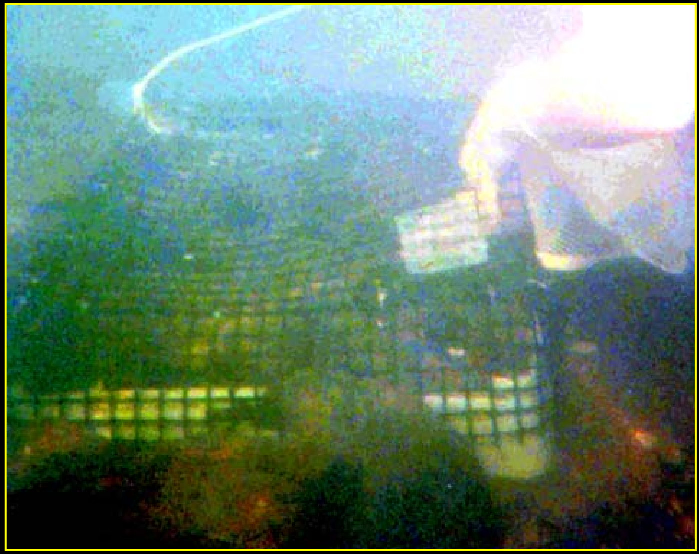



FW Mussel Studies at the Academy

Nutrition

Surveys



Bioindicator Tests

Beyond Biodiversity: the Conservation and Propagation of Native Mussel Biomass for Ecosystem Services

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Academy of Natural Sciences

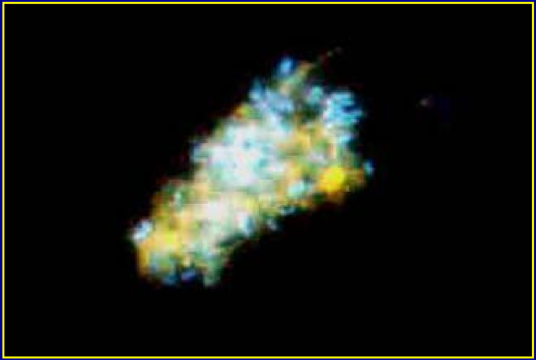
Ecological Functions of FW Mussels

1. Structure

- Provide Habitat
- Bind Bottom
- Increase Bottom Turbulence

Ecological Functions of FW Mussels

2. Material Processing



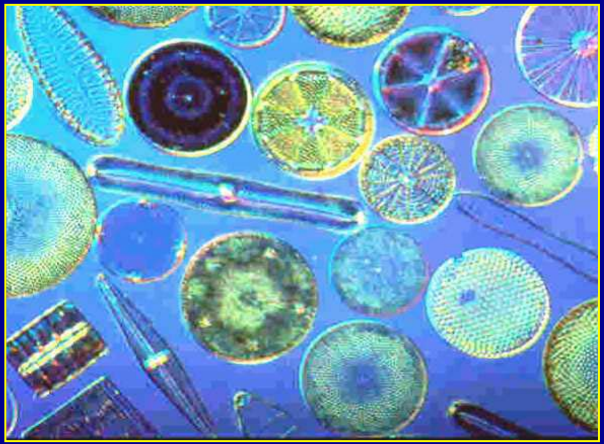
↓ Suspended Particulates

↓ Particulate Nutrients (N, P)

