# Effects of LED lighting on Pacific white shrimp performance and water quality in intensive RAS

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# Recirculating Systems

-Lower water use/waste discharge

-Improved biosecurity/escape risk

-Temperature control

-Indoor, year-round production

    -Land locked areas

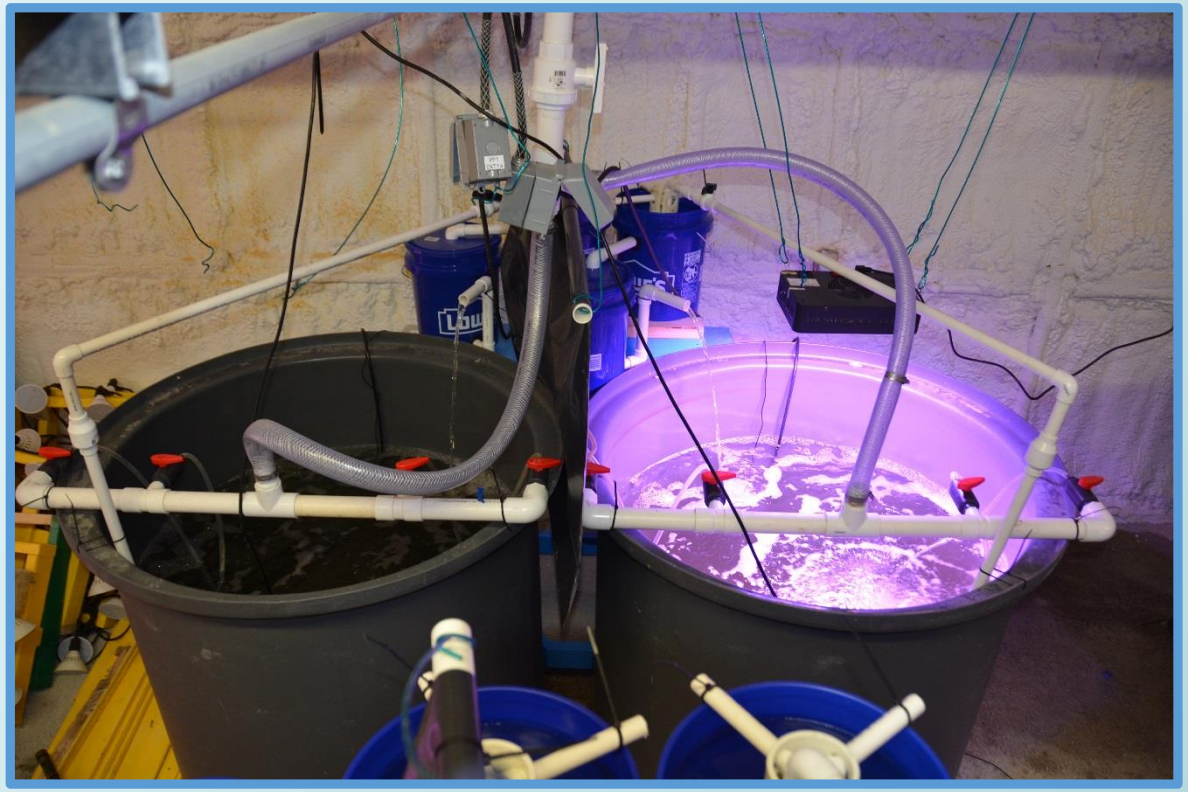
-Higher animal density

-Products near consumer markets

-Product consistency

# System Design

-"Hybrid" system design
-Limit/control solids removal
-Allow biofloc to form in water
-Use external biofilter to stabilize nitrification
-Chemoautotrophic based bacterial community



