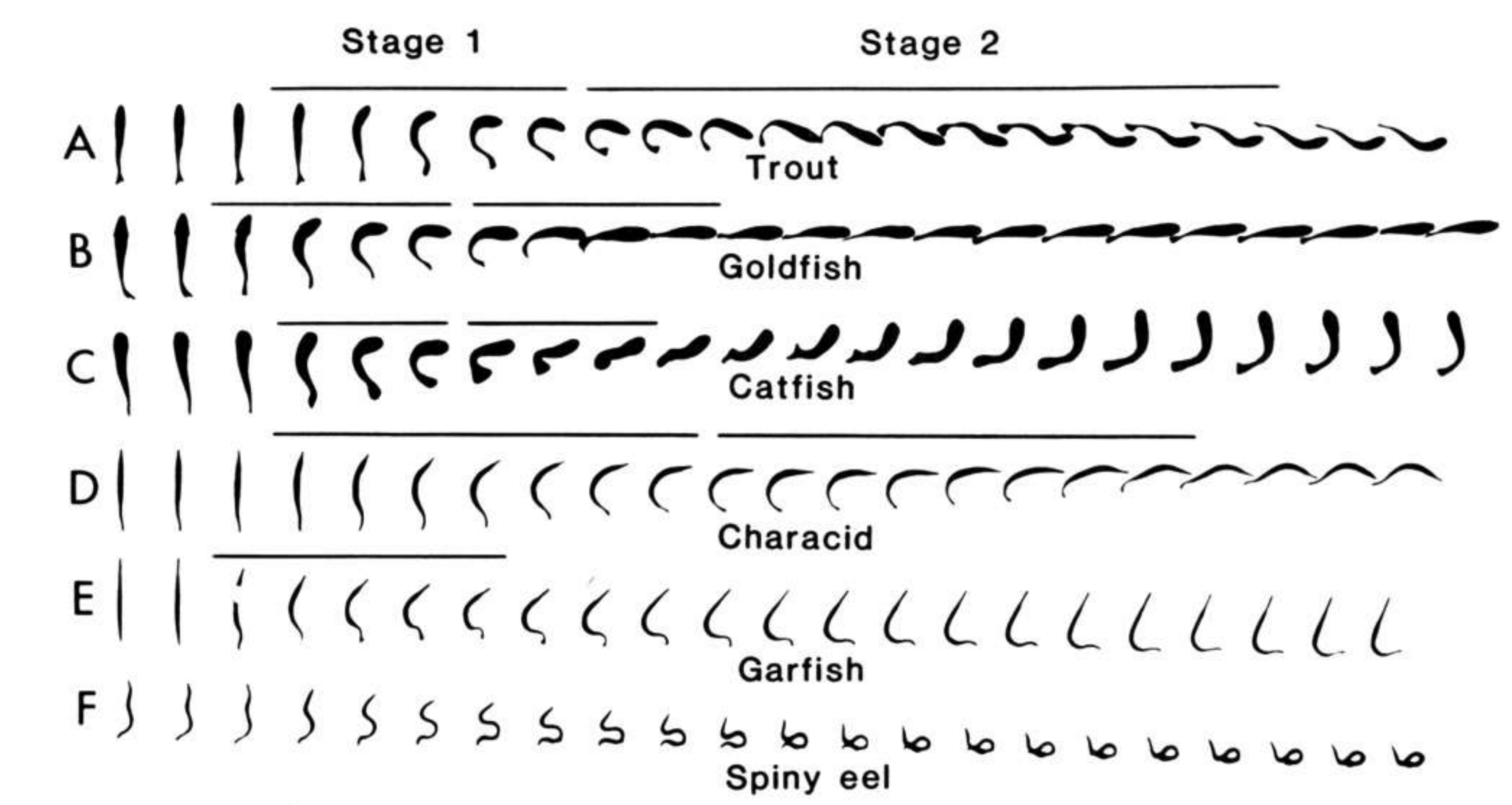
- **Fathead minnow exposures:**
  - 21 day exposure post-hatch
  - 50% daily static renewal
  - monitor survival
  - after 21 days assess growth
  - after 21 days assess predator escape performance ("c-start")
- Phase I – 2008 and 2009
- Phase 2 - 2013

