THE EFFECTS OF DENSITY AND ARTIFICIAL SUBSTRATE ON INTENSIVE SHRIMP (*Litopenaeus vannamei*) NURSERY PRODUCTION

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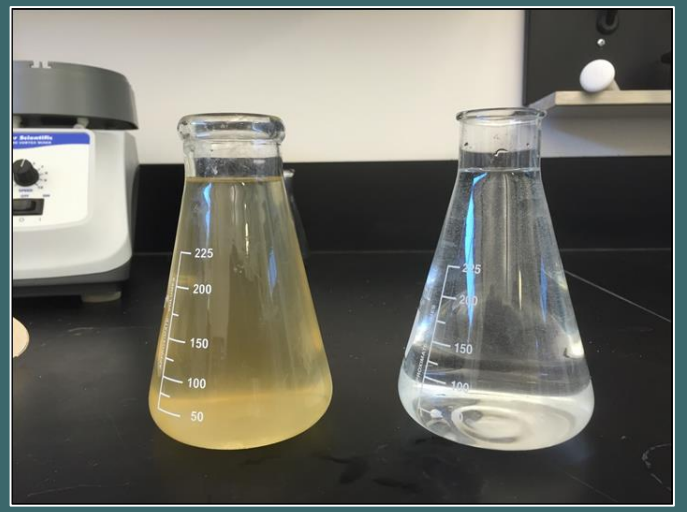
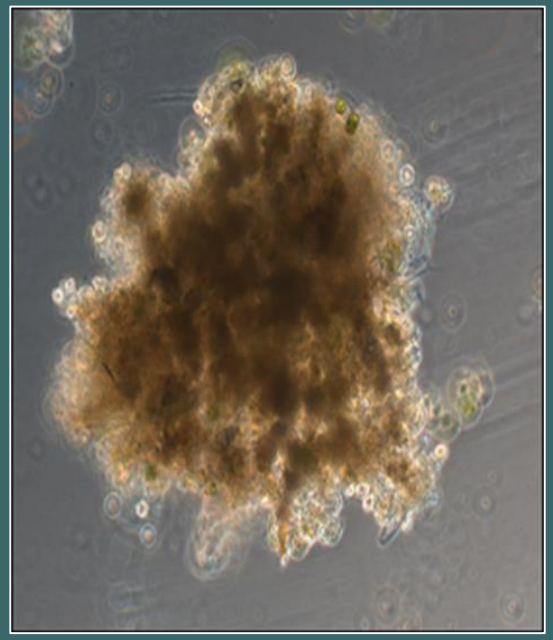
RECIRCULATING AQUACULTURE SYSTEMS (RAS)

- Closed Systems
- Minimal water exchange
  - < 1%
- Heat & salt conservation
  - *L.vannamei* production
    - #1 seafood product in U.S.
- Enhanced biosecurity
- High animal density

Biofloc + Clear-water = Hybrid (HY)

- Integrates benefits from both systems
- Limited solids filtration
  - Settling chamber or foam fractionator
- Includes external biofilter
  - Nitrification (ammonia → nitrate)
- Nutritional supplementation
  - Lower FCR?
- High stocking density
- Water quality more manageable
- Cost may be more practical





Production Dynamics

Density

- Shrimp growth (consistency?)
- Survival
- Growout yields
- Nutrient cycling
- Solids accumulation

Artificial substrate

- Increases surface area
- Additional food or trace nutrients
- Nutrient cycling and water quality
- Reduced competition for space/ reduced cannibalism

Nursery Production

- Inland production increasing
  - Sea level rise, real estate costs, etc…
- Extends culture season/ better yield
- Assess PL inventory
- Maximize space utilization
- Post-larvae (PL) → juvenile
- Biosecurity

