# Aquaculture Pond Water Mitigation and Management: Viability of a Freshwater Mussel (*Elliptio complanata*) as a Biological Filter

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- Graduate Student– Jonathan McKenzie
- Undergraduate Students– Oluchi Ukaegu & Adrienne George
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- Research Faculty- Drs. Dennis McIntosh & Danielle Kreeger & Kevina Vulinec
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# Aquaculture Ponds

- The increased growth of the species being harvested is usually supported by manufactured foods or increased feeding.
- In fish, only 30% of nitrogen & phosphorus are retained from feeding.
- This is of concern because of the possible algal blooms that nutrients can have on a system.
- Excess nutrients in the system can cause algal blooms which lead to the sudden die off of vegetation, causing oxygen depletion.
- Currently eutrophication events in aquaculture are controlled by a combination of chemical & mechanical treatments.

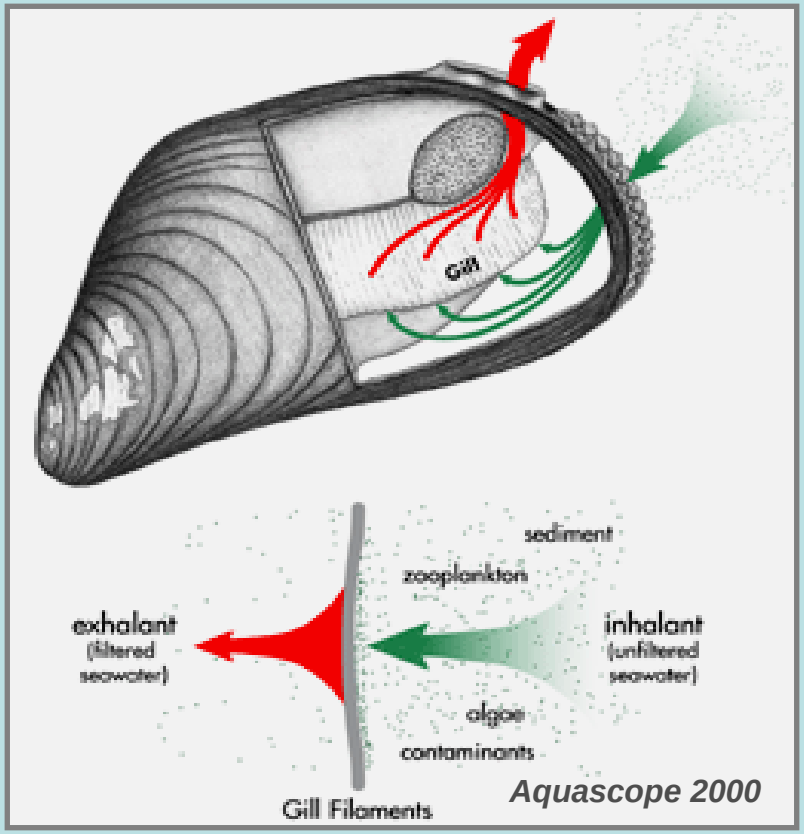
# Bivalve Molluscs

In both marine and freshwater systems:

bivalves have been proven to be an inexpensive method for removing suspended solids, dissolved nutrients & controlling algal growth through suspension feeding.

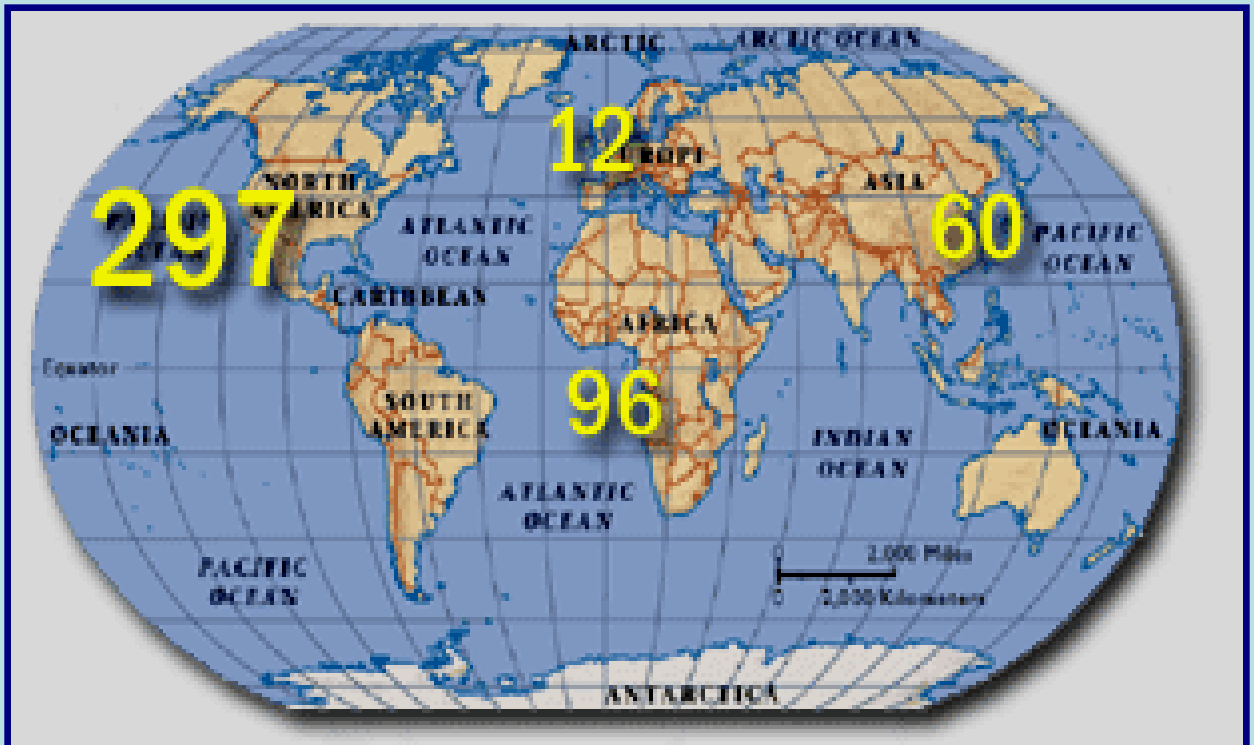
# Mussel Filtration

- Mussels remove suspended solids, dissolved nutrients & control algal growth through suspension feeding.
- Ideal candidate for use as a biological filtration system.
- Use in aquaculture facilities as a biological filter will add a level of filtration that would supplement existing chemical & mechanical treatments.