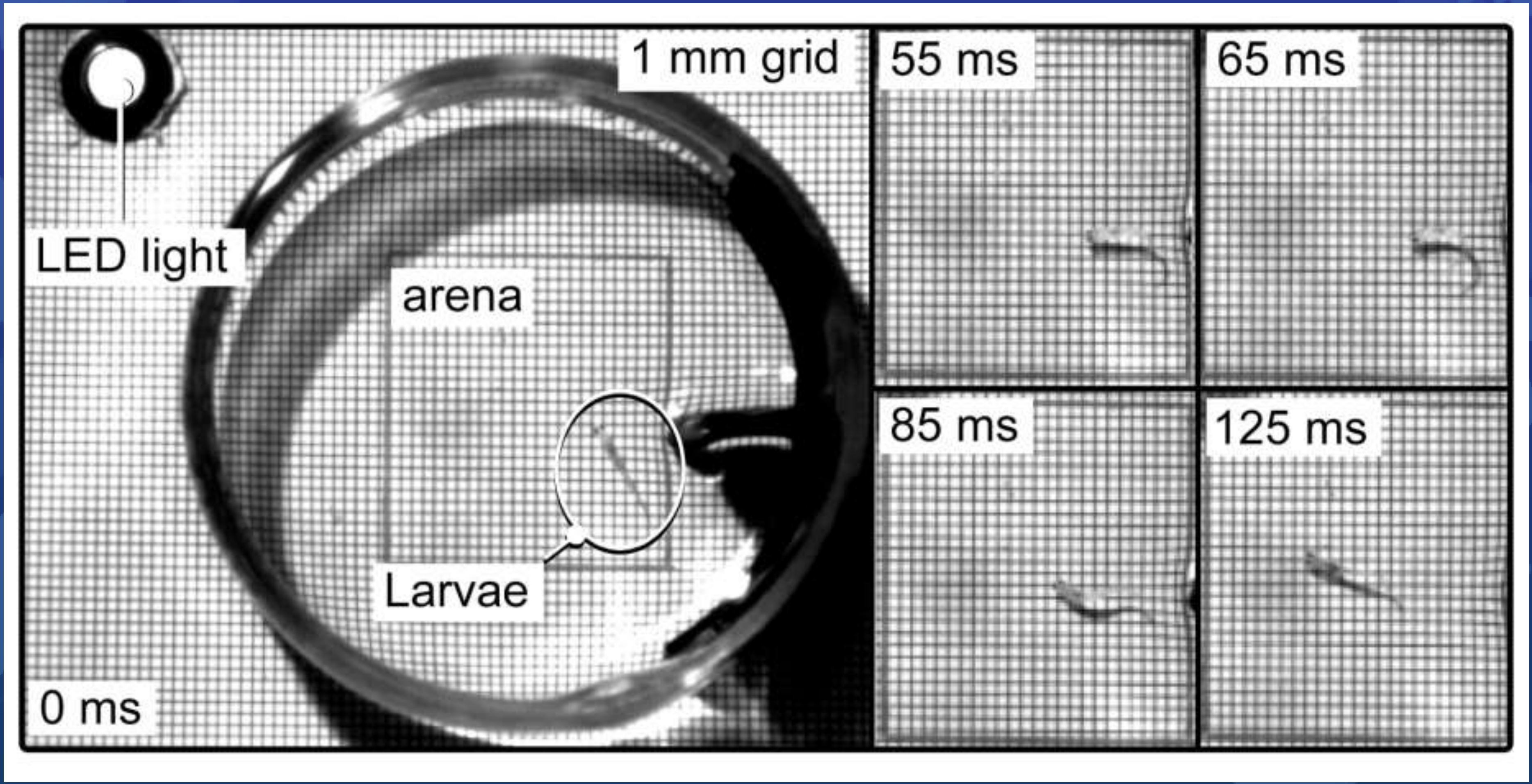
Larvae were exposed in a 50% static renewal system (1/2 of water was exchanged daily)

What is C-Start?

