Solids Management in Biofloc-Based Aquaculture Systems

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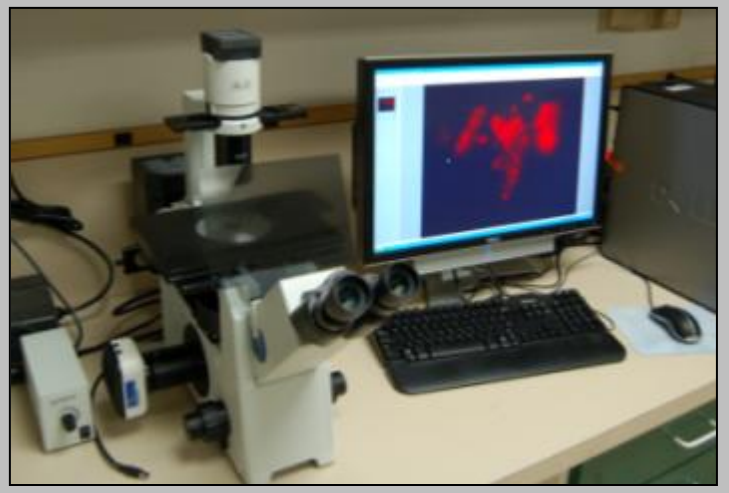
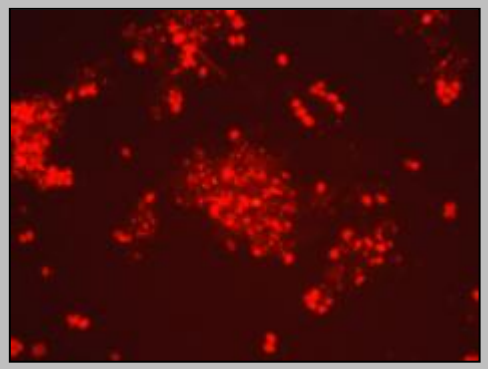
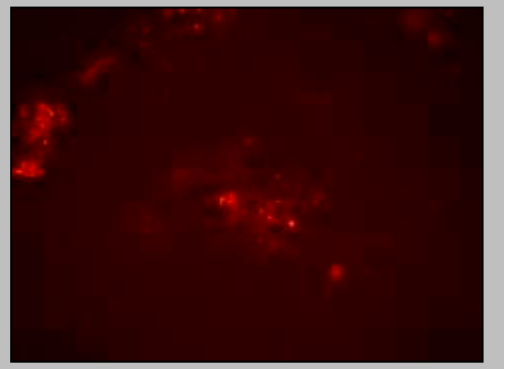
Characterizing Suspended Solids

- TSS (Total Suspended Solids)
- VSS (Volatile Suspended Solids)
- Turbidity
- Settlable Solids
- Floc Volume Index
- Particle Size
- Microbial Composition
  - Microscopy
  - Phenotypic Techniques
  - Molecular Techniques
- Microbial Function
  - Oxygen Production/Demand
  - Nutrient Cycling
- De Schryver et al. 2008





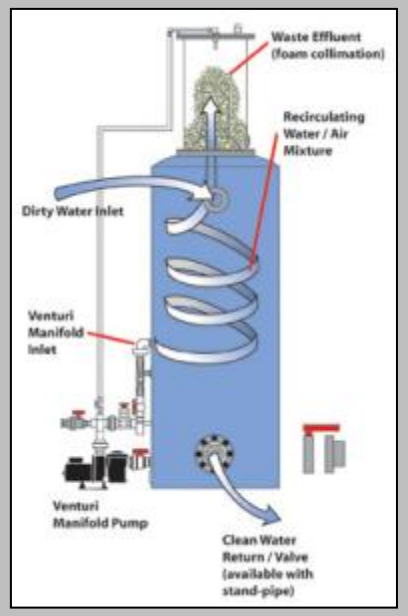


Why Control Biofloc Concentration?