# Freshwater Mussels

North America contains more species of freshwater mussels than any other continent in the world.

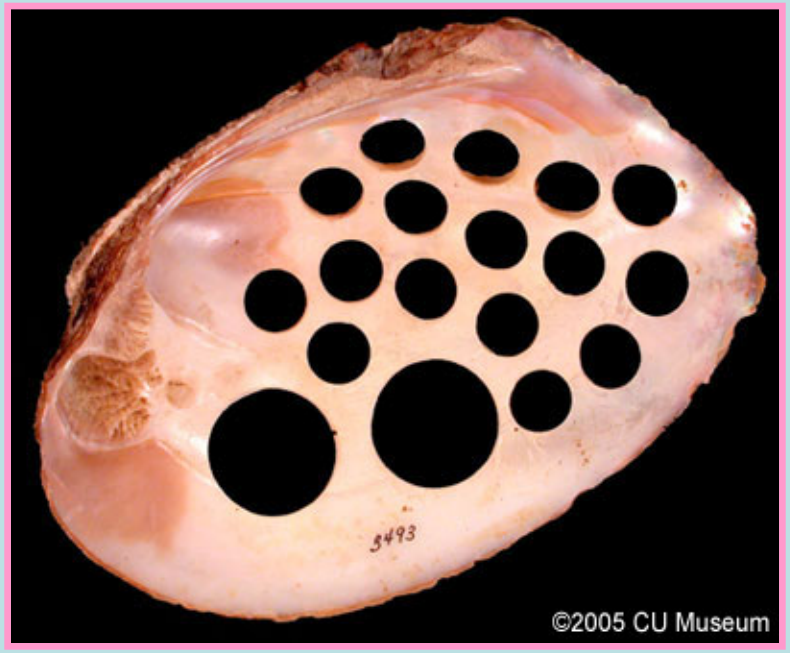



We live in a mussel nation. The United States contains the greatest diversity of freshwater mussels of all continents and countries. Approximately 300 species were historically found within the borders of the US.

VA Department of Game & Inland Fisheries

# Freshwater Mussels

- Mussel shells were once used for buttons & were over fished.
- 55% of the 297 species within North America are considered extinct or imperiled.

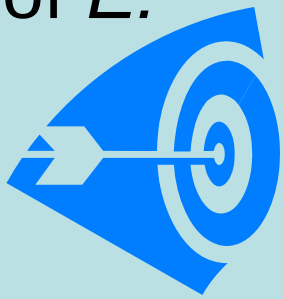


# Eastern Eliptio (*Elliptio complanata*)

- One of the most common mussels found in the Mid-Atlantic area.
- Are closely related to two highly endangered species of mussels; *Elliptio steinstansana & Elliptio spinosa.*
- Has shown high filtration rates within lab & field studies.

# Objectives

**Primary Objective** is to determine the effect of *E. complanata* filtration on water quality of aquaculture ponds.

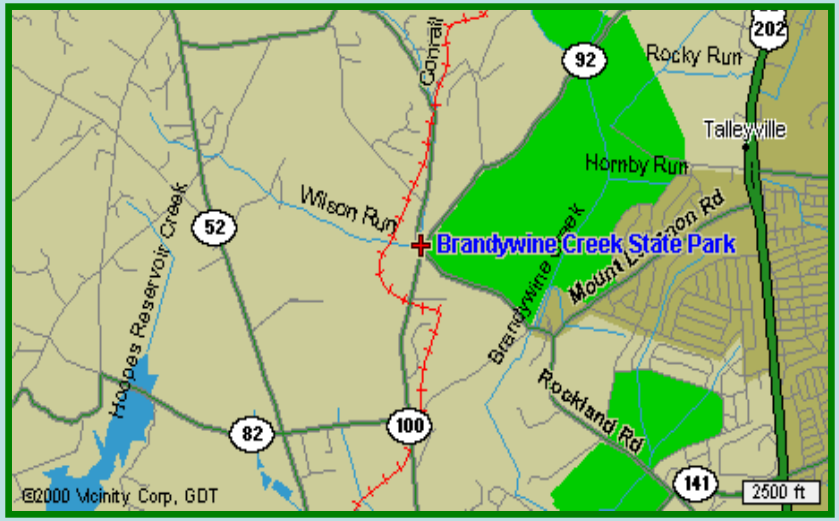


- by looking at physical & chemical water quality parameters: dissolved oxygen, pH, nitrate, nitrite, ammonia, total nitrogen, total phosphorous, soluble reactive phosphorus, chlorophyll-*a* & total suspended solids.

**Other Objectives** are to monitor mussel & fish growth & mortality over a 5 month study period.

- by looking at weight, height & width of *E. complanata* & weight & length of *Ictalurus punctatus.*

# Mussel Collection Site




*E. complanata* were collected from the Brandywine Creek in Brandywine Creek State Park, Wilmington, Delaware.

# Methods

- 12 earthen aquaculture ponds located at DSU were stocked with channel catfish (*I. punctatus*) at a rate of 500 fish per 500m$^2$ of pond space.
- 1600 mussels were collected and spread across the ponds as four mussel treatments: 0, 75, 150 & 300 mussels per aquaculture pond.

# Methods

- Mussels were split between two trays per pond, submerged 15cm below the surface of water & attached to buoys.
- Trays were left in the ponds for a period of five months.