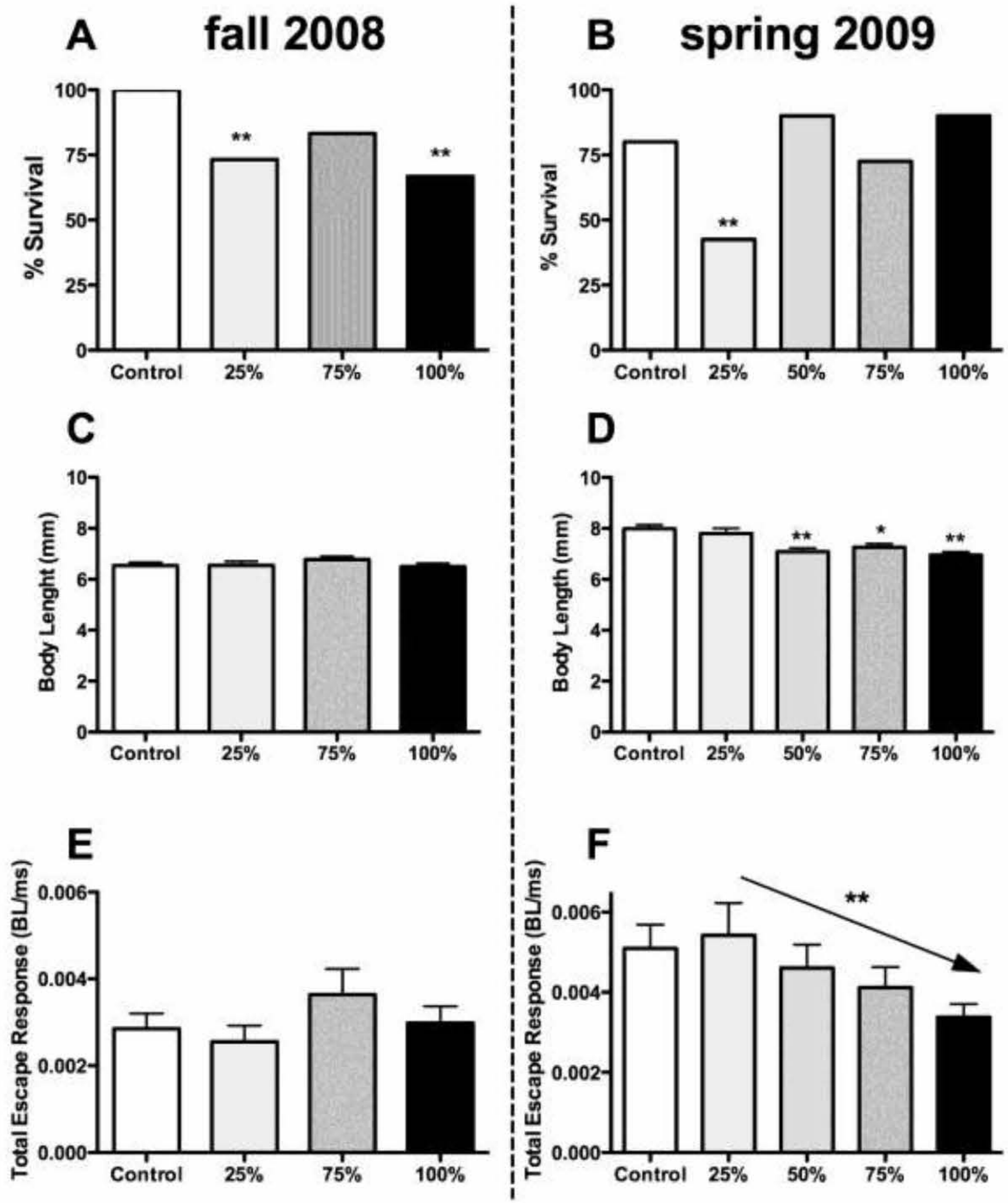
- Survival to reproductive age relies upon optimal non-reproductive trait expression, such as predator avoidance responses
- C-start behavior is an innate escape behavior to rapidly move away from an approaching threat
- Capturing high speed (1000 frames/second) video recordings analysis of latency period, escape velocity, and total escape (latency + escape velocity)
- Have seen altered escape with exposure to Estrone (E1) (McGee et al., 2009).

