

BIOFLOC DYNAMICS IN SUPER-INTENSIVE SHRIMP RACEWAYS: THE GOOD, THE BAD, THE UGLY



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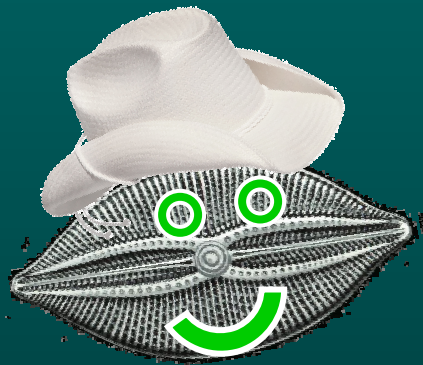
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BIOFLOC DYNAMICS IN SUPER-INTENSIVE SHRIMP RACEWAYS:

THE GOOD



THE BAD



THE UGLY



South Carolina Department of Natural Resources
Marine Resources Research Institute
Charleston, South Carolina

Waddell Mariculture Center
Bluffton, South Carolina



Engineering the Next Generation Systems

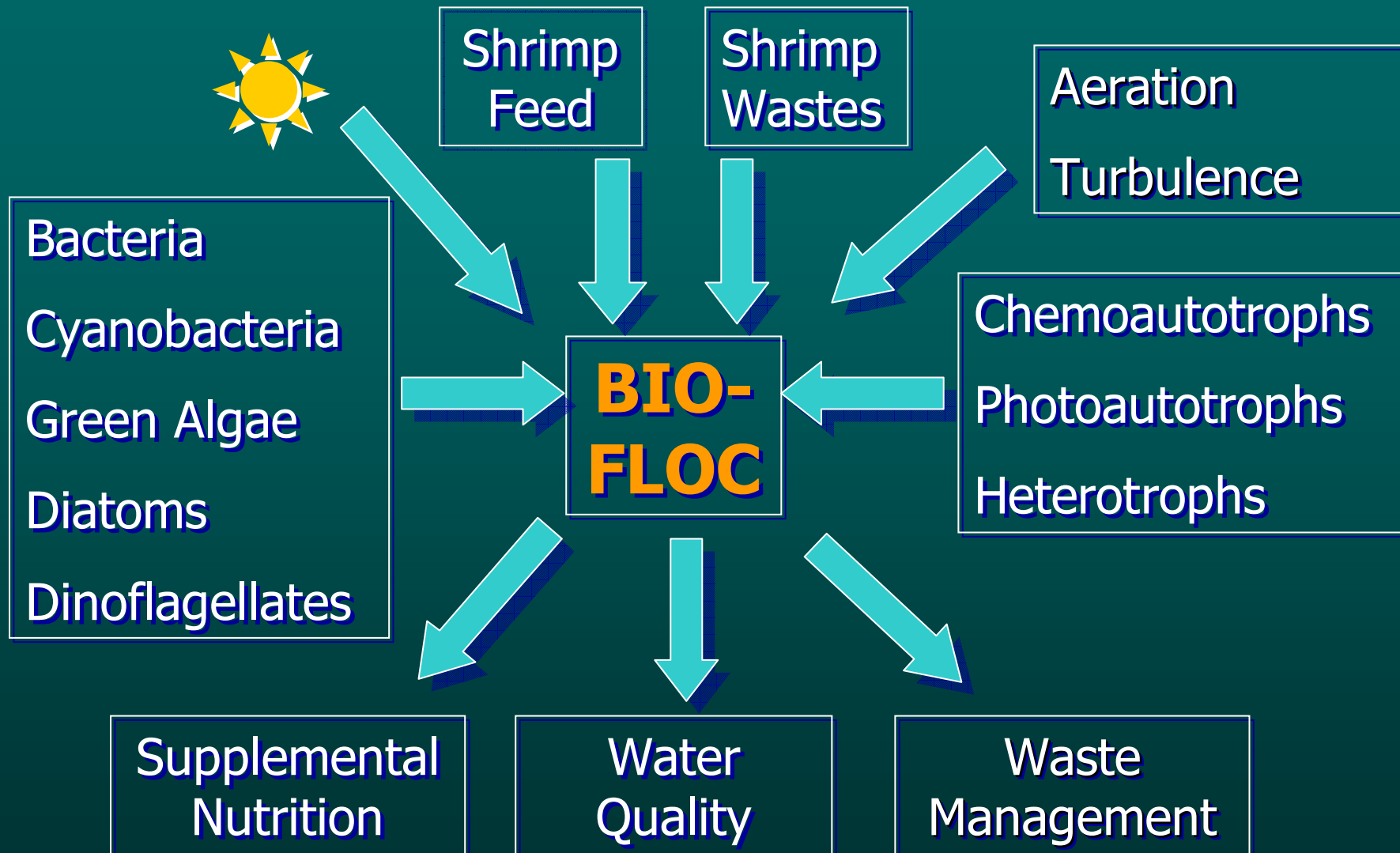
Aerated zero exchange microbial floc systems:

- ❖ Disease-free stock
- ❖ Biosecure raceways
- ❖ Density 300-750/m³
- ❖ Oxygen injection
- ❖ High protein “organic” diets
- ❖ Low salinity - 15 ppt
- ❖ Heat exchange systems
- ❖ Sludge capture, dewatering
- ❖ Water reuse between crops
- ❖ Waste conversion
- ❖ **Microbial community management**

= **BioFloc**



Super-intensive Shrimp Culture



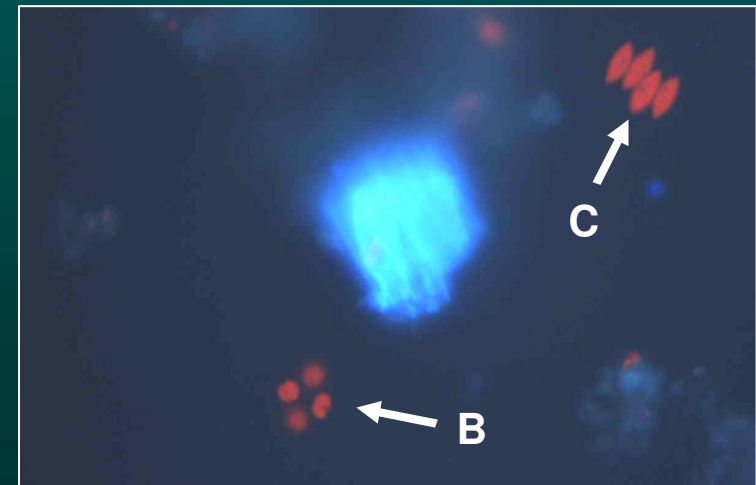
Microscopic Observations of BioFloc



- A - Bacterial filament
- B - *Chroococcus* – cyanobacterium
- C - *Scenedesmus dimorphus* – green alga