# Methods

- Physical water parameters: temperature, pH & dissolved oxygen concentrations were recorded twice daily using YSI 556 Multiprobe System.
- Water samples were tested weekly for a range of parameters using a Turner Design Aquafluor Flurometer, HACH Photospectrometer:
  - Nitrate
  - Nitrite
  - Ammonia
  - Total nitrogen
  - Total phosphorous
  - Soluble reactive phosphorous
  - Total suspended solids
  - Chlorophyll-*a*

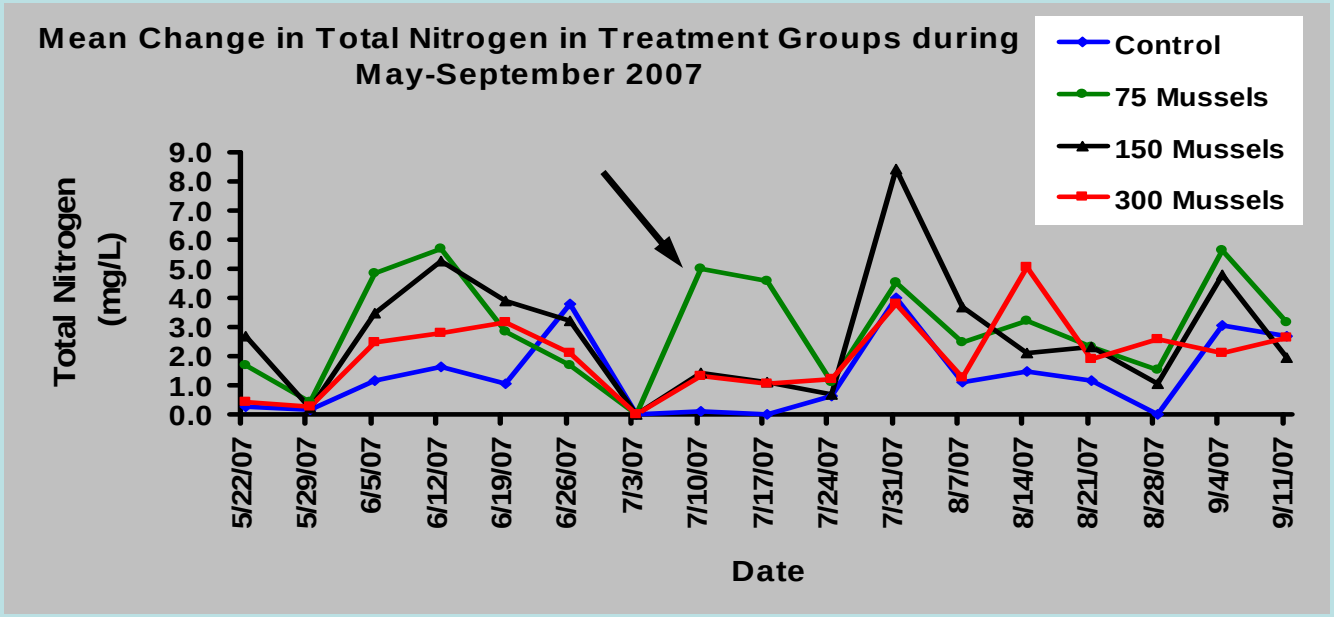
# Methods

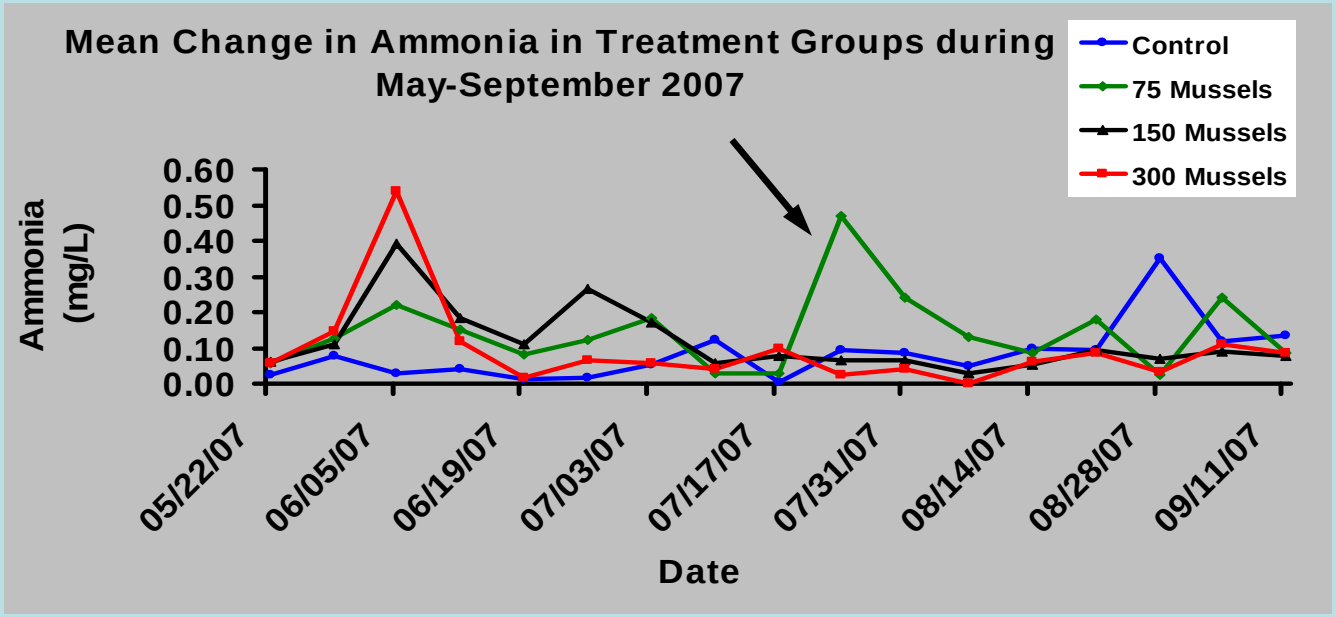
- Ten mussels from each tray were marked & measured monthly for weight, length, height & width using a calibur.
- Fish were sampled biweekly for growth (weight & length) using a ruler.
- Both fish & mussels were measured & counted at the end of the study to obtain mortality rates.