- Issues with excessive particles
  - Gill Clogging
  - Increased Biochemical Oxygen Demand (BOD)
  - Promote the Occurrence of Harmful Microorganisms
    - ↓ Light Penetration
    - Cyanobacteria, zooplankton blooms?, dinoflagellates?
  - Potential for Sludge Deposition
- Control over culture systems
  - Microbiota
    - Remove unwanted organisms
    - Promote a younger/healthier community
  - System Stability
  - Nutrient Removal/Cycling

Particulate Control

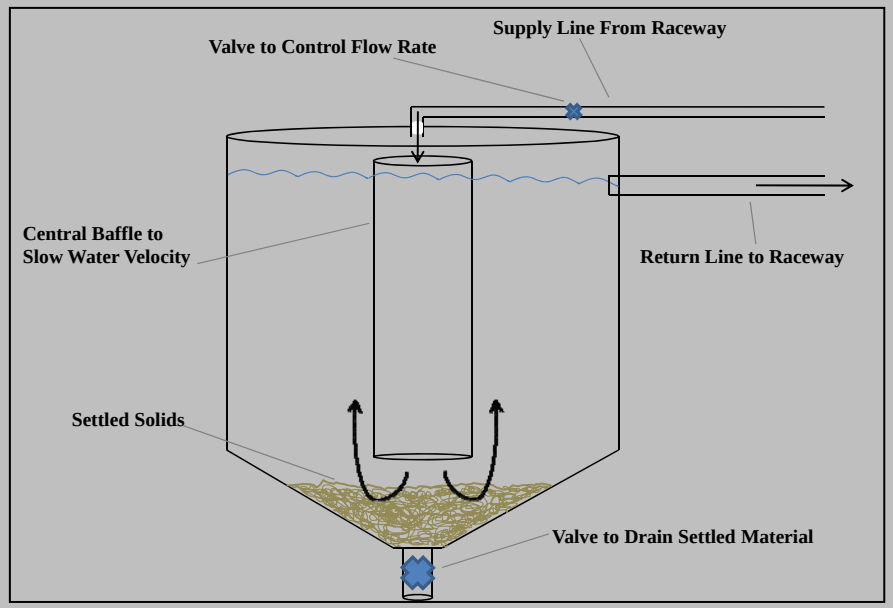
- Bead Filters/Sand Filters
  - Inadequate for intensive biofloc systems (ex. Mishra et al. 2008)
    - Particle load/water use
    - Size? Cost?
- Foam Fractionators
  - Benefits
    - Not prone to fouling
    - Range of particle sizes
    - Dissolved components
  - Drawback
    - Can be inconsistent in what they remove and how much
      - » Dependent on: bubble diameter, solids concentration, air-to-water ratio, surface chemistry of solids, and the surfactant concentration in water
      - » Cost?



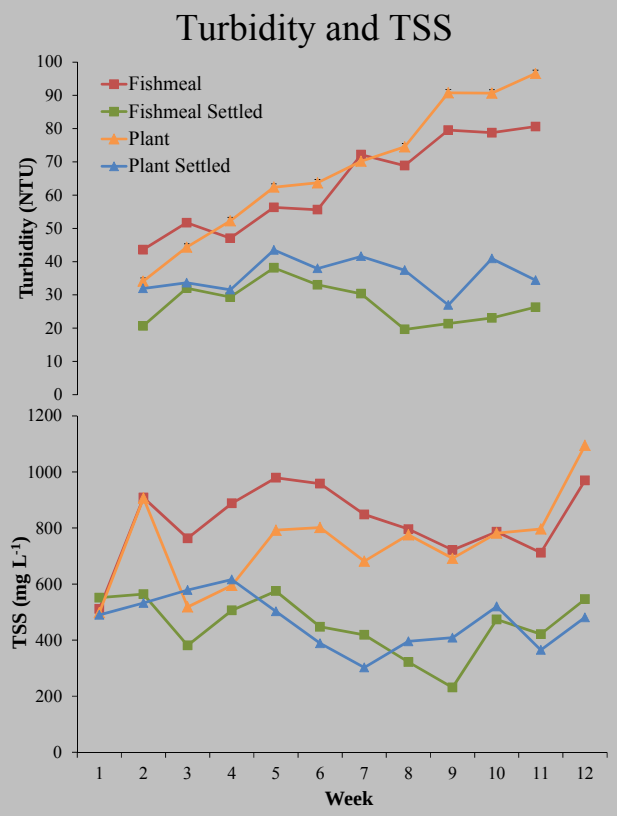
http://www.emperoraquatics.com/images/ff_diagram.jpg

