

Photosynthesis, water respiration and growth performance of *Litopenaeus vannamei* in a super-intensive raceway culture with zero water exchange: Interaction of water quality variables.

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Environmentally Responsible Technologies

Aerated zero exchange biofloc based ponds

- ↓ eutrophication
- ↓ sedimentation
- ↓ escapement
- ↑ nitrogen assimilation
- ↑ water quality stability
- ↑ growth factors
- ↓ production costs
- ↓ pathogen introduction

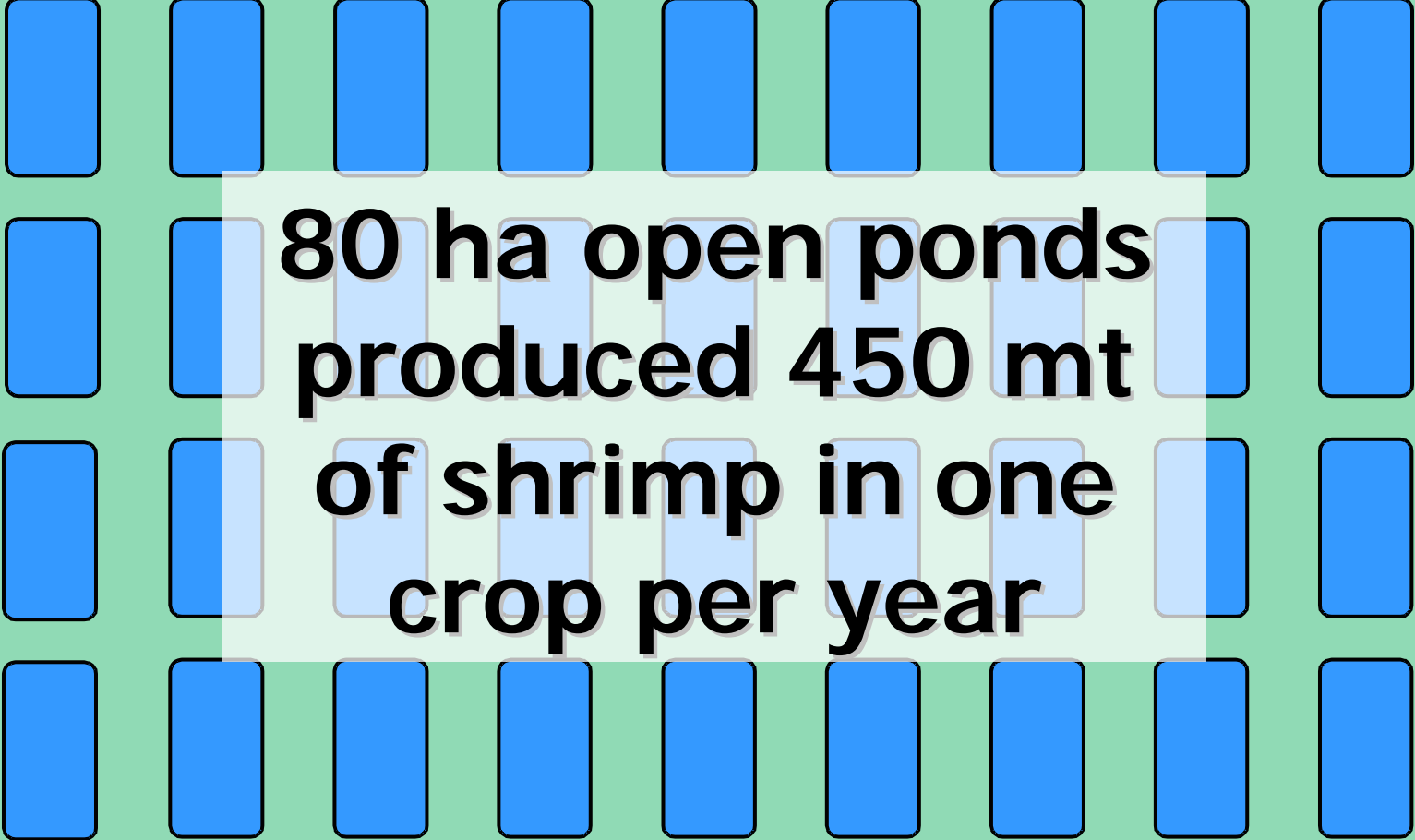


Super-Intensive Biofloc Based Enclosed Shrimp Production Systems

- High output per unit area, nursery phase and multiple crops per year provides for low cost of production per pound
- Use of pathogen free stocks selected for fast growth, biosecurity
- Specially designed feeds
- Advanced engineered systems for environmental and water quality control, water reuse, high aeration
- Specialty 'fresh heads on' marketing opportunities