# Data Analysis

- Repeated measure ANOVAs ($\alpha = 0.05$) were performed with SPSS v 11.0.0, (SPSS, Chicago, Illinois) to determine differences between & within:
  - Mussel treatments
  - Water quality parameters
  - Mussel growth
  - Fish growth

# Water Quality Results



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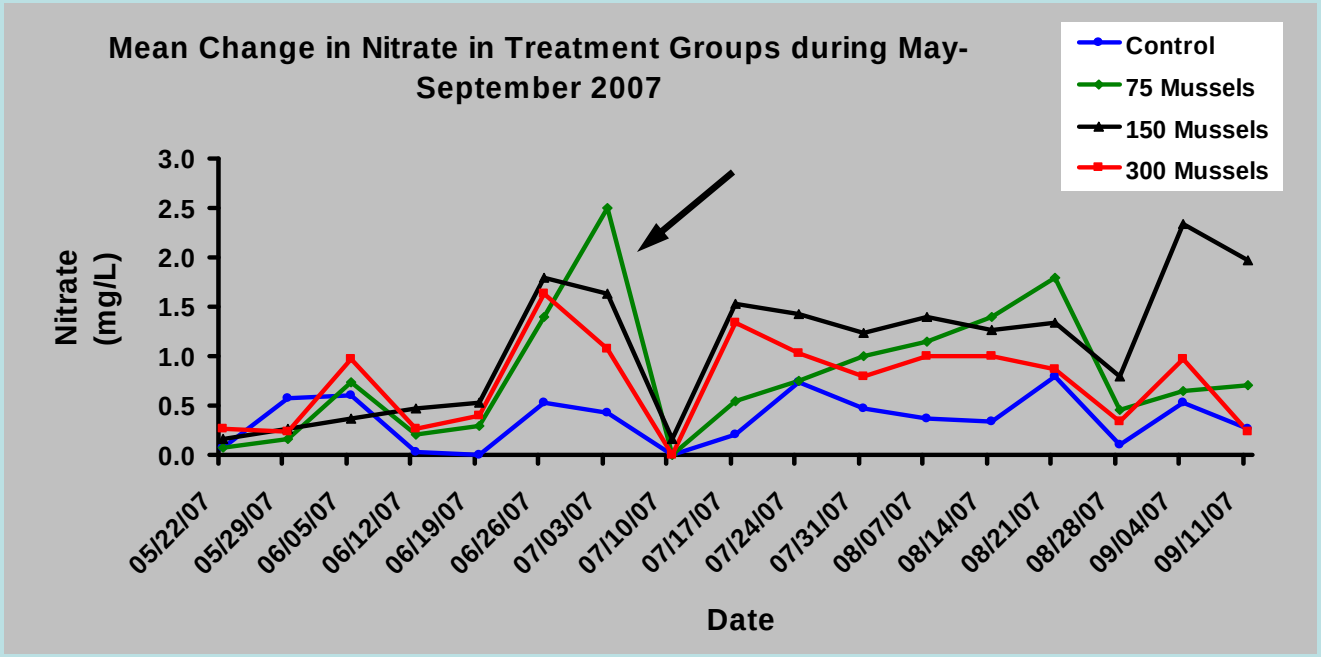