Phase Contrast



Epifluorescence

**SCDNR Waddell
Mariculture Center**

**Experimental
Raceways**



**Raceways 1 and 2
55 m³ each**



**Raceway 3
282 m³**

The Good, the Bad, and the Ugly (BioFloc)

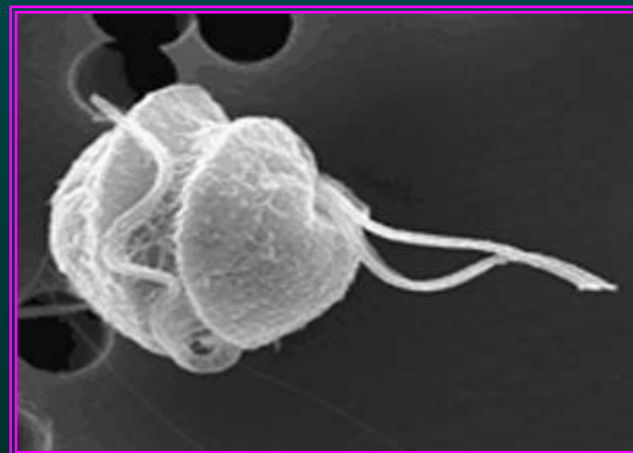
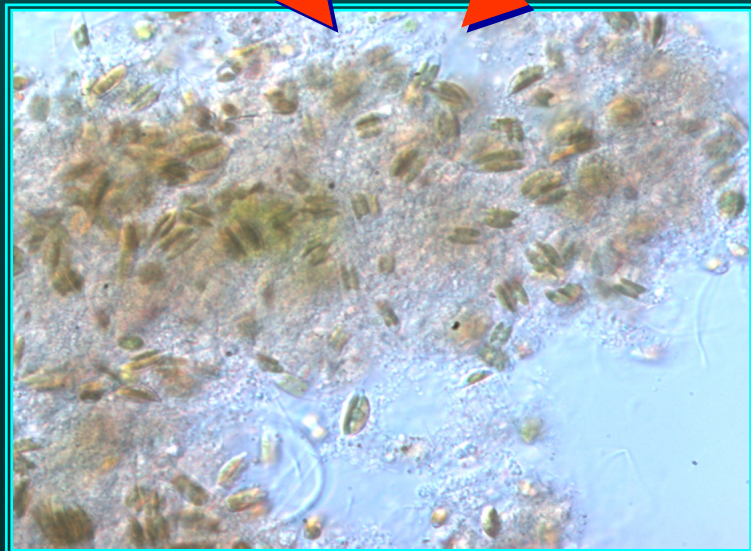
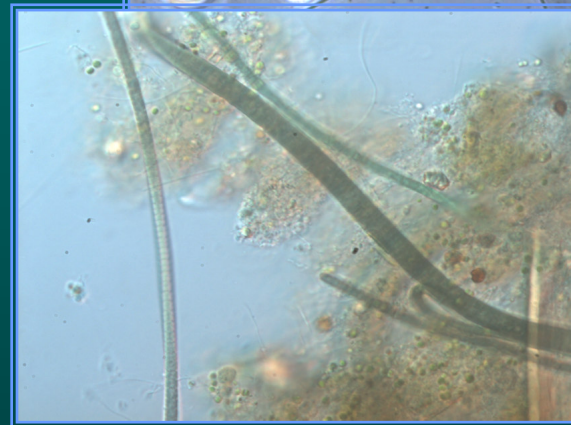
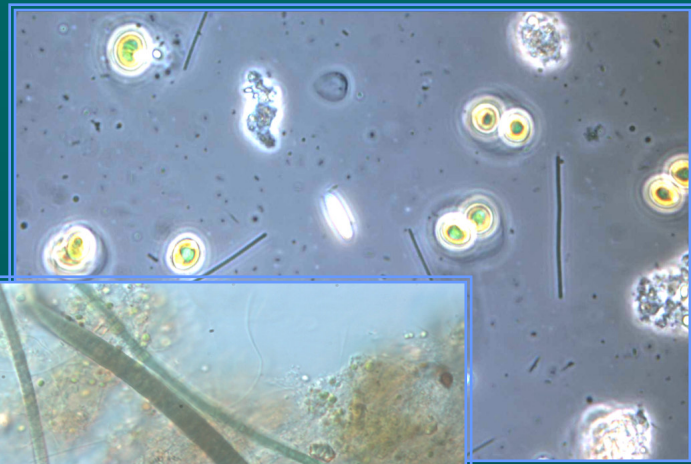
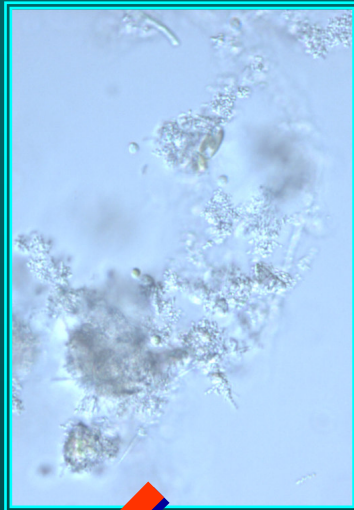
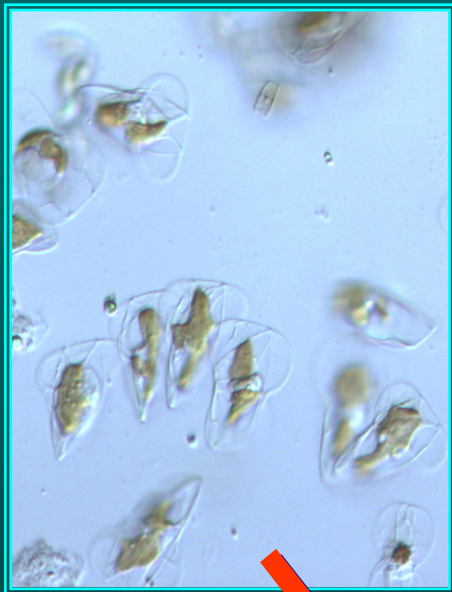
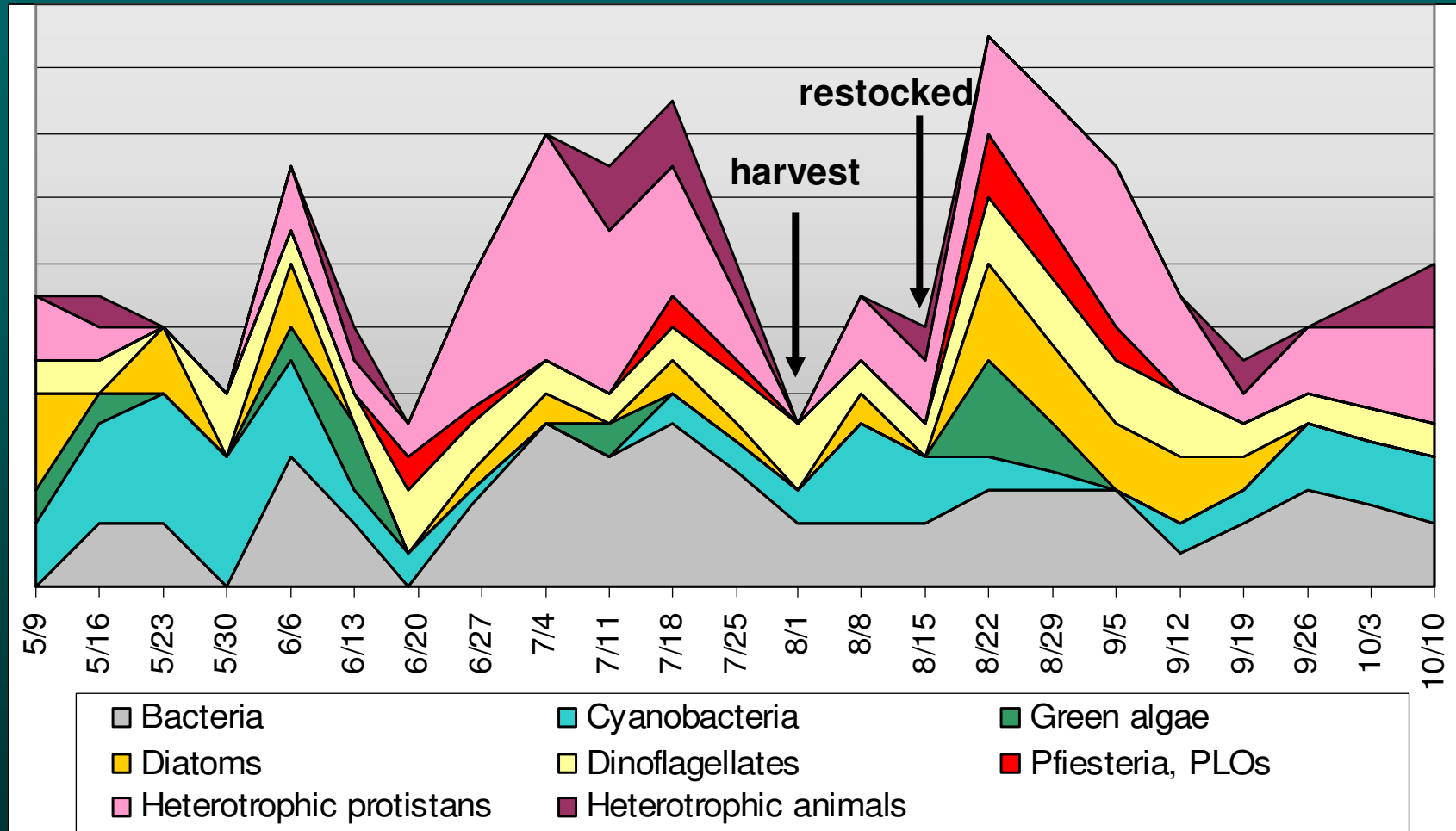