Experimental Design

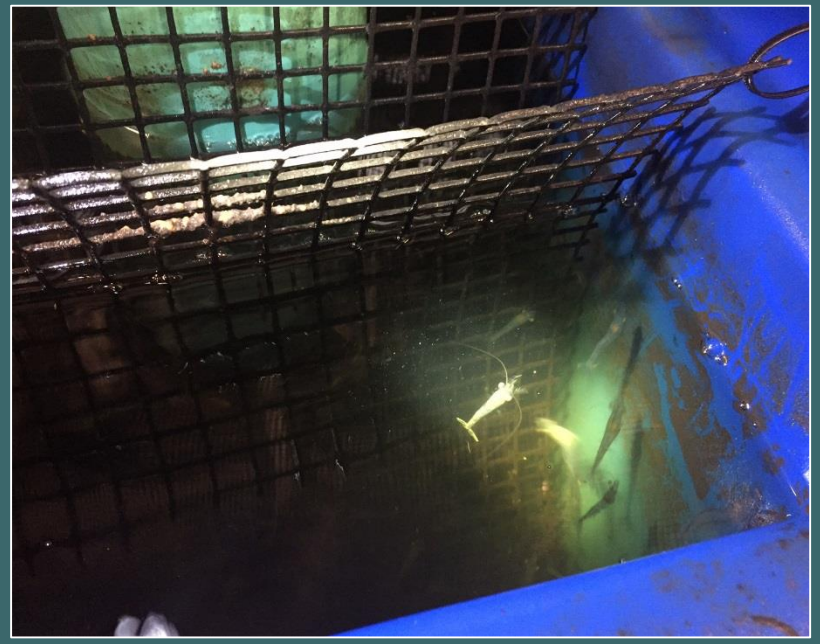
4 Treatments

- 1.) LD: 1500 shrimp/m^3 (~240 shrimp)
- 2.) LD-S: 1500 shrimp/m^3, 7920 cm^2 HDPE substrate/tank
- 3.) HD: 3000 shrimp/m^3 (~480 shrimp)
- 4.) HD-S: 3000 shrimp/m^3, 7920 cm^2 HDPE substrate/tank
- Twelve 160-L tanks
  - 3 tanks per treatment
- HY systems with an external settling chamber & biofilter (MBBR)
  - Settling chamber activated > 30 NTU

- Shrimp Production
  - One-way ANOVA
- Water Quality
  - Repeated Measures ANOVA
  - Two-way ANOVA week 2 NO_2-N
- $\alpha = 0.05$