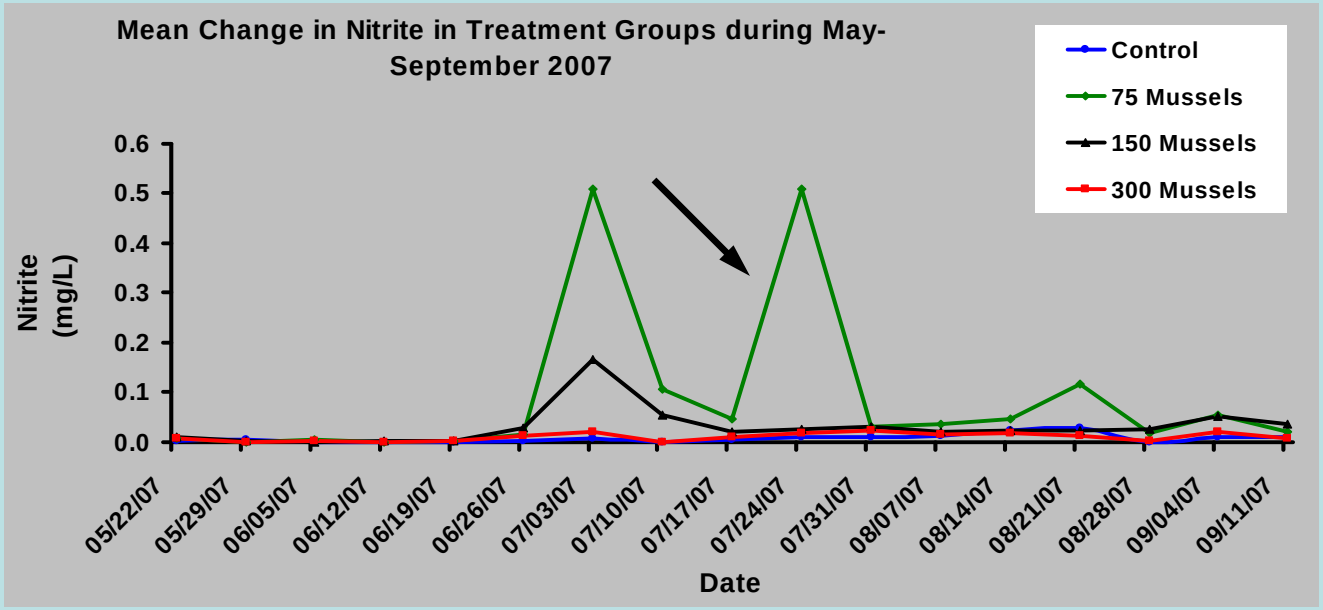

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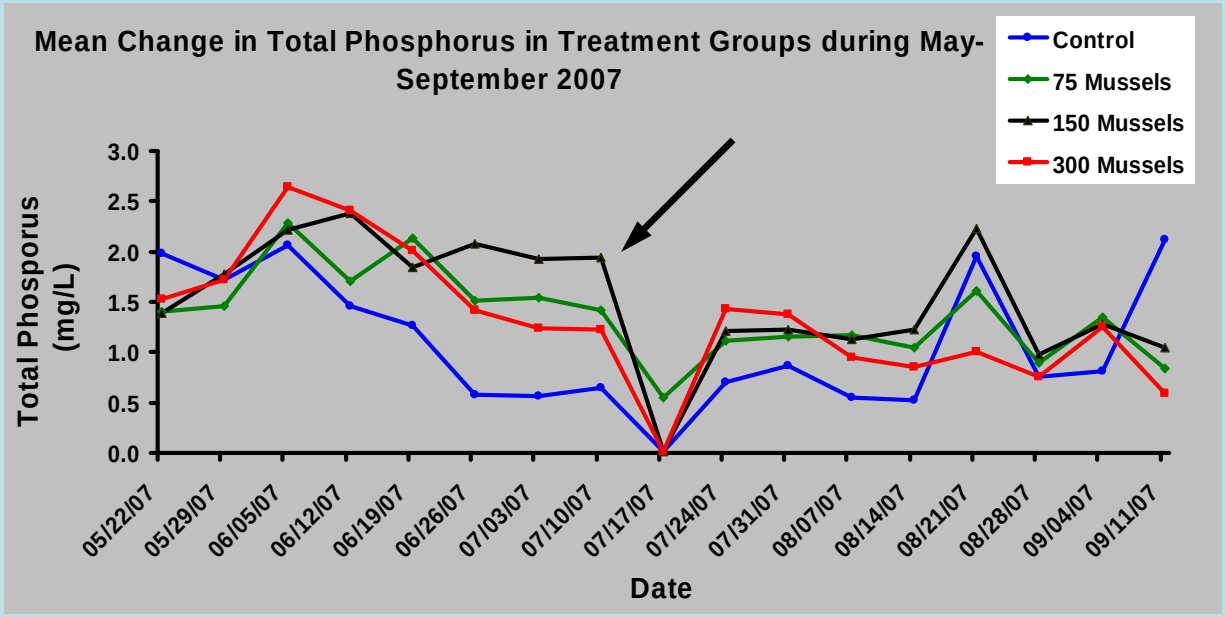