↑ Light

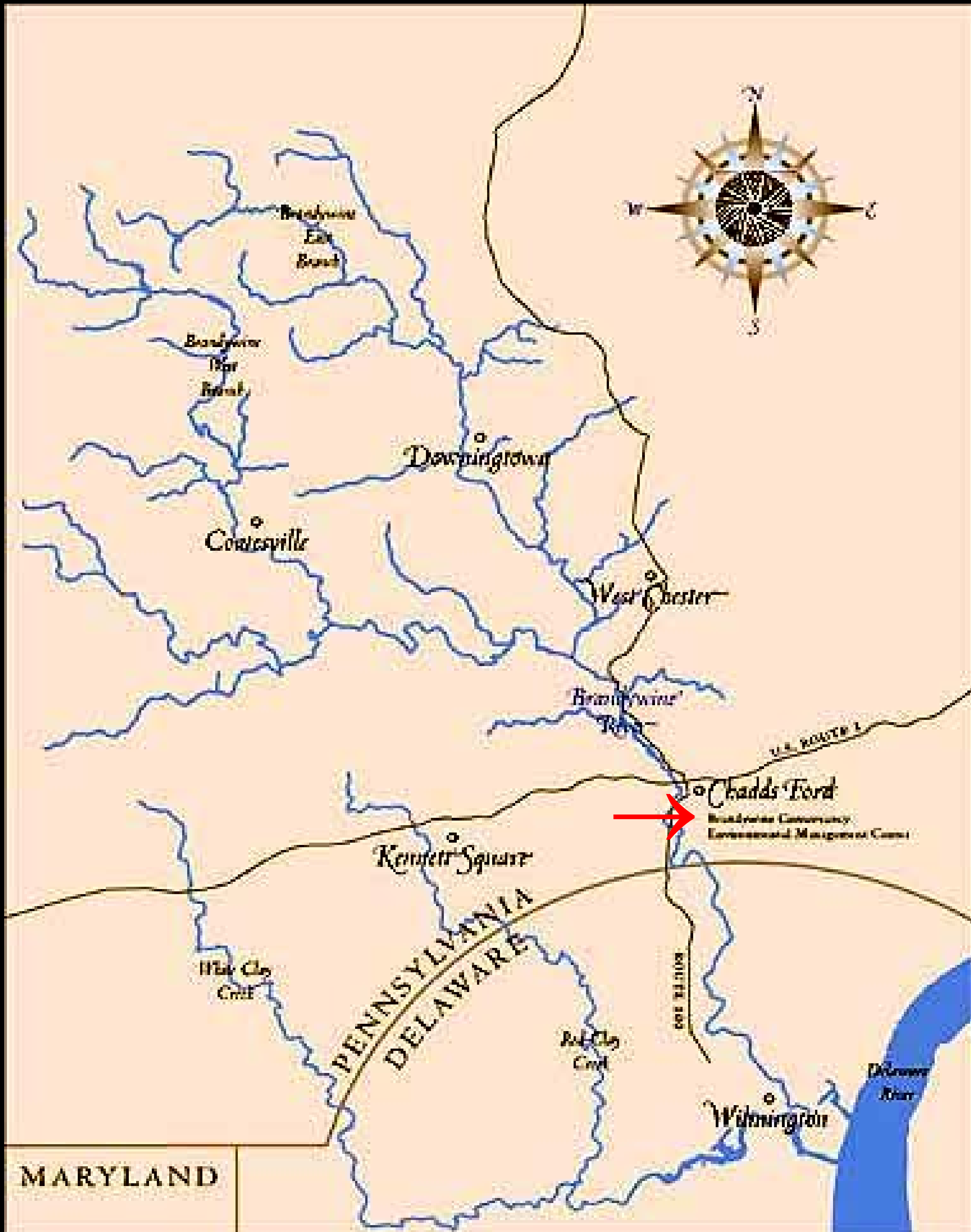
↑ Sediment Enrichment

↑ Dissolved Nutrients



Brandywine River Study

Goal: determine if mussels are sufficiently abundant to significantly affect energy and nutrient cycling



Brandywine Drainage

Map Courtesy of the
Brandywine River Conservancy

Functional Importance Depends On:

1. Biomass
   - Density
   - Body Size
   - Spatial Heterogeneity

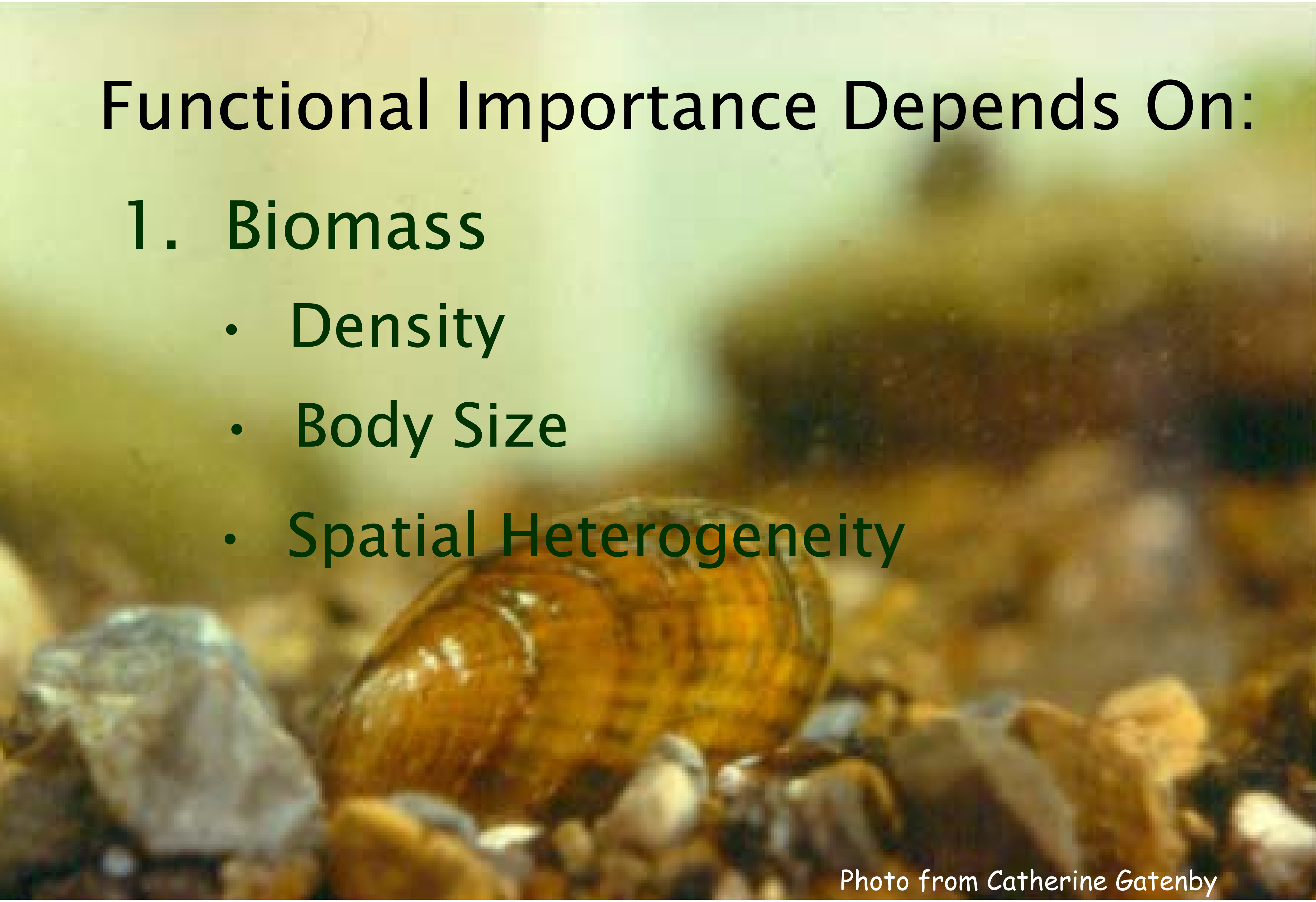


Photo from Catherine Gatenby

Functional Importance Depends On:

2. Physiological Processing

Clearance

Selection

Assimilation

Defecation

Excretion

Biochemical Partitioning

Functional Importance Depends On:

3. Stream Physical Traits
   - Flow Rate, Volume
   - Bottom Area : Volume
   - Turbulence, Mixing Properties

Brandywine Study Approach

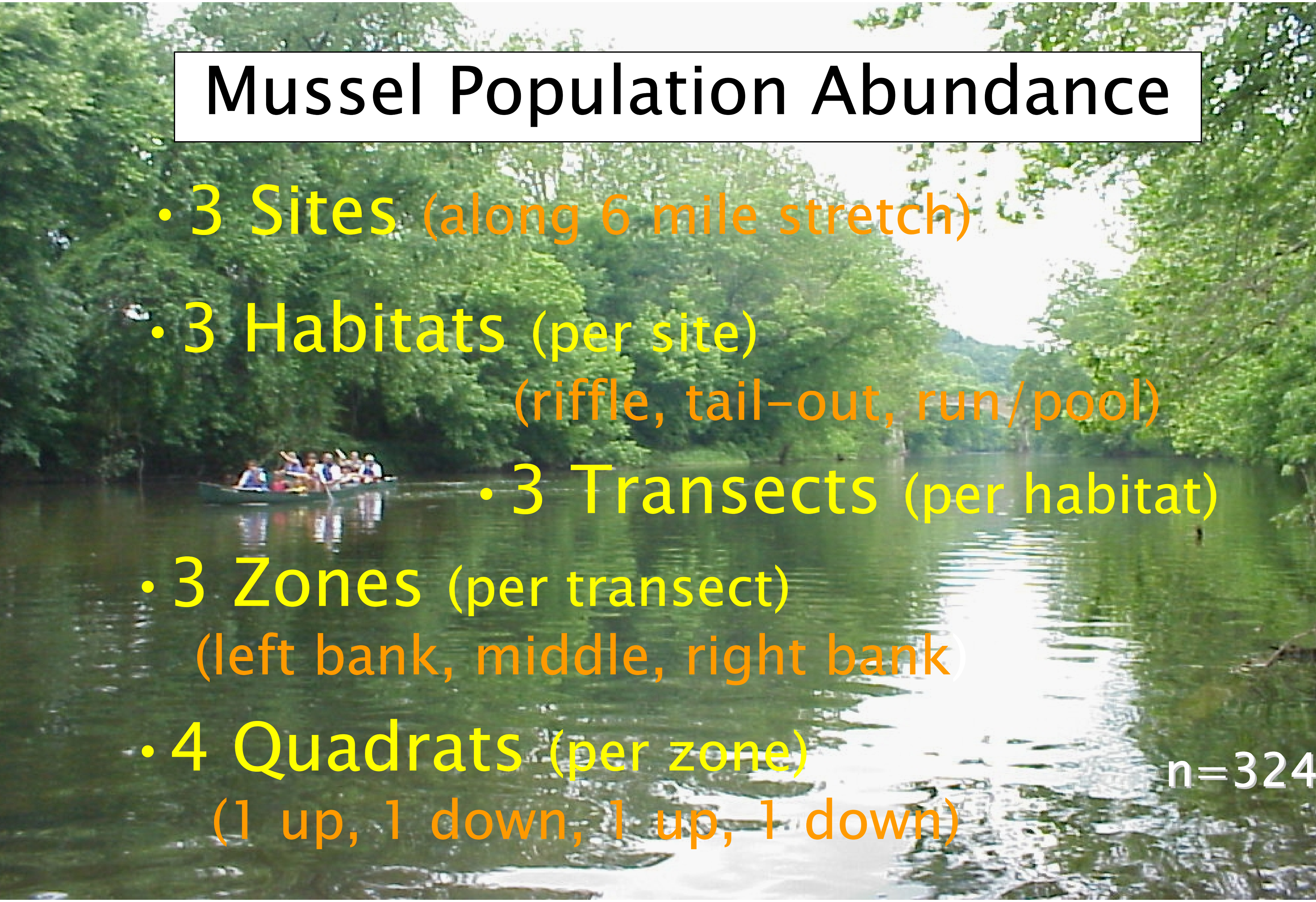
1. Mass Balance Calculation

- Quantify Biomass (per reach length)

- Measure Physiological Rate Functions (per unit biomass)