Management

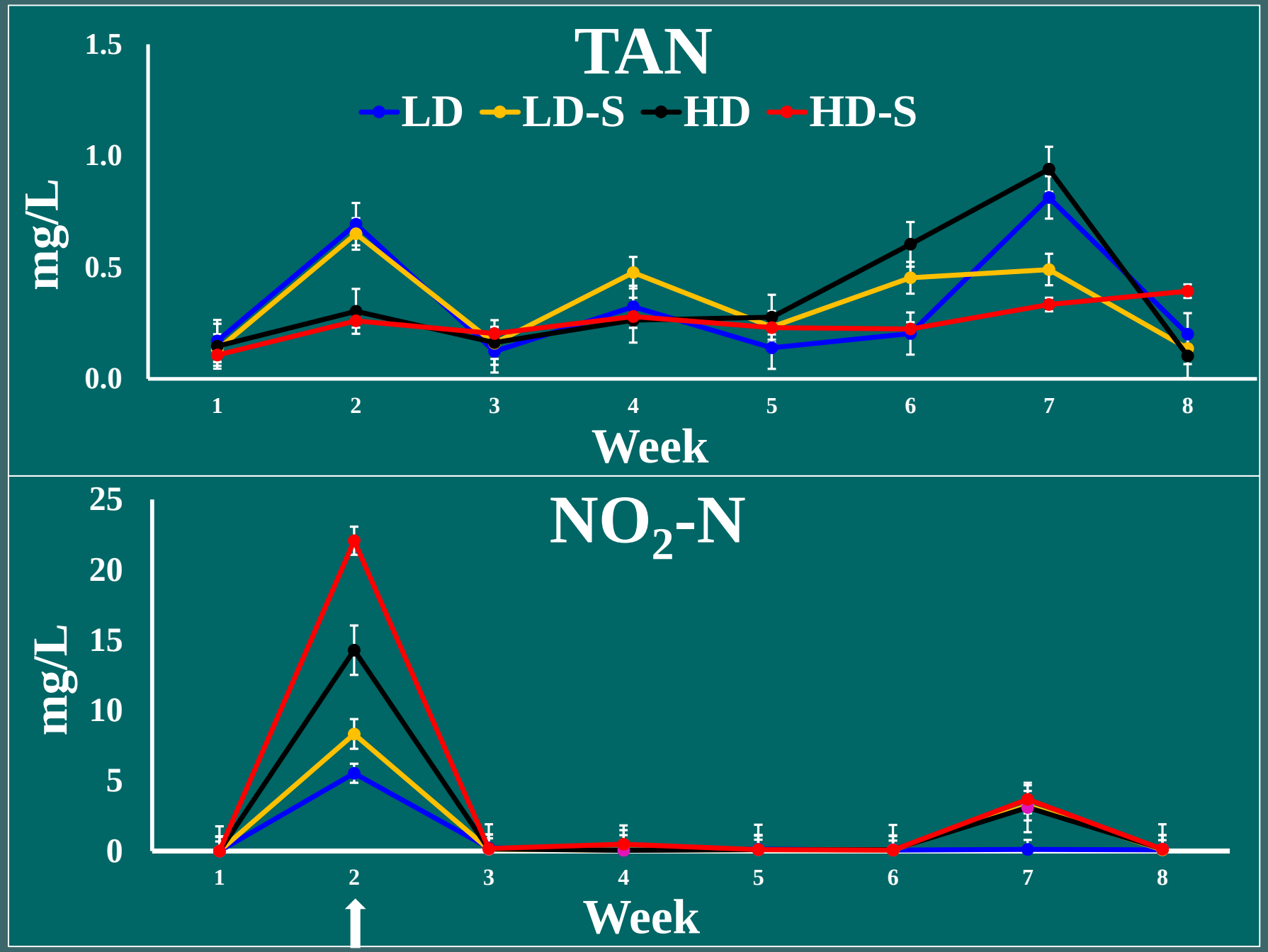
- Duration: 50 days
- Initial weight = 4 mg
- Feed amounts dictated by animal density
- ~12% biomass → 3% biomass
- 2x Daily: Temperature, DO, pH, and Salinity
- 1x a week: Total ammonia nitrogen (TAN), Nitrite (NO_2-N)
- 2x a week: Turbidity (NTU)
- Nitrate (NO_3-N) measured for 6 weeks