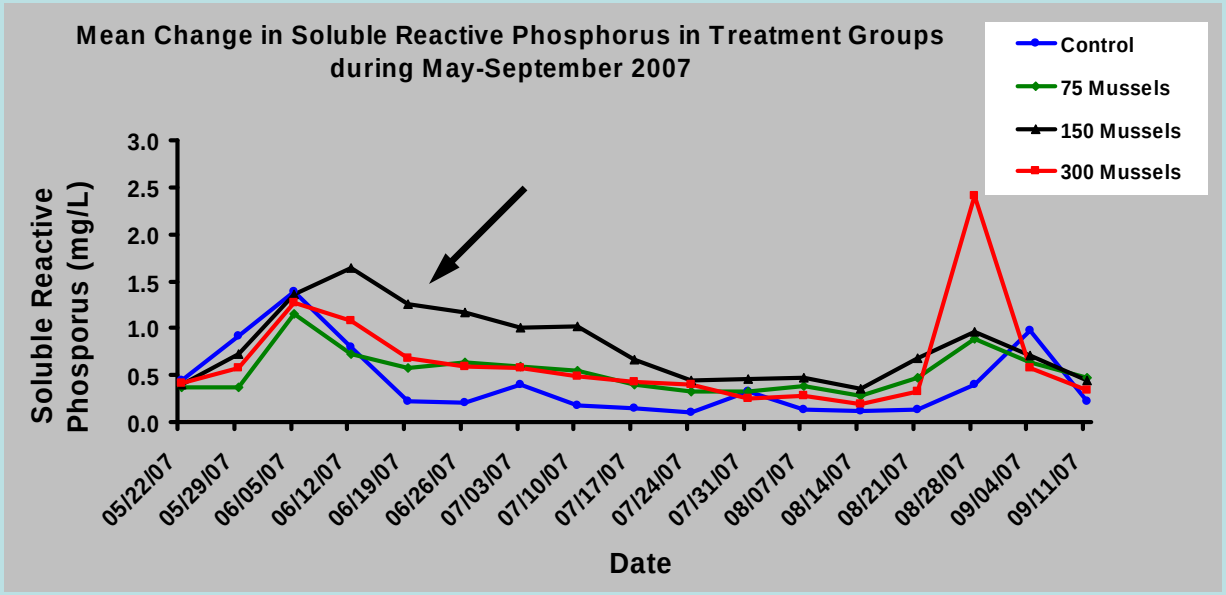

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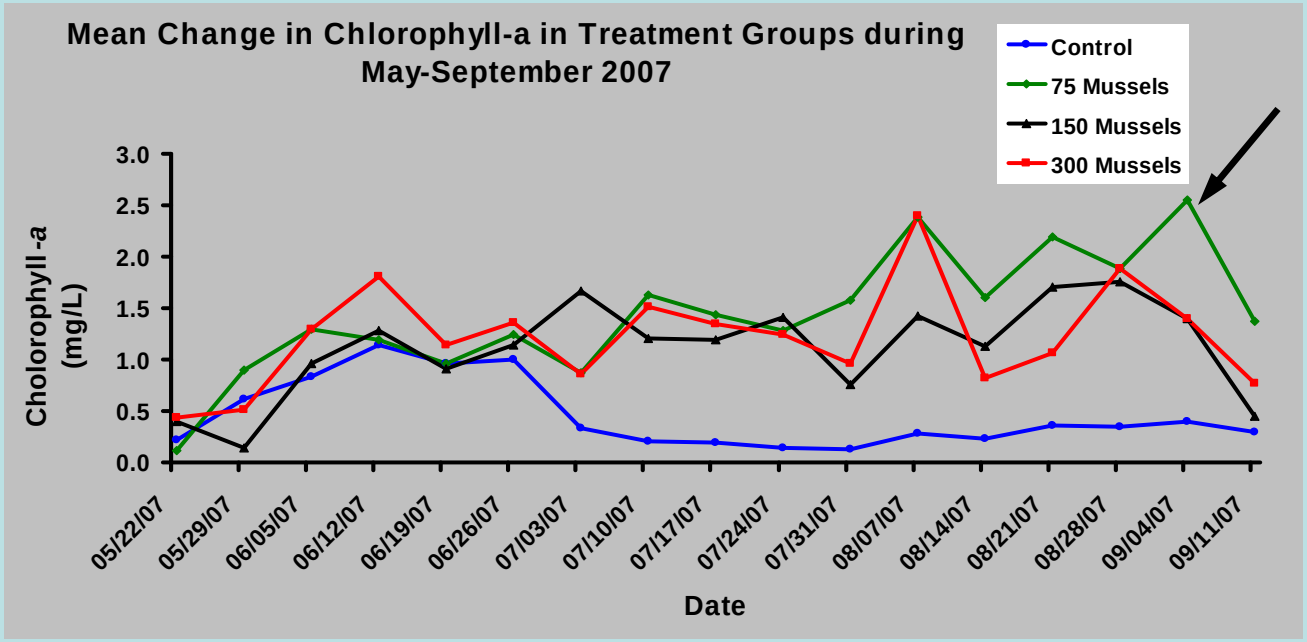
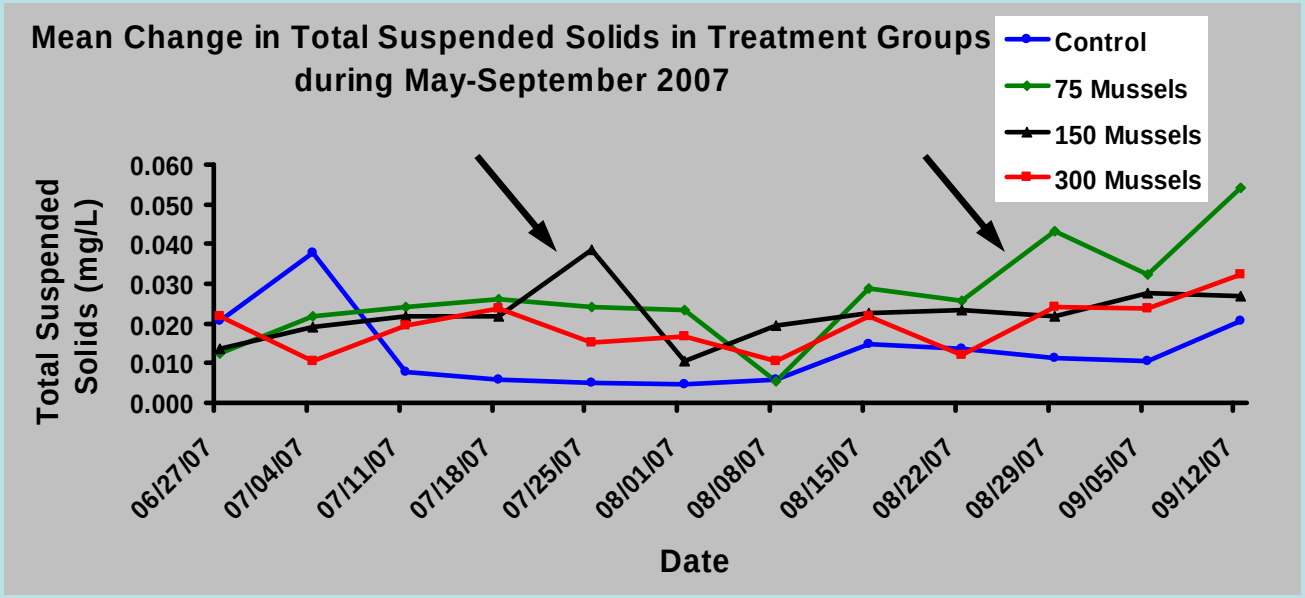
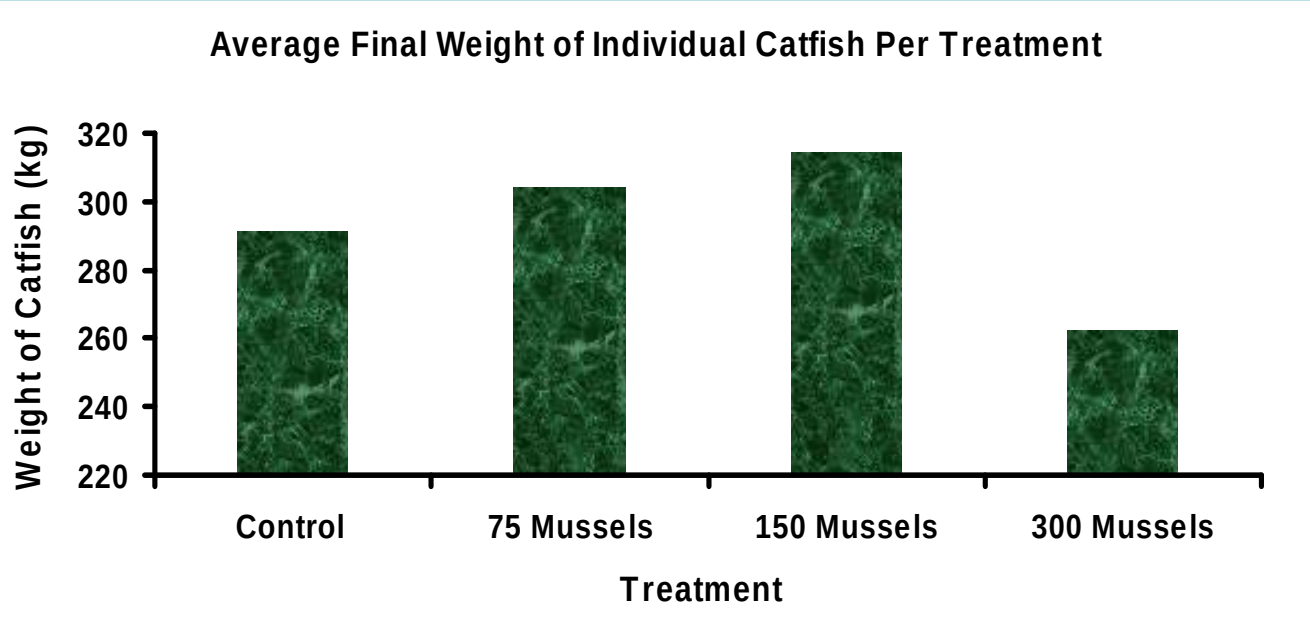


