United States Department of Agriculture
National Institute of Food and Agriculture

USMSFP

Effect of Solids Removal on Production of Pacific White Shrimp *Litopenaeus vannamei* in a Minimal Exchange, Biofloc-Based System

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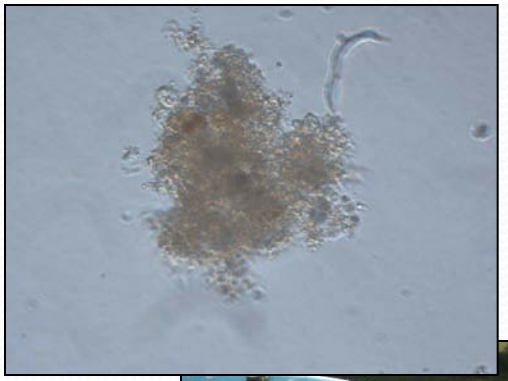
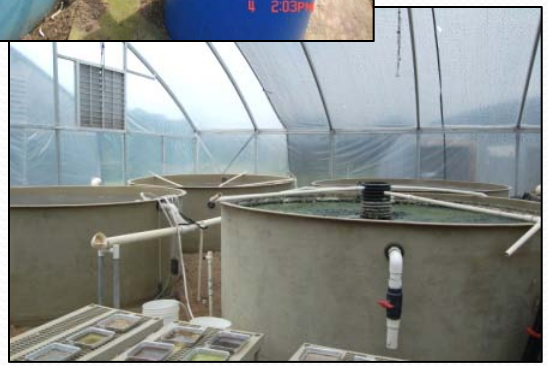
Solids in Biofloc Systems

- Potential benefits
  - Reduced water use
  - Greater biosecurity
  - Reduced capitalization cost
  - Flexibility in site selection
- Solids removal reduced:
  - TSS and VSS
  - Cyanobacteria
  - Bacteria density
  - Rate of nitrate accumulation
  - **Increased** primary production
  - Shrimp growth?





Experimental System

- Fifteen (15) plastic tanks fitted with vinyl pool liners.
- Tank Volume = 6.2 m^3 at an average depth of 70 cm.
- Air supplied by a regenerative blower .

- Conical bottom settling chambers.
- Airlift driven, 5.1-6.2 L/min
- 15 L of sludge removed weekly

Experimental Design

- Five treatments, in triplicate:
  - TRT A “Control”- Continuously unsettled
    - Airstone in settling chamber
  - TRT B Settled 10 hours/week
  - TRT C Settled 50 hours/week
  - TRT D Settled 150 hours/week
  - TRT E Settled 168 hours/week, with 250 µ mesh bag on return pipe.

Stocking

- All tanks “seeded” with established biofloc- rich water
- Stocking Date – June 8, 2010
- Initial Weight- 1.89 g
- 1000 shrimp/tank → **145 shrimp/m³**

