Design and Monitoring of Small Scale Aquaponics System

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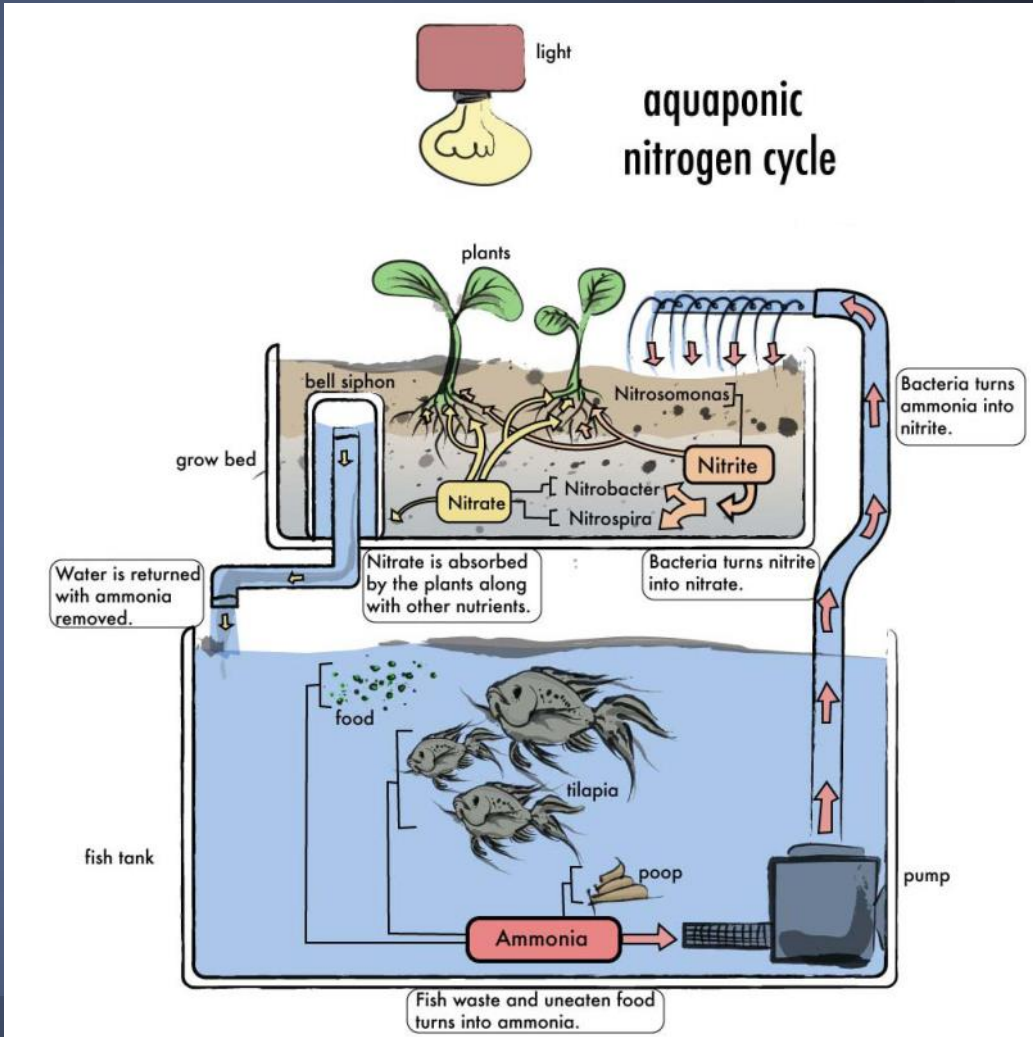
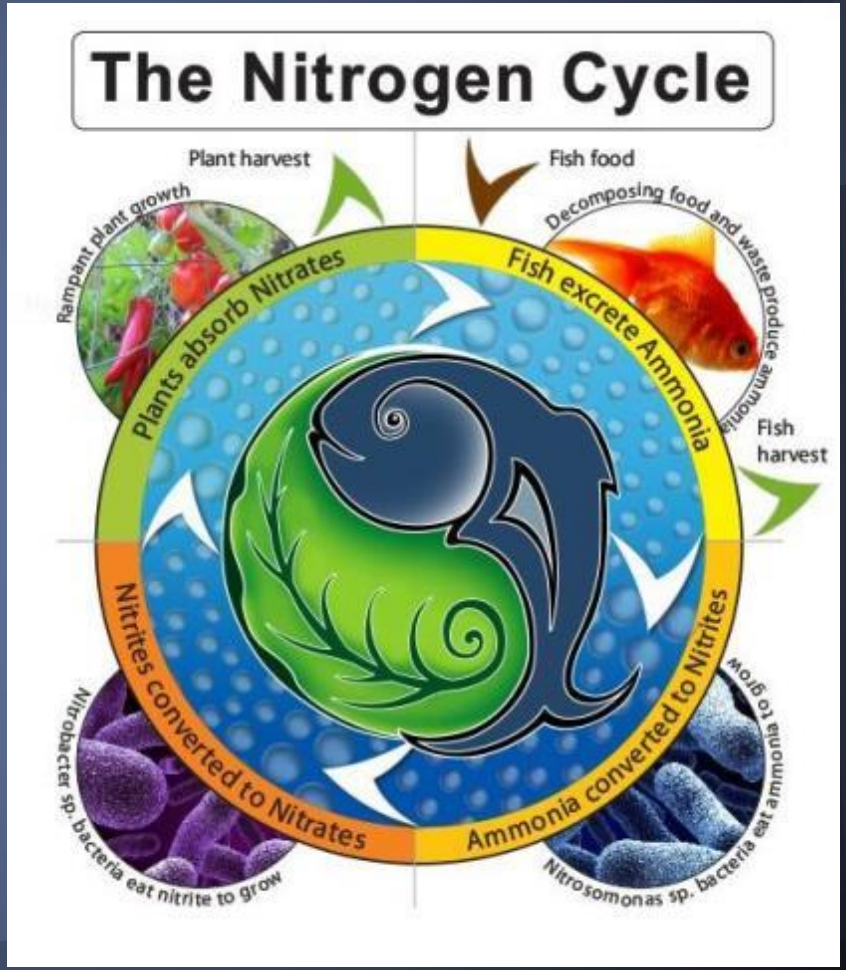
Aquaponics