# System Design

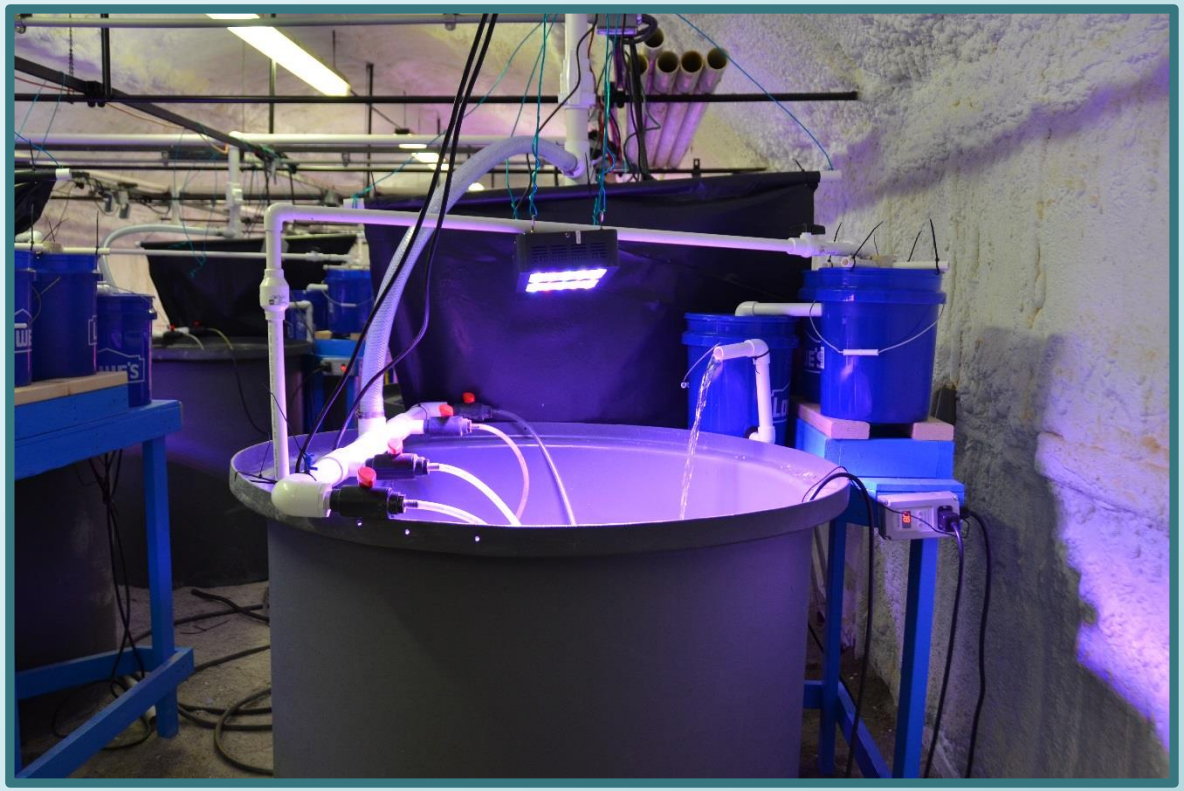
-1 $m^3$ tanks

-Settling chamber (19L)

-Moving Bed Bio-Reactor (MBBR, 19L, 2.7$m^2$ of surface area)

-Heavy Aeration (4 15cm airstones/system)

-Settling Chambers drained weekly



# Experiment

- 1875 $ft^2$, Heated/Insulated building
-3 Treatments
  - Full Light (FL), Partial Light (PL), No Light (NL)
  - 4 Replicate, $1m^3$ Tanks
  - 250 shrimp per tank
  - 1.27g average starting weight
  - 15.8 average Salinity