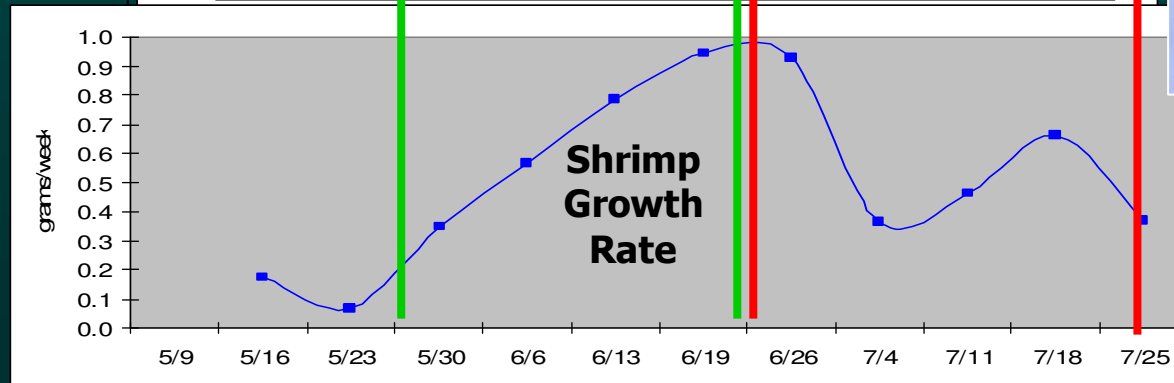
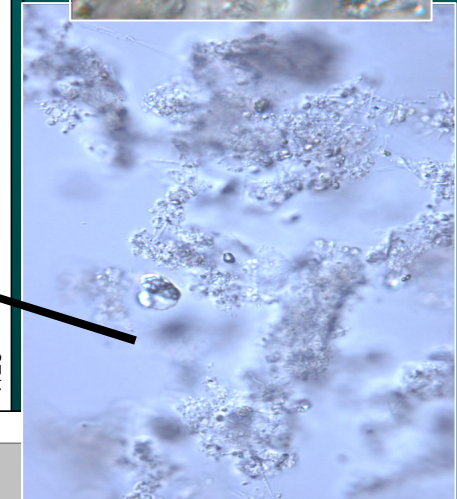
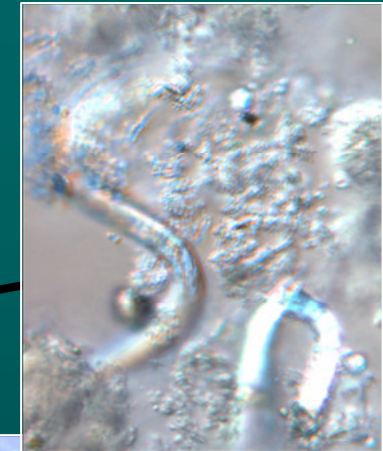
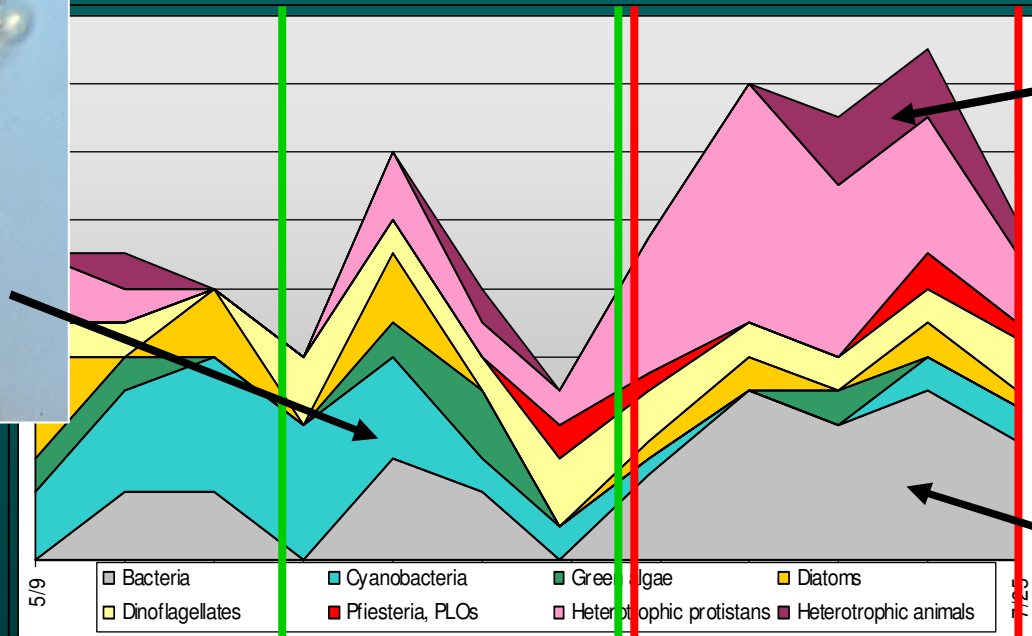
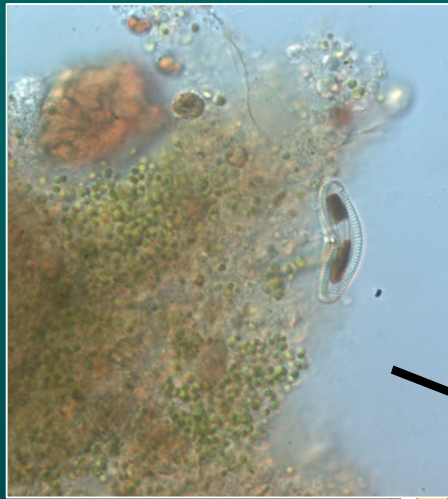
Photo by M. Parrow, Center for Applied Aquatic Ecology.

