

# Battelle

*The Business of Innovation*

## Factors Affecting the Shoreline Distribution of Asiatic Clams, *Corbicula fluminea* (Müller), in the Hanford Reach, Columbia River

Behr Turner, Battelle PNNL

Brett Tiller, Battelle PNNL

Dr. Allan Scholz, EWU



March 9, 2004

# Acknowledgements

---

- Battelle Staff:
  - Corey Duberstein
  - Dr. Janelle Downs
  - Dr. Bill Rickard
  - Ted Poston
  - Craig McKinstry
  - Bob Mueller
  - Ian Welch
  - Mickey Chamness
  - Donald Mendoza
  - Brad Fritz
  - Kate Deters
- PNPL OFP and Research Fellows:
  - Rochelle Shipley
  - Joe Zelinski
  - Kyle Larson
  - James Bernhard
- Eastern Washington University Staff:
  - Dr. Bruce Lang
  - Dr. Nancy Birch
  - Holly McLellan
- Conducted for the U.S. Department of Energy by Pacific Northwest National Laboratory under contract DE-AC06-76RLO 1830
- EWU Biology Department Graduate Research Grant
- EWU Alumni Graduate Research Grant

# Introduction to Asiatic Clam

---

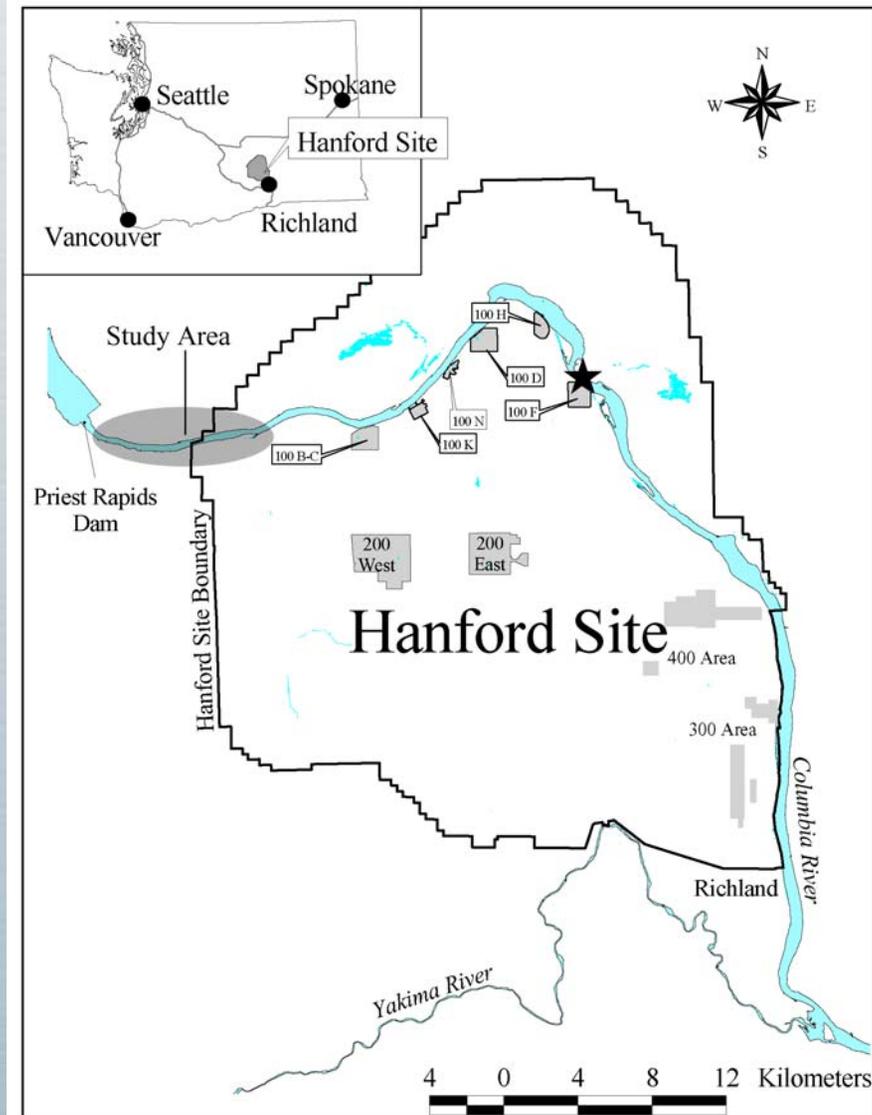
- Exotic
  - From South-central Asia
  - Believed to have been introduced in the 1920's (McMahon 1983)
    - Chinese immigrants
    - Voyage food source
  - In 1938, this species was first identified in U.S. (Burch 1944)
  - No records of Asiatic clams in Hanford Reach of the Columbia River during 1960's and 1970's
- 3-year life span
- Established in Hanford Reach
- Shoreline distribution affected by dewatering (Junk 1975; McMahon 1979; Mouthon 2001; White 1979; White and White 1977)