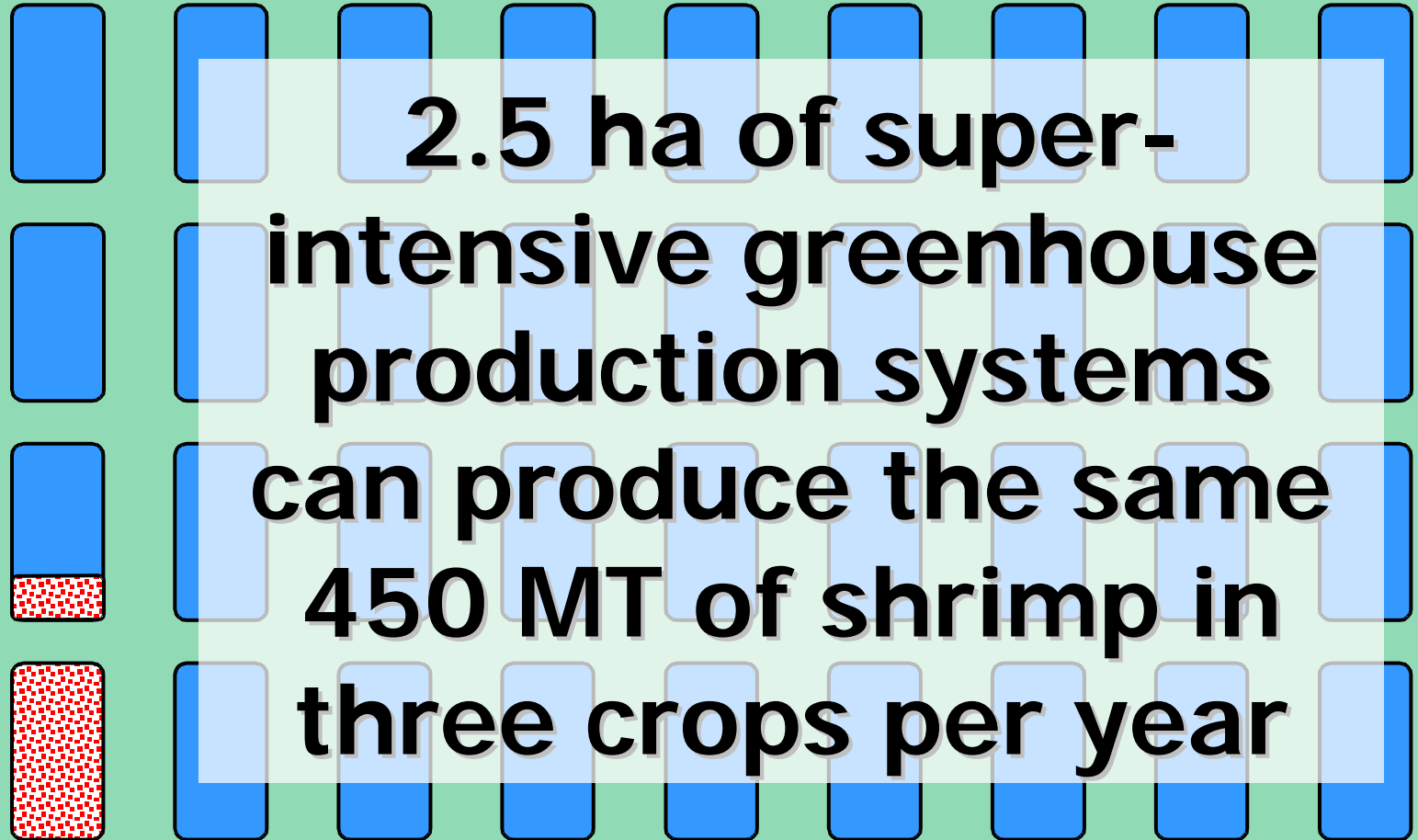


Ponds vs. Super-Intensive Systems



**80 ha open ponds
produced 450 mt
of shrimp in one
crop per year**

Ponds vs. Super-Intensive Systems

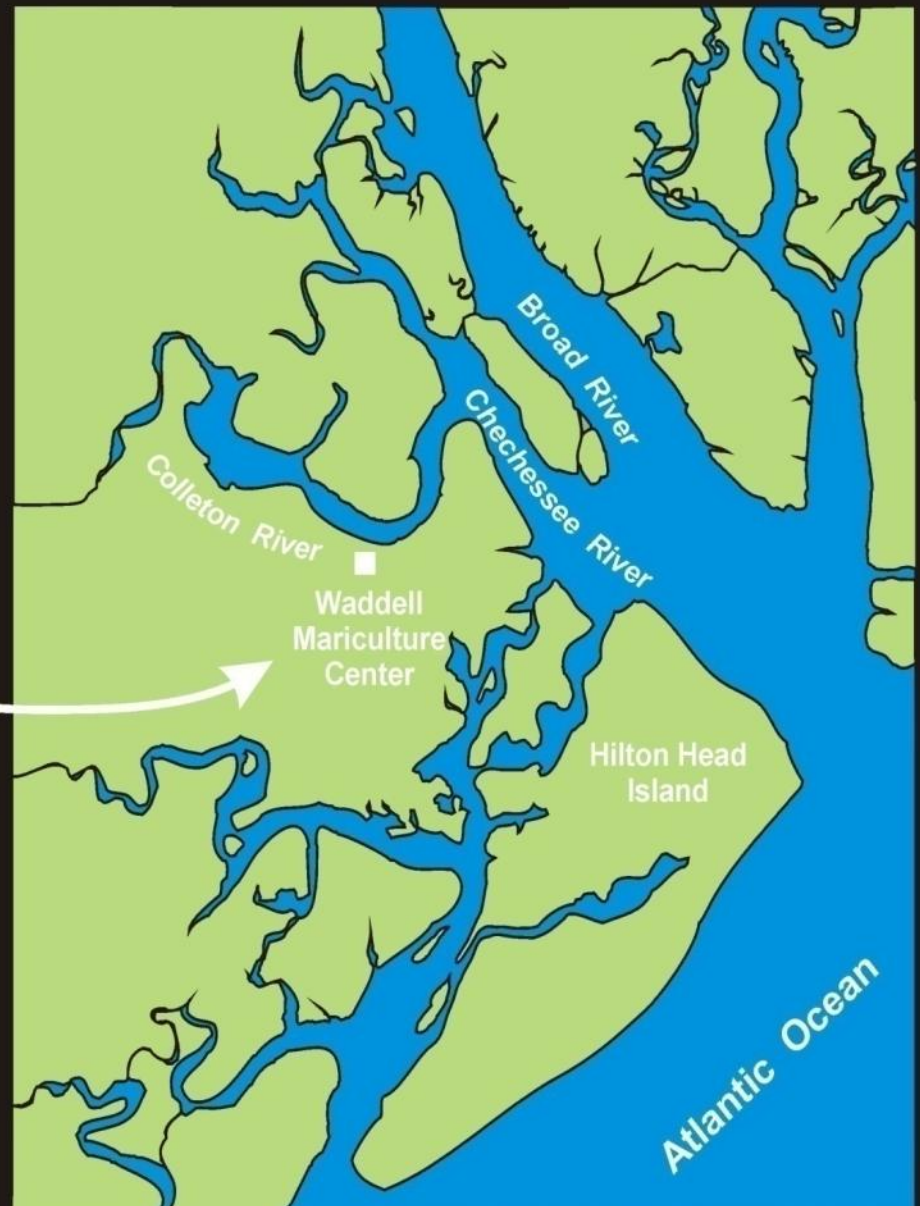


Superintensive Culture Systems

- Completely Reliant on a Dense Microbial Community
- Photosynthesis and Respiration = Monitoring System Function