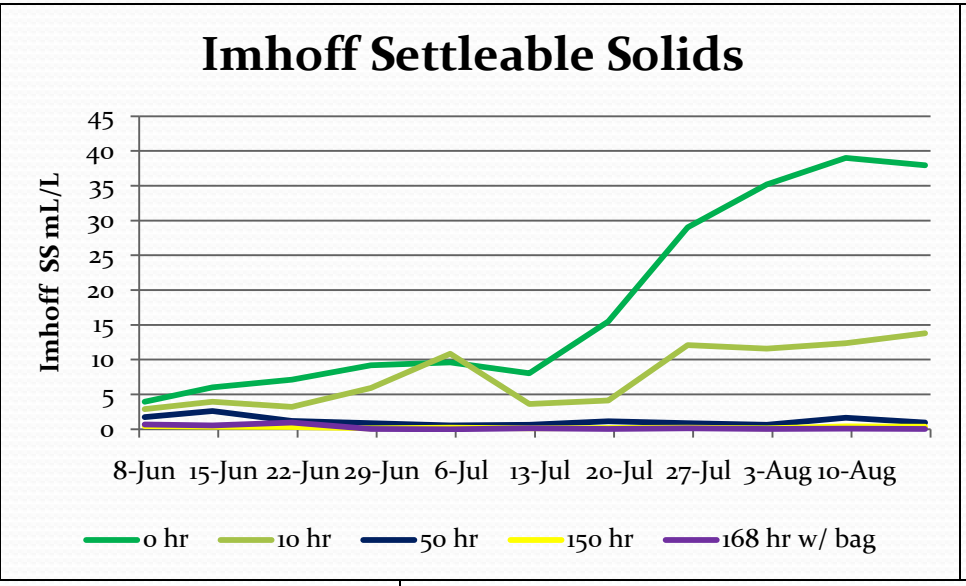
Early Problems

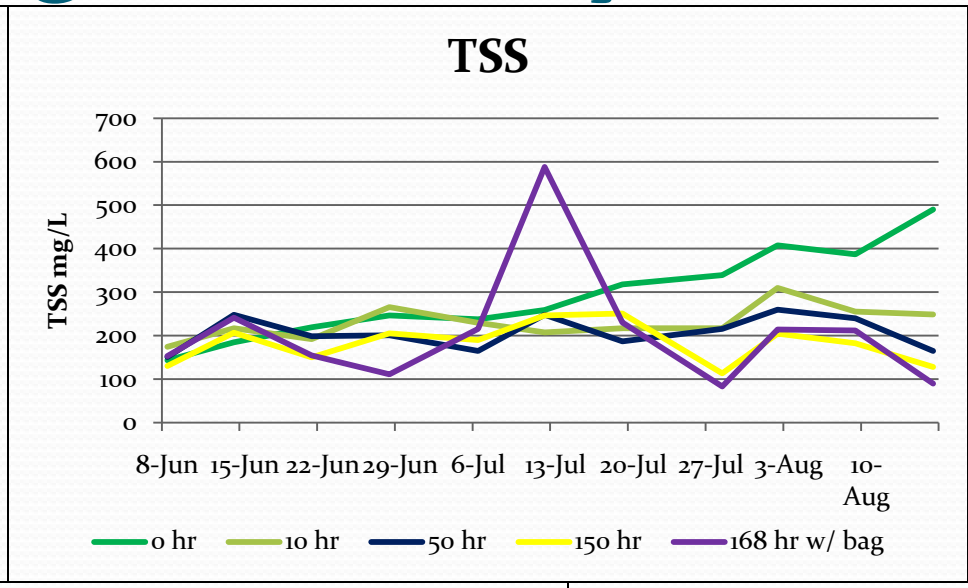
- Mortality June 15-22 (beginning one week after stocking)
- Dead shrimp removed twice per day.
- Losses from 0-188 shrimp
- Daily measurements uniform
- No correlation with NH_3-N or solids level.
- No treatment effect detected
- Shrimp redistributed

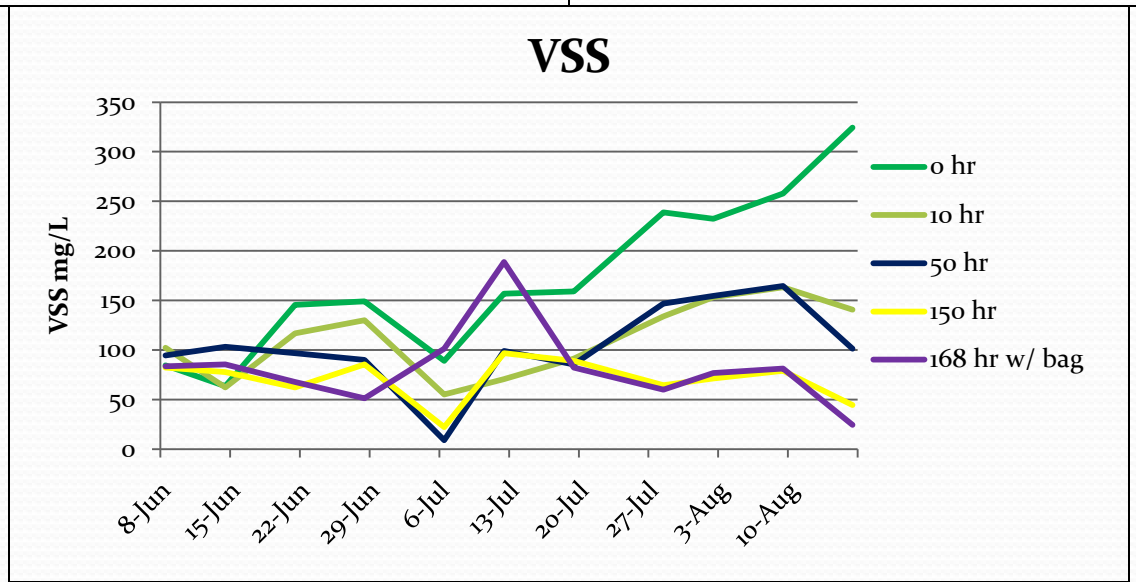
Daily Water Quality

- Temperature 23.9-32.8 ^{0} C
  - Cold snap around July 4th
- pH 7.1-8.9
- Dissolved oxygen ≥ 4.3 mg/L
- Salinity 20.3-25.8 ppt