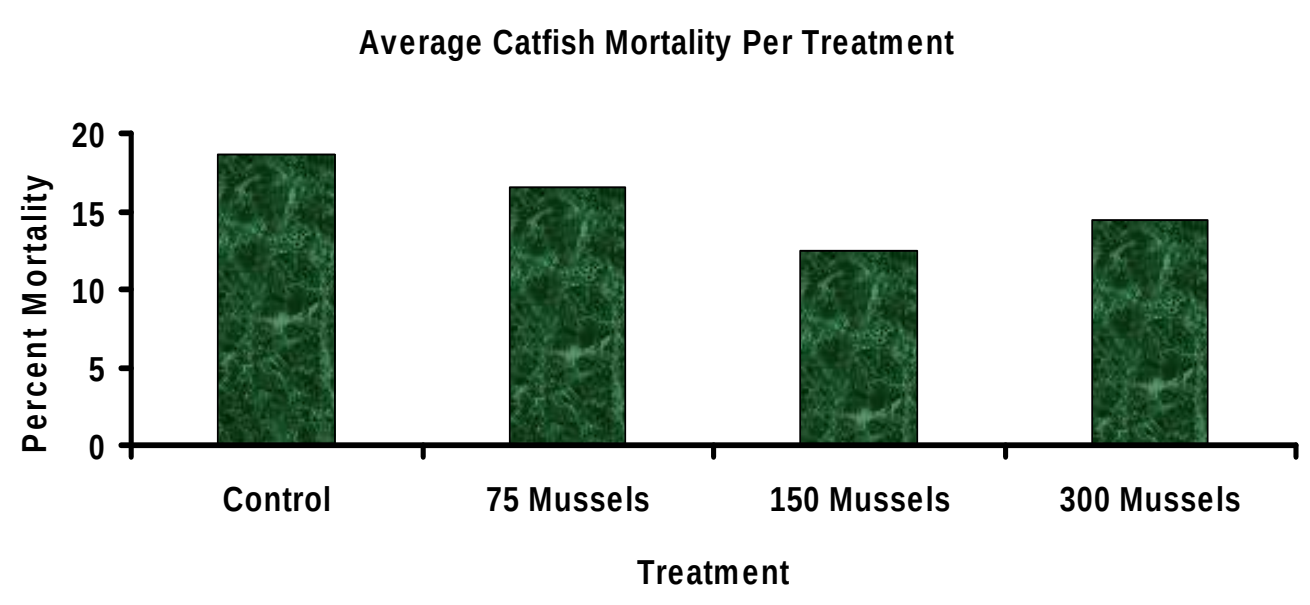



# Water Quality Results

- ***Total Nitrogen:*** 75 mussel treatment was significantly ($P \leq 0.05$) higher than the controls.
- ***Ammonia:*** No significant difference ($P > 0.05$) between treatments or controls.
- ***Nitrate:*** Control is significantly ($P \leq 0.05$) lower than all treatment groups.
- ***Nitrite:*** Control is significantly ($P \leq 0.05$) lower than the 75 mussel treatment.
- ***Total Phosphorous:*** Control is significantly ($P \leq 0.05$) lower than the 150 mussel treatment.
- ***Soluble Reactive Phosphorus:*** 150 mussel treatment is significantly ($P \leq 0.05$) higher than the other treatments.
- ***Chlorophyll-a:*** Control is significantly ($P \leq 0.05$) lower than the other treatments.
- ***Total Suspended Solids:*** Control is significantly ($P \leq 0.05$) lower than 150 & 75 mussel treatments.

# Fish Results



# Fish Growth & Mortality Results

- There was no significant difference (*P>0.05*) in fish growth between ponds or treatments.
- There was no significant difference (*P>0.05*) between final fish weight & treatment.
- There was no significant difference (*P>0.05*) between mortality & treatment.
  - However, we obtained higher average weight of fish in 150 mussel treated ponds than the ponds with other mussel stocking densities & controls.

# Mussel Results

| Treatment | Length x Width Growth (mm) |
|---|---|
| 75 Mussels | 0.88 x 1.03 |
| 150 Mussels | 0.70 x 1.02 |
| 300 Mussels | 0.62 x 0.87 |

| Treatment | Percent Survivorship ± Std |
|---|---|
| 75 Mussels | 85.33% ± 7.06 |
| 150 Mussels | 93.78% ± 2.36 |
| 300 Mussels | 95.00% ± 13.20 |

# Mussel Growth & Mortality Results

- There was no significant difference (*P>0.05*) in mussel growth between any of the ponds or treatments.
- There was no significant difference (*P>0.05*)obtained in survivorships of mussels between ponds or treatments.
  - However, higher survivorship, 95%, was monitored for the mussels in the highest mussel treated ponds as compared to other two treatments.