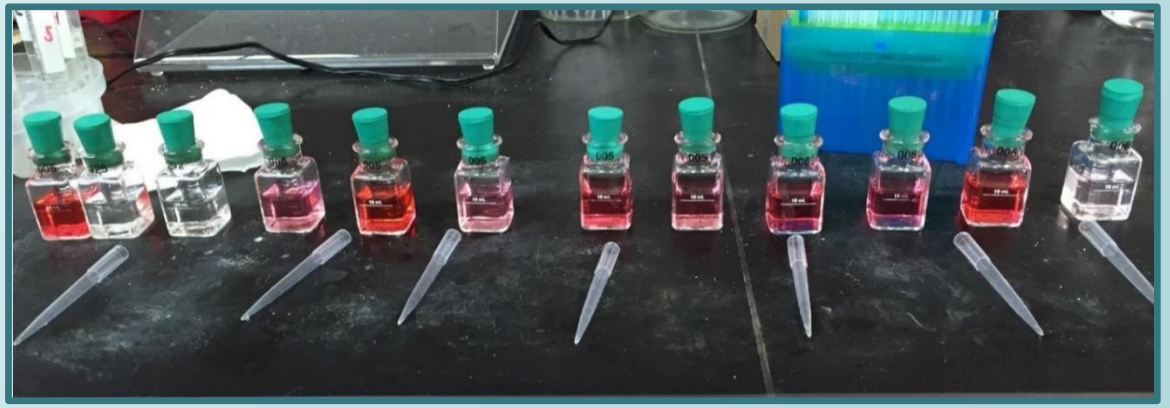
- Light- 300W LED Growlights
  - PAR = 100µmol $m^{-2}/s^{-2}$
  - 420-480nm, 640-760nm

- FL tanks- 24 hrs light/day
- PL tanks- 12 hrs light/day
- NL tanks- No extra light

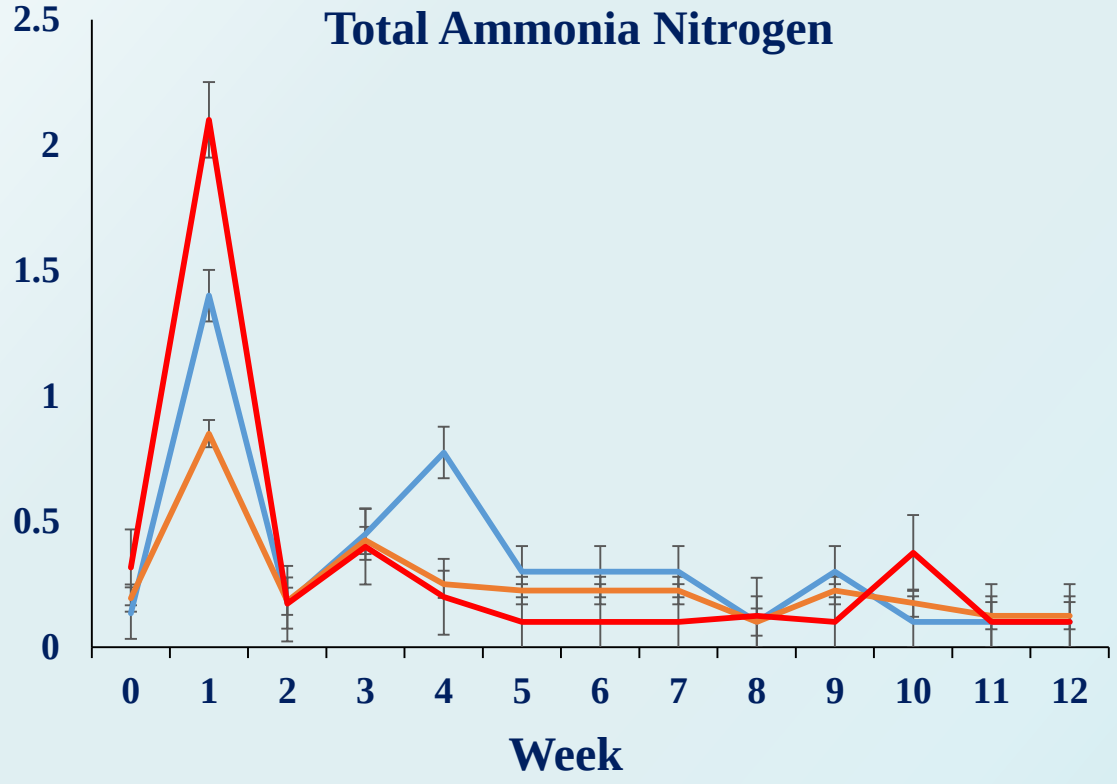
*overhead florescent lights on during working hours, no effect on PAR