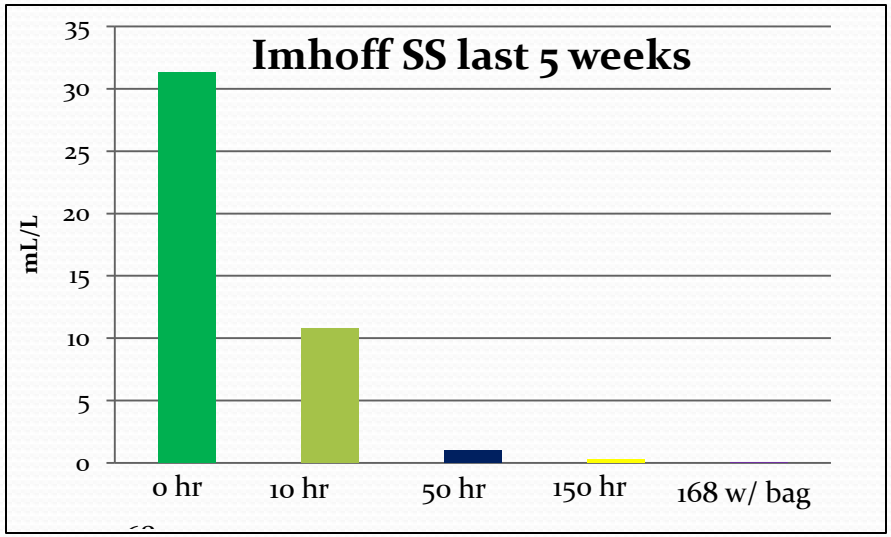
Solids Throughout Study

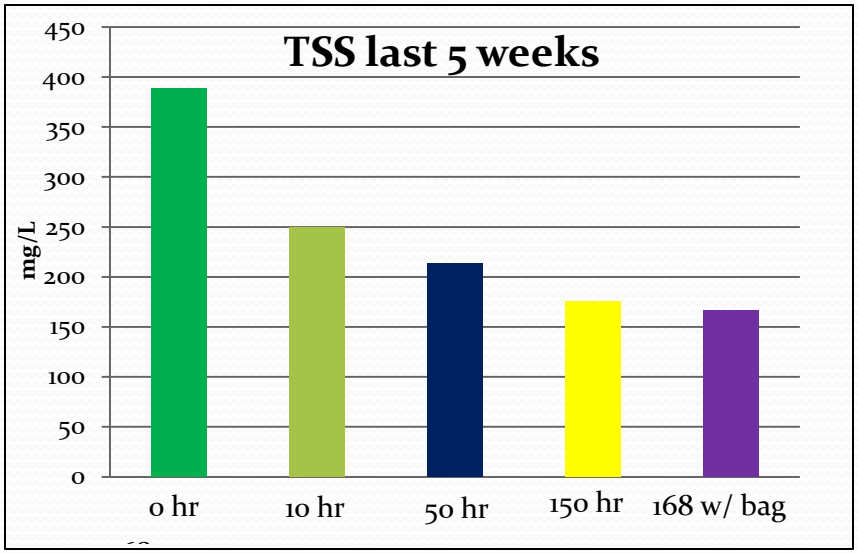


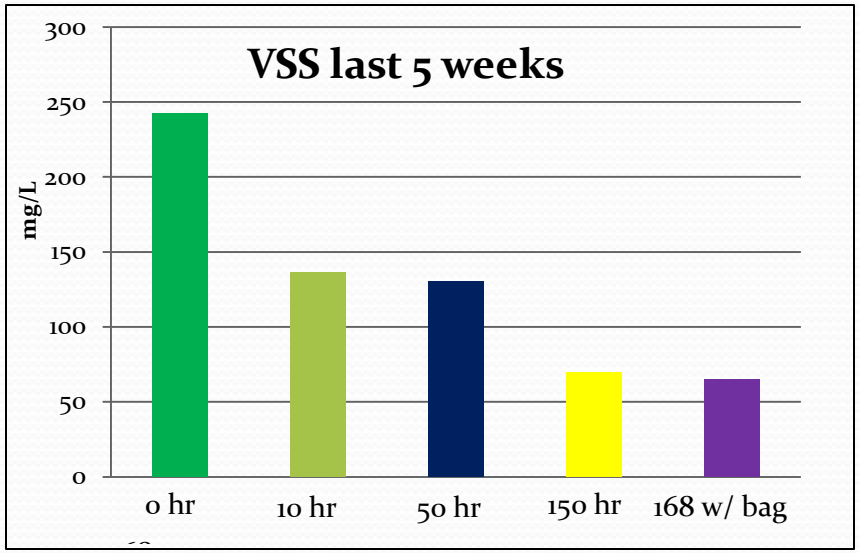




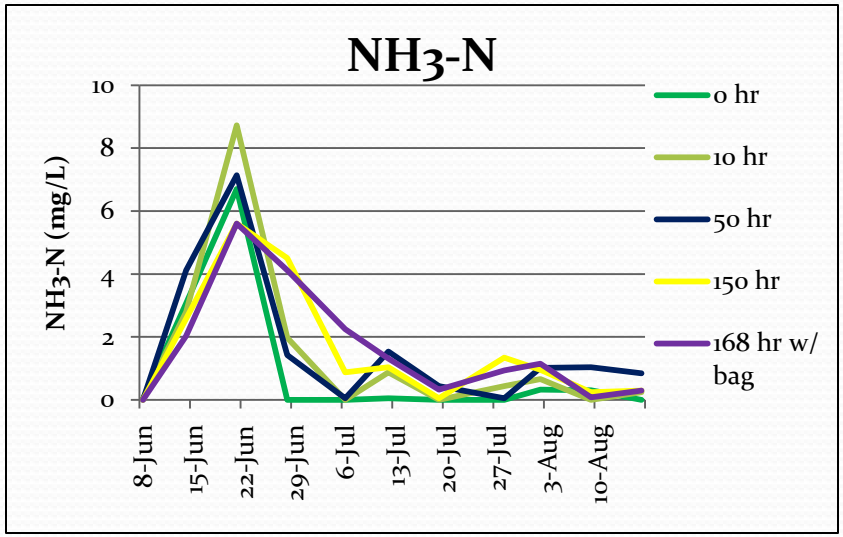
Solids in Last 5 Weeks

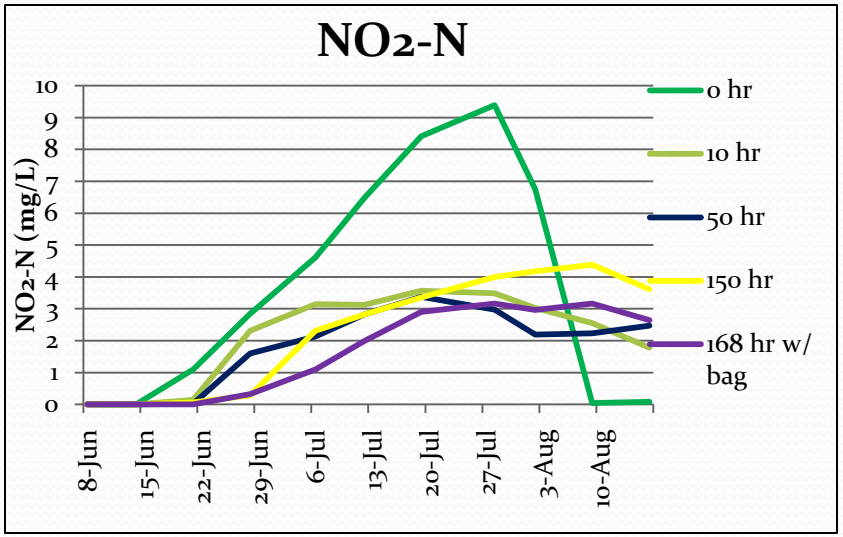