## Study Impetus

---

- Sentinel for monitoring Hanford-related metals and radionuclides in the environment
  - 47 years of plutonium production on the Hanford Site
  - Groundwater
    - Current route of contaminant introduction to river
- River fluctuations complicate interpretation of sampling results and affect species distributions
  - River/Groundwater interaction affects contaminant uptake
  - Dewatering events affect condition and survival
- Need to describe shoreline distribution of A. clams along the Hanford Reach of the Columbia River

# Hanford Reach of the Columbia R. and Study Area



March 9, 2004

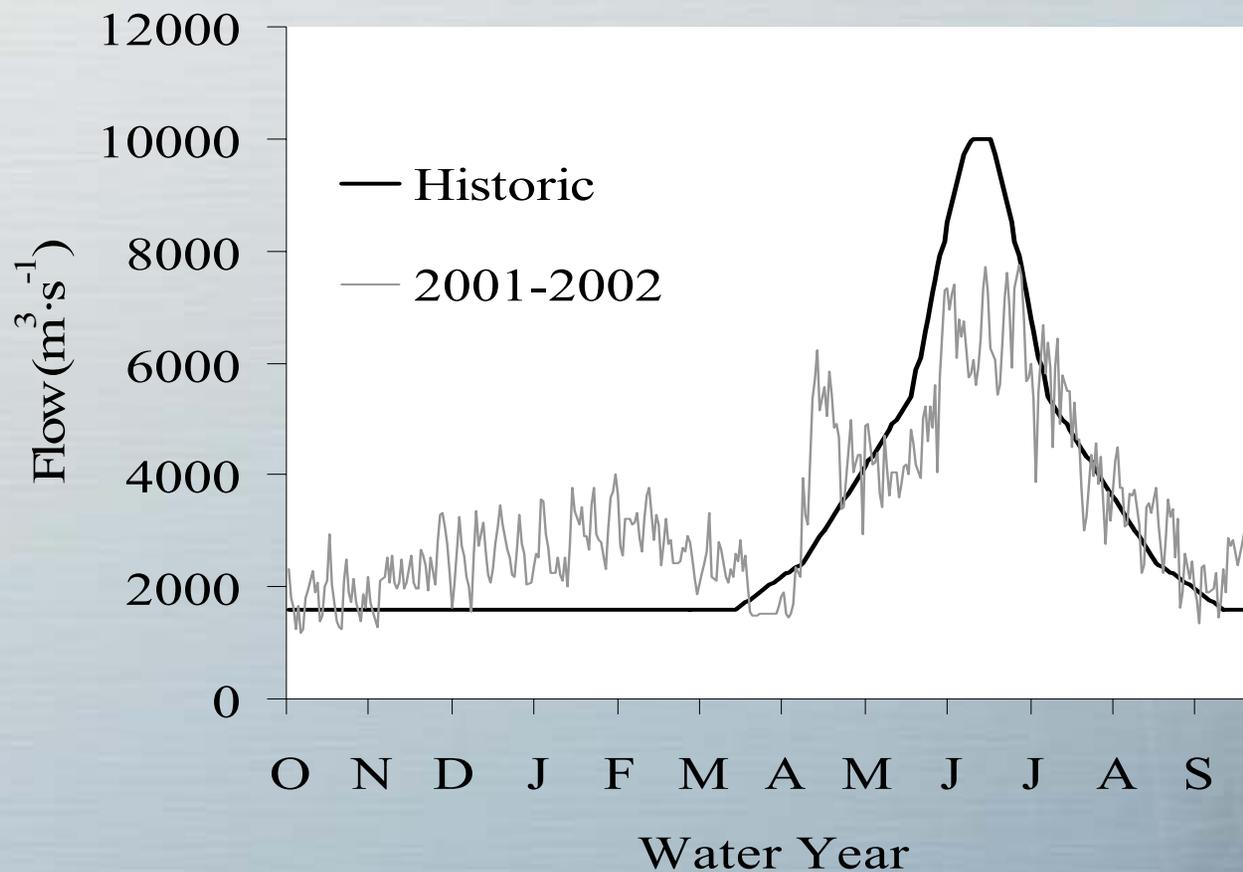
# Introduction

---

- Hanford Reach of the Columbia River
  - Last free-flowing stretch in U.S. above Bonneville Dam
  - Great fluctuations in river elevation
    - Due to hydraulic operations at Priest Rapids Dam
    - Flows greatly altered from natural state