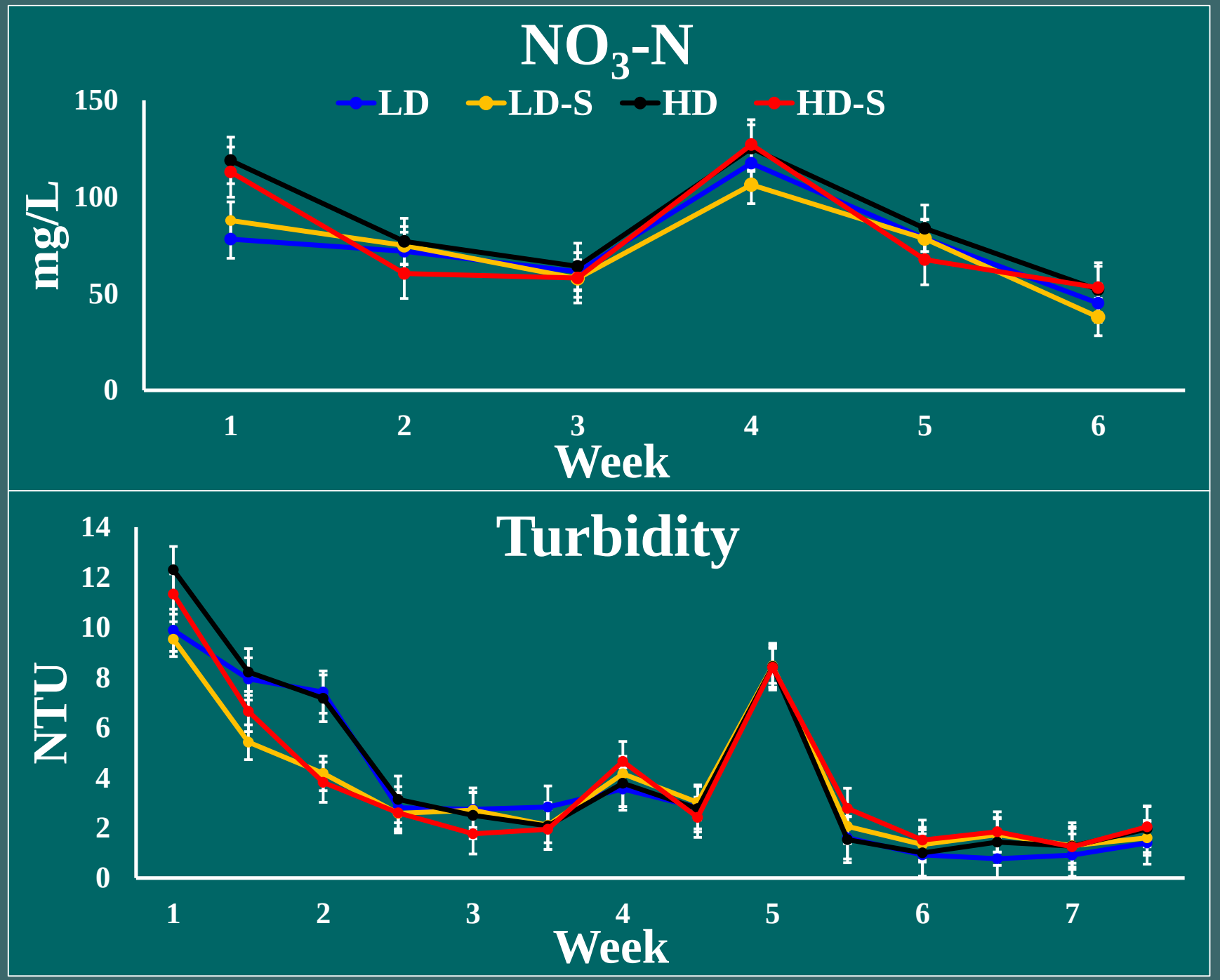
	Treatment			
	LD	LD-S	HD	HD-S
Temperature °C				
AM	28.1	27.9	28.1	28.3
PM	28.2	28.2	28.3	28.4
DO (mg L^{-1})				
AM	6.44^{a}	6.48^{a}	6.40^{a}	6.37^{b}
PM	6.38^{a}	6.42^{a}	6.33^{b}	6.31^{b}
pH				
AM	8.42^{a}	8.44^{b}	8.39^{c}	8.36^{d}
PM	8.42^{a}	8.44^{b}	8.38^{c}	8.35^{d}
Salinity (g L^{-1})				
AM	31.30	30.81	31.13	31.26
PM	31.09	30.60	30.94	31.09