The c-start is an innate behavior commonly found in larval fishes of many species



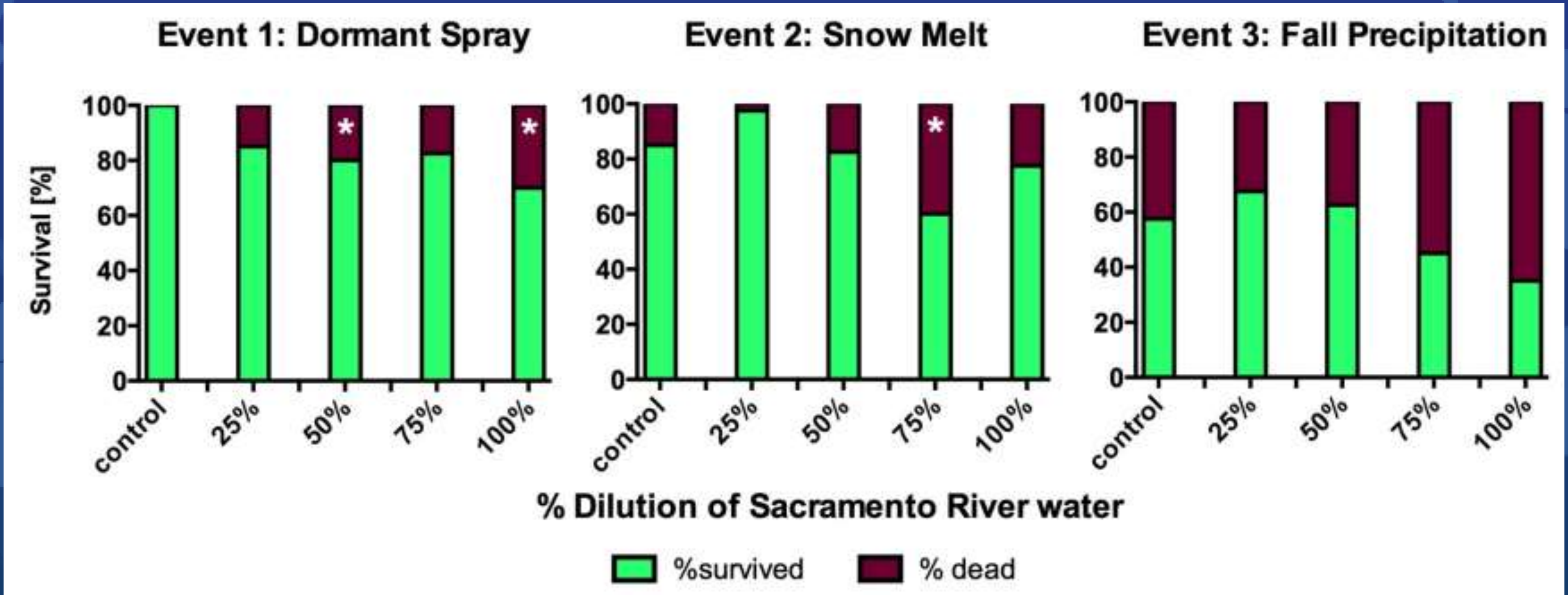


- ecological relevant – ability organism to escape predation



A fall 2008
B spring 2009
% Survival
100
75
50
25
0
**
Control
25%
50%
75%
100%
C
D
Body Lenght (mm)
Body Length (mm)
10
8
6
4
2
*
E
F
Total Escape Response (BL/ms)
0.006
0.004
0.002
0.000