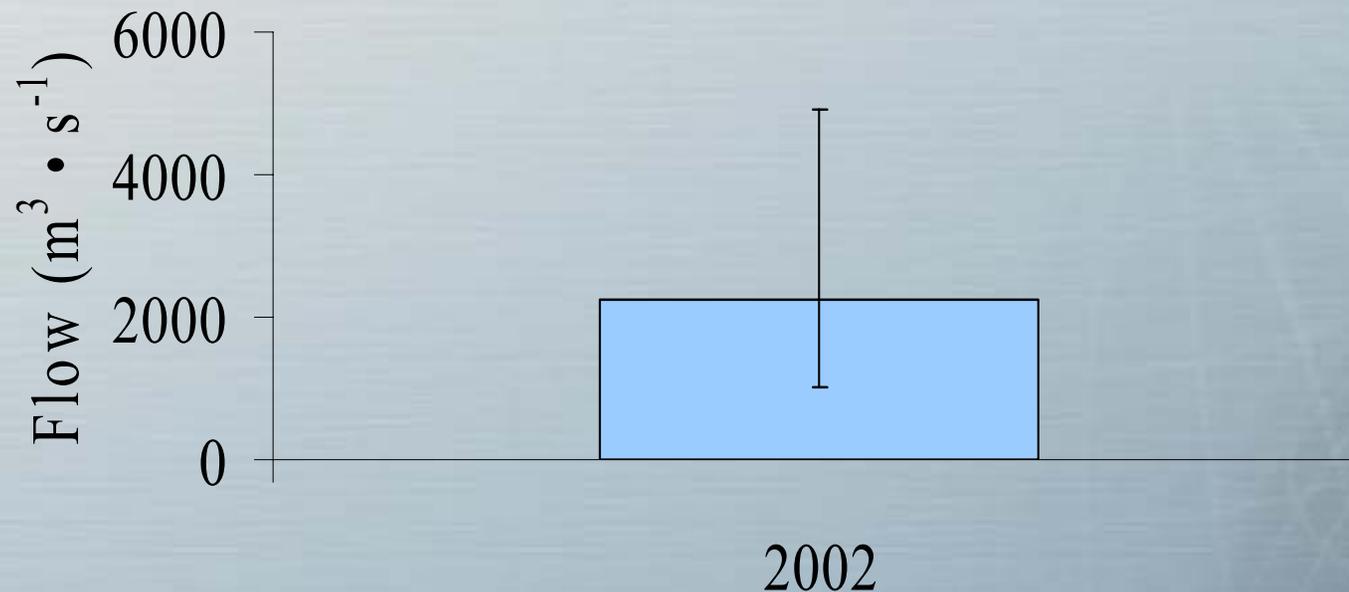
# Historic Versus Recall Flow Patterns



FCRPS 2001; Columbia River DART 2002

# Site Conditions

- Study Area
  - 15-km stretch of the Hanford Reach
  - Characterized by swift currents and cobble substrate
  - Variable flows during sample seasons



