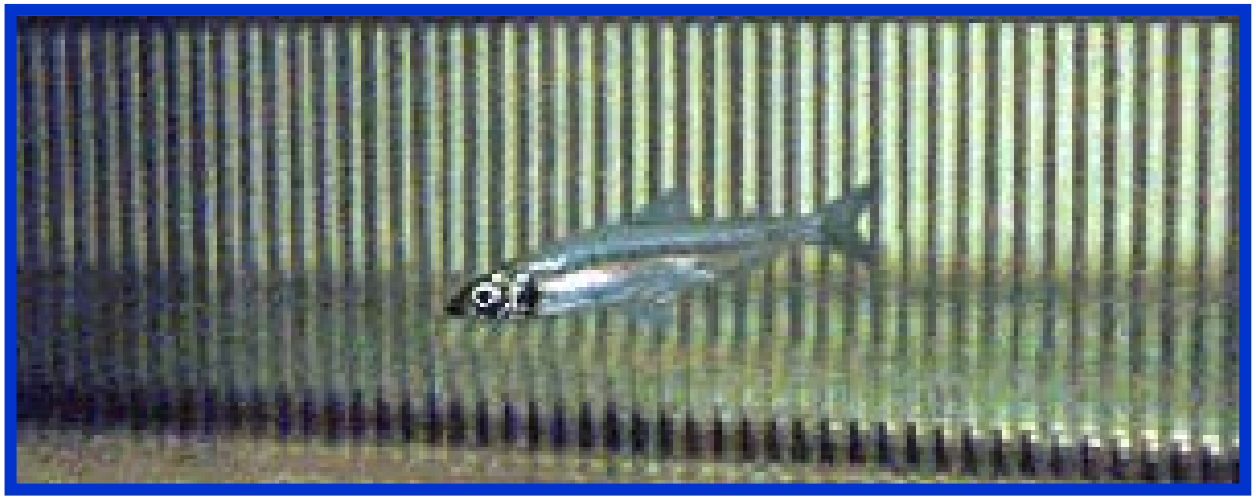
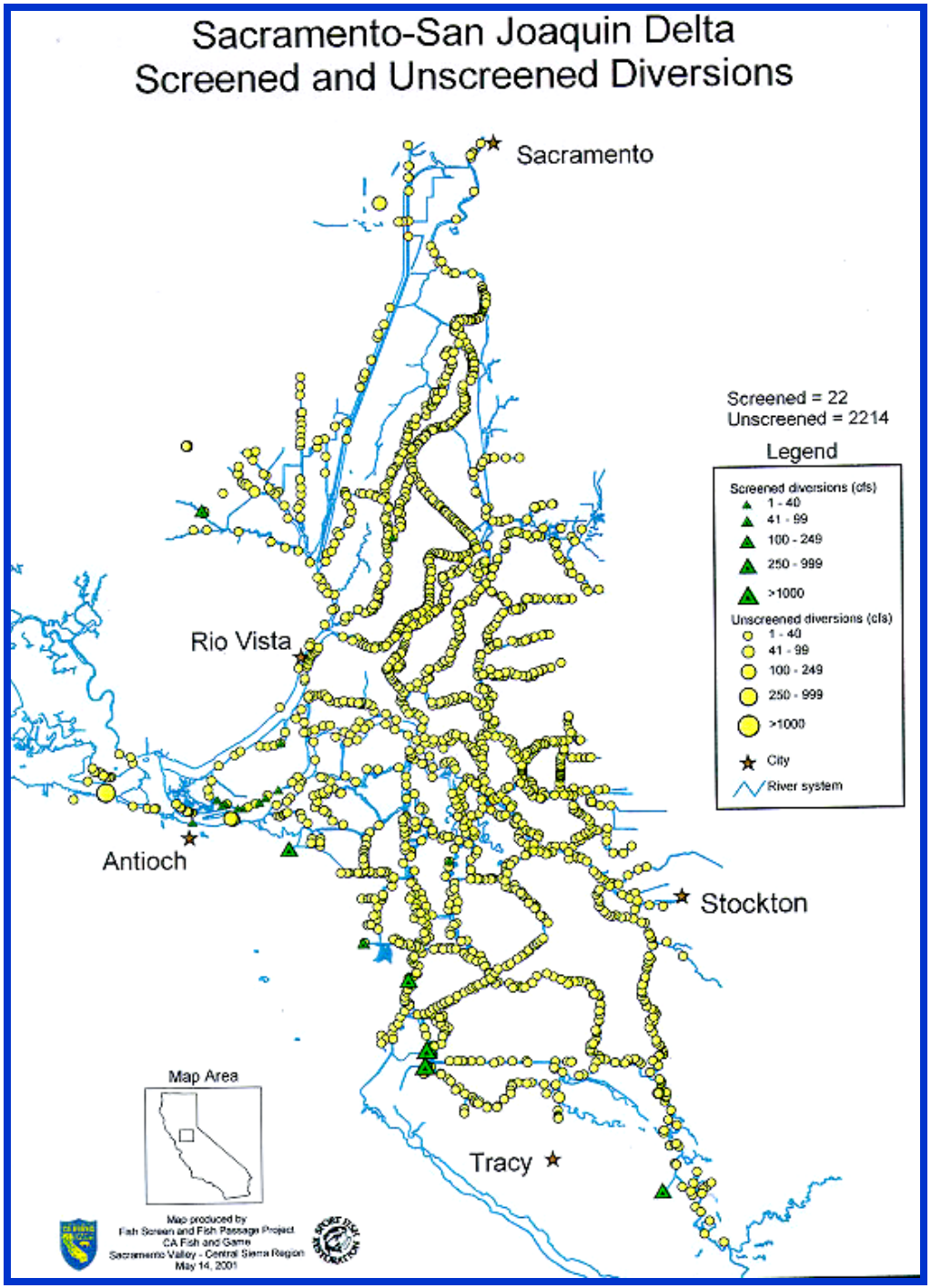
# Close Encounters With a Fish Screen
# Tails From the Fish Treadmill



**Christina Swanson, Paciencia S. Young, Stephanie Chun, Trilia Chen, Teresa MacColl, Leslie Kanemoto, and Joseph J. Cech, Jr.**

**Department of Wildlife, Fish, and Conservation Biology**
**University of California, Davis**

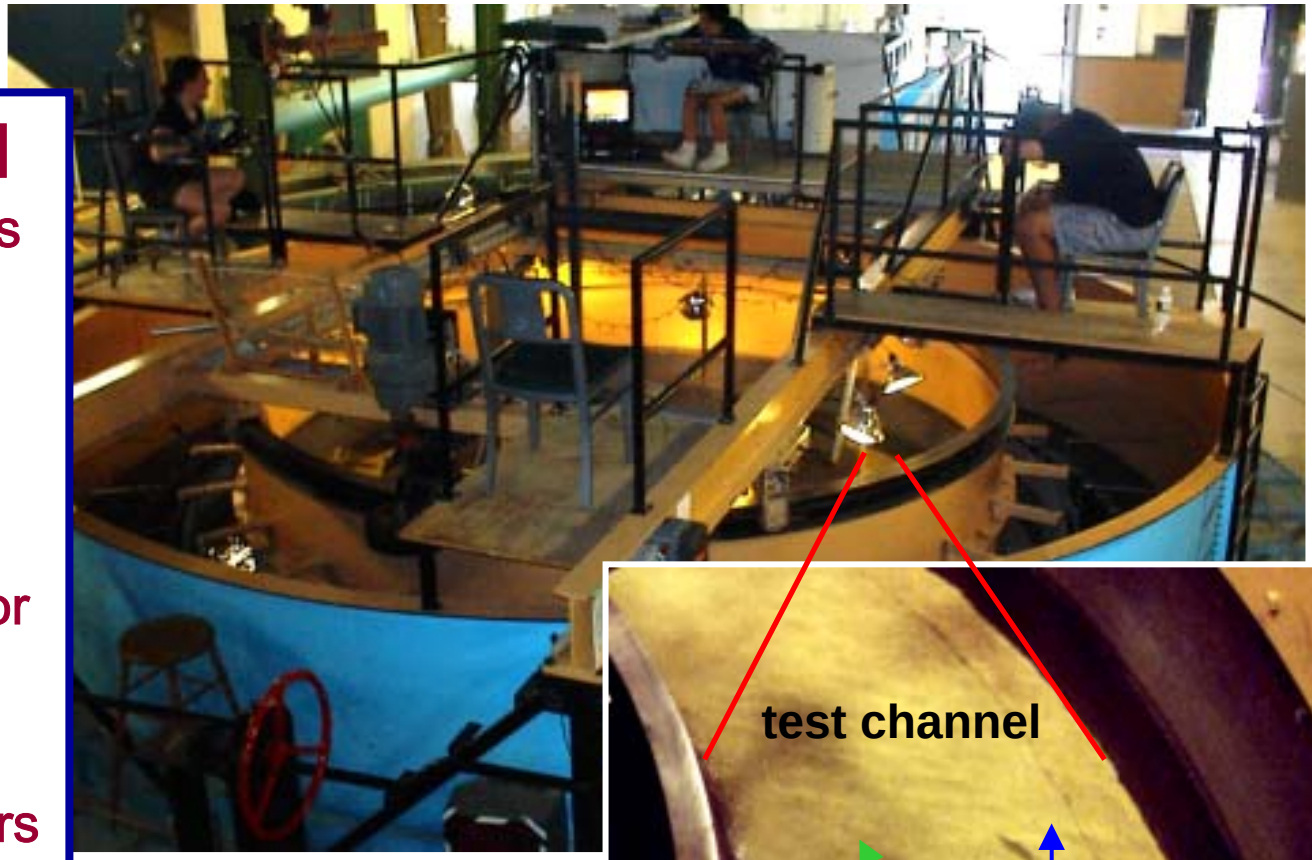
# Water diversions in the Sacramento-San Joaquin Delta