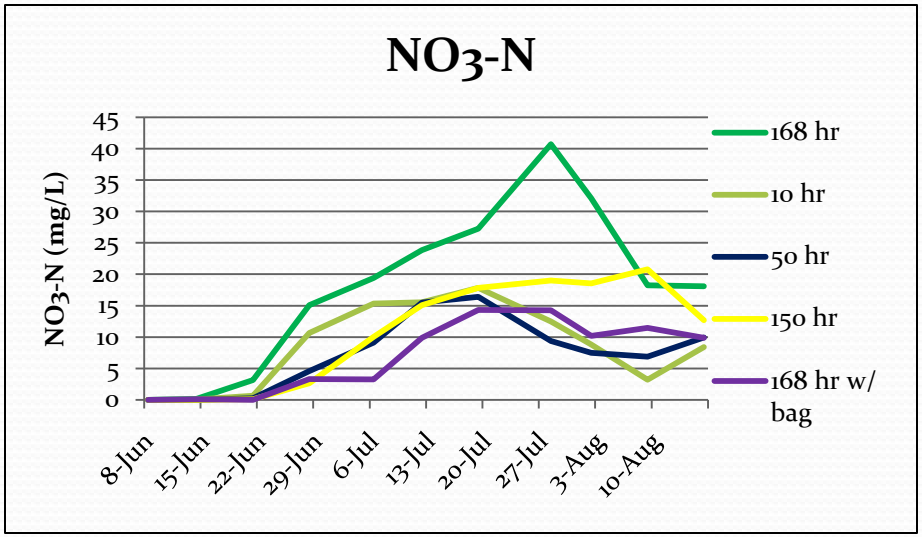




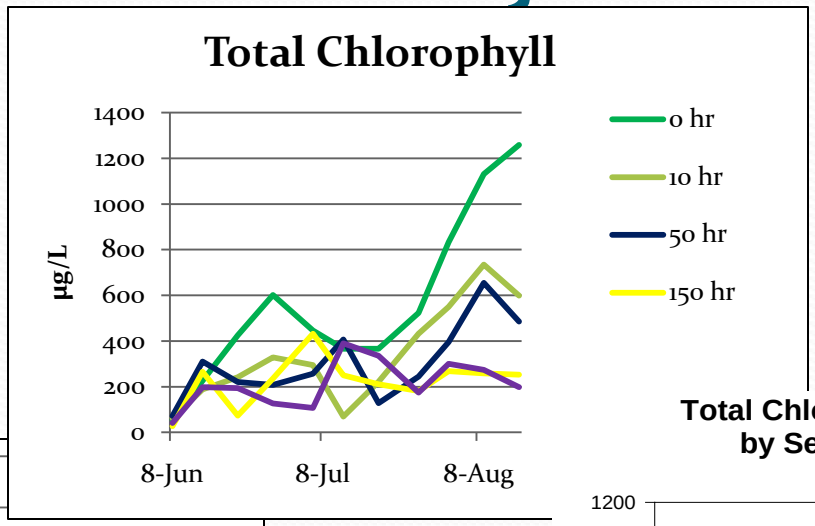
Treatment Effect on Nitrogen Cycling

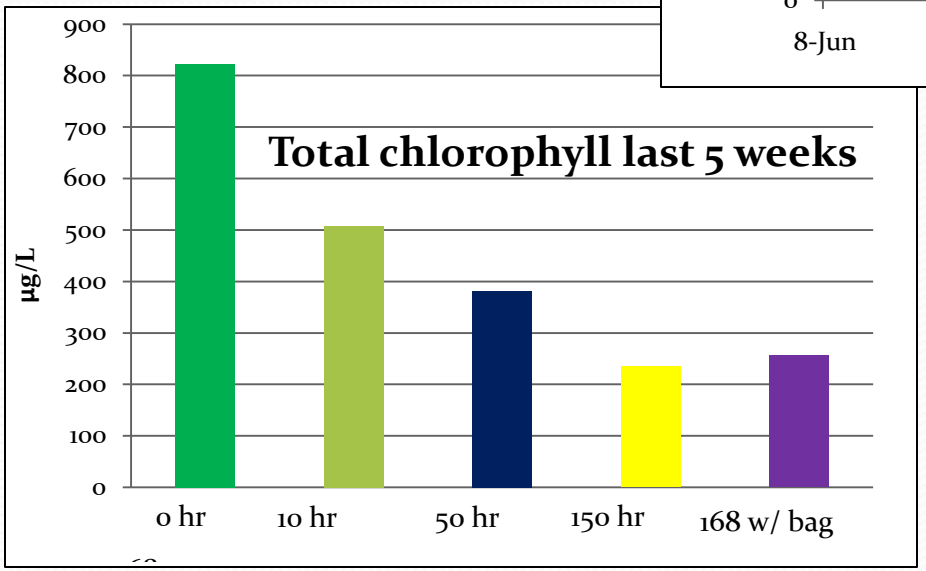


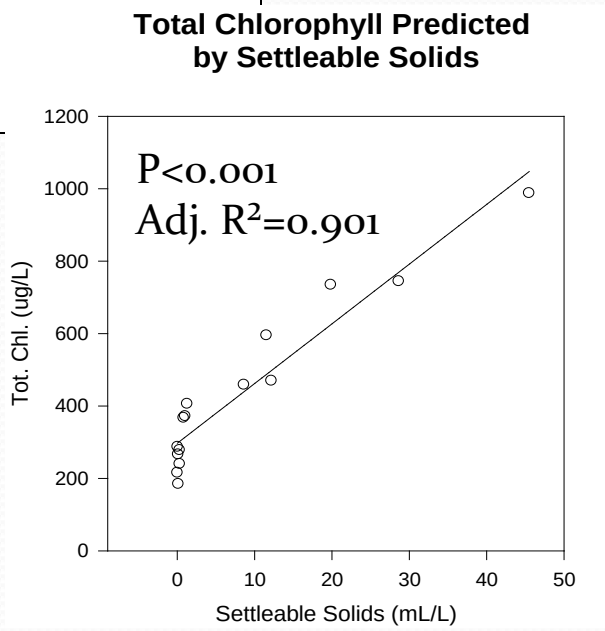