# The Percentage of Time Shoreline Submerged on an Annual Basis

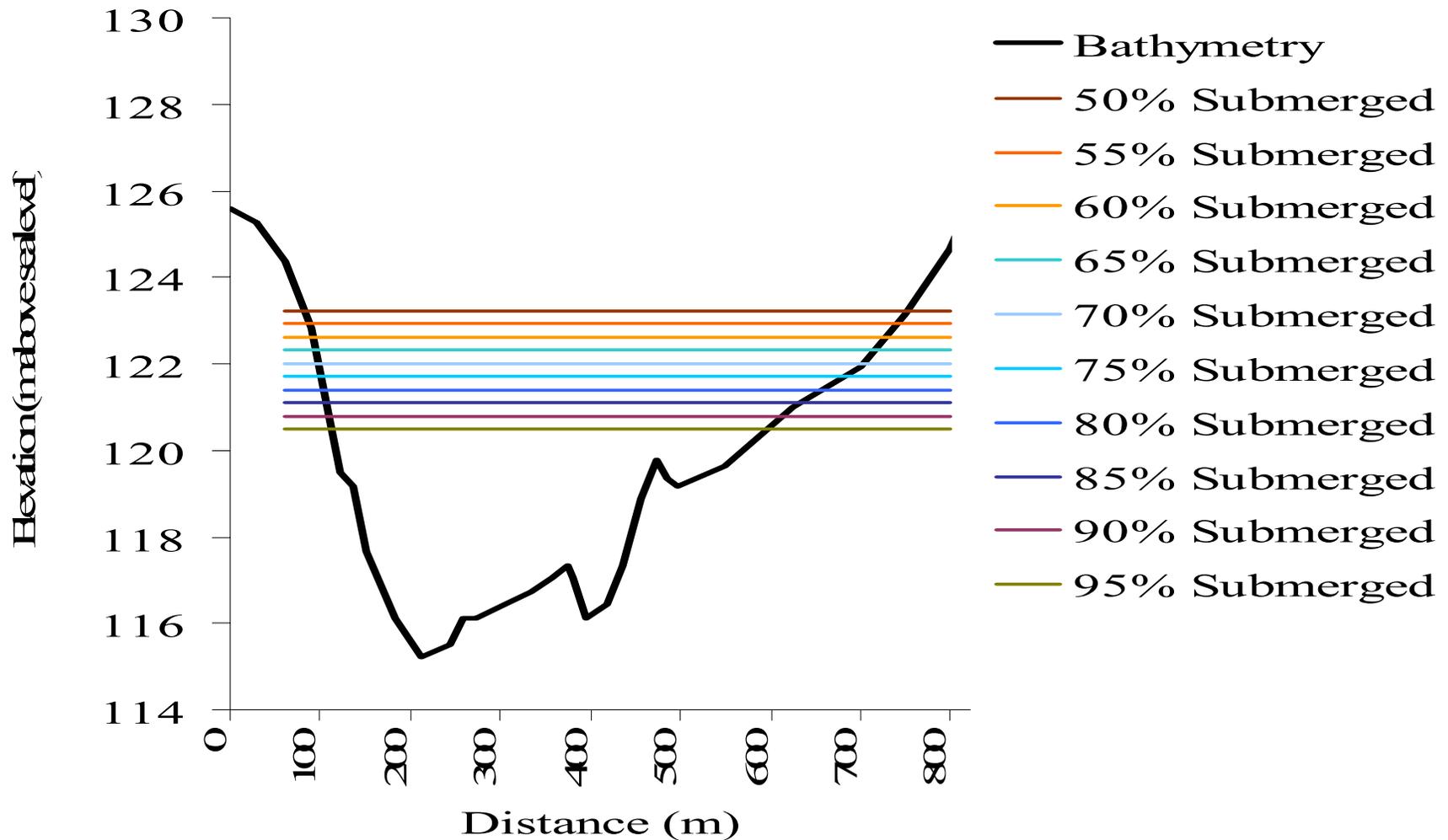
---

- Bathymetry transects
  - USGS and Grant County Public Utility District
- Hourly Priest Rapids Dam flow data
  - 1994-2001
  - 10 increments – a flow frequency distribution
- One-dimensional modular aquatic simulation system coupled with GIS
  - MASS1 (Richmond et al., 2000)
  - Generated GIS positions of known amounts of shoreline submergence

## Established Time Percentages of Shoreline Submergence and Corresponding Flows from 1994-2001 Priest Rapids Dam Hourly Flows

Percentage of time shoreline submerged	$m^3 \cdot s^{-1}$
50.00	3,463
55.00	3,238
60.00	2,983
65.00	2,720
70.00	2,425
75.00	2,139
80.00	1,970
85.00	1,837
90.00	1,630
95.00	1,353

# Depiction of MASS1 Flow Levels and River Bathymetry



# Distribution Data Collection

---

- Data collected August 30-September 29, 2002
- Two methods used to locate sample sites:
  - 1) Navigate to reference GIS position
    - Trimble GeoExplorer® 3 handheld GPS mapping and GIS data collection/maintenance system
  - 2) Average position of 50 percent submerge rate and transect bearing
    - Sample equidistant along transect to a depth of 1.5 m
- GIS point recorded at each location
  - Average of 100 positions logged at a rate of 1 position per second
    - Precision less than 3 m