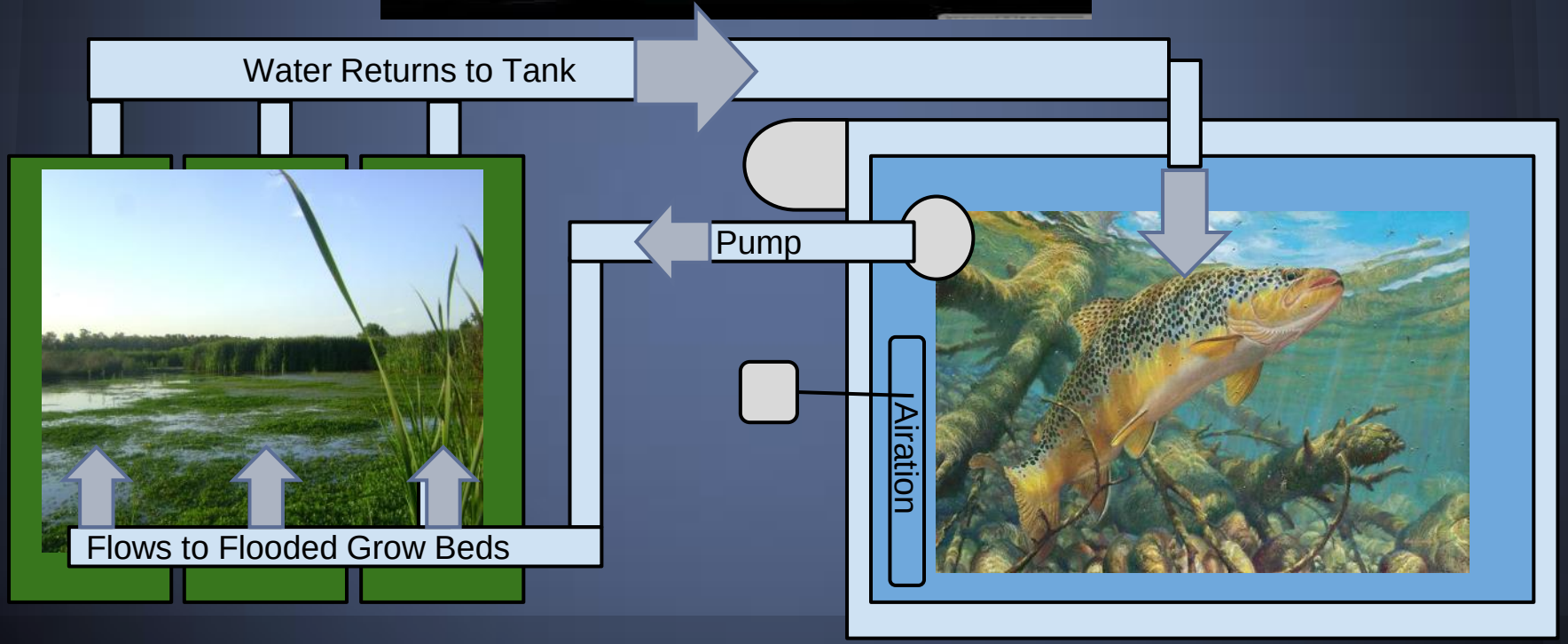
A food production system that combines aquaculture with hydroponics in a symbiotic environment.