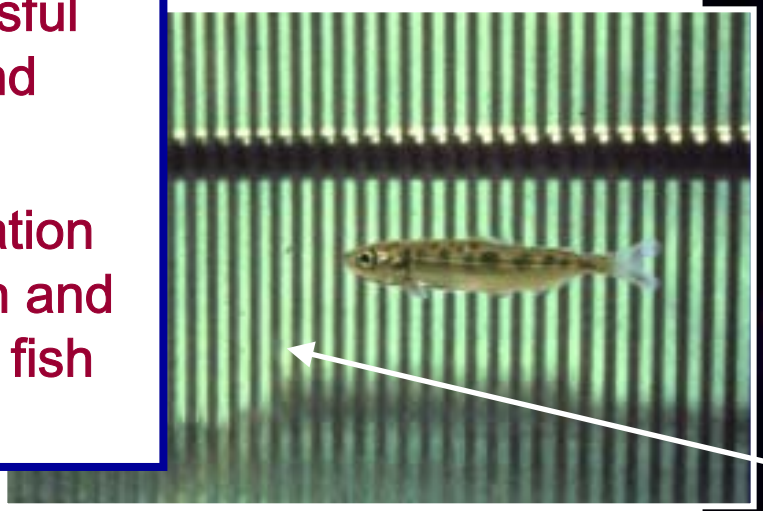


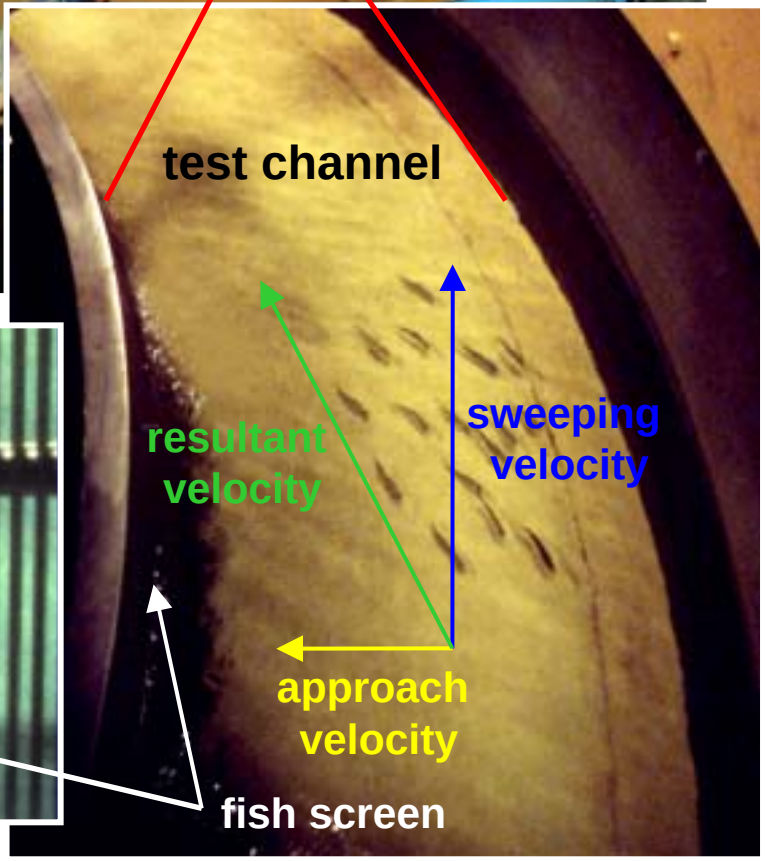
# Fish Treadmill

## UC Davis Hydraulics Laboratory

- Observe and measure fish performance and behavior in two-vector flows near a fish screen
- Identify which factors influence successful fish protection and passage
- Provide information needed to design and operate effective fish screens

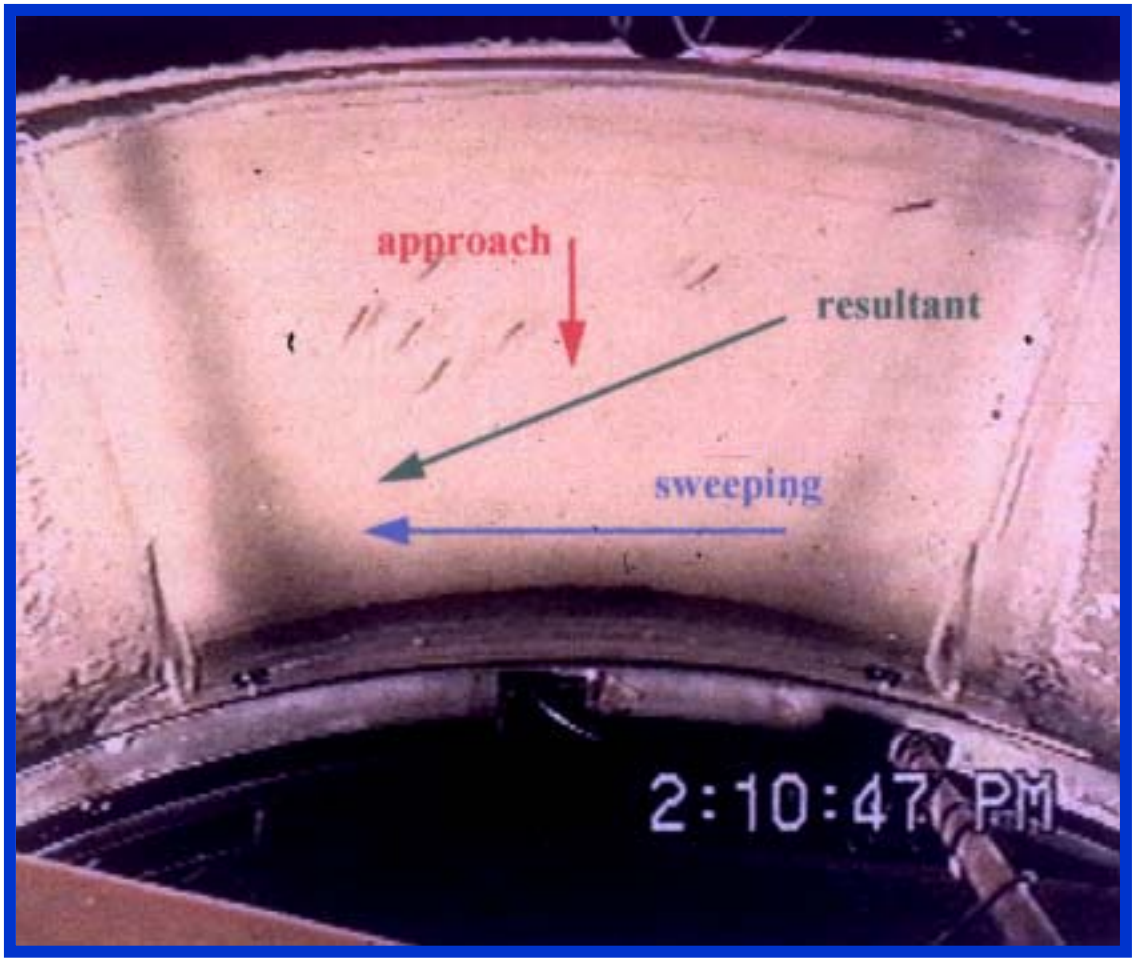






# Approach and Sweeping velocities are independently controlled in the Fish Treadmill

| Approach | | Sweeping |
|---|---|---|
| cm/s (fps) | | |
| 0 | (control) | 0 |
| 6 (0.2) | | 0 |
| 10 (0.33) | | 0 |
| 15 (0.5) | | 0 |
| 6 | | 31 (1.0) |
| 10 | | 31 |
| 15 | | 31 |
| 6 | | 62 (2.0) |
| 10 | | 62 |
| 15 | | 62 |



# Measurements

## Fish – Fish screen interactions

- screen contact rate (total and body contact rates)
- impingement rate

## Injuries and Survival

- injury index (injury rate and severity)
- 48-h post-exposure survival

## Behavior

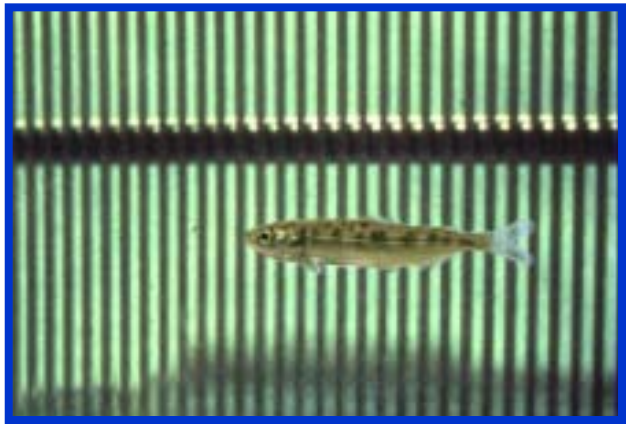
- swimming velocity
- distance from screen
- screen passage velocity