 - Which is Dominant?
 - Related to Improved System Function?
- This Project
 - Relationships Between Respiration, Photosynthesis, Shrimp Performance, and Water Quality
 - What combination of water quality parameters are most important for shrimp production?

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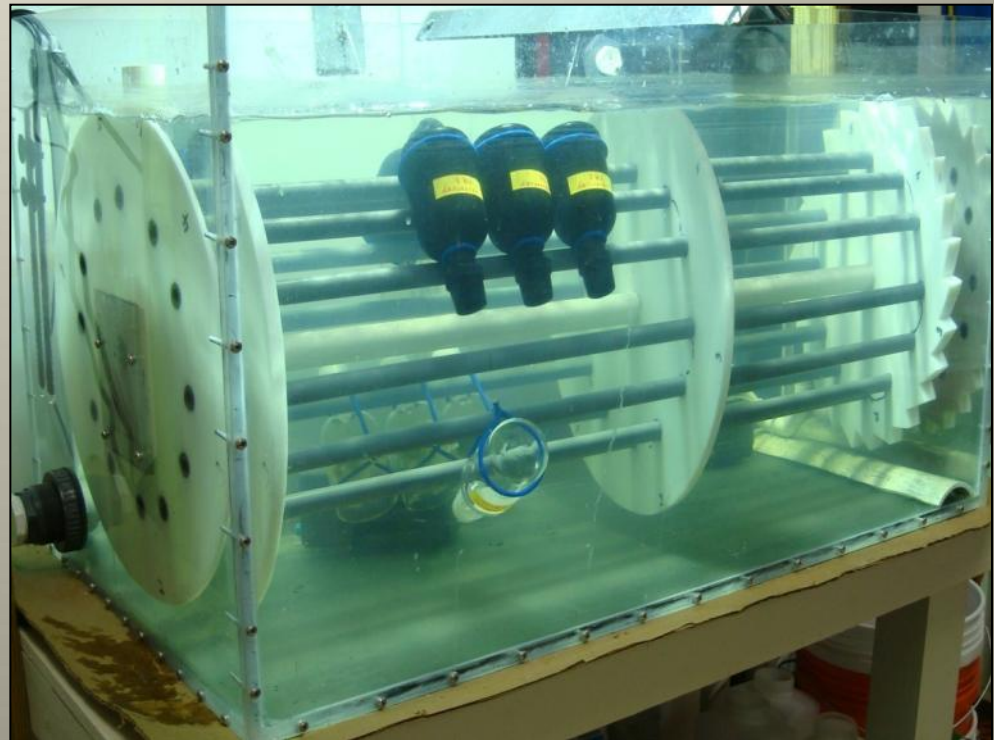


Experimental System

- 271 m² Raceway Within Plastic Greenhouse
- Stocked at 865 PL m⁻³
- Blown Air, Oxygen Generator
 - Maintained Dissolved Oxygen Above 3 mg/L
- Water Quality
 - DO, temperature, salinity, pH
 - Daily
 - Alkalinity, turbidity, TAN, nitrite-N, nitrate-N, PO₄⁻³, TSS, VSS
 - Weekly