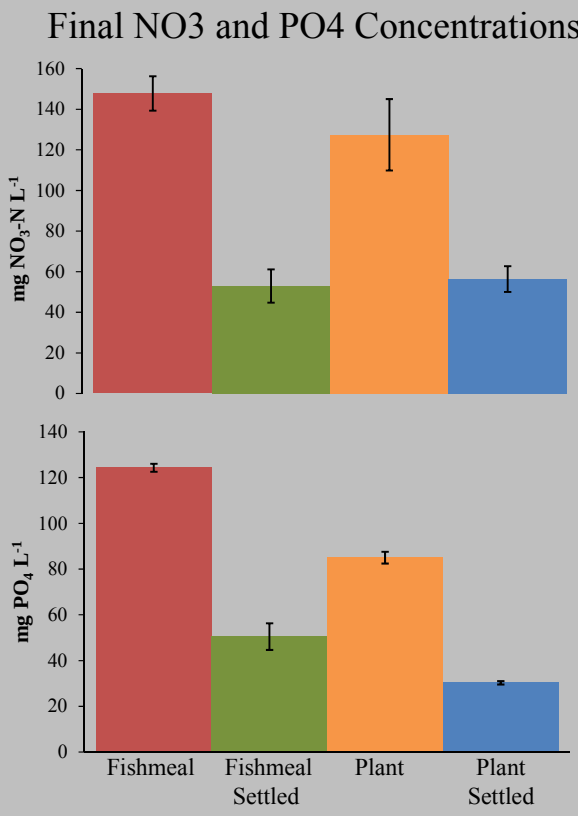
Sedimentation

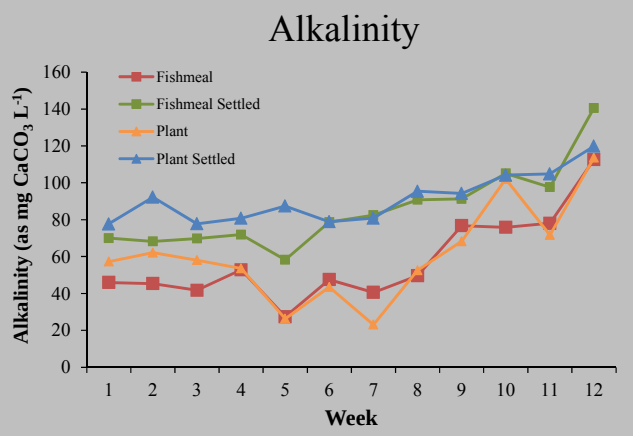
- Gravity
  - Ponds/tanks with drains
  - External ponds
  - External chambers
    - Benefits
      - Simple
      - Inexpensive
      - Scale up or down easily
      - Anaerobic zone separate from culture unit
      - Not prone to fouling
      - Denitrification
    - Drawbacks
      - Small particles?
      - Dissolved components?
      - Surface mats???