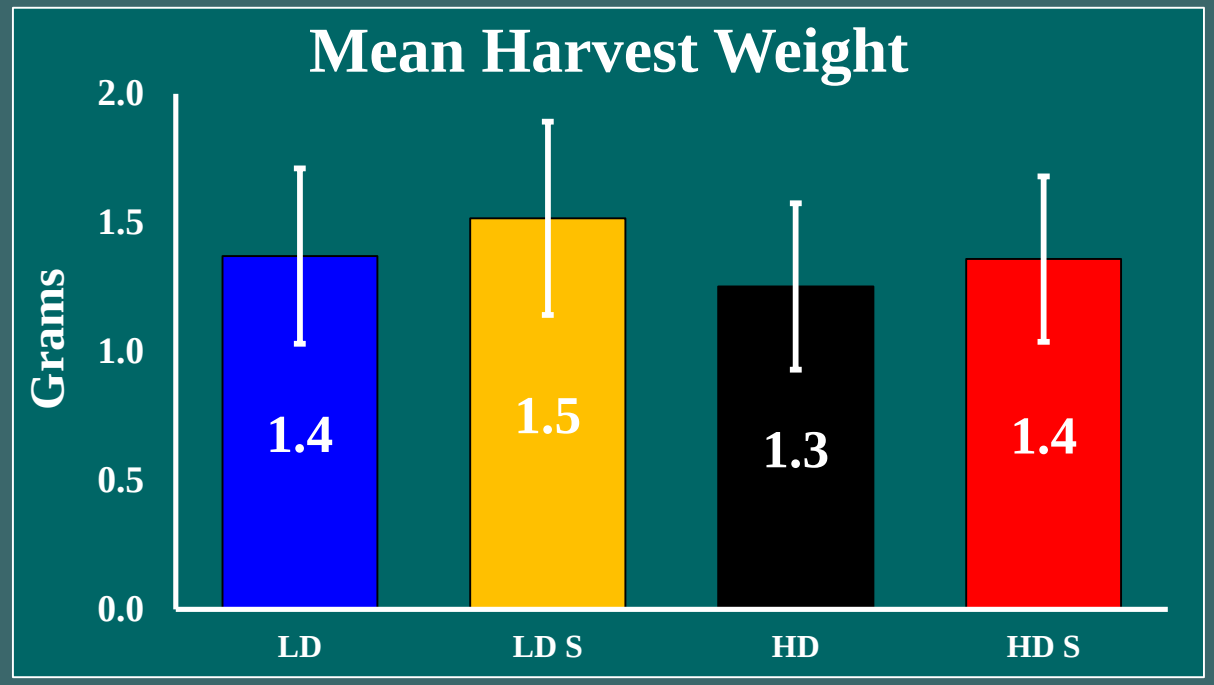
- No significant differences found with TAN

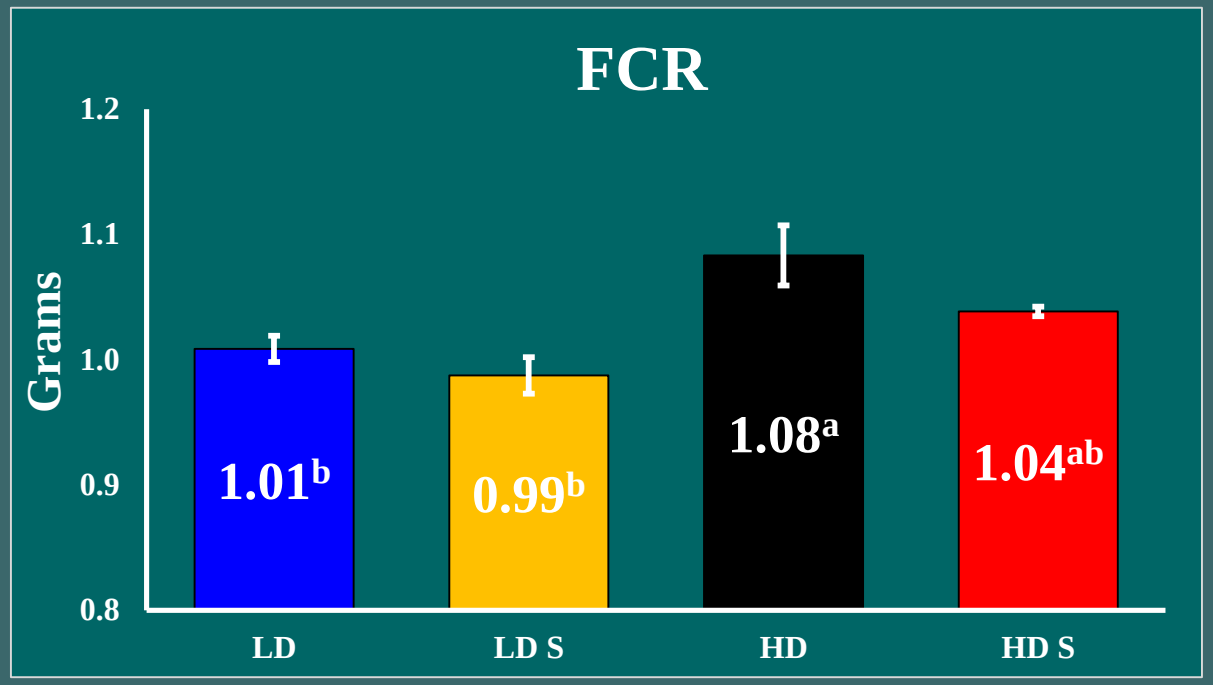
- No significant differences found with NO_2-N