BioFloc Composition Changes over Time

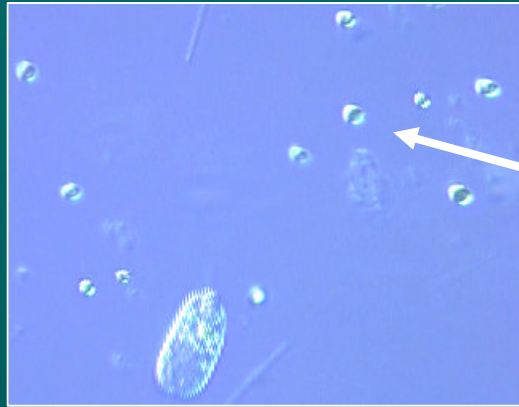


Raceway 1

Correlating Shrimp Growth Rate with Composition of BioFloc Community

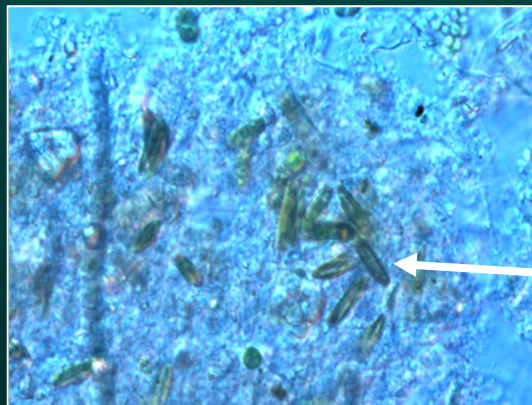


Raceway 1

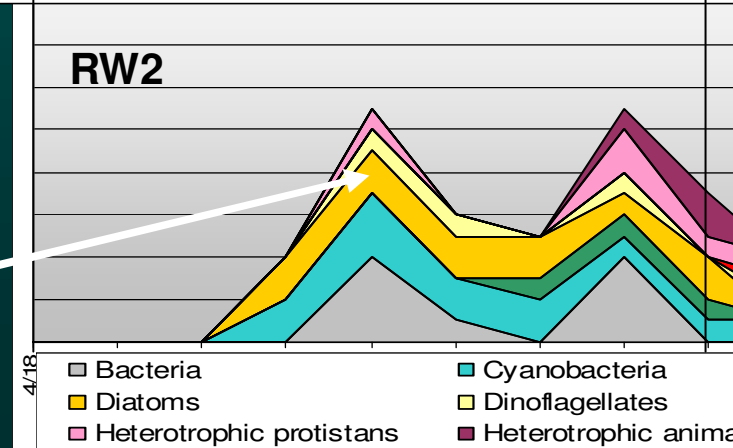
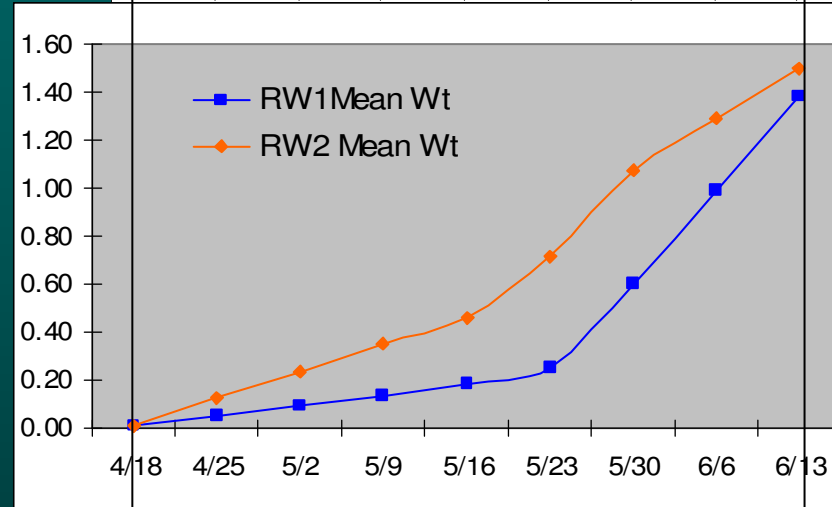