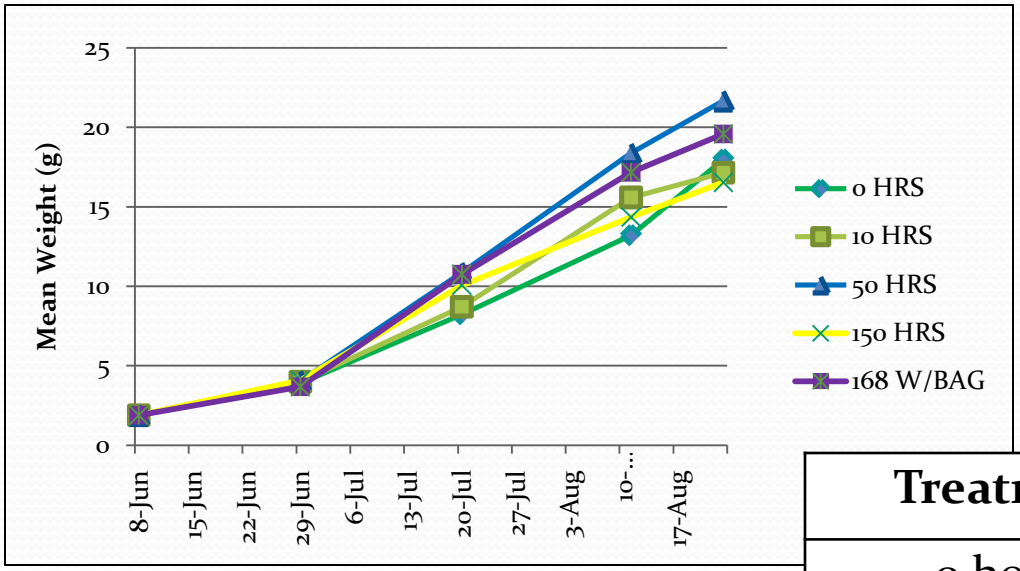
Treatment Effect on Algal Community







Shrimp Growth



Treatment	Growth Rate
0 hours	1.46 ± 0.16 [a]
10 hours	1.39 ± 0.24 [a]
50 hours	1.80 ± 0.23 [a]
150 hours	1.33 ± 0.20 [a]
168 hours w/ bag	1.61 ± 0.19 [a]