The Effects of Solids Management on Water Quality





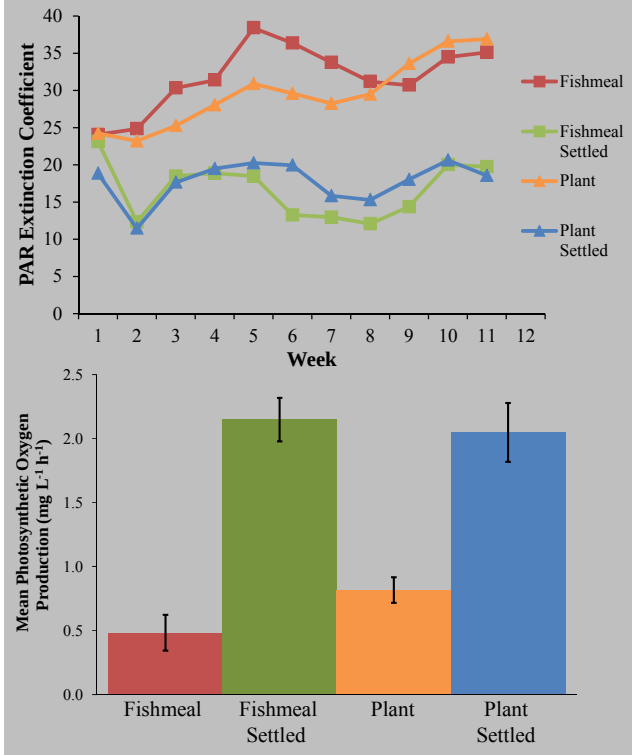


- Settling Chambers in Shrimp BFT
  - 6200 L circular, outdoor tanks
  - 2 experiments one year apart
    - Exp. A = 16 tanks
    - Exp. B = 32 tanks
  - ½ tanks with settling chambers, ½ without

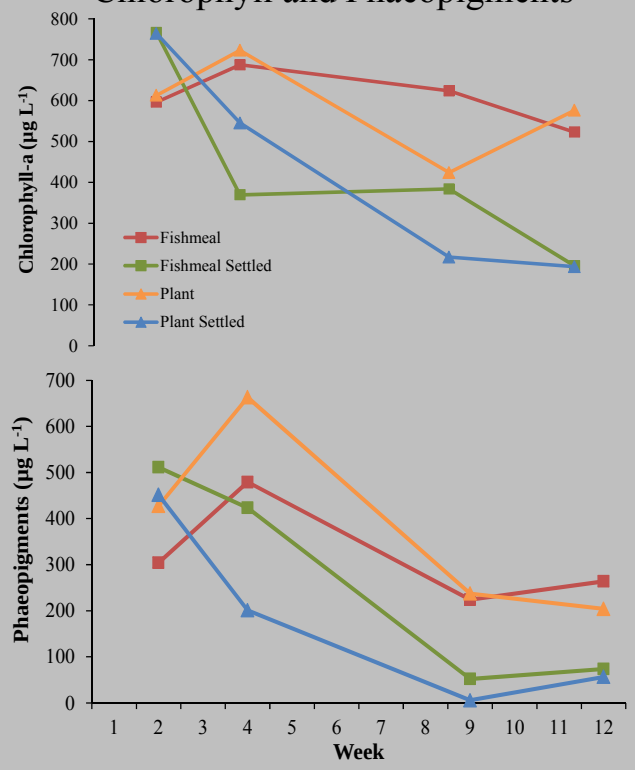
- BFT Settling Chambers – Exp. A
  - 59% ↓ TSS
  - 60% ↓ NO_3-N
  - 61% ↓ Orthophosphate
  - 33% ↑ Alkalinity
  - Denitrification???