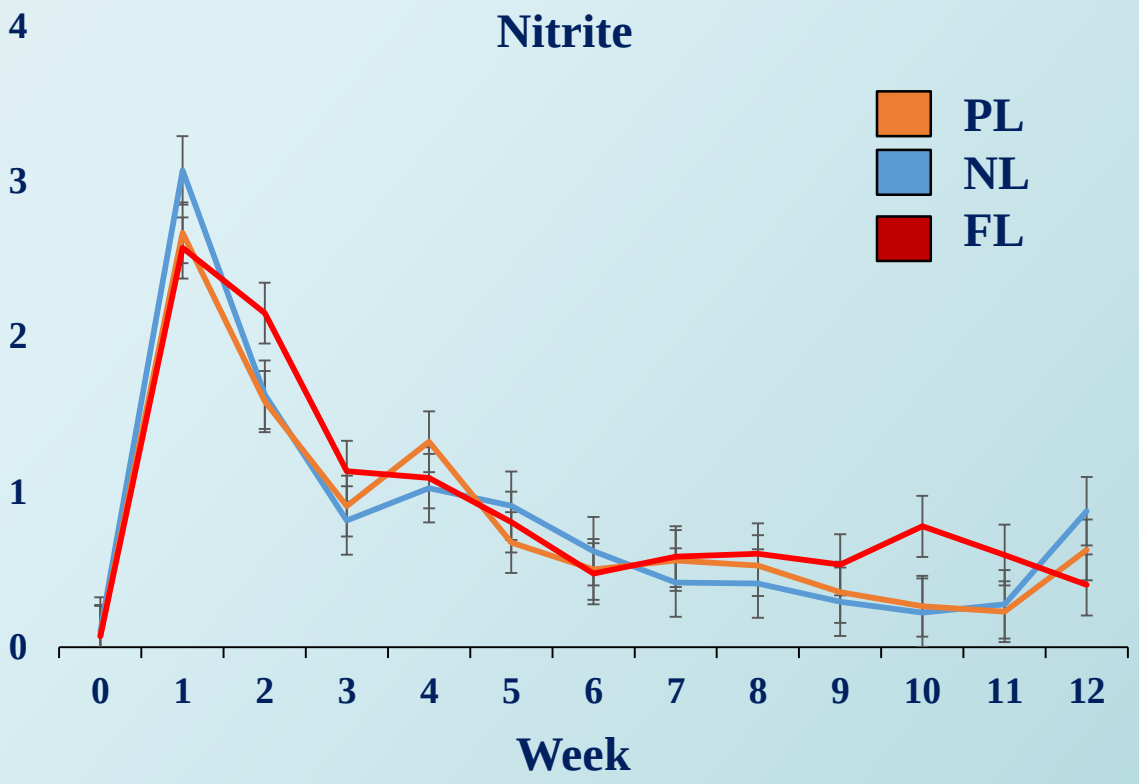
# Experiment

-Shrimp fed on 24hr belt feeders
-Tank parameters measured twice daily
    -Temperature, pH, dissolved oxygen, salinity
-Water quality measured once every week
-Total Ammonia Nitrogen, Nitrite, Nitrate, Turbidity
-Repeated measures ANOVA for water quality data
-Friedman Test for non-normal distribution
-One-Way ANOVA for production data
    -Results considered significant when $p<0.05$