Photosynthesis and Water Column Respiration

- Gross and net photosynthesis and respiration
 - Classic dark and light bottles method(Strickland, 1960)
- Incubated for 2 hours
 - Two incubators
 - Laboratory conditions
 - Raceway conditions
 - Comparison of collected data (t-test)



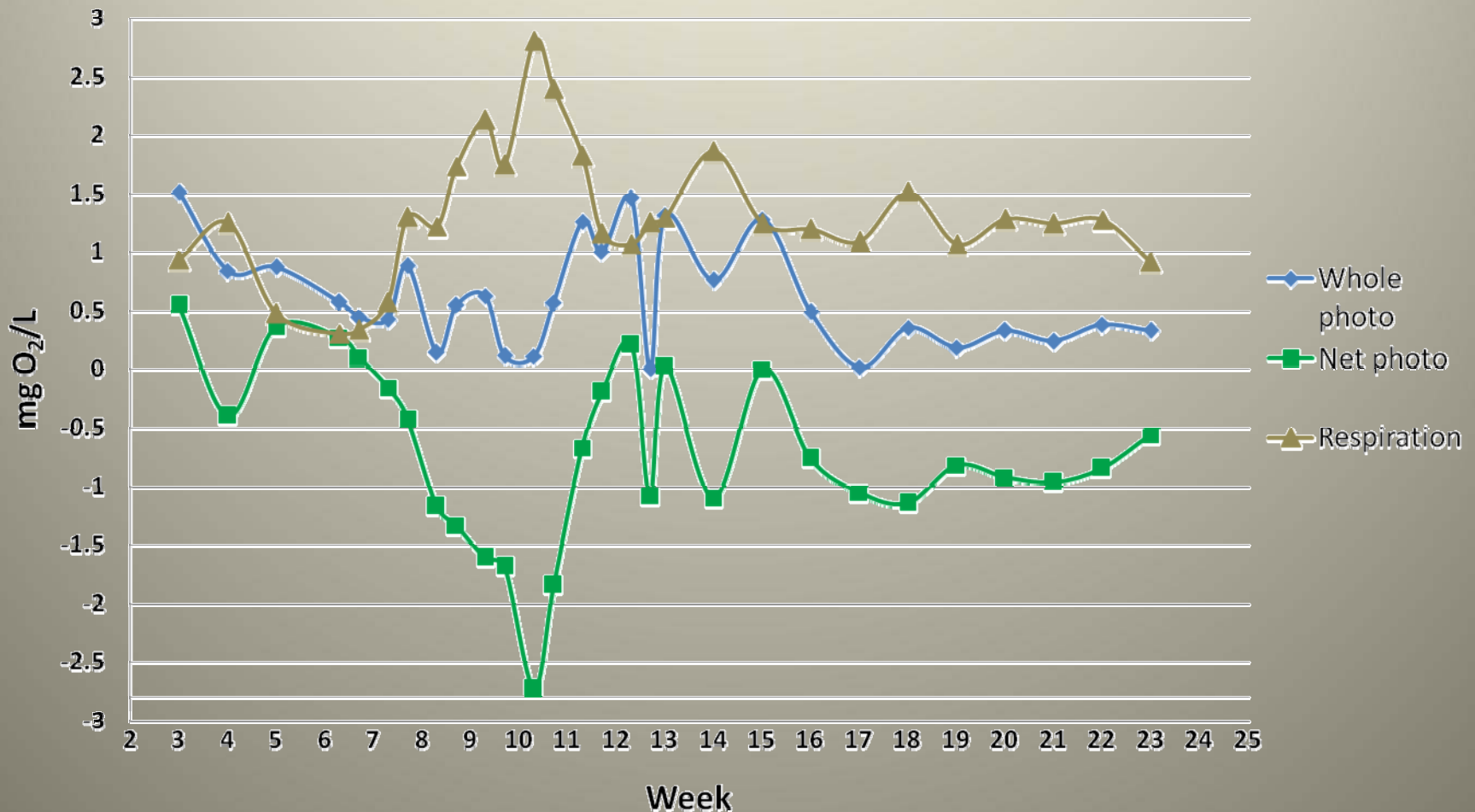
Incubators

- 250 L Polycarbonate Aquariums
- Rotating Wheel to Which BOD Bottles are Strapped
- Laboratory Incubator
 - Metal Halide Light ($150 \mu\text{mol photons/m}^2\text{-s}$)
 - Constant Temperature (28°C)
- Raceway Incubator
 - Located Within Raceway Greenhouse
 - Same Light Exposure
 - Same Temperature

Measured Parameters

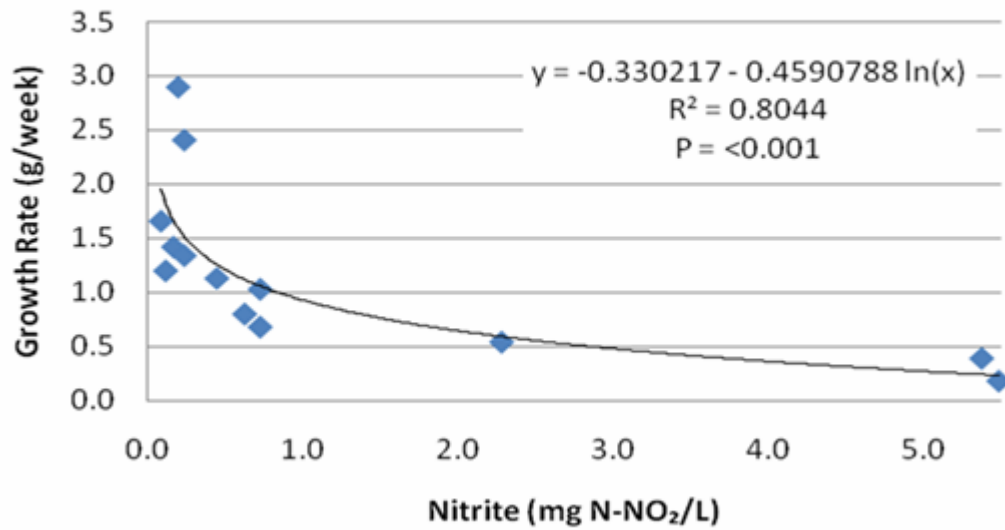
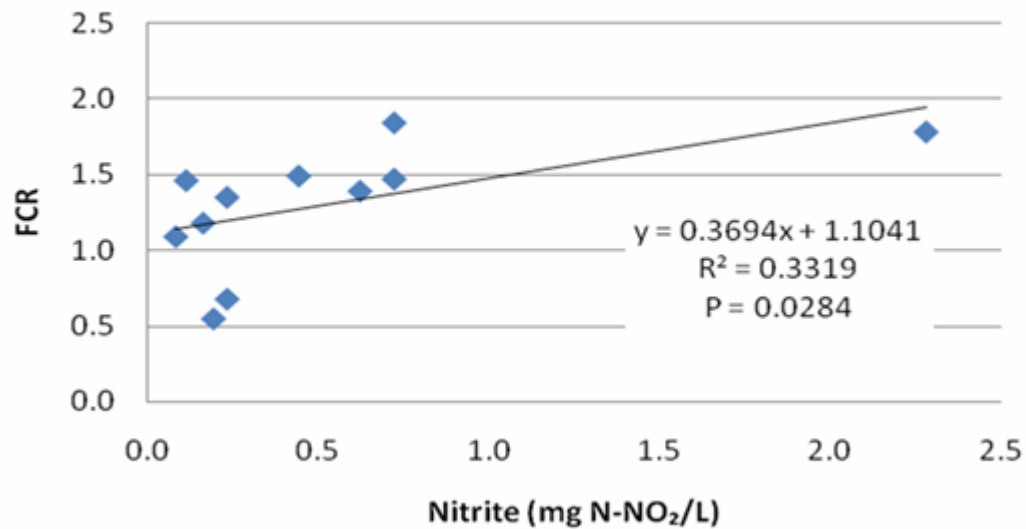
Parameter (units)	Method
Dissolved oxygen (mg O ₂ /L) ¹	Multiparameter YSI 556 MPS
Temperature (°C) ¹	Multiparameter YSI 556 MPS
Salinity (‰) ¹	Multiparameter YSI 556 MPS
Light (μmol photons/m ² .s) ¹	Light meter LI COR (LI-1400) ^a
pH ²	Multiparameter YSI 556 MPS
Alkalinity (mg CaCO ₃ /L) ³	Titration method (HCl 0.1 N)
Turbidity (NTU) ³	La Motte Turbidity Meter 2020
Total ammonium nitrogen - TAN (mg/L) ^{3b}	HACH method 8155 (salicylate)
Nitrite nitrogen (mg N-NO ₂ /L) ³	HACH method 8507 (diazotization)
Nitrate nitrogen (mg N-NO ₃ /L) ³	HACH method 8039 (cadmium reduction)
Dissolved orthophosphate (mg PO ₄ /L) ³	HACH method 8114 (ascorbic acid)
Total suspended solids - TSS (mg/L) ³	EPA method 340.2
Volatile suspended solids - VSS (mg/L) ³	EPA method 340.2