# RESEARCH
and
# APPLICATIONS

## Delta smelt

# FIELD VALIDATION

## Chinook salmon

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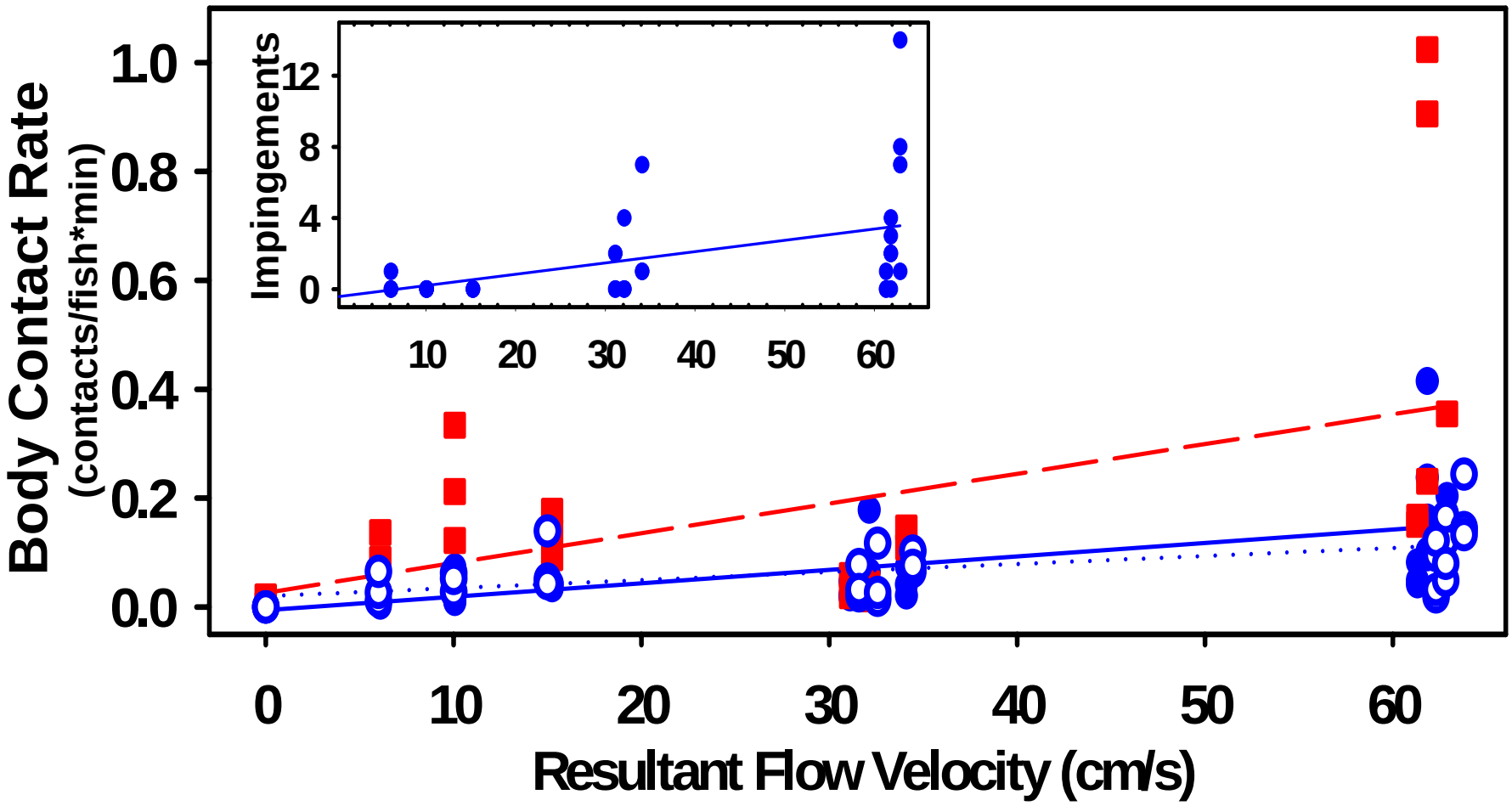
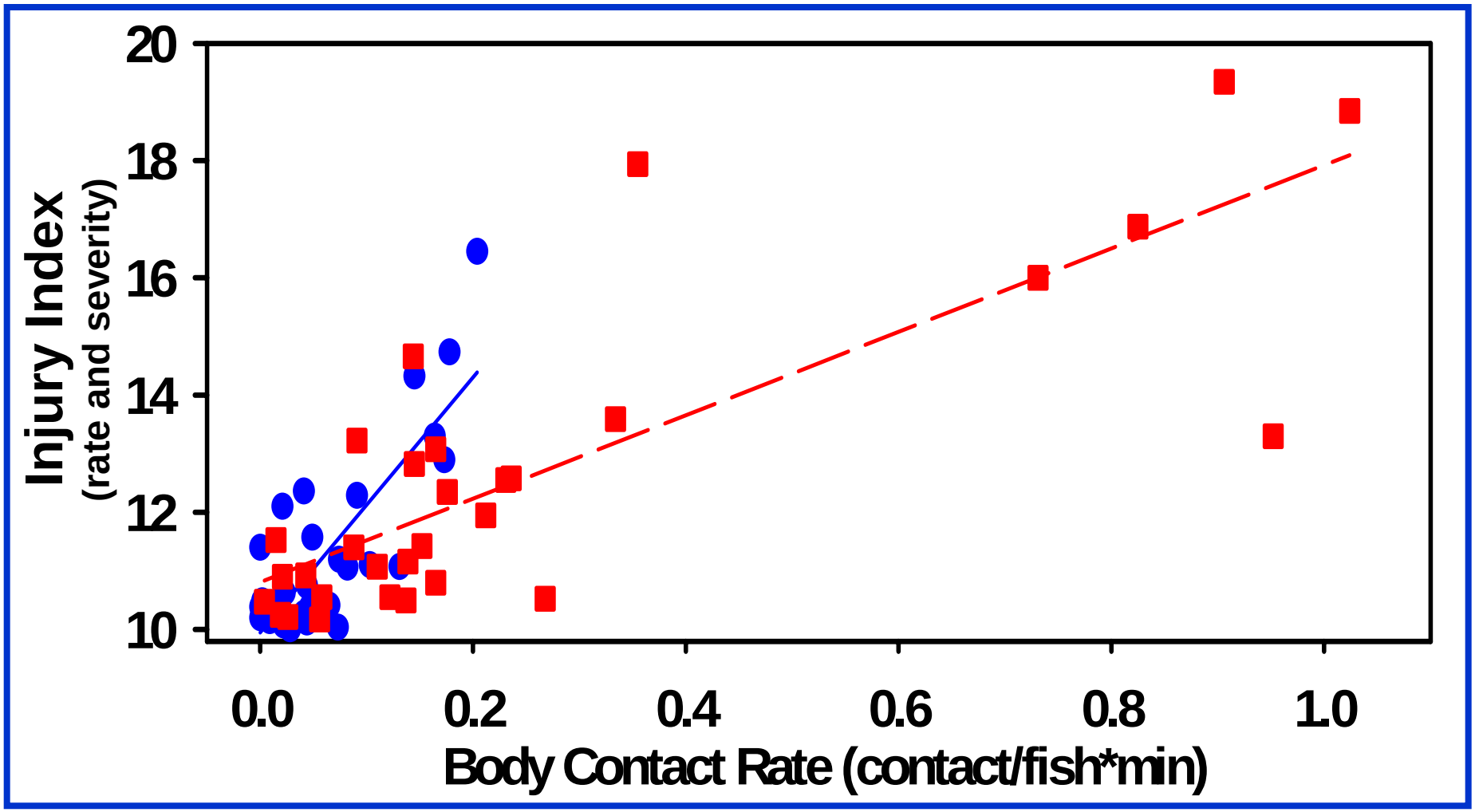
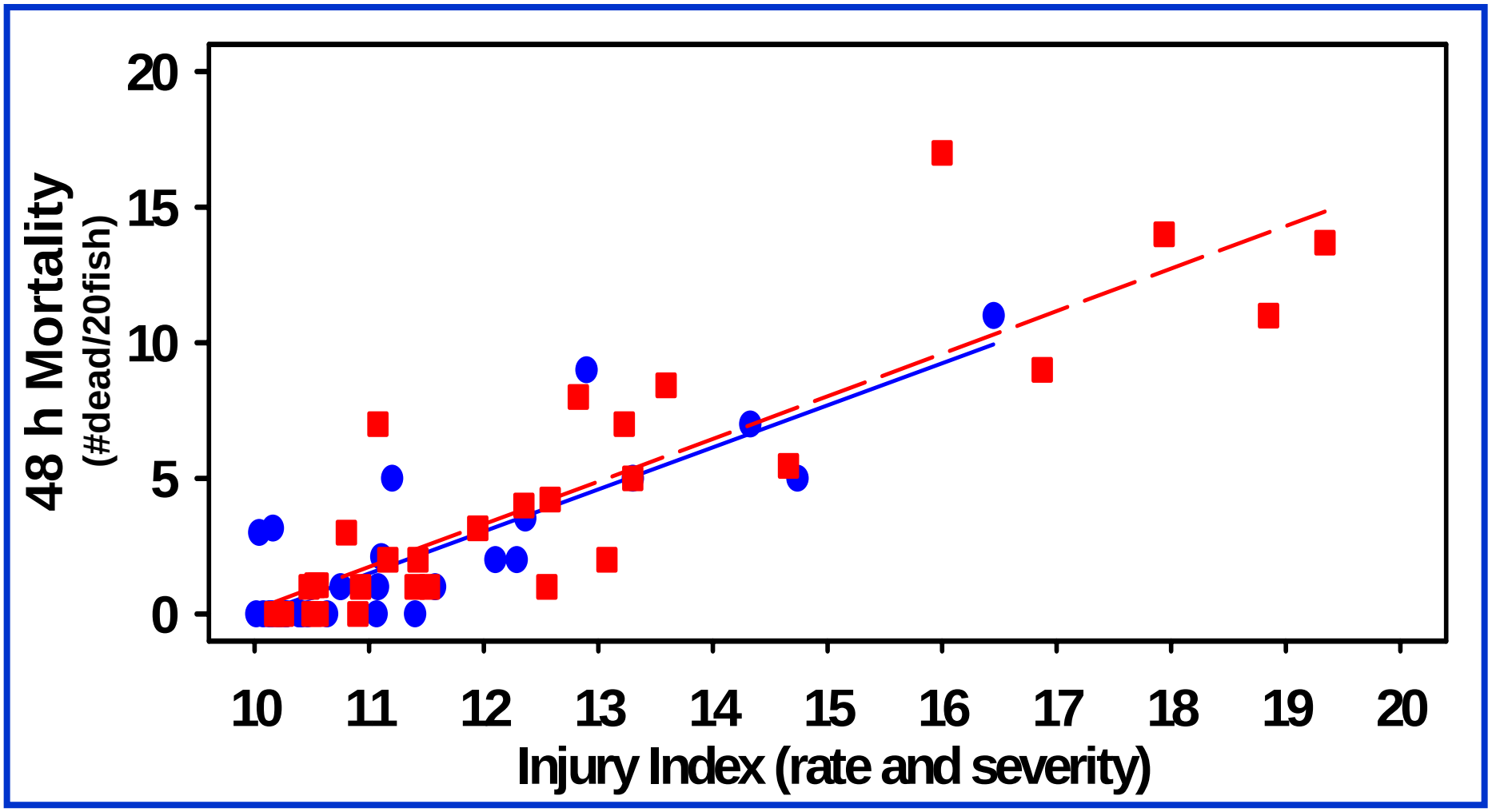
# RESEARCH
## Effects of Flow on Screen Contact Rates