Solids Management and Microbial Communities

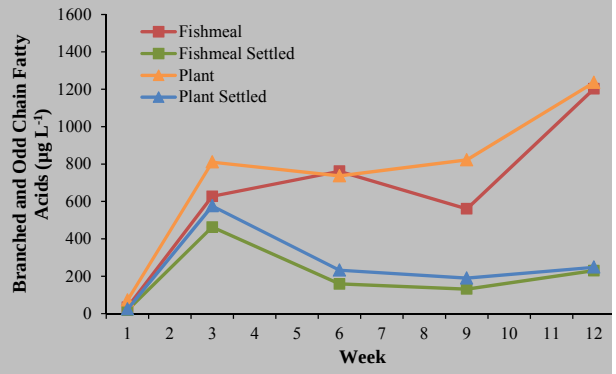
PAR Extinction and Oxygen Production



Chlorophyll and Phaeopigments



Fatty Acid Bacterial Indicators

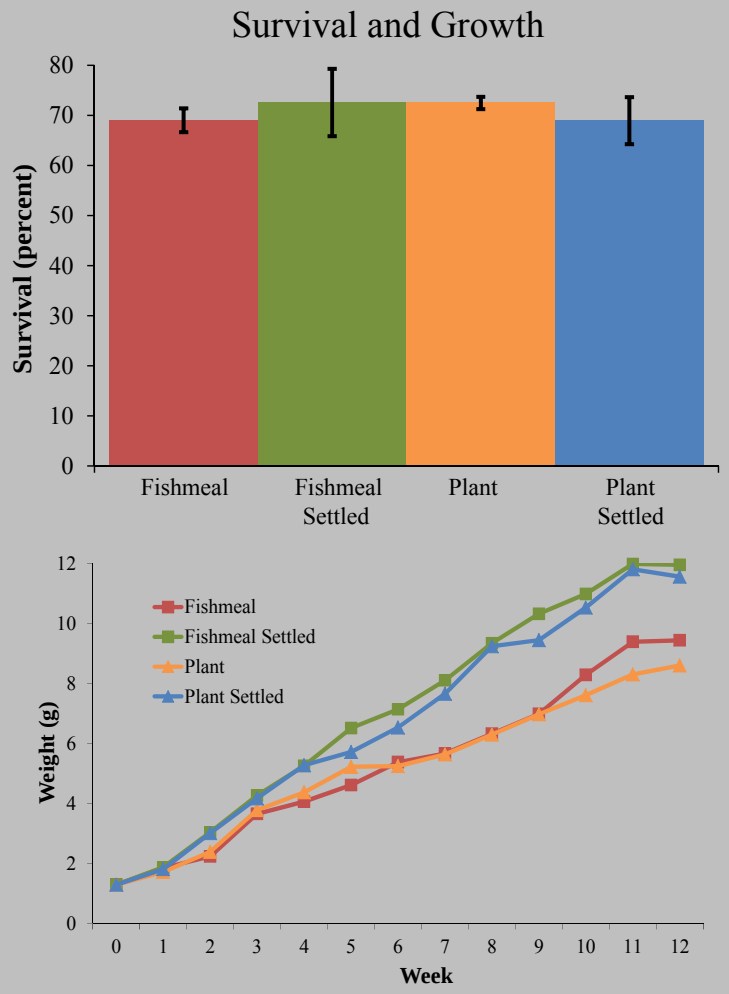


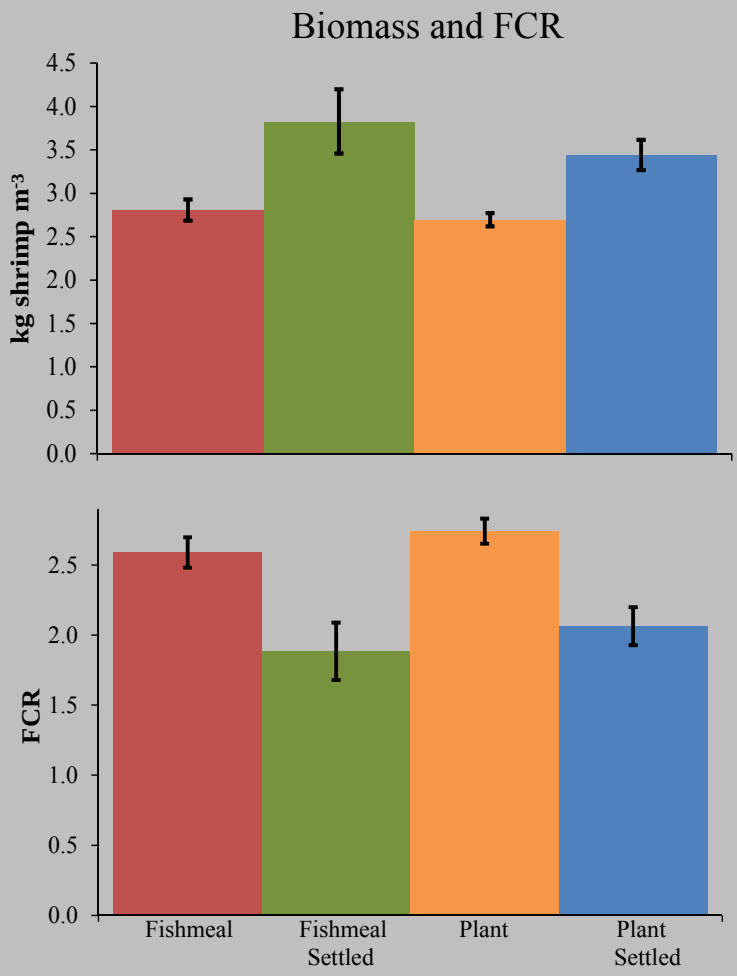
- BFT Settling Chambers – Exp. A
  - 47% ↓photosynthetically active radiation extinction coefficient
  - 200% ↑ photosynthetic oxygen production
  - 65% ↓ final chlorophyll-a
  - 72% ↓ final phaeopigments
  - 80% ↓ fatty acid bacterial indicators

Solids Management and Microbial Communities

- Microbes – Exp. B
  - No detectable difference with respect to chlorophyte, diatom, or dinoflagellate abundance
  - 60% ↓ in final nematode abundance
  - 19% ↓ in final rotifer abundance
  - 23% (visual), 17% (epifluorescence) ↓ final cyanobacteria abundance