Nitrogen Cycle

- Water circulates
- Ammonia is converted to nitrites and next to nitrates by bacteria
- Plants absorb nitrates





Layout of Recirculating Aquaponic System with Ecosystem Analog

Fish Tank Buildout

We excavated until we hit groundwater

Repurposed materials were used to hold back the gravel and to protect the liner from puncturing.

We built the raised walls out of 2x8 rough cut boards.

The addition of above ground walls increased the total volume.

The underground portion added temperature stability

Tank

Total Volume: 650 gallons

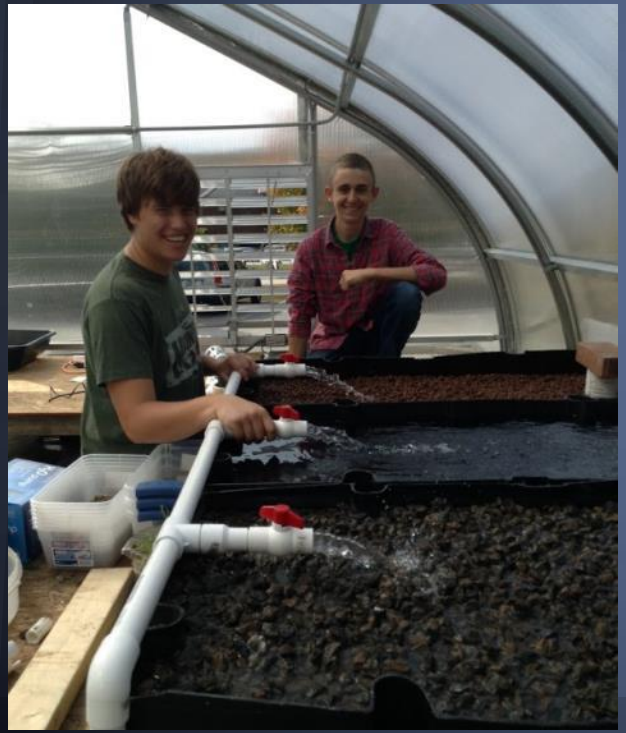
Addition of RPE liner secured with top framing