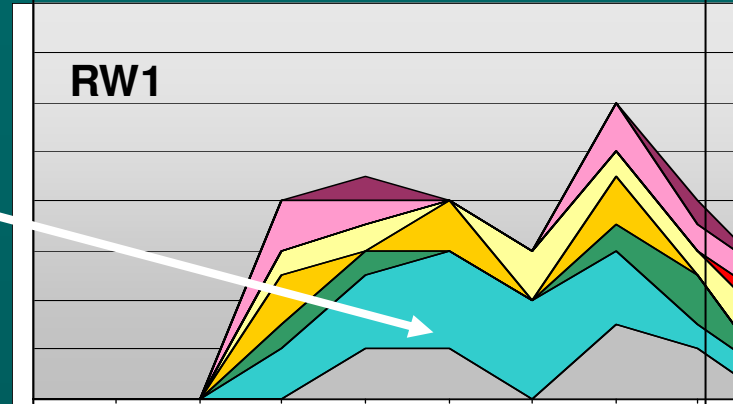


Synechococcus
(microcystins)

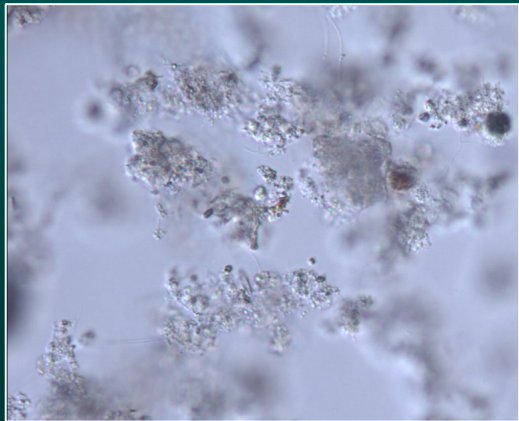
Growth Rates of PL's Stocked in "Identical" Raceways



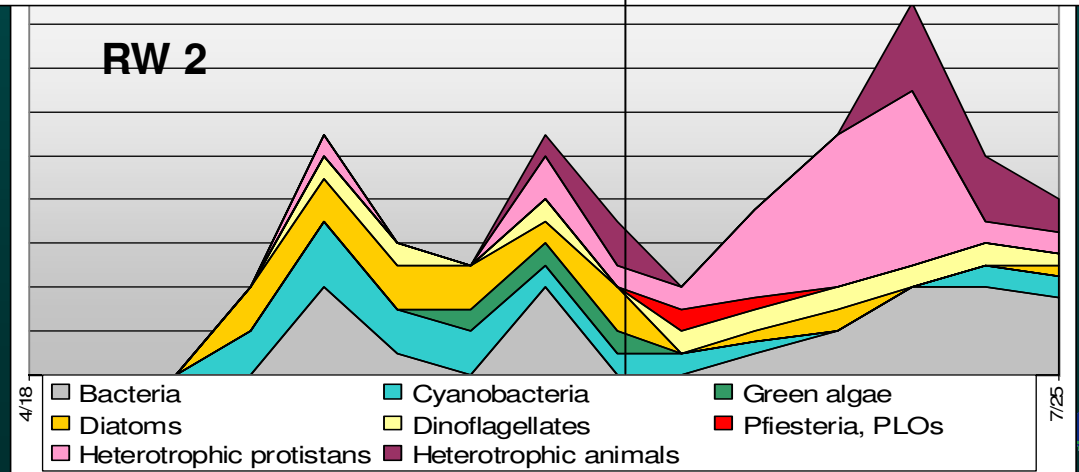
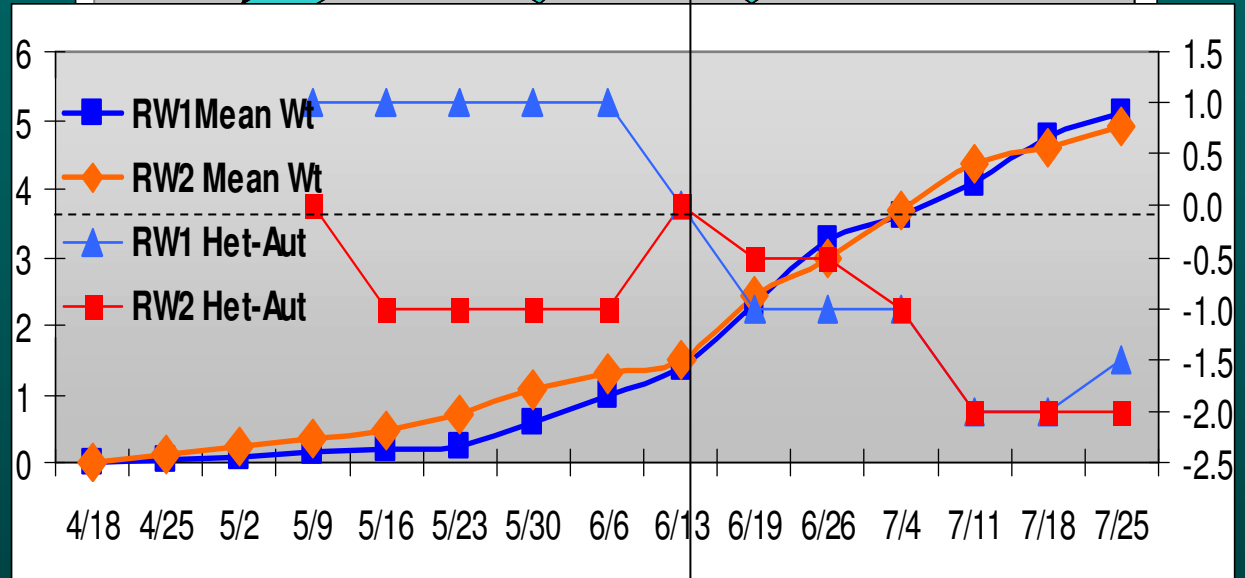
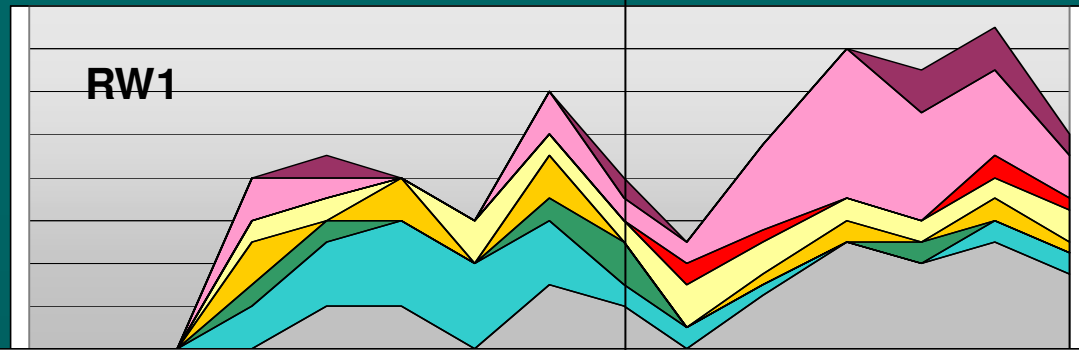
Diatoms in bacterial matrix