# Discussion

- Numbers were selected based on mussel clearance rates of 1.8 L/h (Daniel Kreeger, personal communication).
- This clearance rate led to permit for 1600 mussels.
- Based on filtration rates from a previous lab experiment (McKenzie and Ozbay, unpublished data), adult mussels have a clearance rate of 0.3 L/h.
- At highest treatment it would take 88 days to turn over the pond.
- Not enough mussels to show a significant difference in water quality between the control & the treatment ponds.
- Should the number of mussels be increased in future research attempts.
  - the possibility that fish growth will increase with the increased quality of the water.

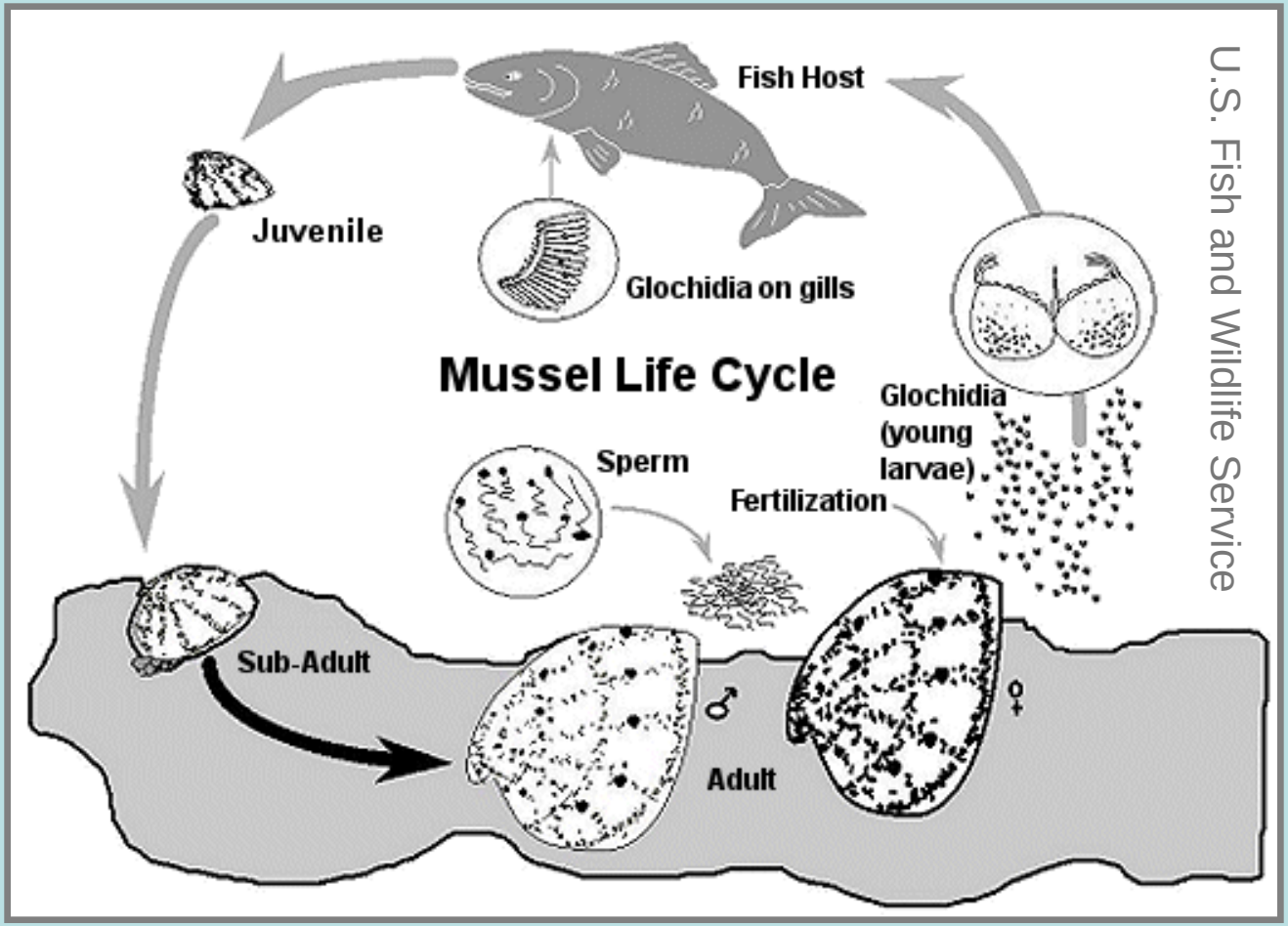
# Discussion

- Fish growth was slow in the control ponds during the first month, after this initial period the growth began to rise & exceed mussel treated ponds.
  - Possibly due to the lack of increased quality of the water in the ponds.
- Our hypothesis of increased fish growth in mussel ponds was only viable if mussels had a positive impact on water quality.
  - which was not seen during this experiment.
- Mussel growth was not significantly different between treatments but there was a trend favoring the lower concentration treatments.
- Survivorship in the higher concentration treatments was not significant but there is a clear trend that increased mussel concentration is positively correlated with mussel survivorship.

# Conclusion

- With the proper number of mussels a significant effect may be seen on both water quality & fish growth.
- Using *E. complanata* for treatment of pond & effluent water will allow pond mangers to save time, money & space.
- Improved water quality should help aquaculture facilities financially by decreasing stock loss, product yield should increase.
- Even though no significant affect on water quality or fish growth their use in aquaculture ponds may still be beneficial.
  - These ponds could be used for mussel conservation.
  - Using freshwater mussels in ponds may be beneficial for restoration efforts by serving as a habitat for propagated mussels.
- This project demonstrates to pond managers & others associated with high nutrient-laden water systems that the use of native biological organisms may be beneficial in controlling water quality.

# Mussel Propagation

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# Questions!