Larval survival after 21 day exposure to Hood Water (2013)



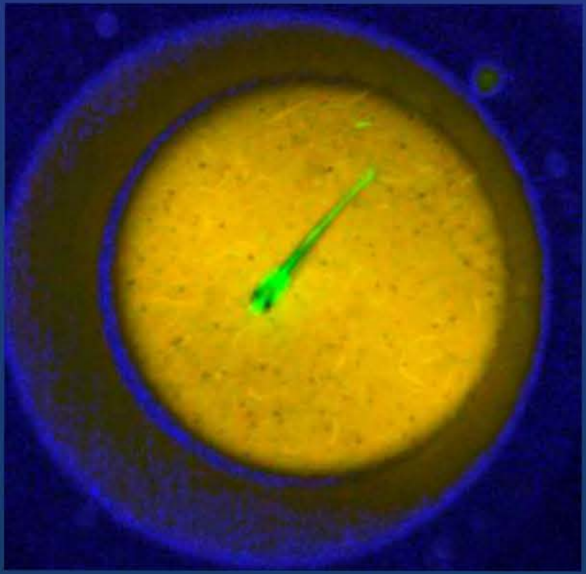
Note: previous Phase I, showed a reduction in growth and total escape performance in the spring event.

Conclusions

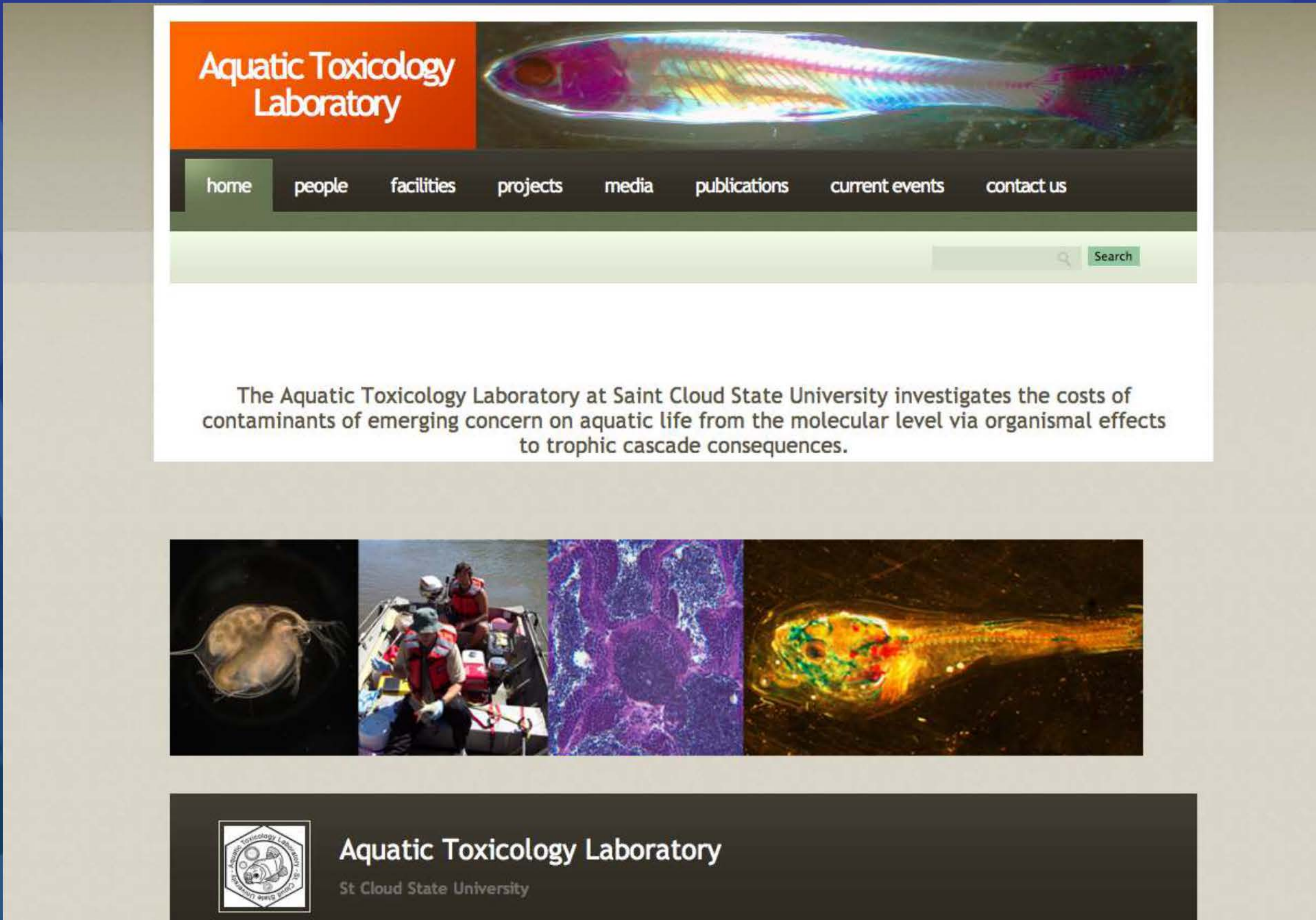
- Phase I results – demonstrated C-start reductions during Phase I and II, in the spring event time (Spring Runoff)
- Phase II results -in two of the three events river water reduced larval survival, and in the spring event the predator avoidance behavior of larvae was impaired