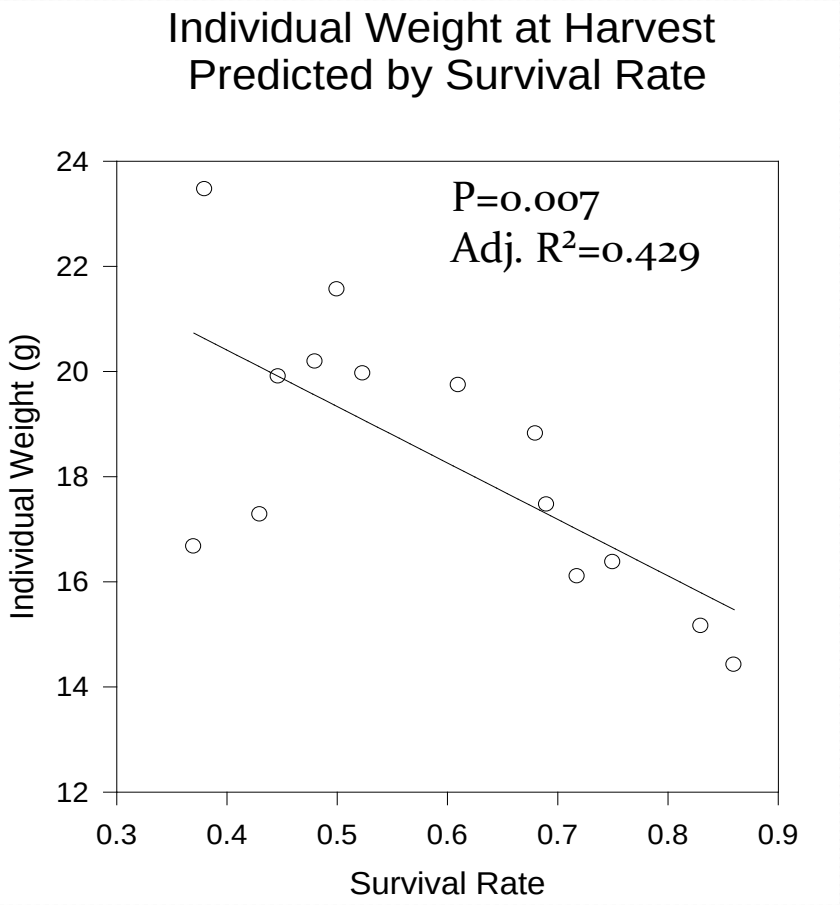
Means with the same superscript are not significantly different at $P<0.05$.

Mean Individual Shrimp Weight

Treatment	Mean Shrimp Weight (g)
0 hours	18.0 ± 1.8[a]
10 hours	17.2 ± 2.7[a]
50 hours	21.7 ± 2.5[a]
150 hours	16.5 ± 2.2[a]
168 hours w/ bag	19.6 ± 2.1[a]

Means with the same superscript are not significantly different at P<0.05.

Linear regression shows no significant relationship between level of solids and individual shrimp weight.

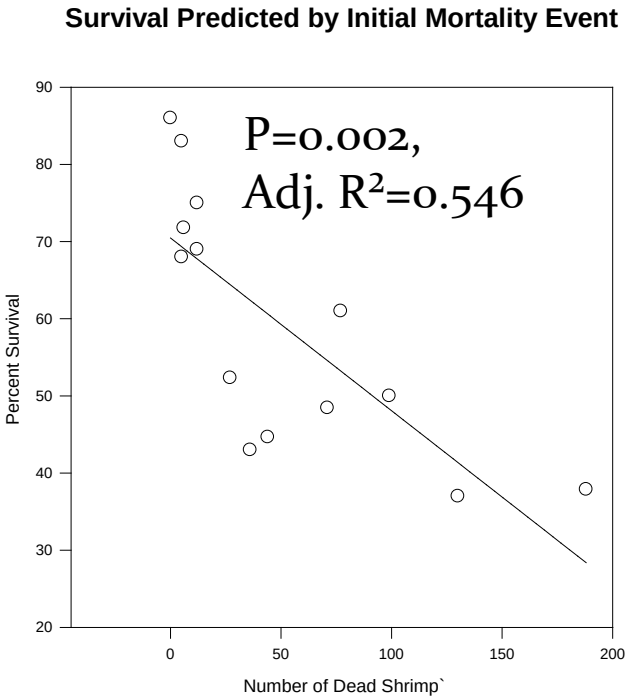


Survival

Treatment	Percent Survival
0 hours	44.0 ± 7.55^{b}
10 hours	$67.7 \pm 17.90^{a\ b}$
50 hours	$41.5 \pm 4.95^{\ b}$
150 hours	76.3 ± 9.07^{a}
168 hours w/ bag	60.0 ± 9.54^{ab}

Means with the same superscript are not significantly different at $P<0.05$.

Simple Linear Regression shows:
- no significant relationship between survival and NH_3-N or NO_2-N;
- no significant relationship between survival and solids measures ($@P<0.05$).