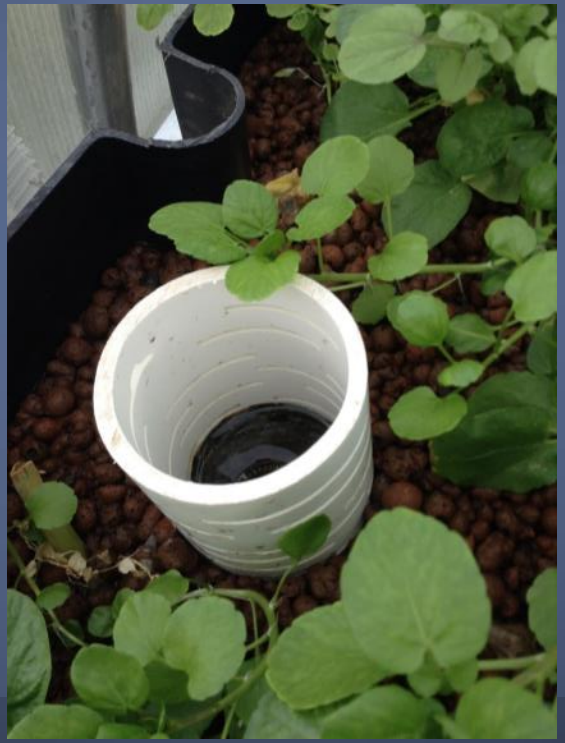
Submersible Pump:

1200 Gallon/hr

2 full circulations through grow beds / hour

Flooded Grow Beds





Plants and Grow Beds

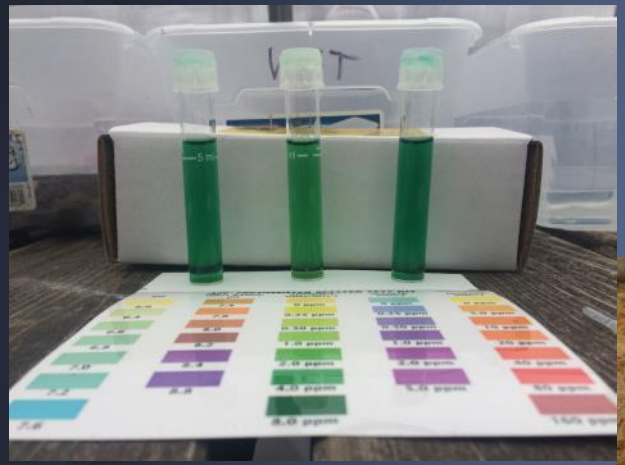
- Watercress : Easy to transplant, cold tolerant and nutrient dense
- Grow beds with varied substrates

Brown Trout

- Cold Tolerant (fall -> winter duration)
- Locally available
- No Permit Necessary
- Inexpensive

(picture taken from within our tank)

System Monitoring



Water Chemistry:

Temperature, pH, and DO
Ammonia and Nitrates

Plant Growth, overall health and change in biomass

Fish growth and survival

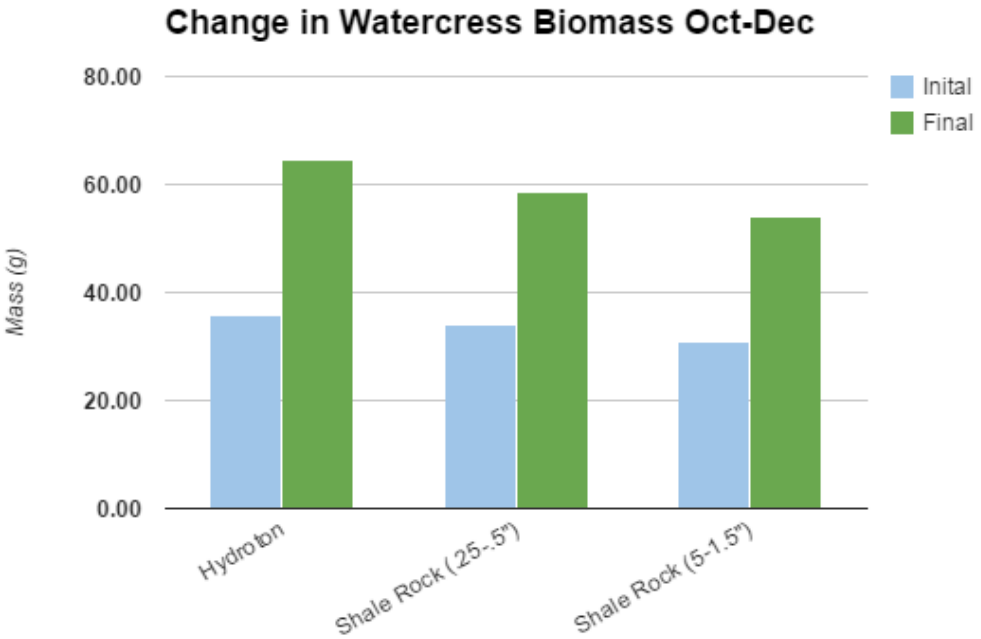
10/23