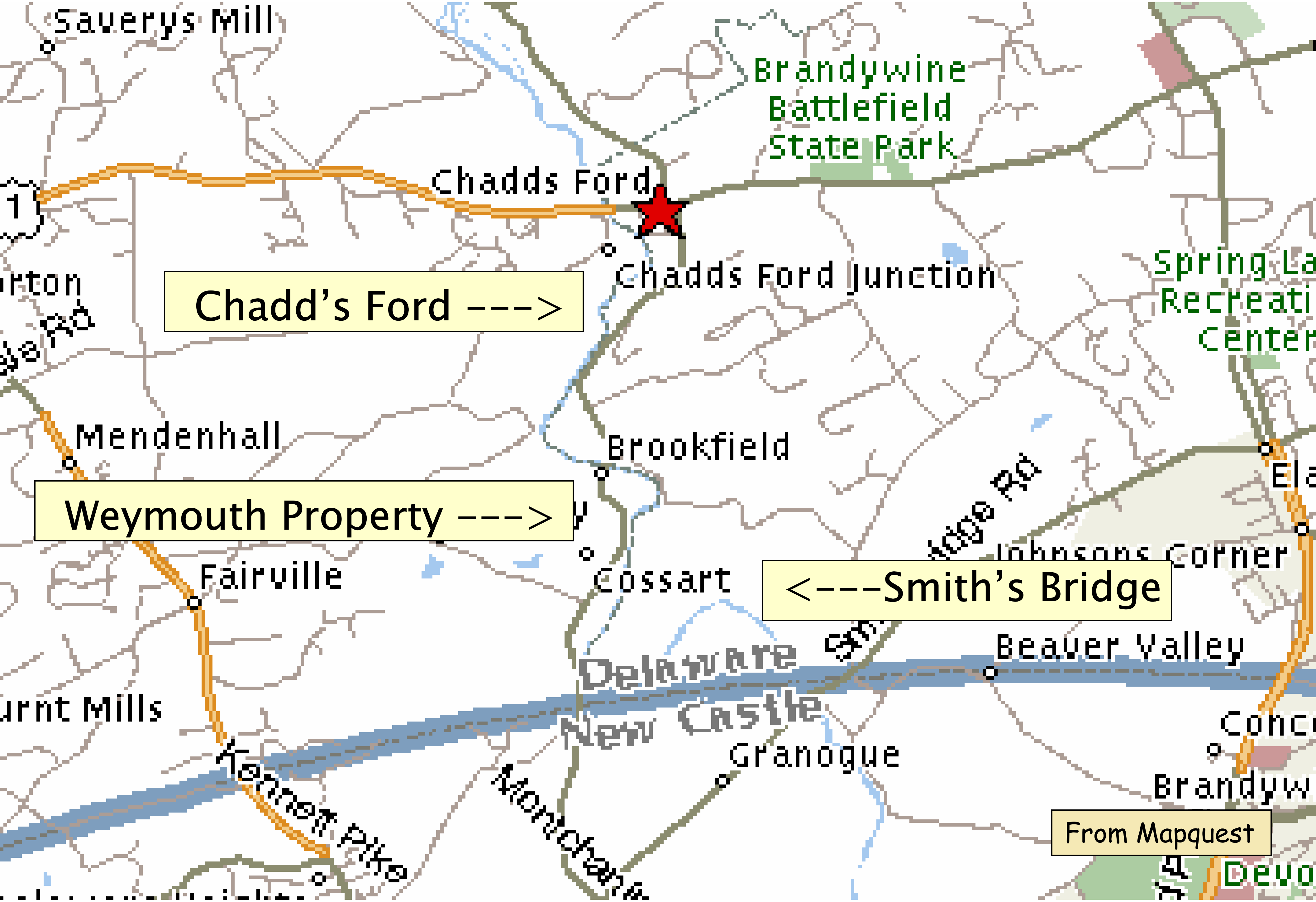
- Relate Processing by Population to Volume and Time (base flow conditions)