Shrimp Growth Rates Converge when BioFloc Community Compositions Converge

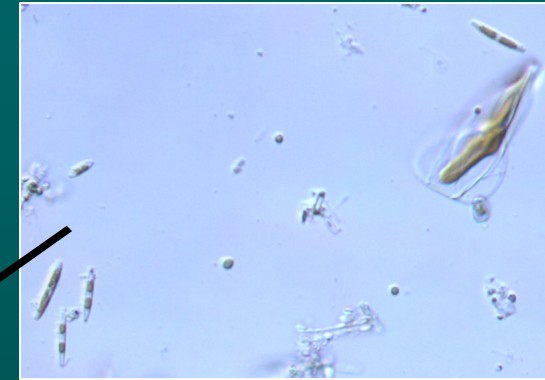
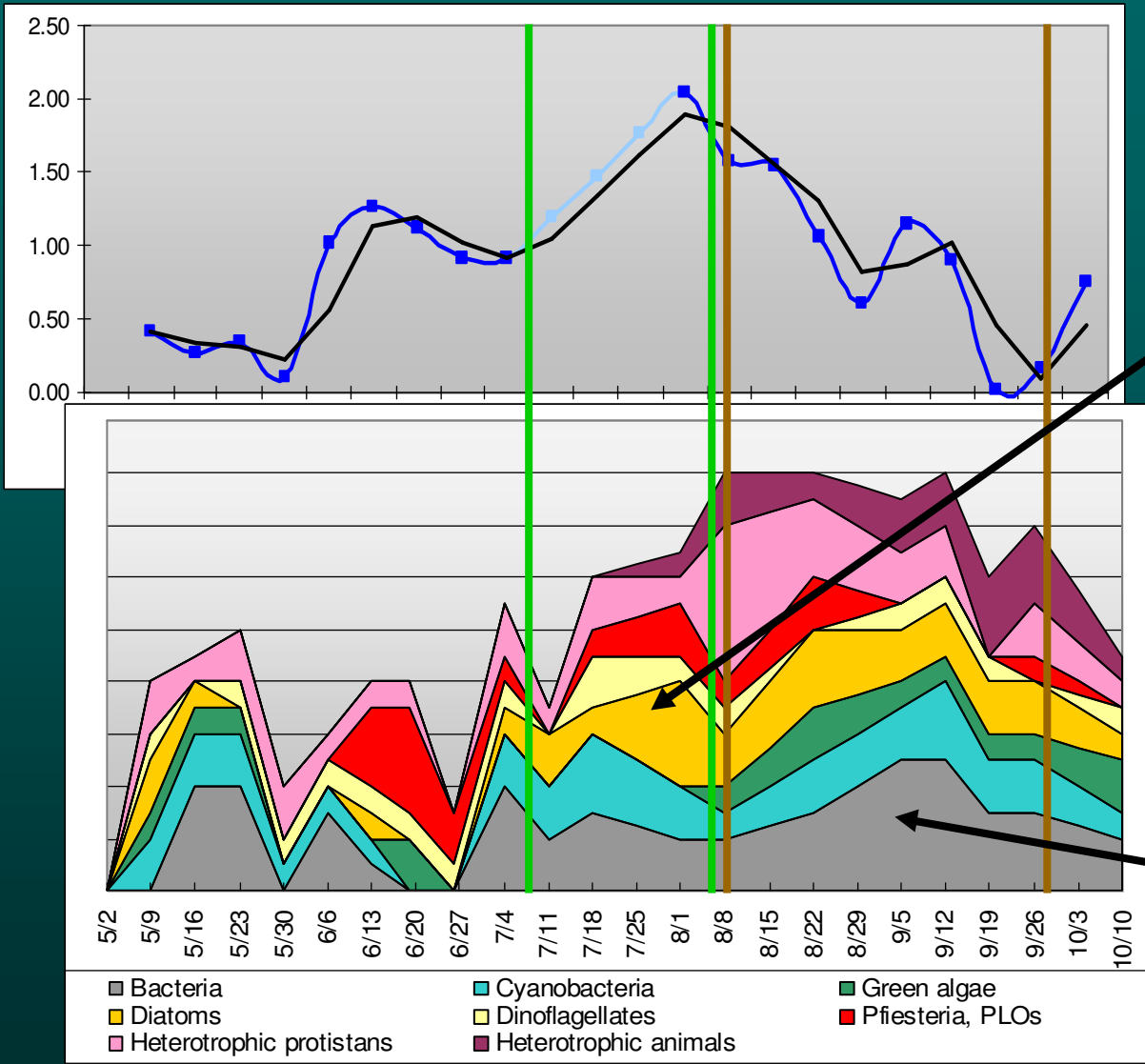