11/4

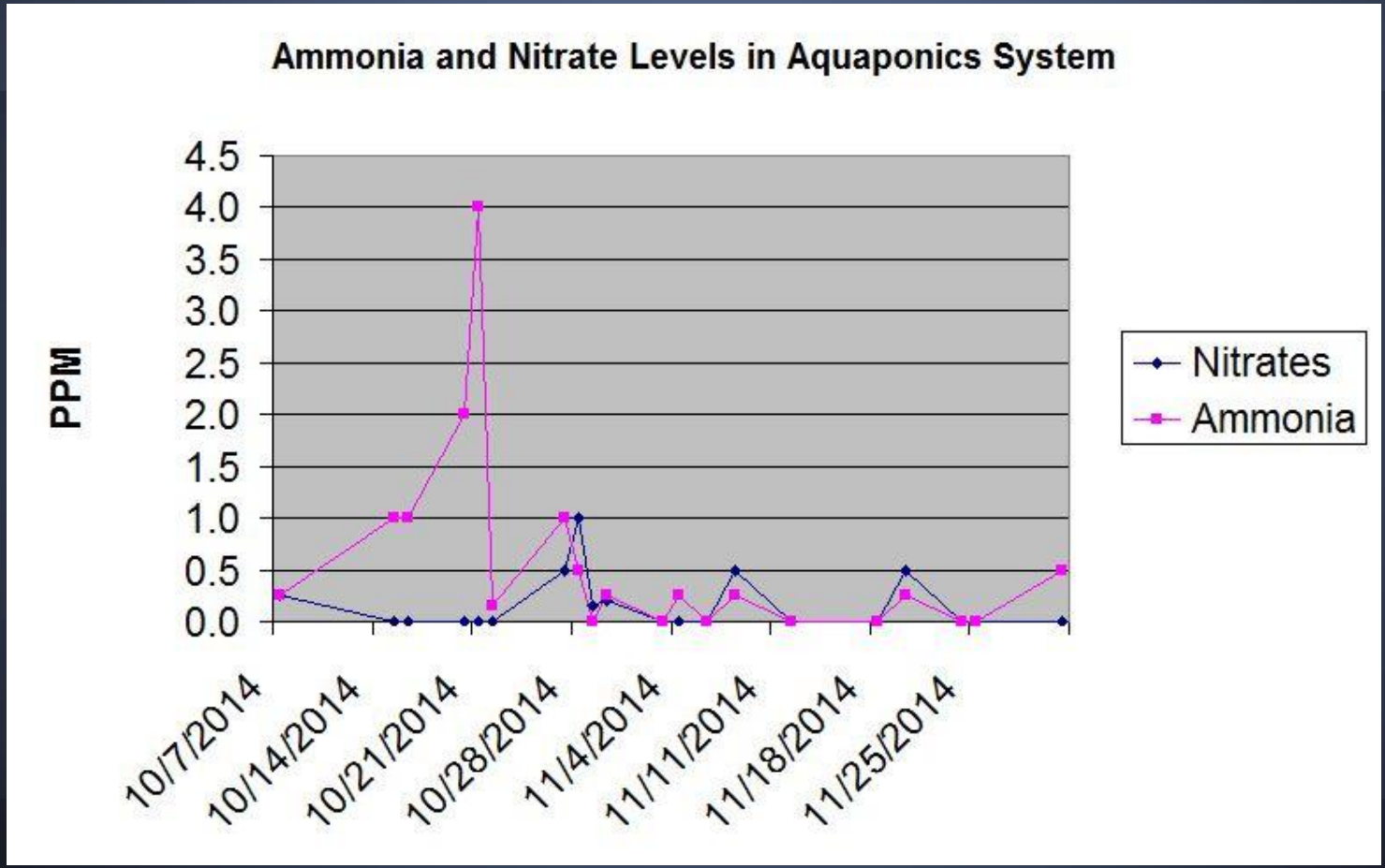
11/25

12/16

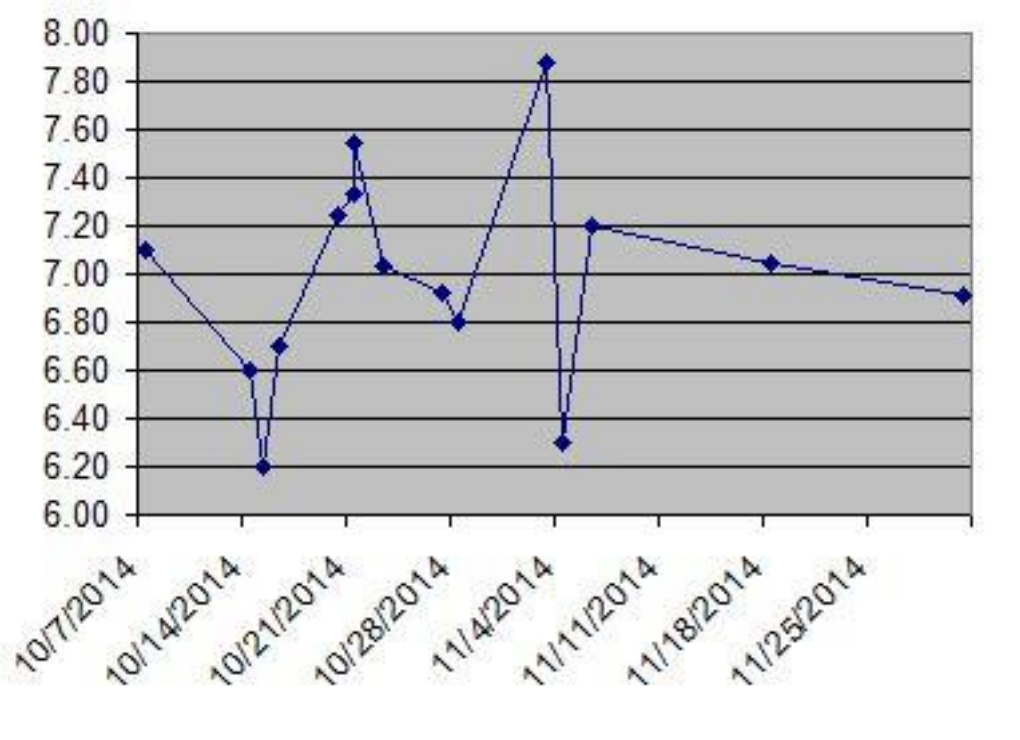
Change in Watercress Biomass in Response to Substrate Composition