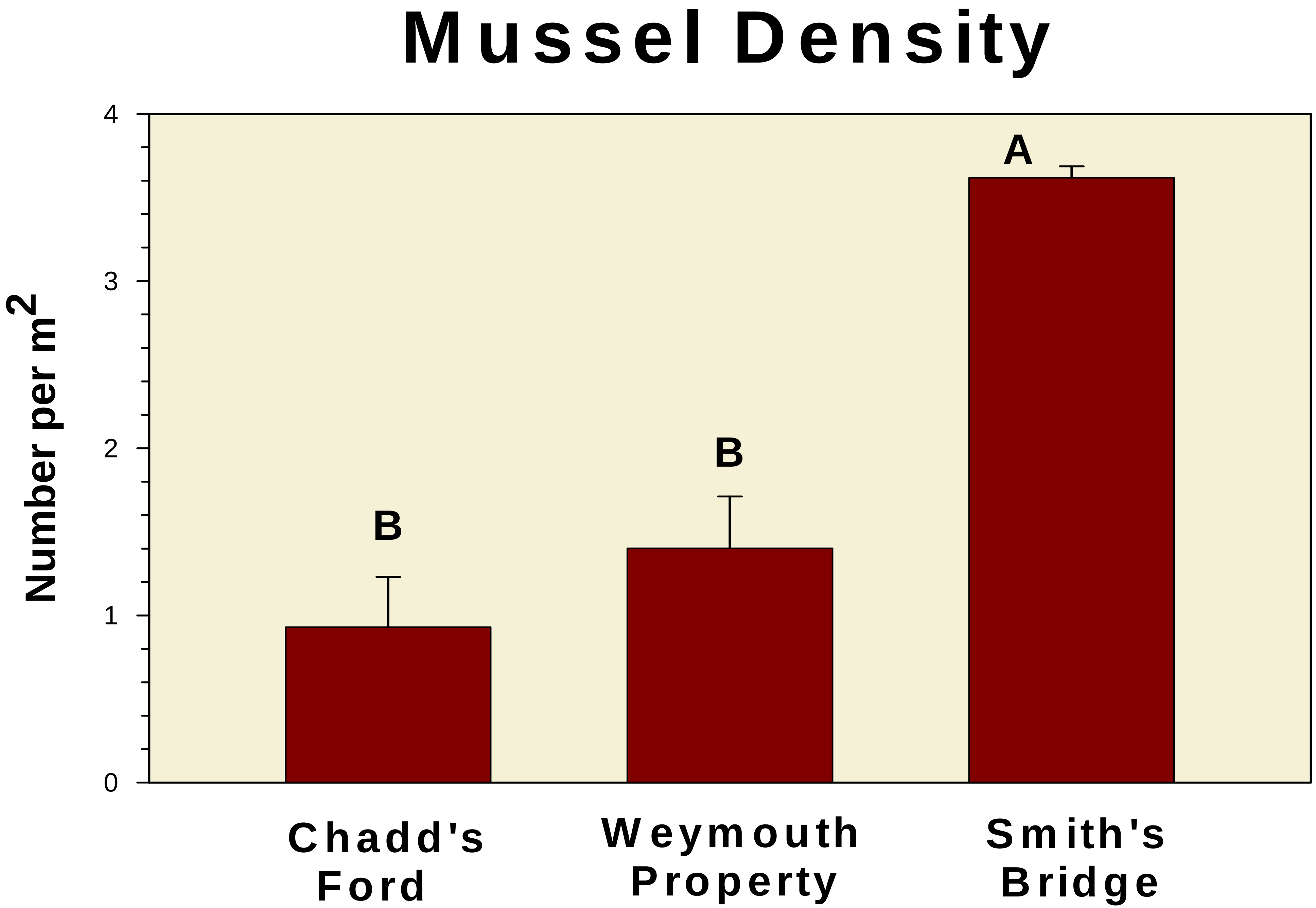
Elliptio complanata


Mussel Population Abundance
• 3 Sites (along 6 mile stretch)
• 3 Habitats (per site)
(riffle, tail-out, run/pool)
• 3 Transects (per habitat)
• 3 Zones (per transect)
(left bank, middle, right bank)
• 4 Quadrats (per zone)
(1 up, 1 down, 1 up, 1 down)
n=324

Quadrat Measures

- Physical Aspects
  - Depth
  - Substrate Type
  - Percent Cover of Plants
- Mussels
  - Number
  - Shell Heights


Saverys Mill
Brandywine
Battlefield
State Park
Chadds Ford
Chadds Ford Junction
Spring La
Recreati
Center
Chadd's Ford --->
Mendenhall
Brookfield
Weymouth Property --->
Fairville
Cossart
Johnsons Corner
<---Smith's Bridge
Beaver Valley
Delaware
New Castle
Granogue
Kennett Pike
Montchanin
From Mapquest