# Water Quality



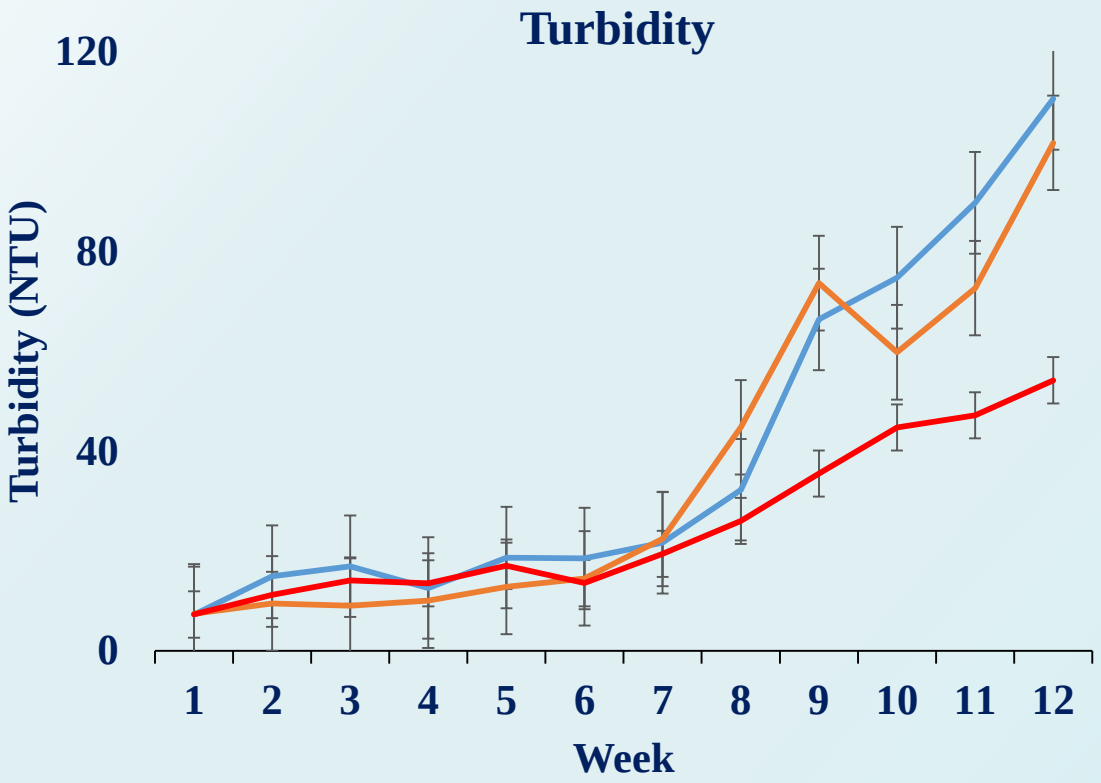



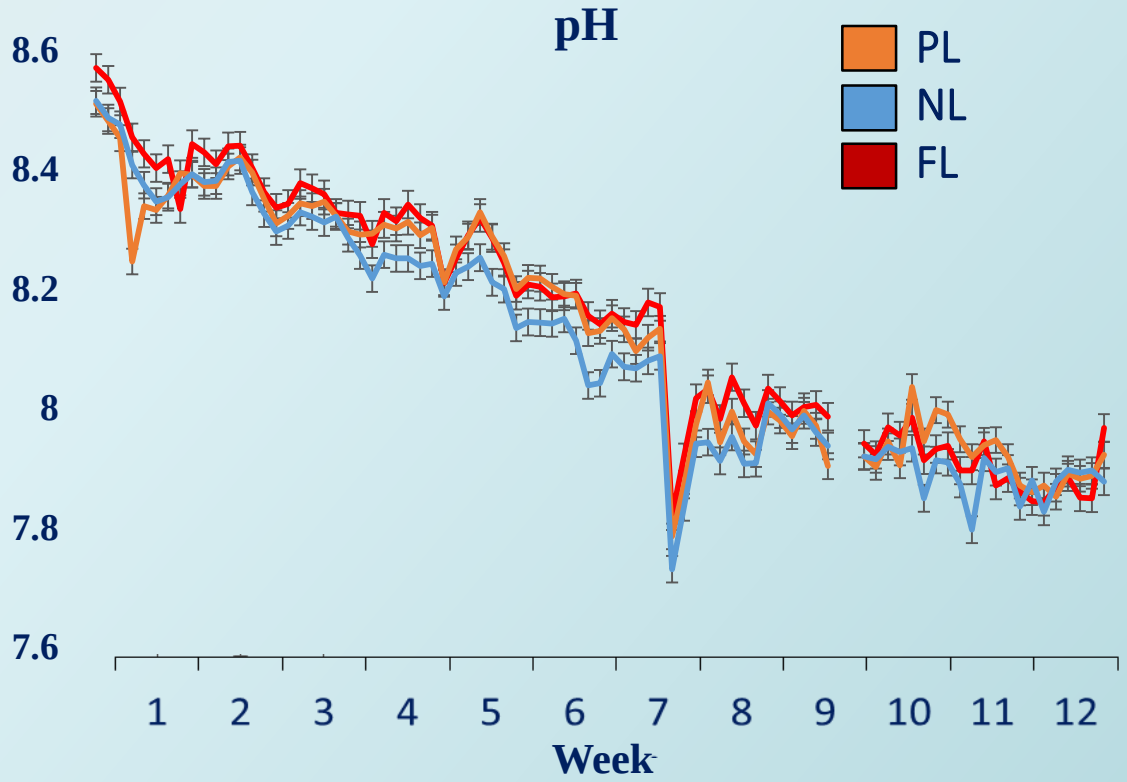

-No significant differences in ammonia or nitrite concentrations over course of study.

-Nitrate significantly lower in FL systems at end of study

-FL tanks had highest initial ammonia spike during system startup

# Water Quality




-pH significantly higher in FL and PL tanks compared to NL

-NL systems required a significantly higher amount of Sodium Bicarbonate to maintain pH above 8.0

-Turbidity significantly higher in PL and NL tanks compared to FL

# Production Results

| Treatment | Average Wt.(g) | Total Harvest(kg/m$^3$) | Survival | FCR | SGR |
|---|---|---|---|---|---|
| FL | 25.0$^a$ | 4.6$^a$ | 74.1$^a$ | 1.37$^a$ | 3.5$^a$ |
| PL | 24.2$^a$ | 3.4$^b$ | 57.2$^b$ | 1.80$^b$ | 3.4$^a$ |
| NL | 19.9$^b$ | 3.1$^b$ | 62.0$^{ab}$ | 2.04$^b$ | 3.2$^b$ |

*Superscript denotes a significant difference between treatments

-Significant differences in Production Results

-Total Harvest significantly better in FL

-Significant difference in Survival between FL and PL

-FCR significantly better in FL

-Survival likely due to effects of lights turning on and off

# Shrimp Nutritional Results

| Treatment | Crude Fat | $n^{-6}/n^{-3}$ Ratio | Crude Protein | EPA | DHA | Linoleic | Linolenic |
|---|---|---|---|---|---|---|---|
| FL | 0.61 | $1.25^{a}$ | $22.95^{ab}$ | 9.77 | $8.7^{a}$ | $22.73^{a}$ | $1.51^{a}$ |
| PL | 0.74 | $1.26^{a}$ | $23.3^{a}$ | 9.51 | $8.9^{a}$ | $22.74^{a}$ | $1.41^{b}$ |