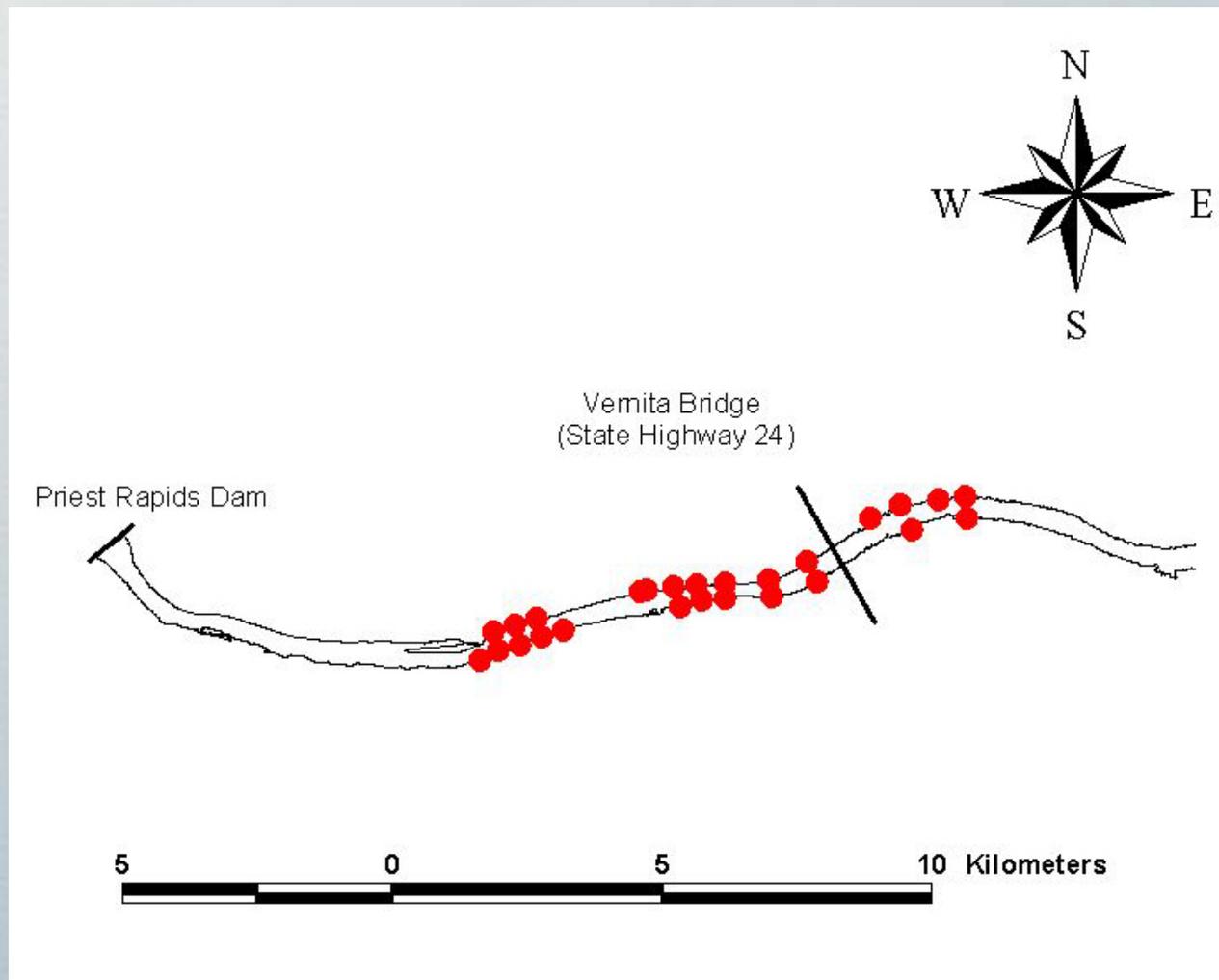
# Distribution Data Collection

---

- Asiatic clam presence/absence:
  - Two 0.1-m<sup>2</sup> plots randomly placed within 1-m<sup>2</sup> plot