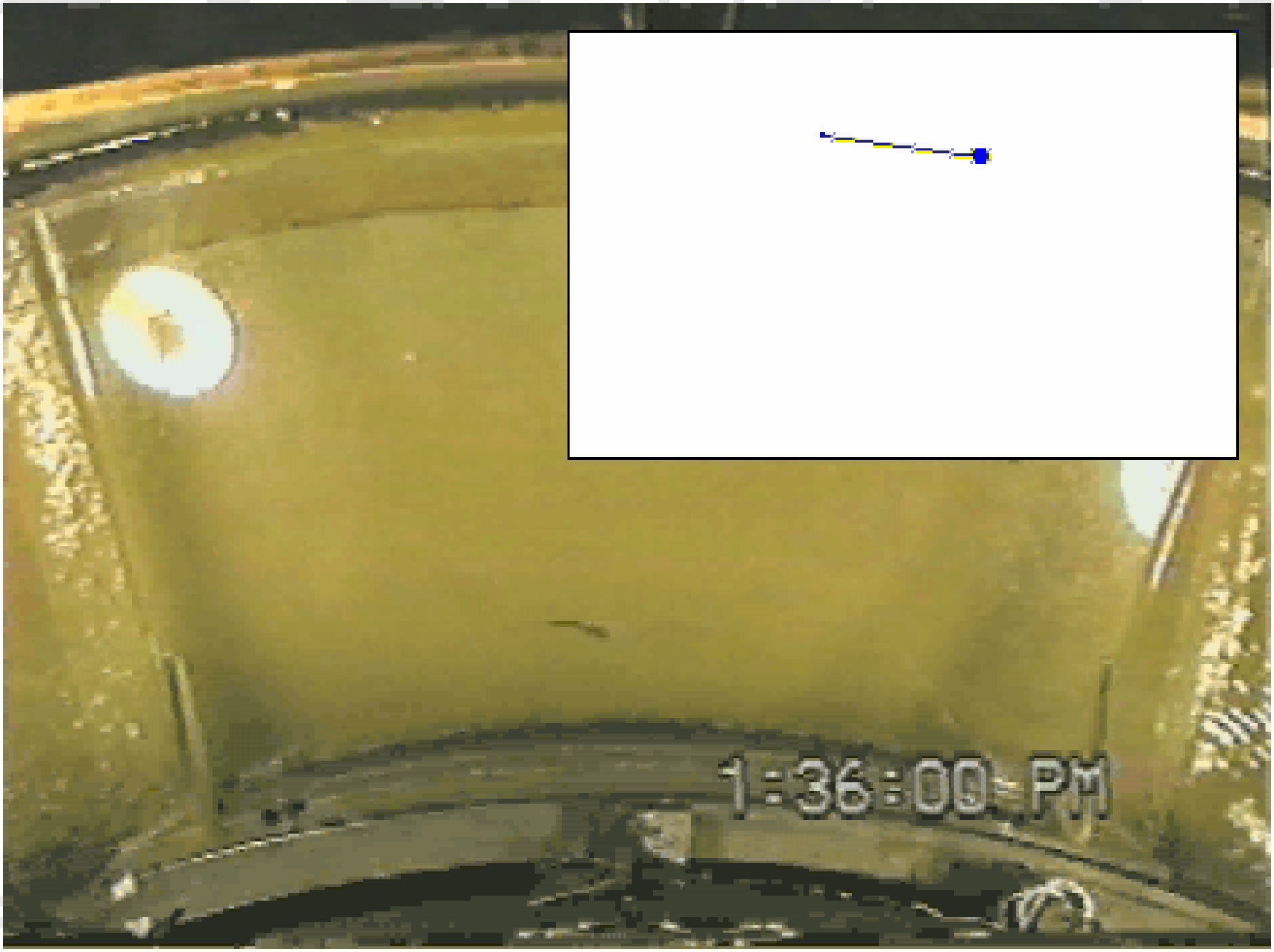


# RESEARCH
## Effects of Screen Contact on Injuries



# RESEARCH
# Effects of Injury on Mortality

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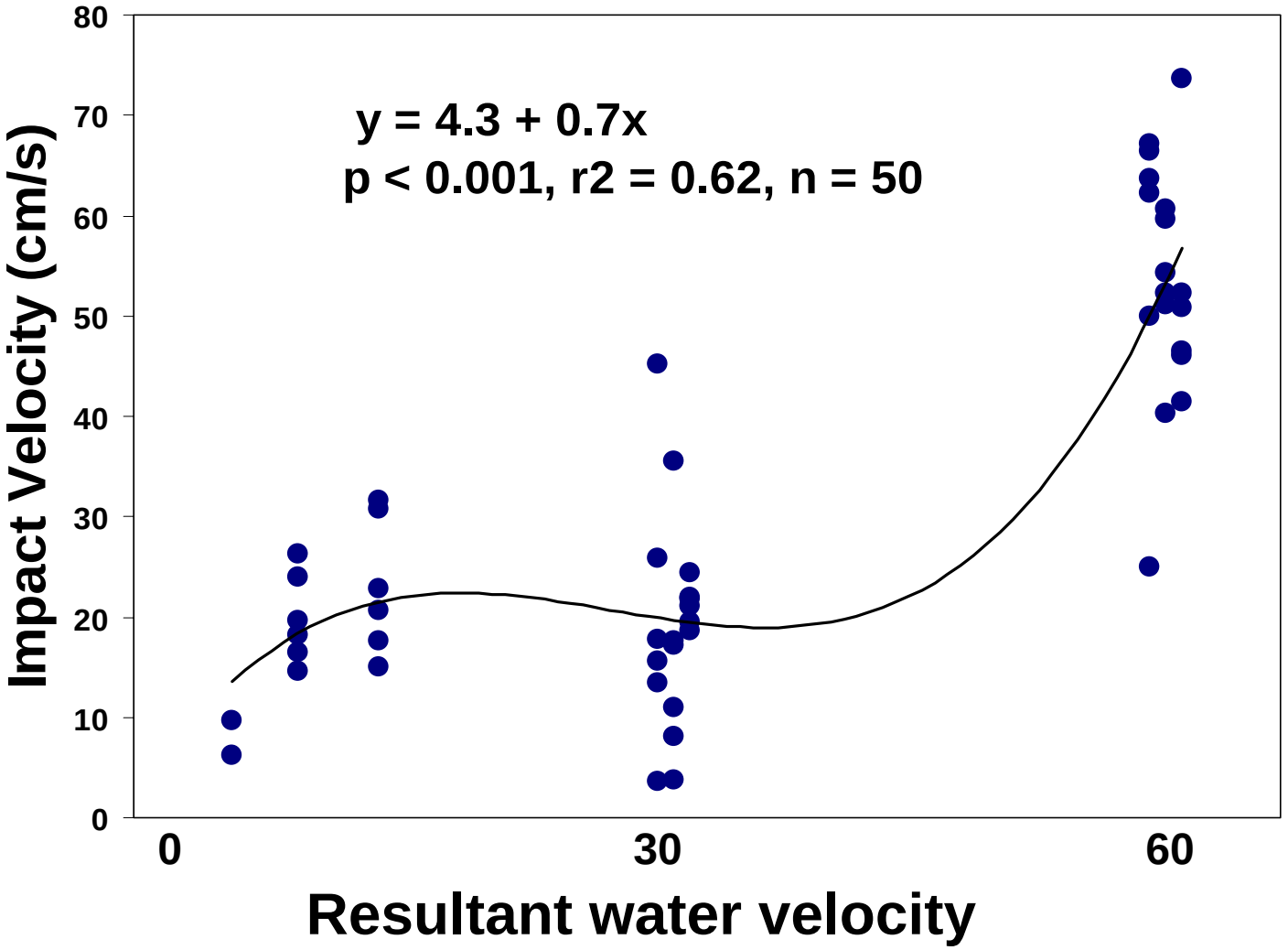
# RESEARCH