Both became strongly heterotrophic, bacterial driven communities

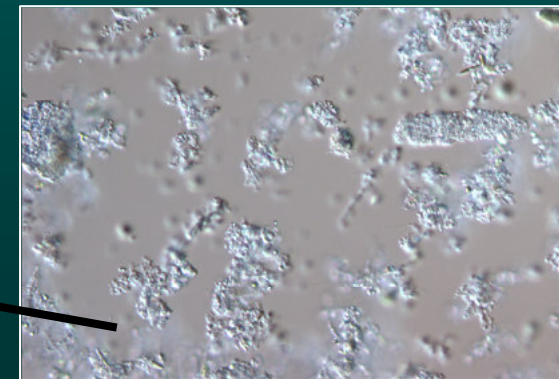


4/18 7/25
 Bacteria Cyanobacteria Green algae
 Diatoms Dinoflagellates Pfiesteria, PLOs
 Heterotrophic protists Heterotrophic animals

Similar Correlations between Growth Rates and BioFloc Community Composition

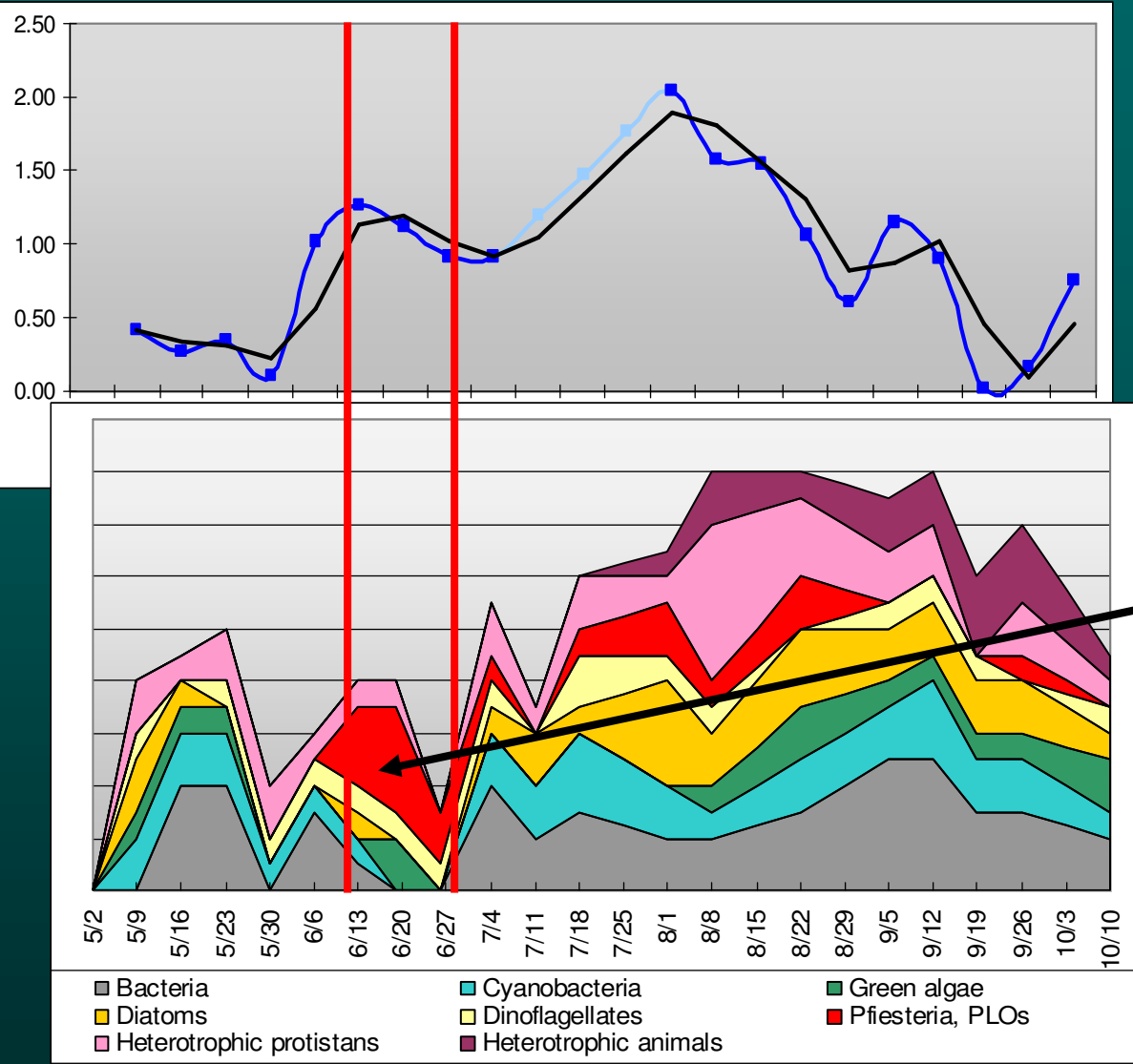


Diatoms, less bacterial floc



Bacterial floc, bacteriovores

And now ... the "UGLY" Floc



Pfiesteria

Raceway 3

Pfiesteria

- a heterotrophic dinoflagellate
- *warm months in brackish water*
- *Pfiesteria or its toxins may cause fish kills*
- *Toxins, if present, may be inhaled or absorbed through the skin*
- *Headaches, dizziness, skin or eye irritation, skin lesions, nausea, intestinal distress, short-term memory loss*

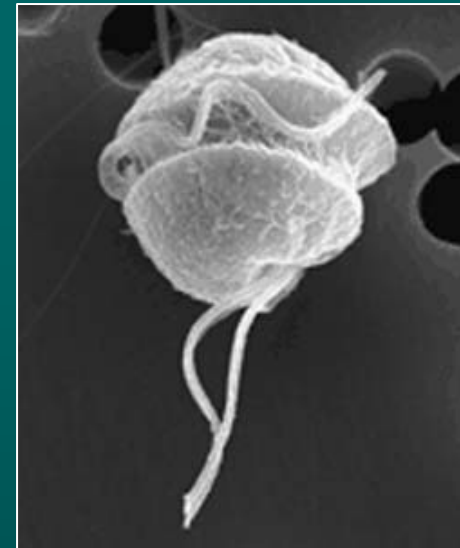


Photo by M. Parrow, Center for Applied Aquatic Ecology.