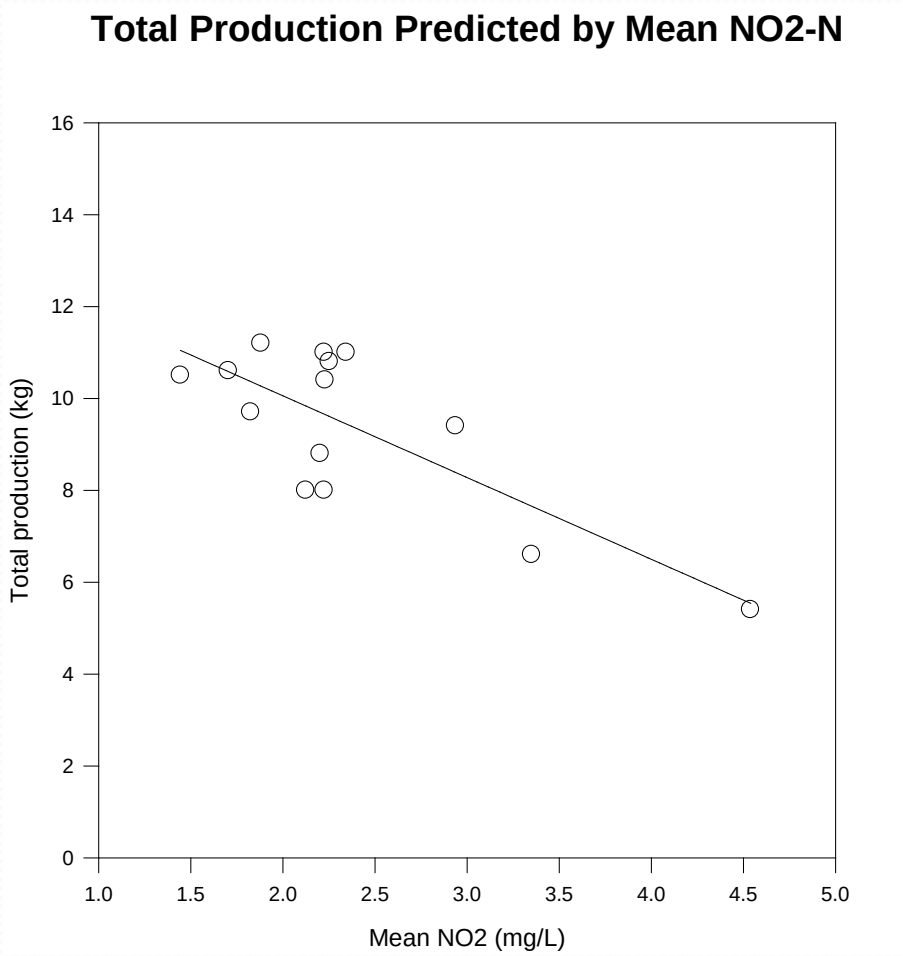


Mean Harvest Weight per Tank

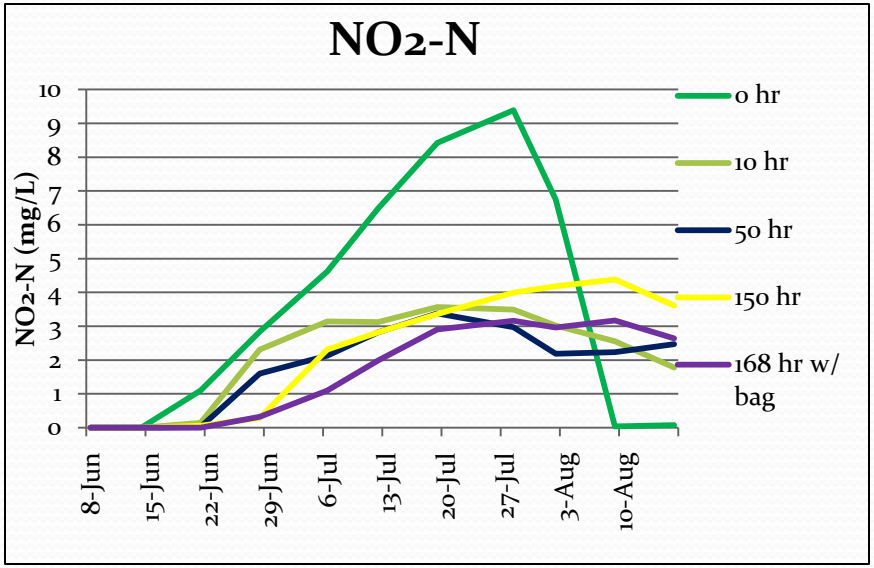
Treatment	Mean Harvest Weight (kg)	kg/m³
0 hours	7.23 ± 1.96 [b]	1.16
10 hours	10.17 ± 1.37 [ab]	1.64
50 hours	8.05 ± 0.07 [ab]	1.30
150 hours	11.23 ± 0.23 [a]	1.81
168 hours w/ bag	10.47 ± 0.67 [a]	1.69

Means with the same superscript are not significantly different at $P<0.05$.

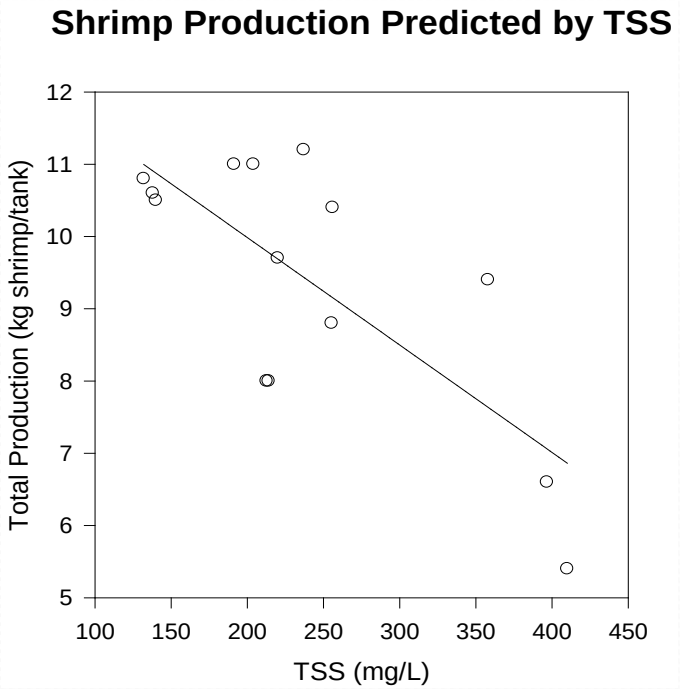
Effect of NO_2-N on Production



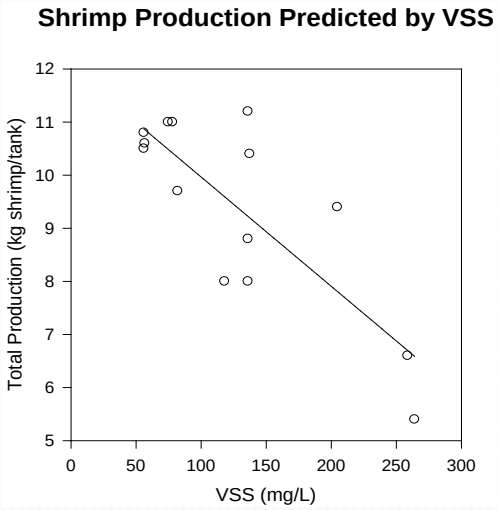
Simple Linear Regression:
Higher NO2-N leads to lower shrimp production.
P=0.001, Adj Rsqr = 0.566