## Effects of Flow on Screen Impact Velocity



# Using Fish Treadmill Results

**Multiple measurements**

↓

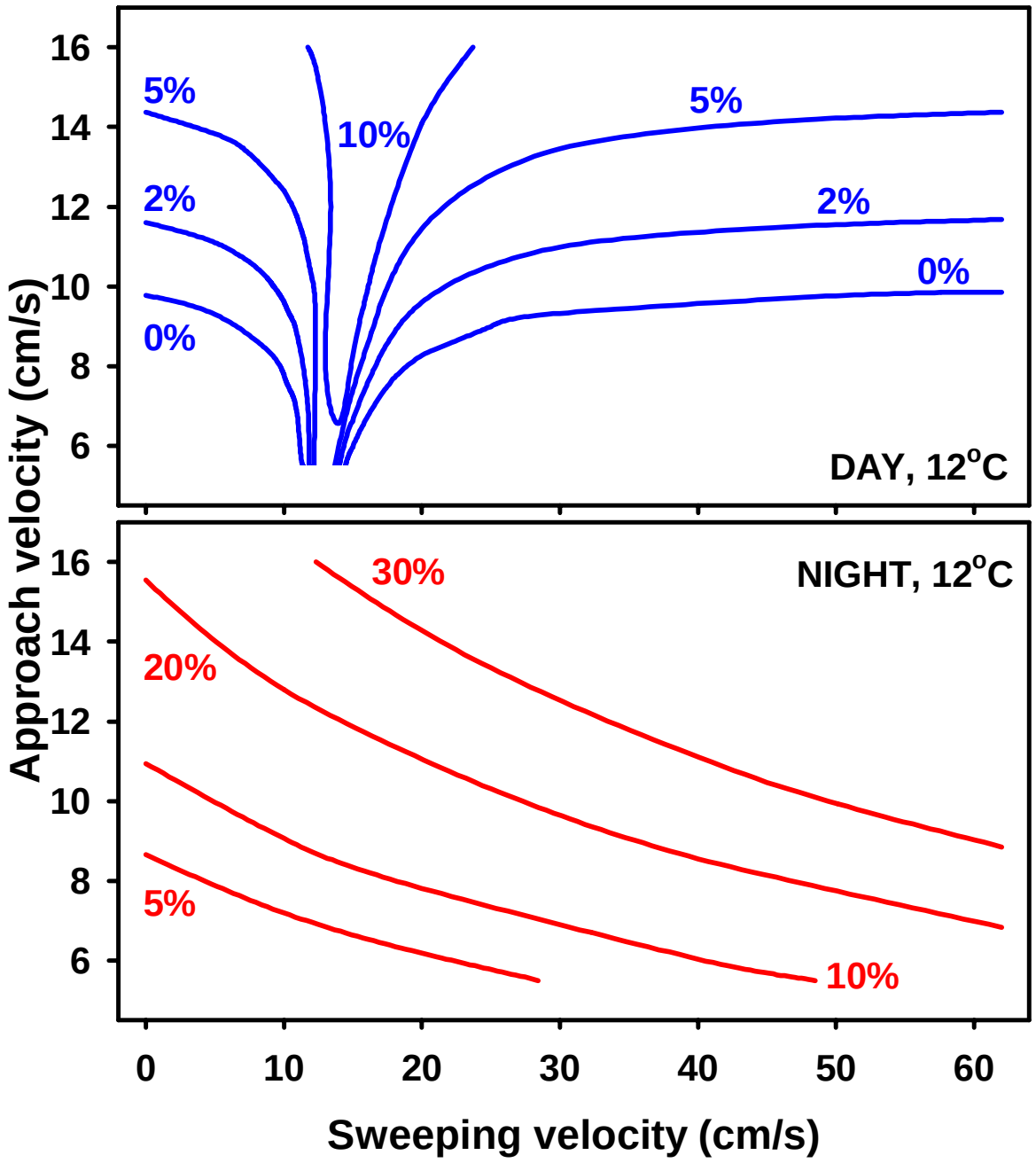
**Statistical models**

↓

**Predictions**

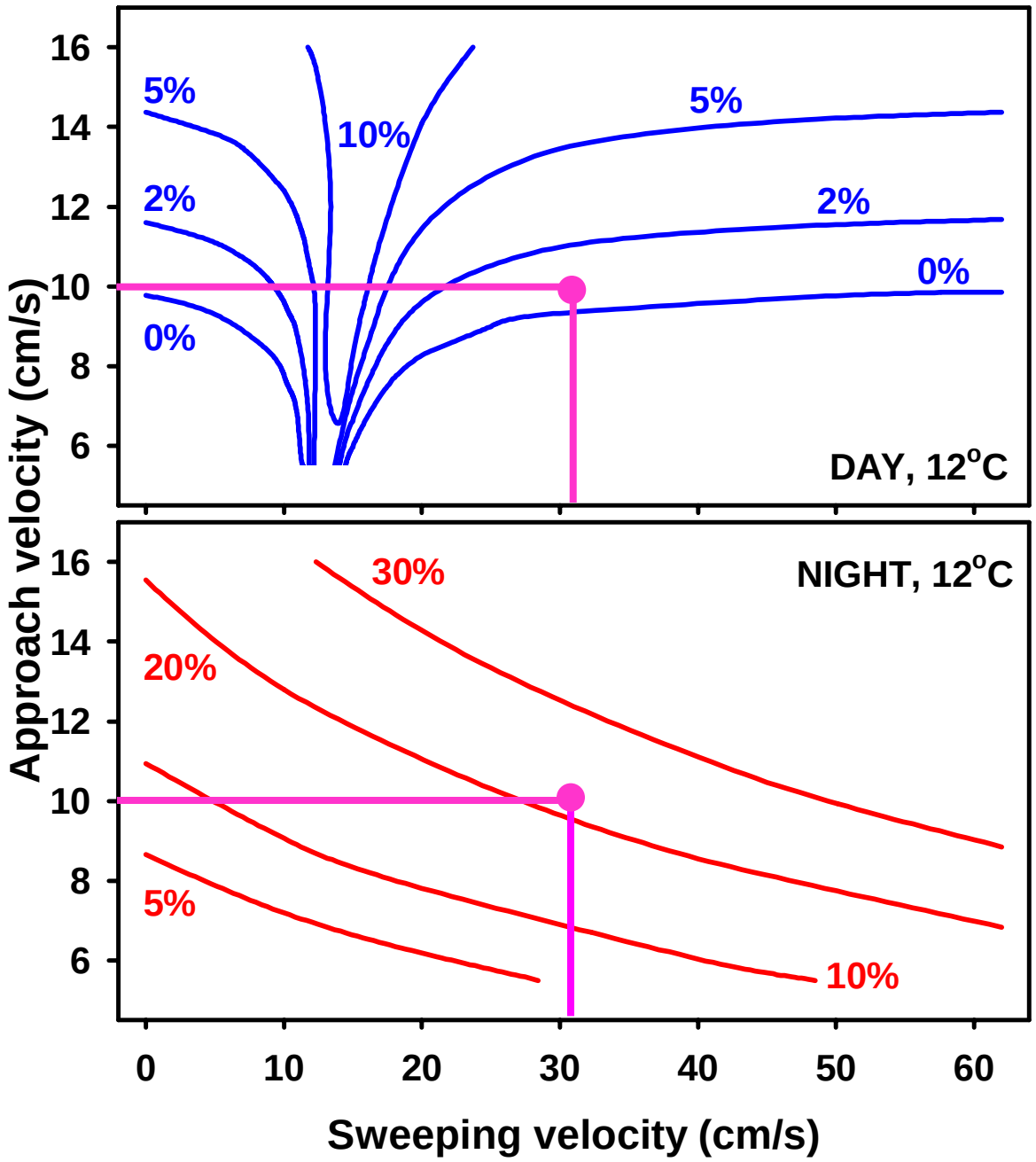
**Behavior (swimming velocity, passage velocity)**
**Exposure duration**
**Probability of screen contact**
**Survival**