# 26 Shoreline Sites of Distribution Data Collection

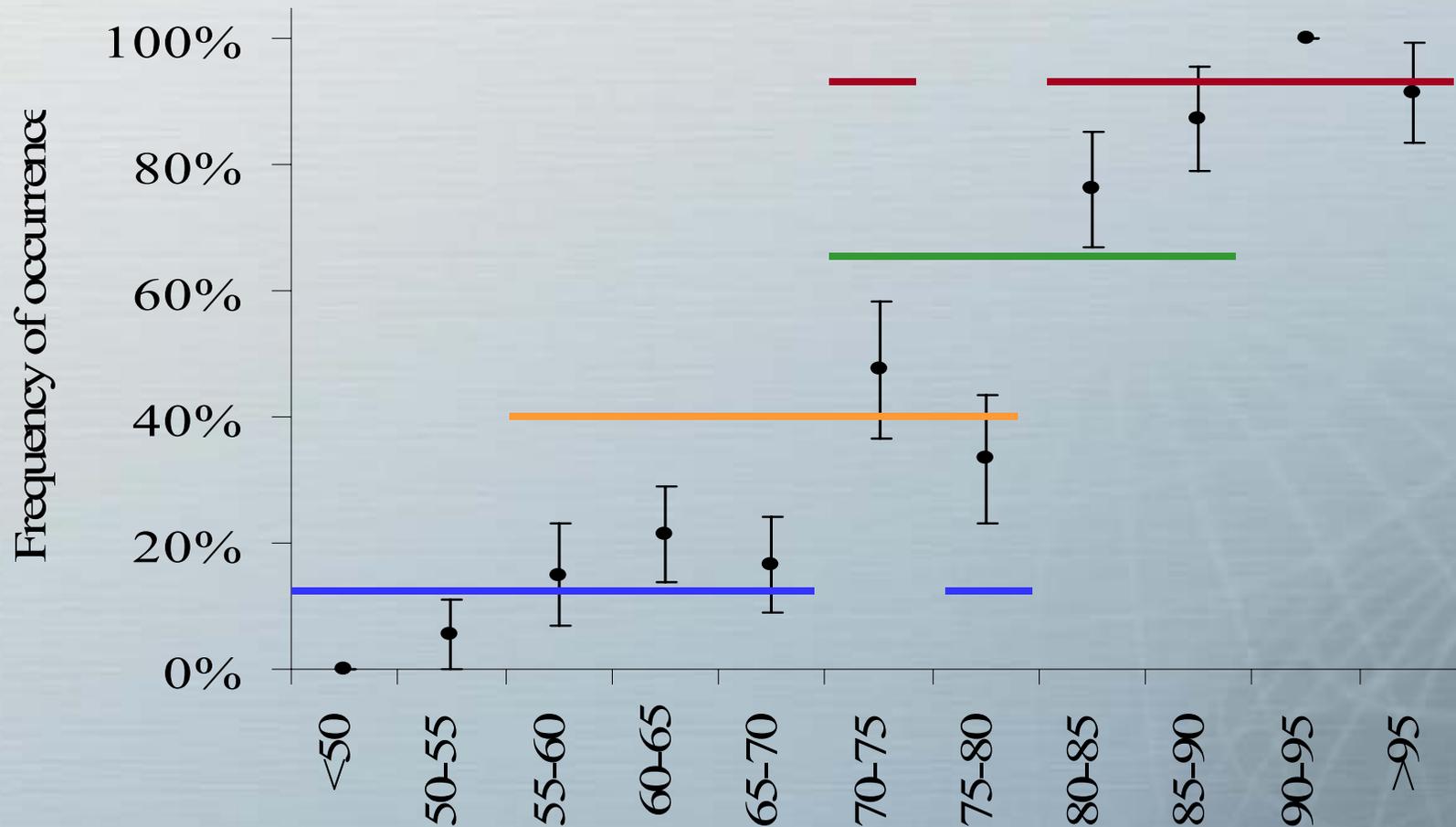


# Distribution Data Analysis

---

- Chi-Square Tests of Homogeneity
  - Based on presence and absence
  - Tested 11 shoreline submergence durations
- Pairwise comparisons
  - (Marascuilo and McSweeney 1977)