- No significant difference between raceway and laboratory incubation data ($p < 0.05$)
- Positive net photosynthesis during 4 of 17 weeks

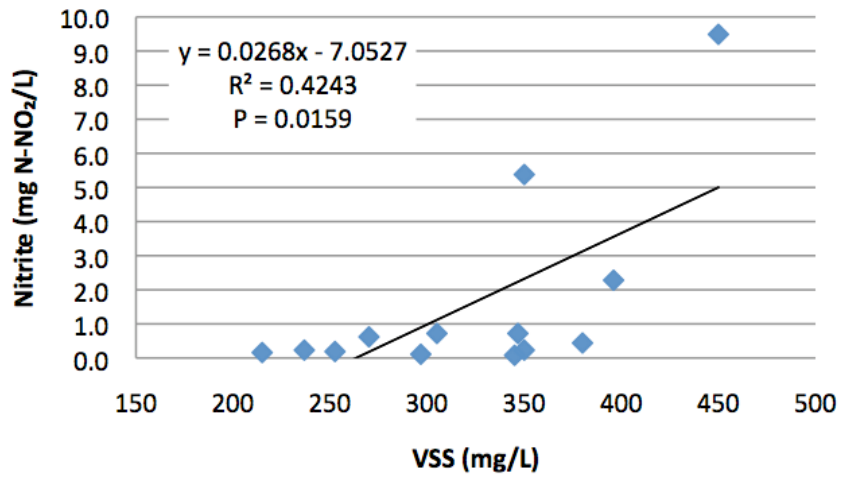


Correlation coefficients (Spearman ρ) and p values (between parenthesis) found among gross photosynthesis, water column respiration, shrimp growth rate and feed conversion rate with some water quality parameters of a super-intensive zero-water exchange *L. vannamei* culture.

	Temperature	pH	Nitrite-N	VSS	Turbidity
Gross photosynthesis	-	-	-	-0.792 (0.0010)	-
Water column respiration	-	-	-	-	0.626 (0.0480)
Shrimp growth rate	0.771 (<0.0001)	-0.632 (0.0193)	-0.873 (<0.0001)	-0.746 (0.0039)	-
Feed conversion rate	-	-	0.703 (0.0145)	0.770 (0.0068)	-
Nitrite	-	-	-	0.719 (0.0071)	-
Nitrate	-	-	-	0.623 (0.0285)	-