→ **Go to Excel spreadsheet**



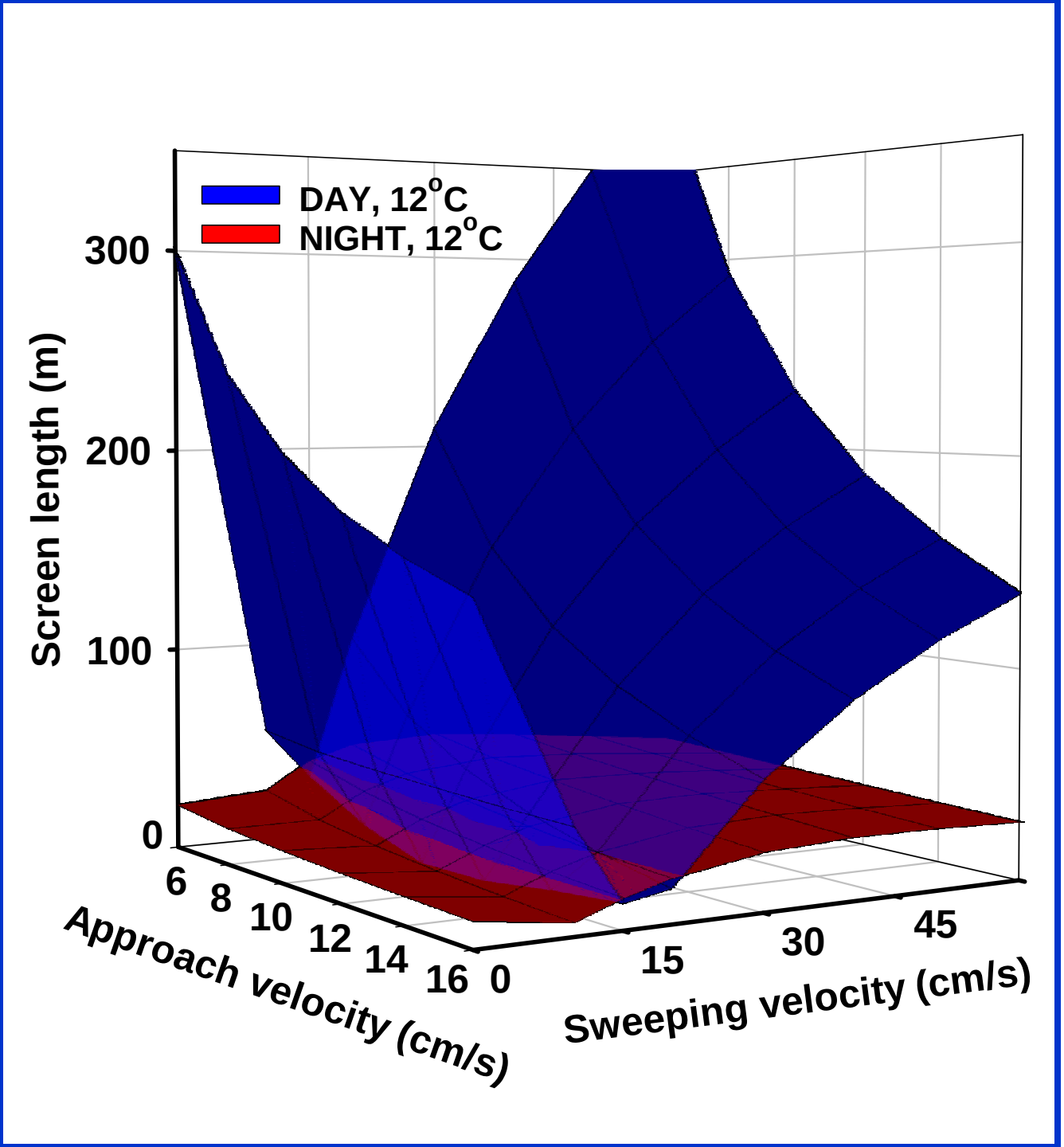

# APPLICATIONS

## Effects of Flow on Survival




# APPLICATIONS

## Effects of Flow on Survival



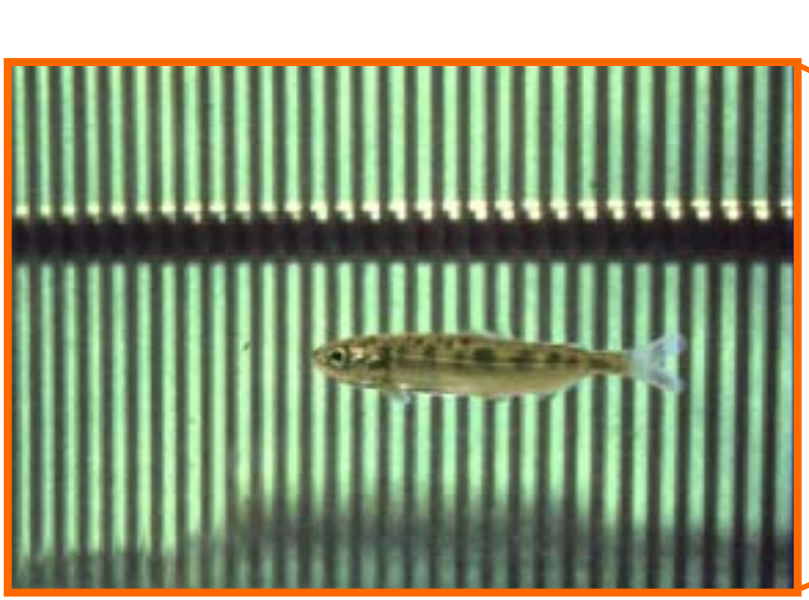

# APPLICATIONS

## Predicting Screen Length

**Target exposure duration:**

**1.0 contact/fish**

# FIELD VALIDATION
## Linking Laboratory and Field Studies on Juvenile Chinook Salmon



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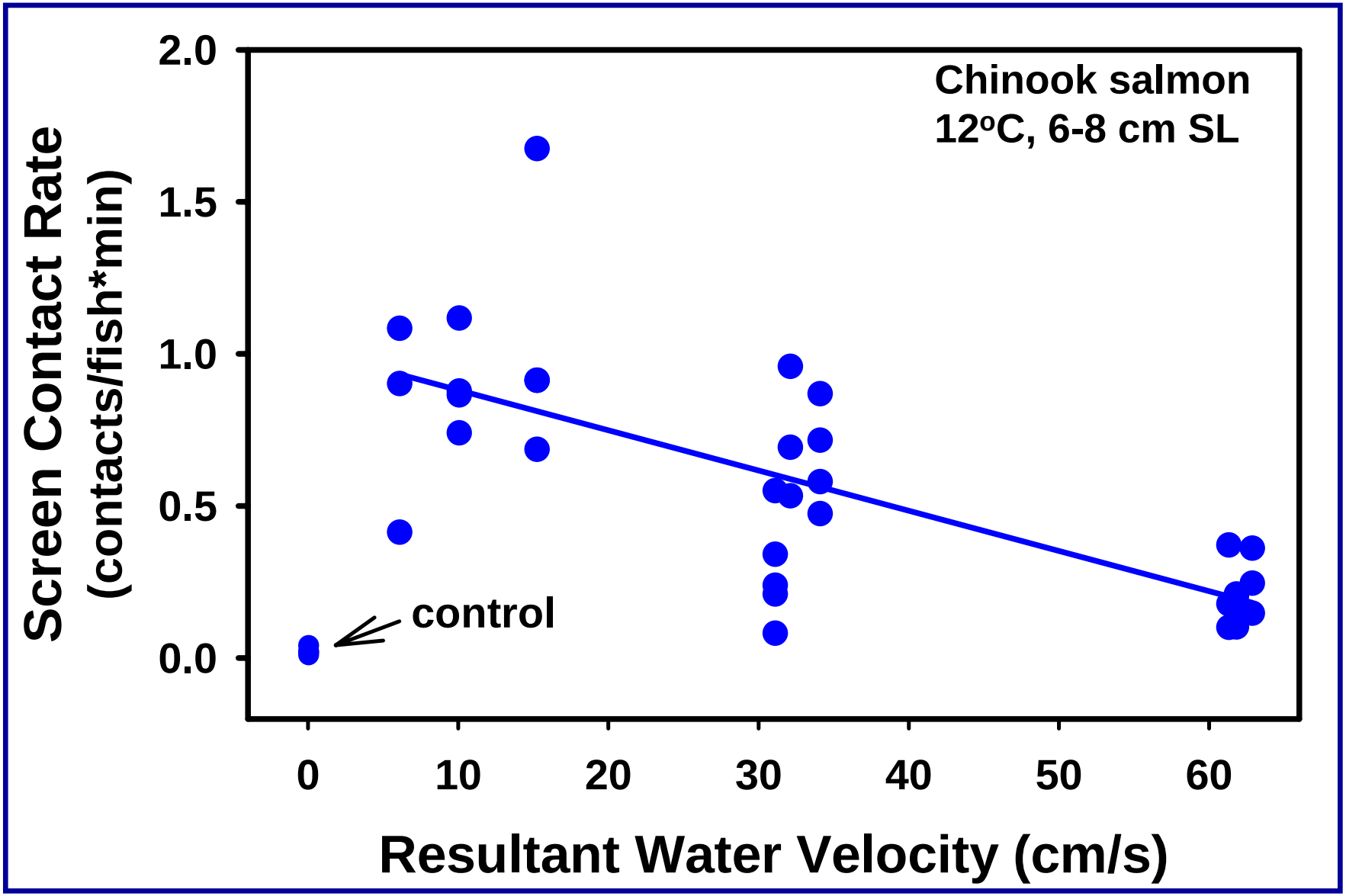
University of California, Davis