Conclusions (Cont)

- Studies showed the benefit of multiple levels of biological measurements from cellular to whole organism
- Need both Field and Lab Based Exposures, as well as real time chemistry
- Need integrator sites within watersheds
- Continued use of Ex-Situ techniques help capture more true exposure of organisms
  - CEC pilot study; Delta RMP



web.stcloudstate.edu/aquatictox



Land use
Existing literature
Regulatory permitting
Climate, Hydrology,
Biology and Chemistry

Historical Knowledge

Identify suspect stressors

Potential collaborators

Tool identification ,
Development, method modifi

Feasibility
Logistical
Limitation
(Tools table)

Experimental Design

- Site selection
- Exposure time
- Sample size
- Organism selection
- Biomarkers selection

Spatial and Temporal Integration

Data Collection
& interpretation

Data collection and interpretation

Biales, AD, Denton, DL, Riodan D, Breuer, R, Deanovic LA, Batt AL, Crane DB, Schoenfuss H. In Review. Complex Watersheds, Collaborative Teams: Assessing Pollutant Presence and Effects in the San Francisco Delta.

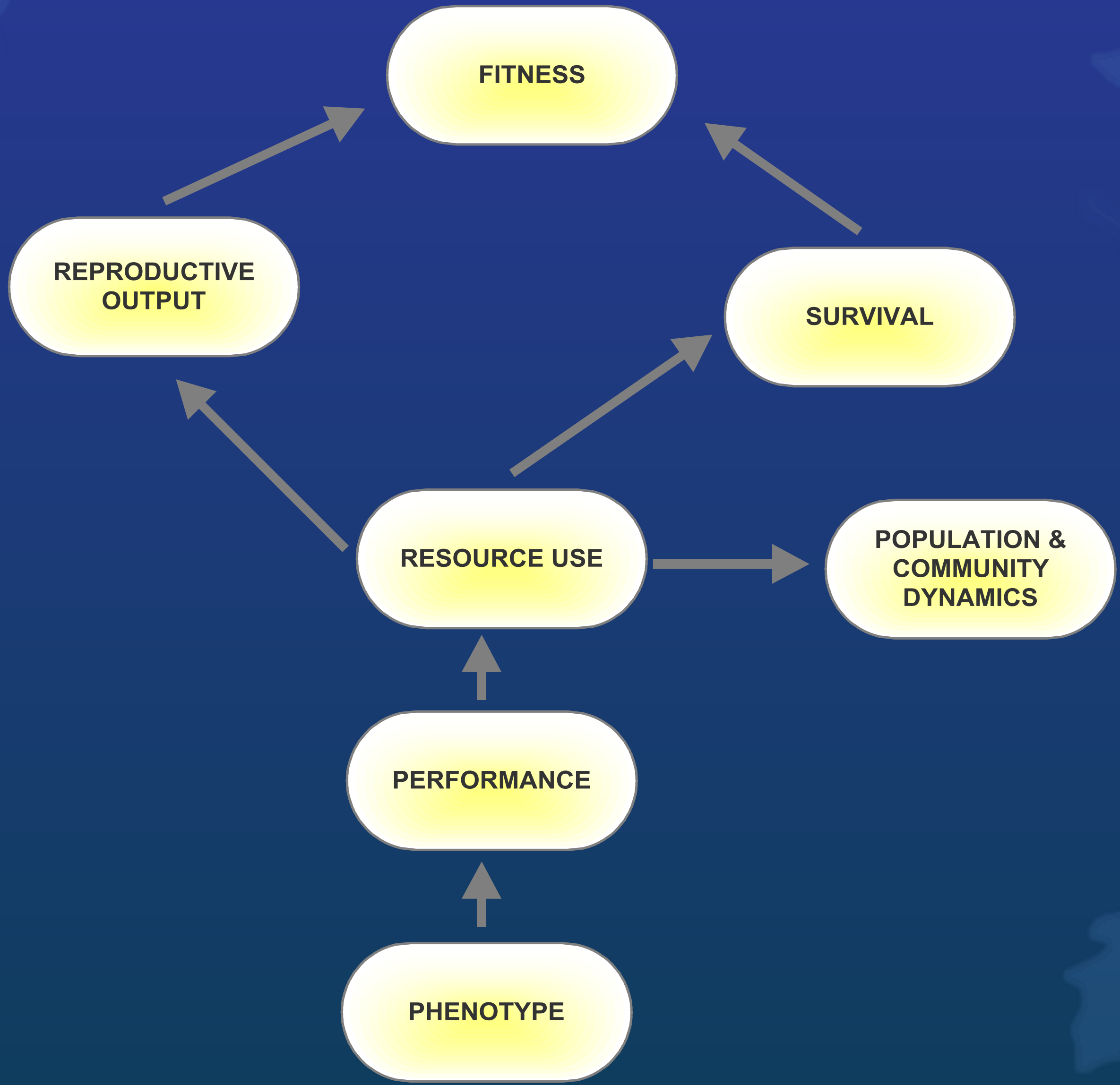
Collier T, Denslow N, Gallagher E, Kostich M, Lattier D. 2014. Evaluating Stressors in the San Francisco Estuary using Biomarkers. Report of an Independent Scientific Advisory Panel.

https://www.dfg.ca.gov/erp/biomarkers.asp Click on "Panel Report" in the box on the right-hand side.

Deanovic L. Stillway M, Callinan Hoffmann K, Jeffries KM, Connon RE, Teh S. A Thorough Toxicity Assessment of the Sacramento River at Hood, CA (Testing the Toxicity Toolbox). 2014.

Wainwright PC. 1994. Functional morphology as a tool in ecological research. In Wainwright PC, Reilly SM, eds, *Ecological Morphology*. The University of Chicago Press. Chicago, IL, USA.

Overall Fitness



Wainwright PC. 1994.