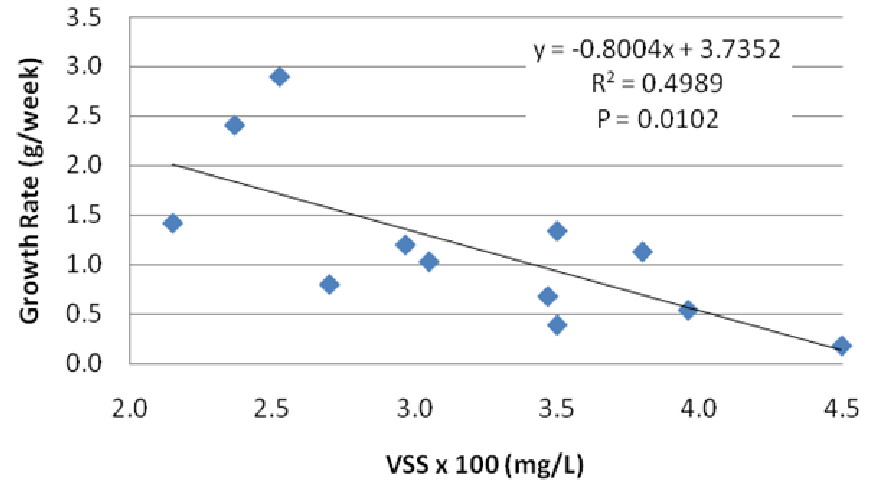
A**Nitrite vs Growth Rate****B****Nitrite vs FCR**

VSS vs Nitrite



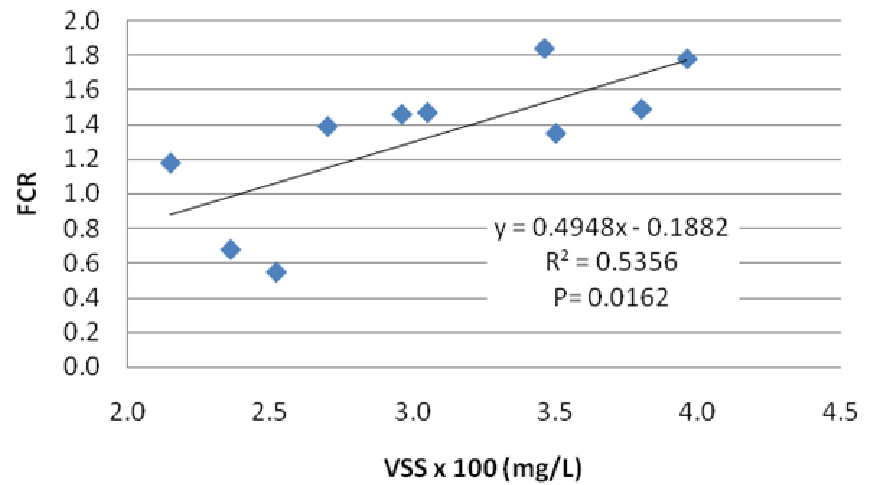
A

VSS vs Growth Rate



B

VSS vs FCR



Summary

- Laboratory BOD Bottle Incubation is Equivalent to Field Incubation
- \uparrow Turbidity = \uparrow Respiration
 - Particles as substrate for bacteria?
- \uparrow Volatile Suspended Solids
 - \downarrow Photosynthesis
 - Light penetration?
 - \uparrow Nitrite-N
 - \uparrow Nitrate-N
 - \downarrow Shrimp Growth Rate
 - \uparrow Feed Conversion Ratio

Conclusions

- Photosynthesis was influenced inversely by volatile suspended solids (VSS) concentration, while water respiration was found to be directly proportional to turbidity.
- Final shrimp productivity was influenced directly by temperature and inversely by pH, nitrite and volatile suspended solids.
 - Nitrite may have reduced growth at between 0.72 and 9.49 mg N-NO₂-N/L
- Photosynthesis and water column respiration, in spite of having shown significant correlations with some water quality parameters, did not have a significant impact on the shrimp productivity



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Thank you