Richard Wantuck and Dan B. Odenweller
NOAA Fisheries

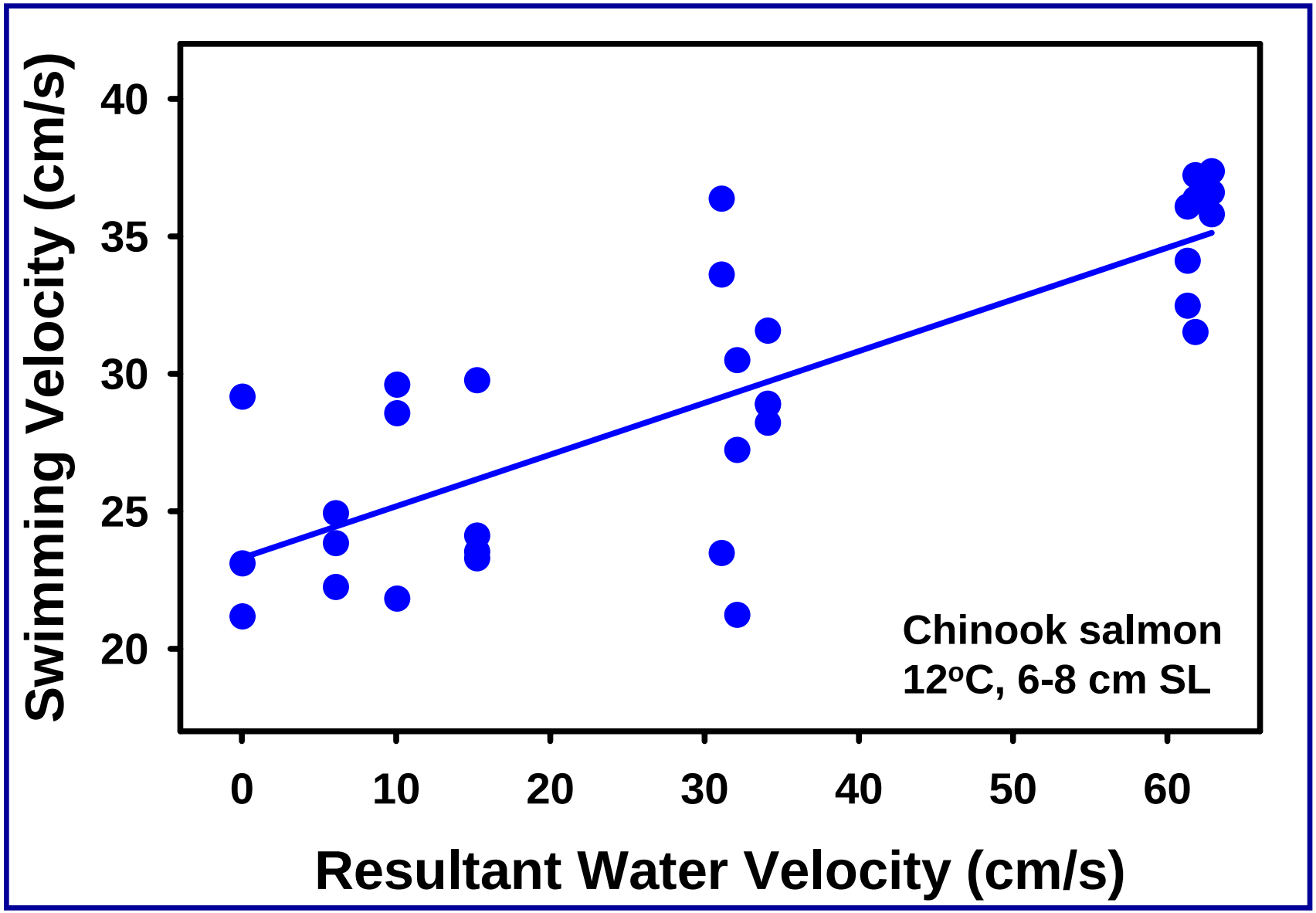
# RESEARCH

## Screen contact rates decrease with water velocity



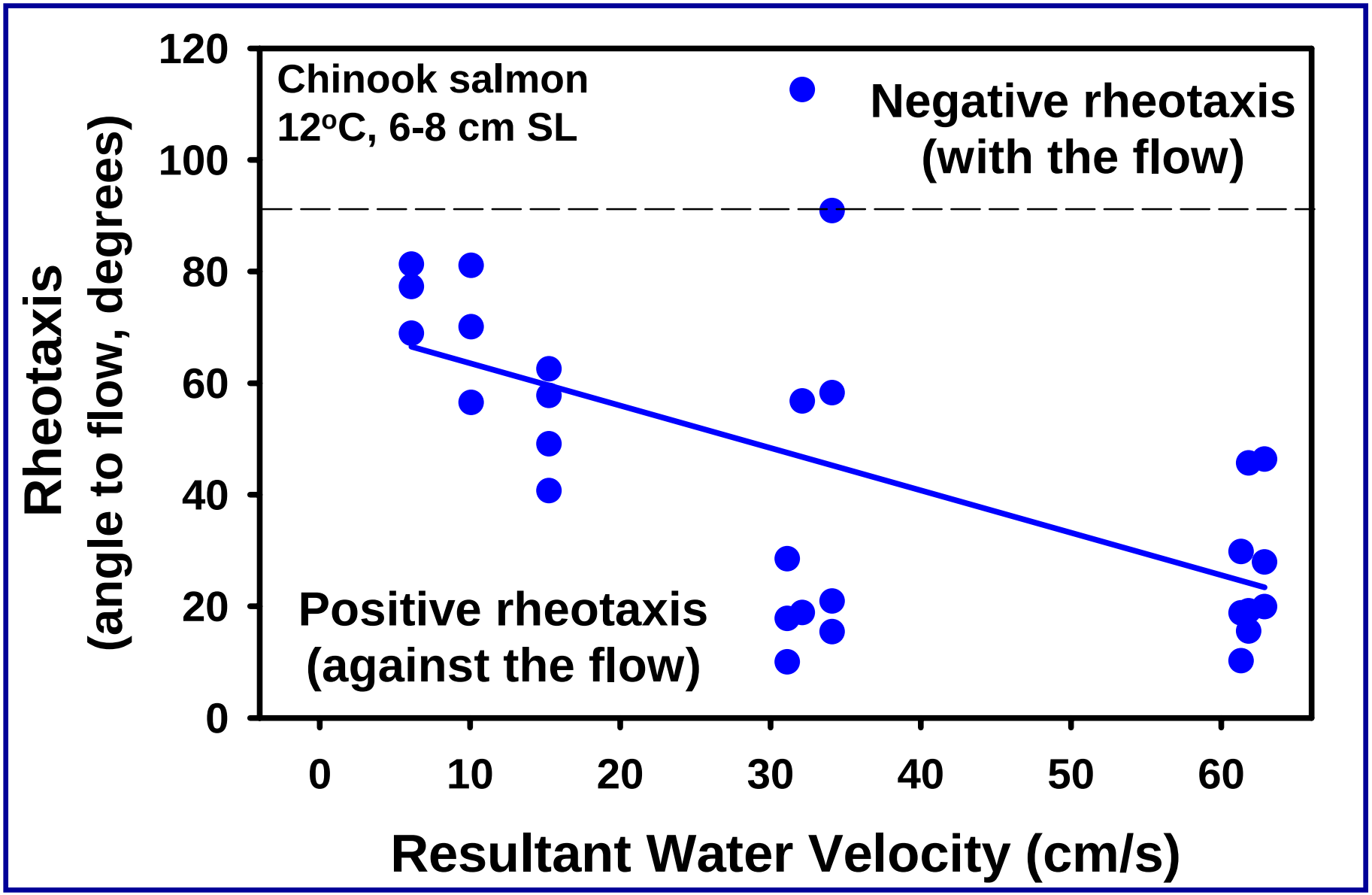
# RESEARCH

## Swimming velocity increases with water velocity



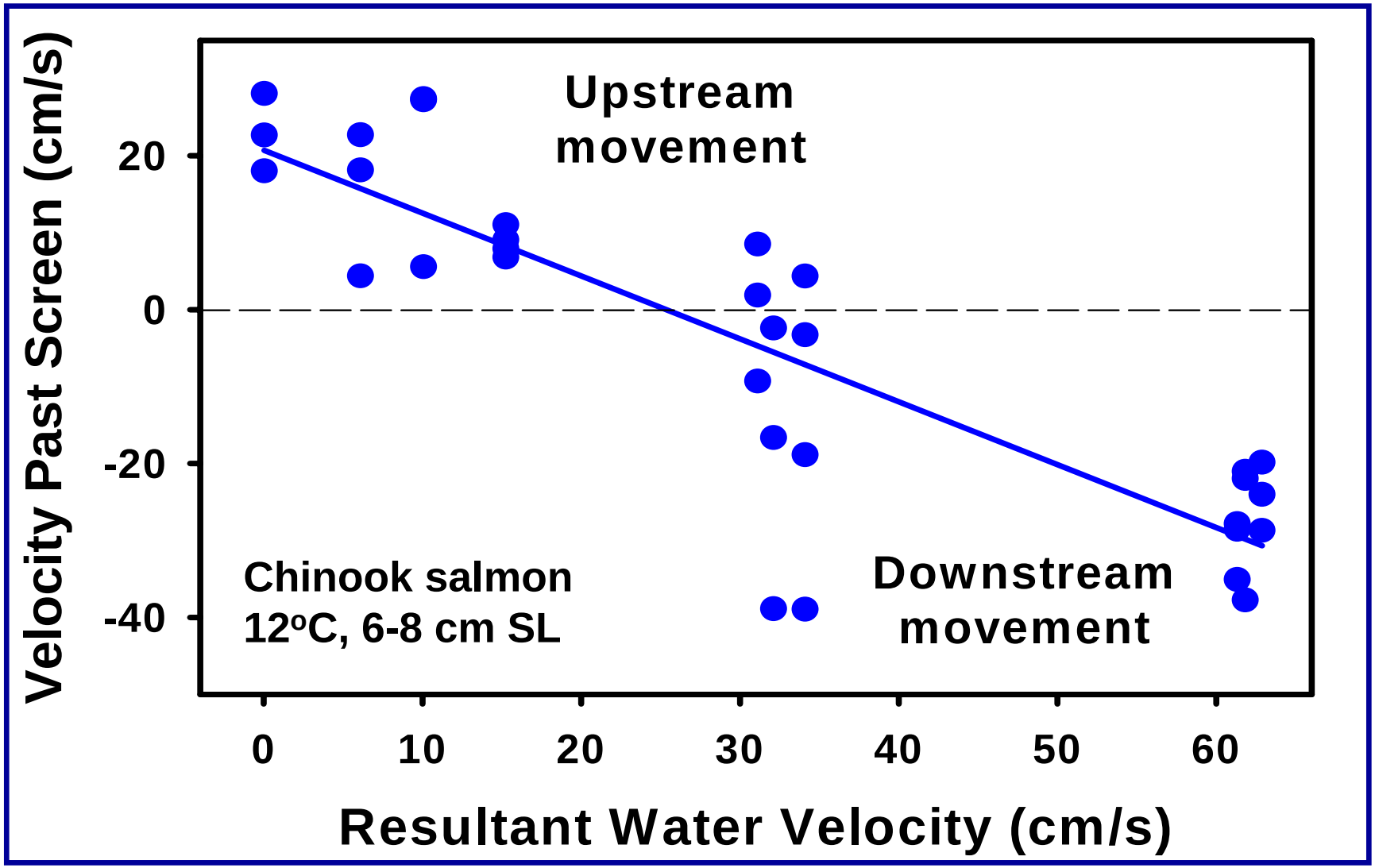
# RESEARCH

## Positive rheotaxis increases with water velocity



# RESEARCH

## Movement past the screen is lowest at intermediate water velocities



**RESEARCH FINDINGS**

**Interpretations and Potential Applications for Fish Screen Flow and Operational Criteria from the Fish Treadmill Project**

**Anadromous Fish Screen Program, Cooperative Agreement No. 114201J075**

Prepared by

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Department of Wildlife, Fish, and Conservation Biology
University of California, Davis, CA 95616