  - 60% ↓ final fatty acid bacterial indicators

Solids Management and Shrimp Production



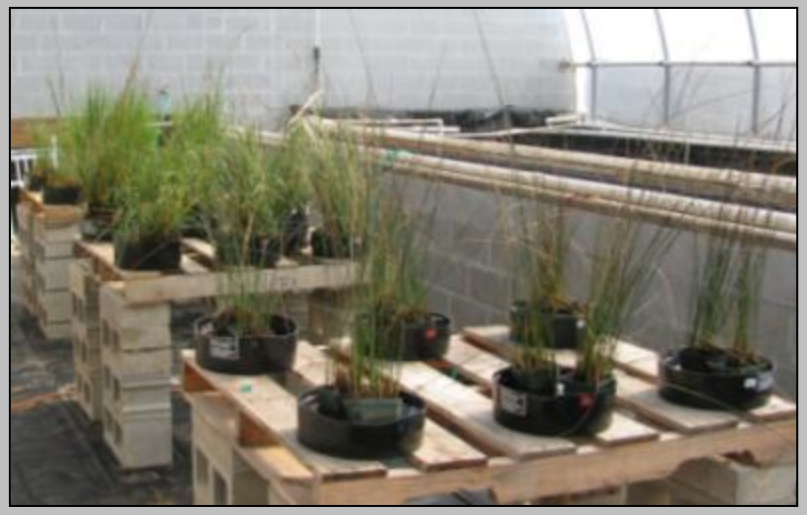


- Shrimp Production – Exp. A
  - No significant difference in survival
  - 28% Increase in growth rate
  - 41% Increase in final biomass
  - 26% Decrease in FCR

Needed Research

- Refining the optimal concentration of biofloc particles = This Afternoon!

- Remediation of Removed Material
  - Dissolved Nutrients
    - Sequence batch reactors
    - Plants
  - Solids
    - Nutritional supplement = This Afternoon!



Thank You

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- The two experiments described here were conducted at the Waddell Mariculture Center, Bluffton, South Carolina, USA; thank you to the staff of that facility.