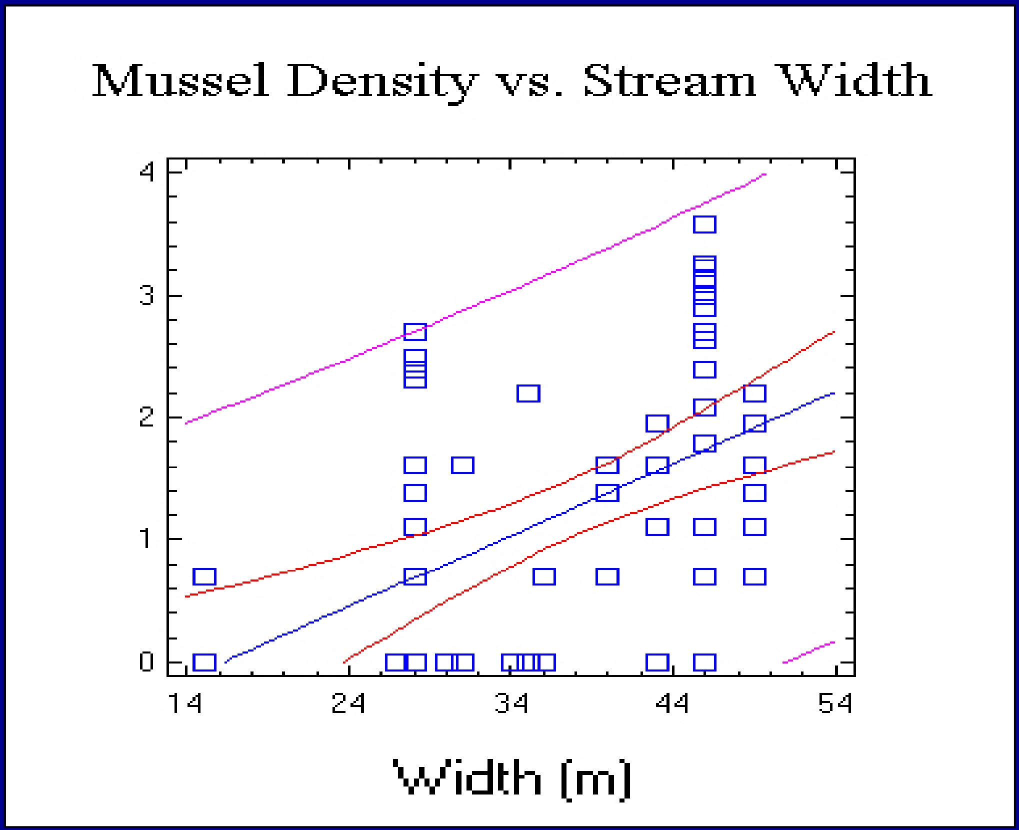

Mussel Density
Number per m2
0
1
2
3
4
A
B
B
Chadd's Ford
Weymouth Property
Smith's Bridge

- Habitat Differences ($p=0.006$)

  Run ($3.0\ m^{-2}$) > Tail Out ($1.8\ m^{-2}$) > Riffle ($0.9\ m^{-2}$)

- Zone Differences (n.s.)

- Mussel Density Increased with Stream Width ($p<0.0001$)



- Average Density = 1.67 mussels m^{-2}
- Overall Average Size = 72.1 mm
- Height:Weight Relationship
  log Hgt = [0.201 * (log Wgt)] + 4.359 ($n=111$, $p<0.0001$)
- Average Biomass = 0.669 g
- Average River Width = 33.1 m ($n=27$)
- Per 100 m Reach: 5527 mussels
  weighing 3.7 kg dry tissue

- Clearance Rates (Field) = 3.4 L h^{-1} g DTW^{-1}

  = 301,800 L d^{-1} 100 m^{-1}
- Base Flow = 2.4 mg L^{-1} TSS and 200 cfs
- TSS Top Inputs = 978 kg d^{-1} per 6 mile
- Bed Clearance = 0.724 kg d^{-1} 100 m^{-1}

  = 69.5 kg d^{-1} per 6 mile study stretch

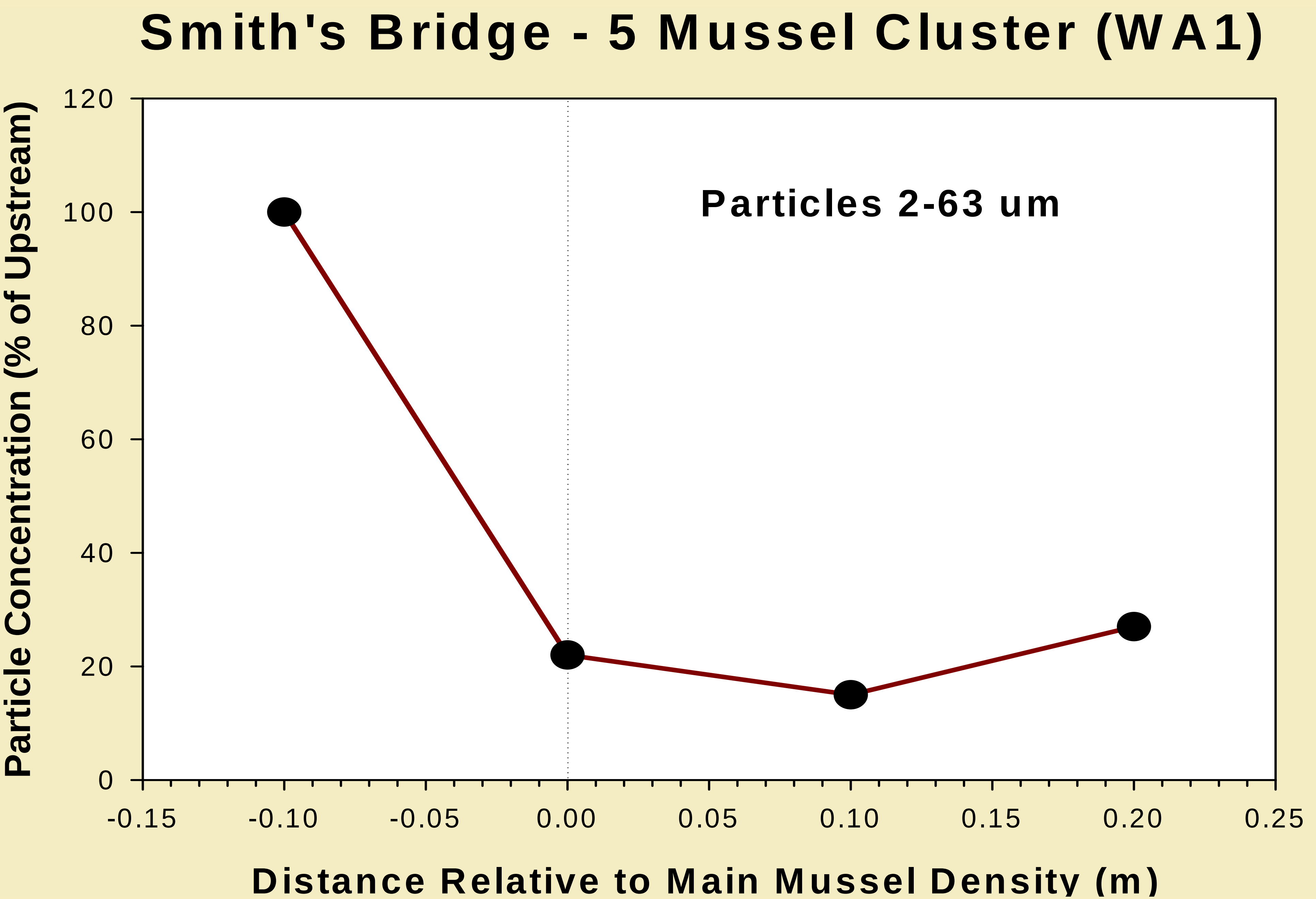
  = 25.4 metric tons dry TSS per year
- Potential Removal = 7.1 %