**Species:** Chinook salmon, *Oncorhynchus tshawytscha*

**Size (Age):**4-6 cm standard length (SL), "parr"
6-8 cm SL, "smolt"

**Environmental Conditions:** 12°C, winter and spring
Day (light conditions) and Night (dark conditions)

Submitted to

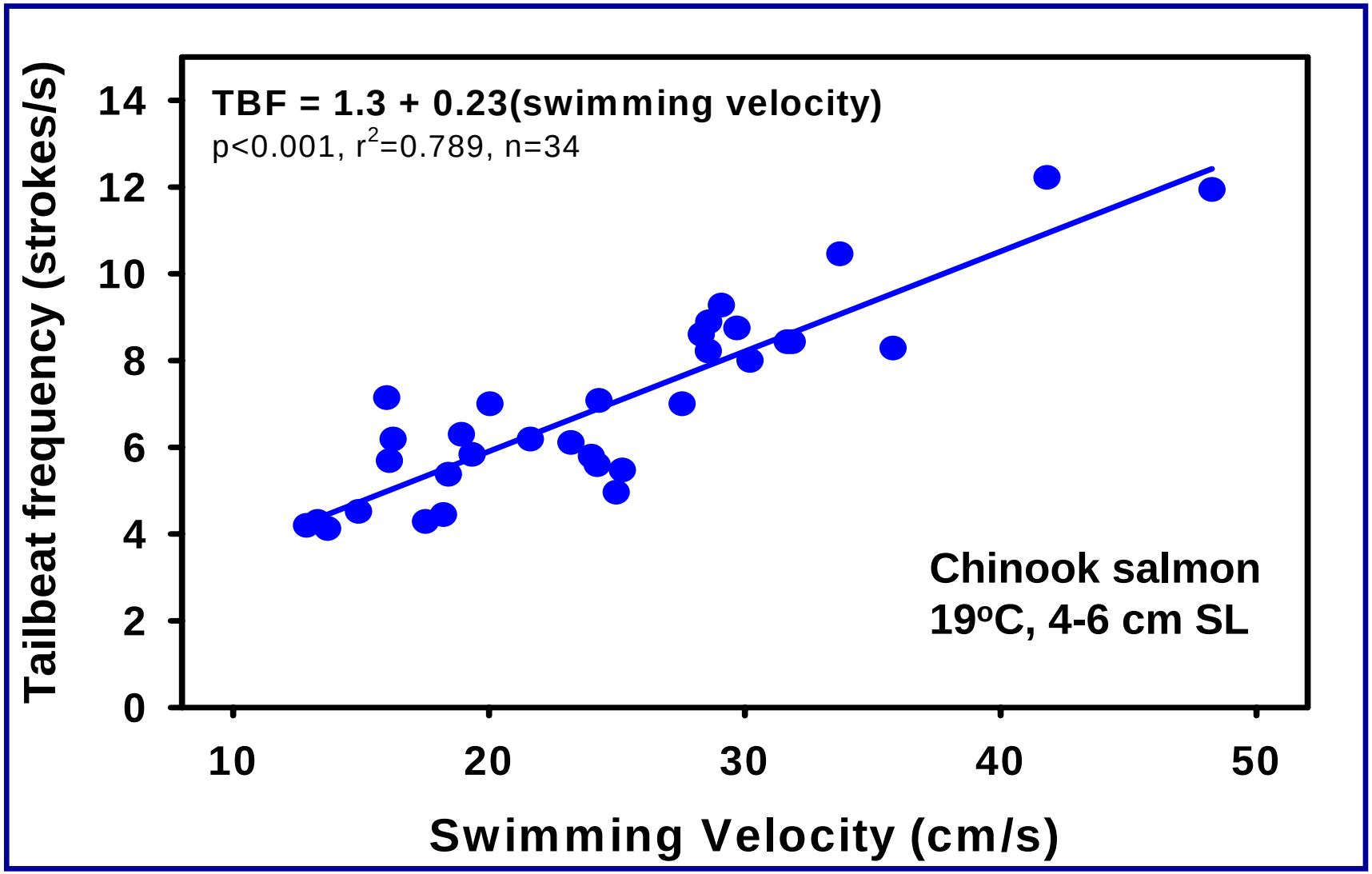
**The Anadromous Fish Screen Program**
**U. S. Fish and Wildlife Service**
**Sacramento, CA**

# FIELD VALIDATION

How does performance and behavior observed in the Fish Treadmill compare with that of fish in the field near an operational water diversion?

# VALIDATION TOOLS: Videotape and research results

## Tailbeat frequency increases linearly with swimming velocity



# Parrott - Phelan Fish Screen

## Butte Creek, CA

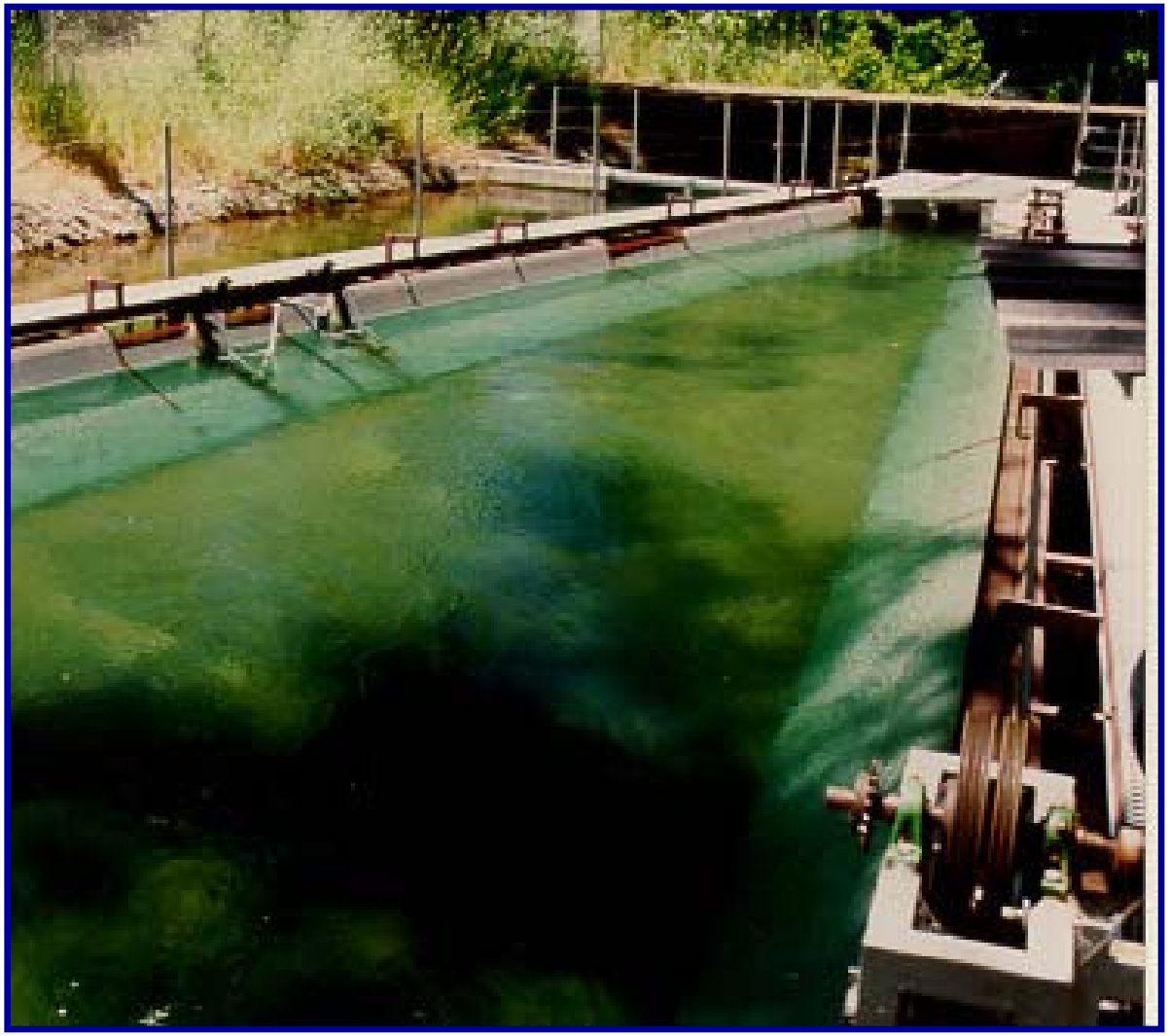
## FIELD RESULTS

### Water velocity
30-38 cm/s

### Swimming velocity
32.7+4.7 (SD) cm/s
(range: 25-39 cm/s)

### Rheotaxis
generally positive

### Passage
no net downstream movement in 2 h



# GCID Fish Screen

## Sacramento River, CA

## FIELD RESULTS

### Water velocity

67-78 cm/s

### Swimming velocity

38.3+4.4 (SD) cm/s
(range: 32-47 cm/s)

### Rheotaxis

positive

### Passage

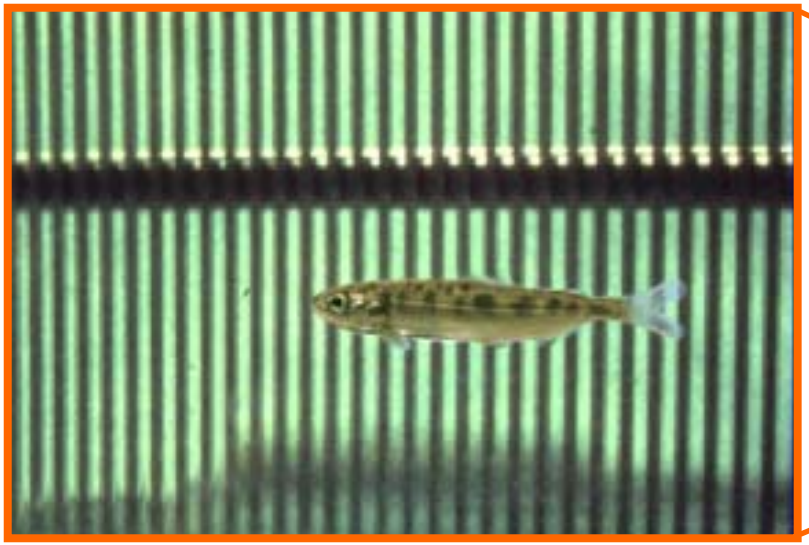
net downstream movement

Some fish diverted into bypass

# Conclusions

**Behavior of juvenile chinook salmon in the Fish Treadmill is similar to that of fish observed near two screened water diversions in the field**

**This supports the applicability of Fish Treadmill results for refining and developing fish screen flow and exposure duration criteria**



# Future Applied Research

**Alternative fish passage strategies**

**Effects of debris and “hot spots”**

**Fish screen detection, visual vs mechanoreception**

**Alternative screen types**

**Multiple screen exposures**

# ACKNOWLEDGEMENTS

## Many people contribute to the Fish Treadmill Project

We thank M. L. Kavvas, Z.Q. Chen, W. Summer, E. Velagic, H. Bandeh, A. Karakas, E. Dogrul, S. Sharma, N. Ohara, Y. Tekeli of the University of California, Davis, Hydraulics Laboratory who operate and maintain the Fish Treadmill.

We also thank R. Brown, D. Hayes, J. Andrew, T. Frink, S. Mayr, M. Kirkland, T. MacColl, Z. Matica, R. Kurth (DWR), D. Odenweller, K. Urquhart, R. Fujimura, G. Edwards, G. Aasen, D. Shigematsu, R. Watanabe, D. Killam, J. Long, G. Brazil,, S. San Julian, C. Dorrough, P. Macias, R. Soto, (DFG); W. O'Leary and C. Liston (USBR), R. Wantuck (U.S. National Fisheries Service); T. Chen, M. Kondratieff, and B. Nathaniel (UCD).

This research is supported by California Departments of Water Resources (DWR) and Fish and Game (DFG), U.S. Bureau of Reclamation (USBR), and the CALFED Bay/Delta Ecosystem Restoration Program.