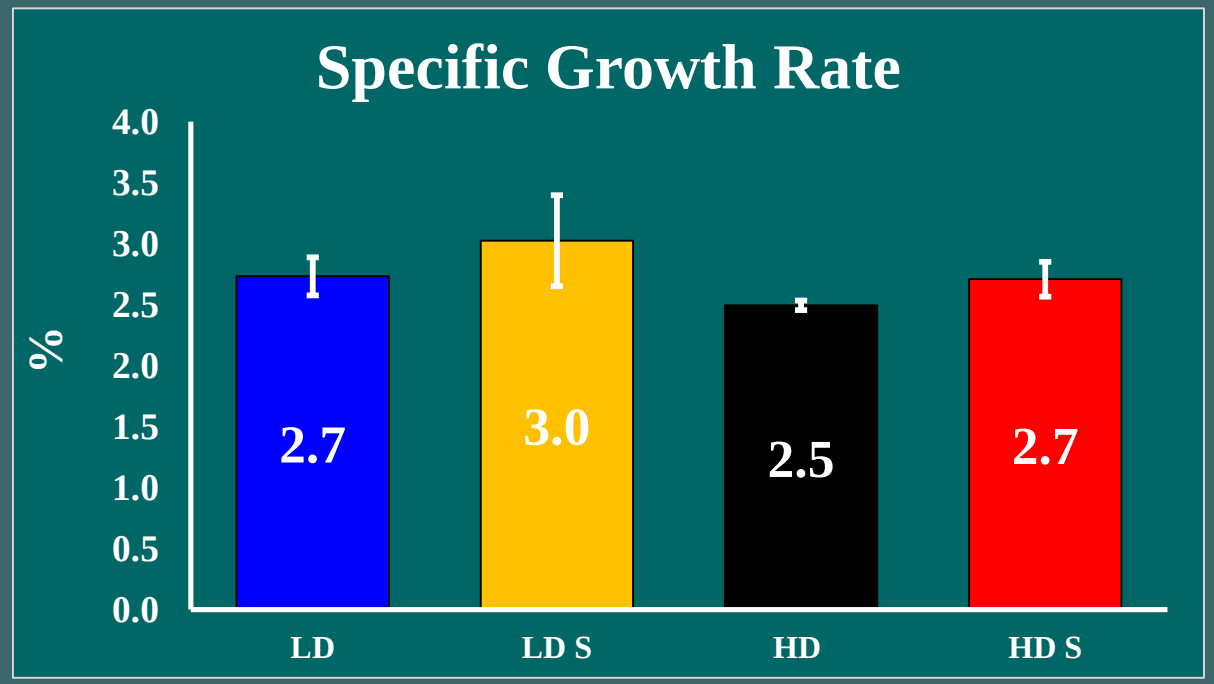


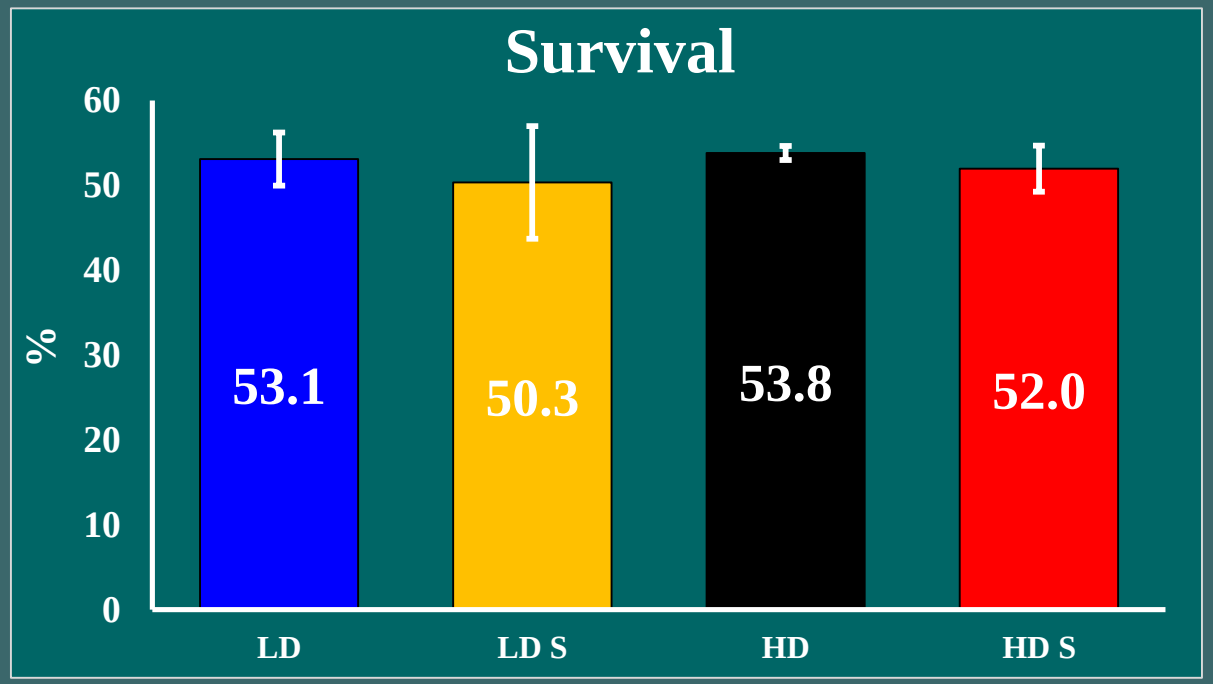
- No significant differences found with NO_3-N
- No differences found with turbidity
- Settling chambers were not activated




Mean Harvest Weight
Grams
2.0
1.5
1.0
0.5
0.0
1.4
1.5
1.3
1.4
LD
LD S
HD
HD S


FCR
Grams
1.2
1.1
1.0
0.9
0.8
1.01b
0.99b
1.08a
1.04ab
LD
LD S
HD
HD S


Specific Growth Rate
%
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2.7
3.0
2.5
2.7
LD
LD S
HD
HD S


Survival
%
60
50
40
30
20
10
0
53.1
50.3
53.8
52.0
LD
LD S
HD
HD S

Conclusions

- HD significantly higher FCR than LD and LD S
  - No differences found with mean harvest weight (g), SGR, or survival
- Significantly higher NO_2-N in week 2
  - However, no significant interaction
- Significantly lower DO and pH corresponding to higher density

Future Investigations

- Comparison of different types of substrate
- Increase culture density
- Increase the amount of substrate
- Stable isotope analysis ($^{13}C/^{12}C$ & $^{15}N/^{14}N$) of the periphyton

Thank You!

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- Aquaculture Production Sciences Lab

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