# Asiatic Clam Distribution For Shoreline Submergence Intervals



$X^2 > 101.56$ , d.f.=10,  $p < 0.05$

# Discussion

---

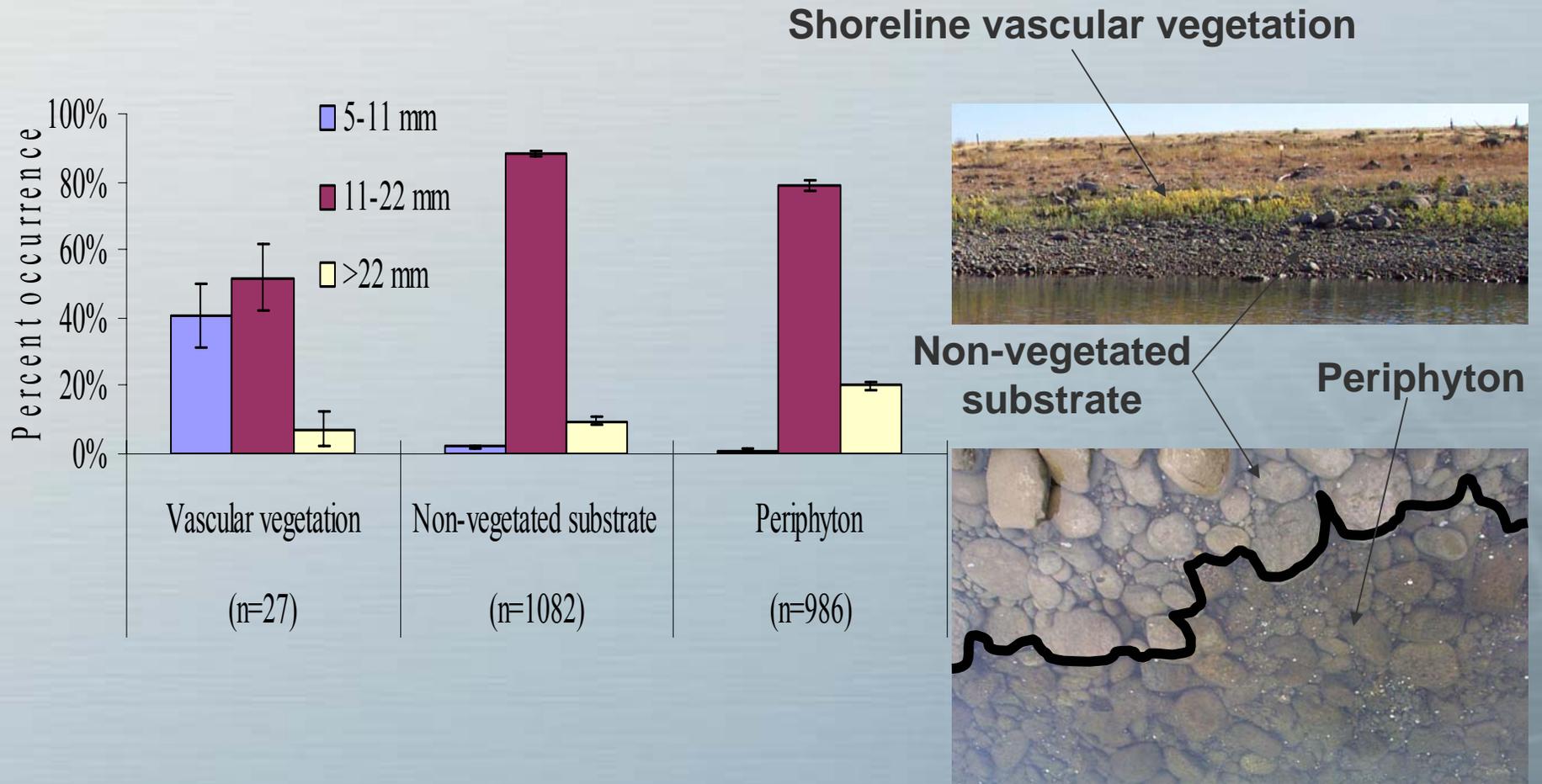
- Asiatic clam distribution
  - Intolerant to aerial exposure
  - In other bodies of water, clams not found in dewatered shoreline areas (Junk 1975; McMahon 1979)
    - 50 % mortality after 4 days exposure (White and White 1977)
    - 98 % mortality after 12 days exposure (White 1979)
  - Some shoreline areas experienced several consecutive days of dewatering at air temperatures exceeding 35 °C
    - A. clams were present in such areas

# Discussion

---

- Asiatic clam distribution mechanism
  - Mucous thread creates buoyancy
  - Clams 14 mm in shell length could maintain buoyancy in  $0.1 \text{ m}\cdot\text{s}^{-1}$  current (Prezant and Chalerwat 1984)
  - Deposited during flow fluctuations

# Asiatic Clam Size Class Distribution between Three Functional Shoreline Zones in the Hanford Reach



## Conclusions

---

- Clams were consistently found in shoreline areas submerged > 90 percent of the time on an annual basis
- Dewatering is an environmental stressor
- Future aquatic biota exposure and impact studies on the Hanford Reach of the Columbia River (and other regulated river systems) should be performed at or below the low-water level