Advanced Technology
Environmental Education Center



Pfiesteria in Raceway 3 - 2006

June 7 – no PLO's

June 14 – Abundant PLO's: **1,478 cells/mL**

Real time PCR: *Pfiesteria piscicida*

June 15 – Preliminary **guidelines** for raceway staff:
ventilate building; avoid contact with
water; alcohol wash; change clothing

June 16-22 – PLO counts: **2,655 - 2,966 cells/mL**

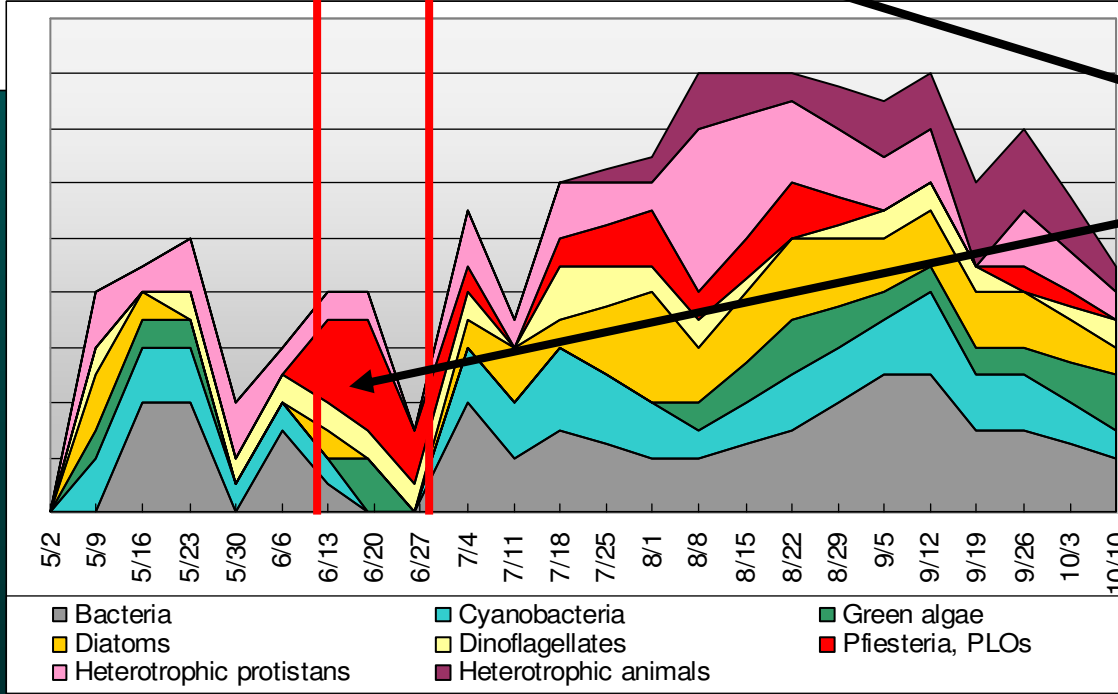
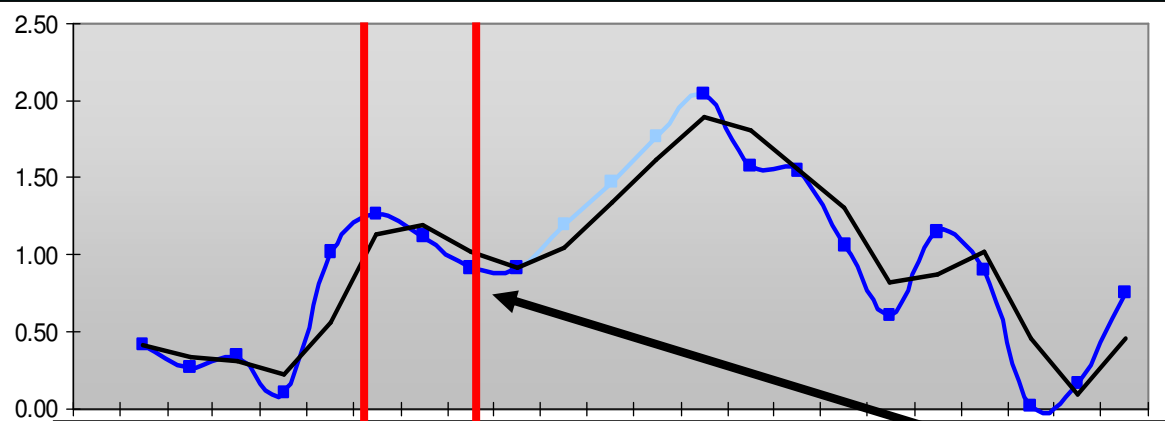
- Fish **bioassays** run by NCSU lab
- *Pfiesteria* **toxin assays** run by NOAA-Hollings Marine Laboratory
- Samples screened for PLO's from most WMC ponds, raceways, and river



***Pfiesteria* in Raceway 3 - 2006**

- June 21** – **Safety measures** implemented facility wide; Temporary containment of all water, shrimp and fish on site
- June 22** – Fish and chemical assays **negative for toxins**
- June 23** – SC Harmful Algal Task Force Emergency Meeting
- June 28** – **No PLO's**; *Pfiesteria* by PCR only
 - No further occurrences

Did *Pfiesteria* Affect Shrimp?



Pfiesteria

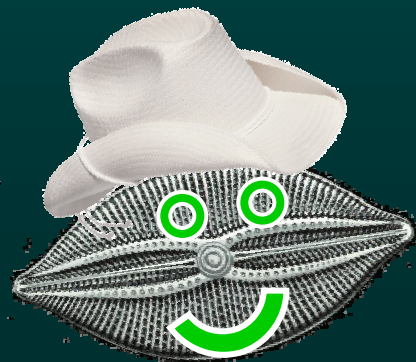
Raceway 3

Conclusions

- BioFloc is **key** to super-intensive, greenhouse shrimp production
- BioFloc is a **complex** microbial community
- BioFloc community structure is **dynamic**
- BioFloc community structure may directly influence **shrimp** productivity
- Some BioFloc species may have potential to impact **human health**

Current Research

- **Monitor** BioFloc communities quantitatively and correlate with shrimp productivity
- **Understand** parameters controlling BioFloc structure and function
- Develop **management** tools to guide BioFloc communities into optimal composition
- Integrate desirable BioFloc community composition into **protocols** for organic shrimp production



Thank You!



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