| NL | 0.73 | $1.16^{b}$ | $22.69^{b}$ | 9.84 | $9.44^{b}$ | $21.71^{b}$ | $1.32^{c}$ |

*Superscript denotes a significant difference between treatments

-Omega-6:3 ratio significantly higher in FL and PL compared to NL

-Crude protein significantly higher in PL vs NL

-DHA significantly higher in NL vs FL

-Linoleic and Linolenic higher in treatments with light

-No difference in total fat

# Biofloc Nutritional Results

| Treatment | Crude Protein | Moisture | Crude Fiber | Ash |
|---|---|---|---|---|
| FL | 5.8[a] | 52.6 | 1.9[a] | 32.6 |
| PL | 4.6[b] | 53 | 1.2[b] | 34.6 |
| NL | 4.0[b] | 53.9 | 0.9[b] | 34.9 |

*Superscript denotes a significant difference between treatments

-Higher levels of protein and fiber found in biofloc samples from FL treatments

-Indication of increased algal abundance in FL systems

# Summary

-Full Light tanks significantly outperformed Partial and No Light
-Low survival in Partial Light tanks due to shrimp jumping
-Light impacted turbidity, possibly increased biofloc uptake by shrimp, altered biofloc composition
-Omega-6/3 ratio in shrimp altered by lighting, possible nutritional impacts
-24 hour lighting has a positive effect on shrimp growth
-Further research
    -Photoperiod effects on shrimp
    -Light spectrum for optimum shrimp/algae production
    -Further nutritional studies on the change in omega-6/3 ratios
    -Cost of lighting ($68 per $m^3$ in this study)

# Thank You!

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**KSU Aquaculture Webpage: http://www.ksuaquaculture.org/**