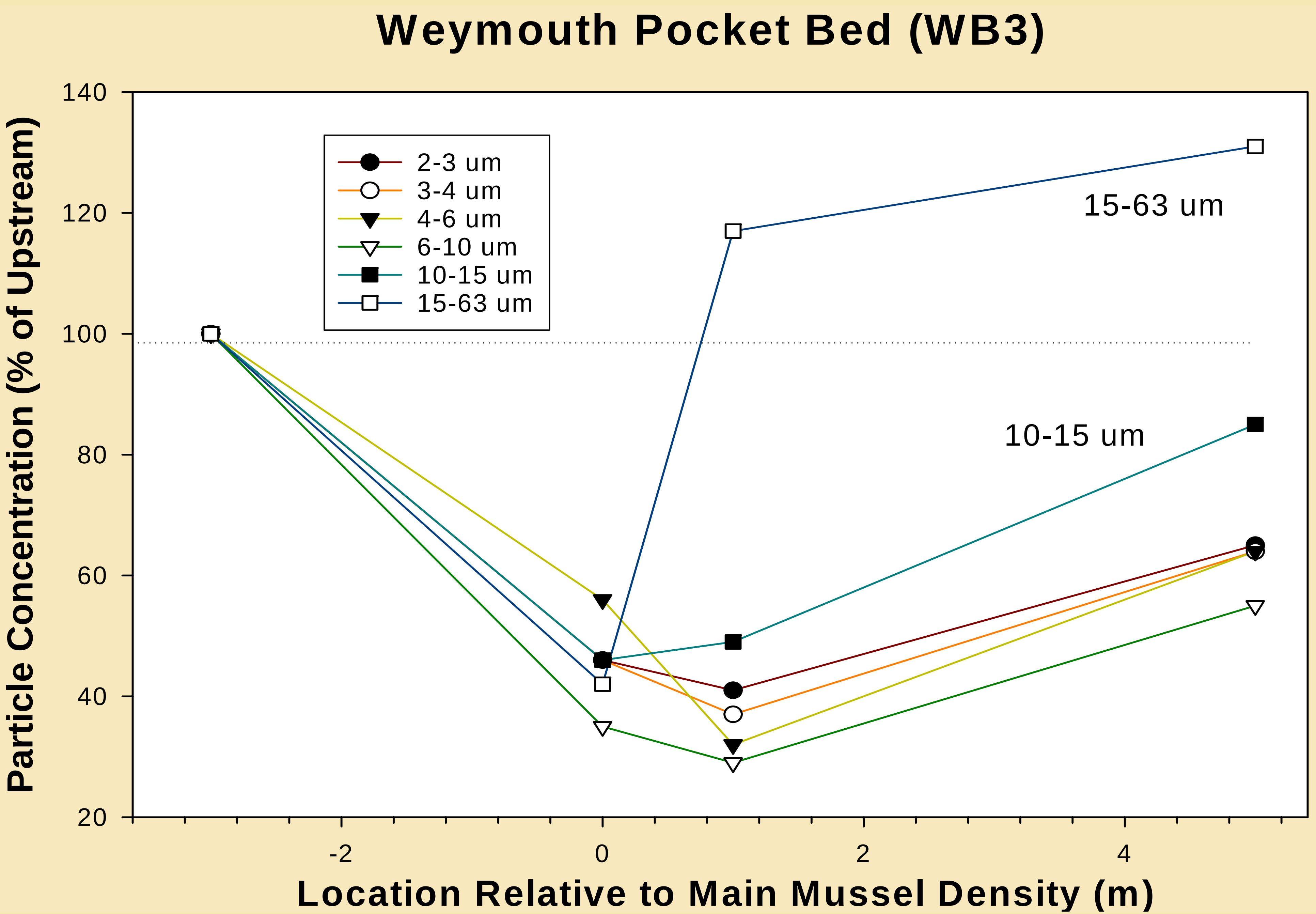
Brandywine Study Approach

2. Relate Water and Sediment Quality to a Mussel Bed

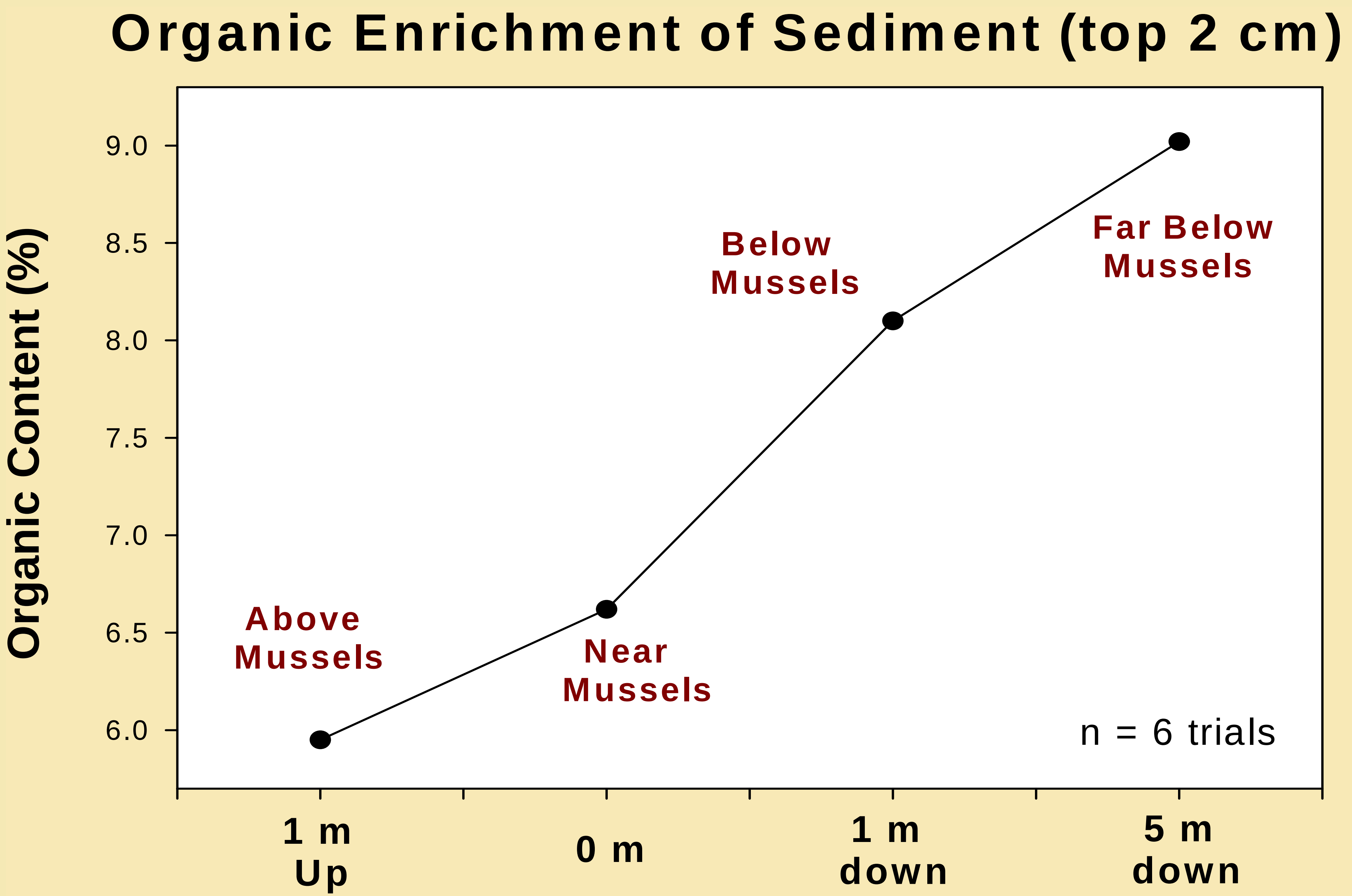
    - Define and Map a Mussel Bed
    - Measure Water Quality in Relation to Bed
    - Measure Sediment Enrichment in Relation to Bed

Sampling Strategy


Smith's Bridge - 5 Mussel Cluster (WA1)
Particles 2-63 um
Particle Concentration (% of Upstream)
0
20
40
60
80
100
120
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
0.20
0.25
Distance Relative to Main Mussel Density (m)



Weymouth Pocket Bed (WB3)
Particle Concentration (% of Upstream)
140
120
100
80
60
40
20
-2
0
2
4
Location Relative to Main Mussel Density (m)
2-3 um
3-4 um
4-6 um
6-10 um
10-15 um
15-63 um
15-63 um
10-15 um



Organic Enrichment of Sediment (top 2 cm)
Organic Content (%)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Above Mussels
Near Mussels
Below Mussels
Far Below Mussels
n = 6 trials
1 m Up
0 m
1 m down
5 m down

Conclusions

- **The functional ecology of freshwater mussels is poorly understood**

  We know that in many marine communities, bivalves are regarded as *the* keystone consumers capable of regulating fundamental ecosystem functions. But relative to their marine counterparts, we know little about how freshwater mussels physiologically consume and transform natural microparticulate material.

- **Freshwater mussel beds affect seston and sediment composition**

  Where healthy beds still occur, mussel biomass can be sufficiently abundant to quantifiably reduce suspended particle concentrations (e.g., up to 80%) and enrich sediments with organic matter (e.g., up to 50%).

- **Beds of freshwater mussels should be conserved and/or propagated to fulfill important ecological and economic services**

  Our six mile study reach was estimated to be home to >500,000 *Eliptio complanata* that collectively were estimated to remove >25 metric tons of dry suspended solids per year (>7% of base-flow TSS). Hence, their role in maintaining water quality is not insignificant.

Future Directions

- Modeling of population-level effects (energy and nutrient cycling)
- Field Experiments to Manipulate Biomass (cause-effect data)
- Economic Valuation

  (ecological services)
- Bioremediation Feasibility Studies (e.g., propagation of biomass for water quality reclamation)