Production Predicted by Solids Level



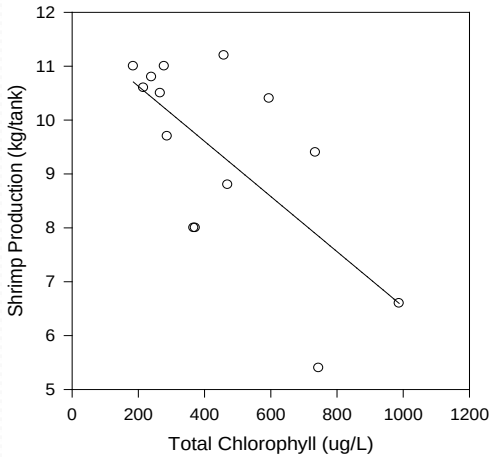
P<0.001
Adj. R^2=0.515



P<0.001
Adj. R^2=0.621

P=0.007
Adj. R^2=0.421

Shrimp Production Predicted by Total Chlorophyll

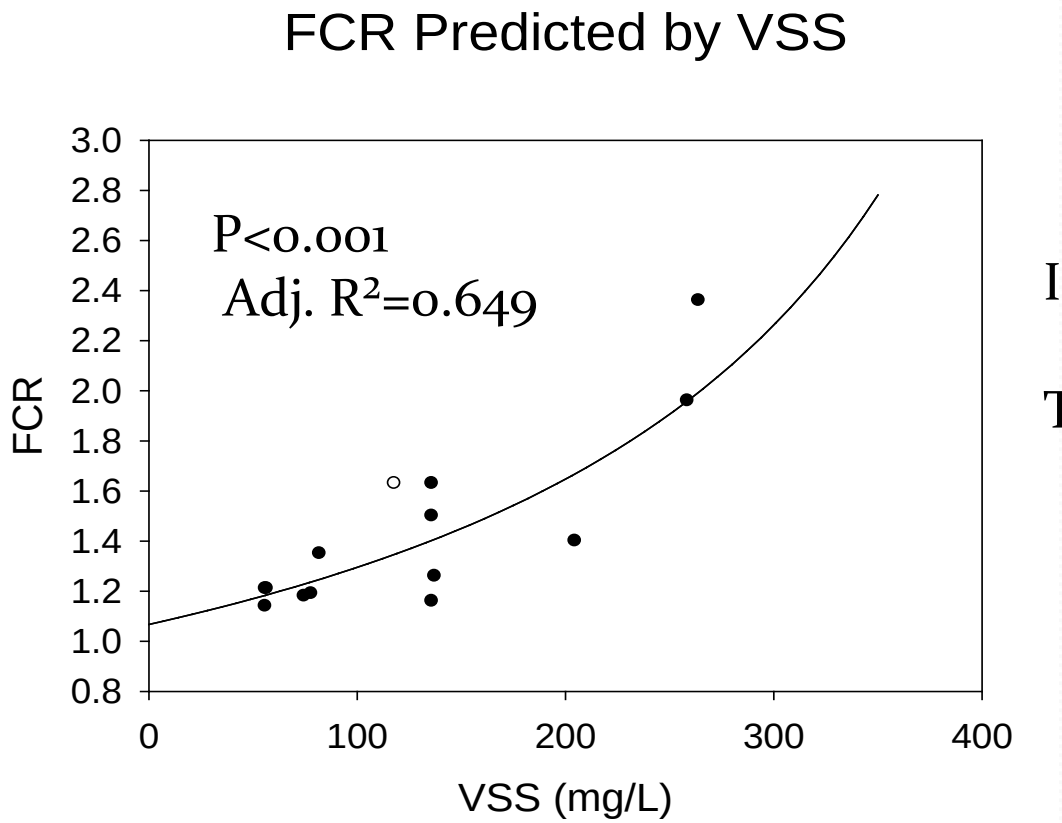


FCR

Treatment	FCR
0 hours	1.91 ± 0.48 [a]
10 hours	1.31 ± 0.17 [ab]
50 hours	1.63 ± 0.00 [ab]
150 hours	1.17 ± 0.03 [b]
168 hours w/ bag	1.26 ± 0.08 [ab]

Means with the same superscript are not significantly different at $P<0.05$.

FCR Predicted by Solids Level



Imhoff: P=0.011, Adj. R^2=0.383

TSS: P=0.001, Adj. R^2=0.558

Conclusions

- The initial mortality event reduced survival.
- Chlorophyll levels increased with increasing solids; much of the solids was algae. Production decreased with increasing total chlorophyll.
- Total production was negatively influenced by mean NO_2-N.
- Solids level did not affect growth rate or mean harvest weight. The effect on survival is unclear.
- Systems with lower solids levels had higher total production and lower FCR.