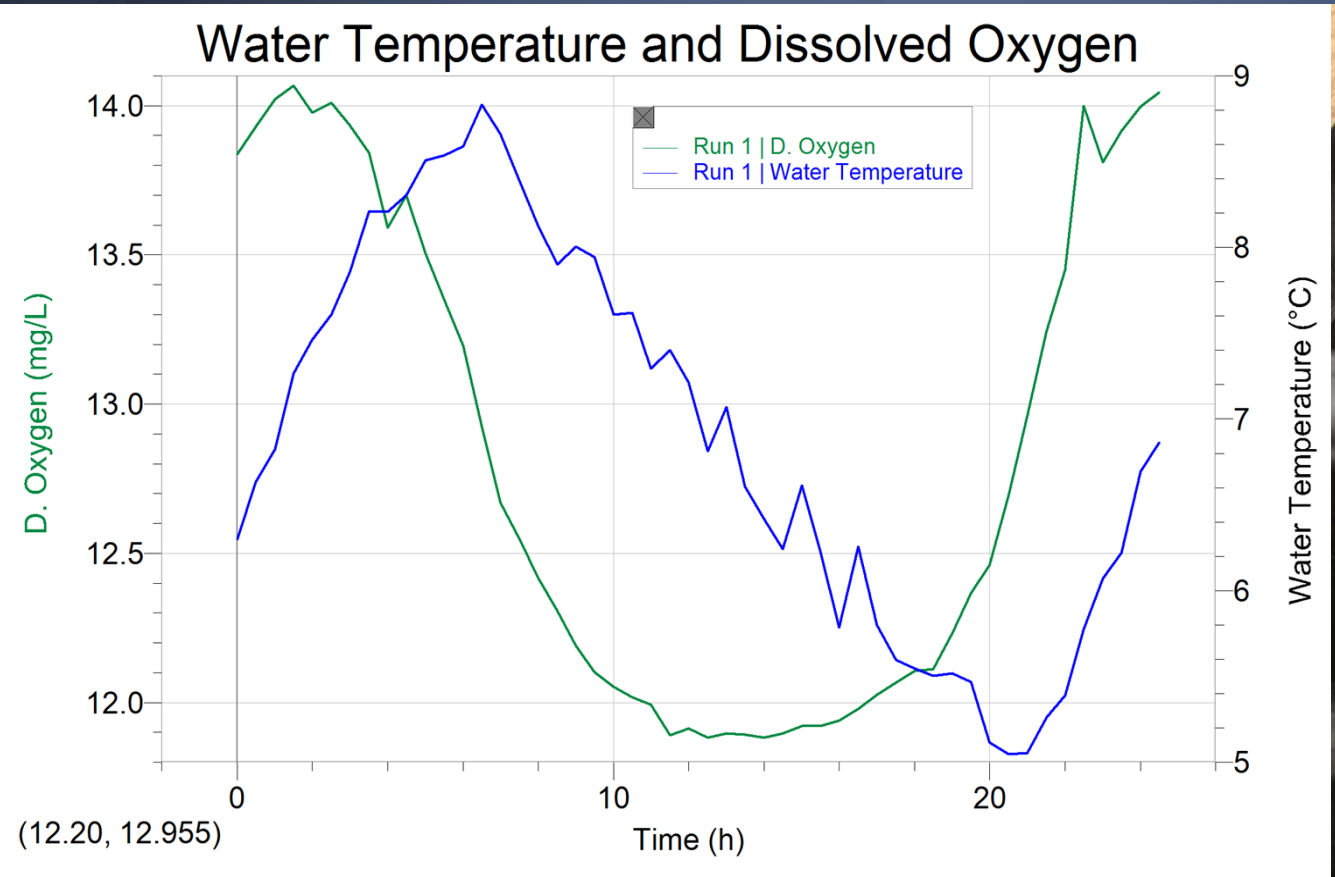
Chemical Tests: Ammonia and Nitrates



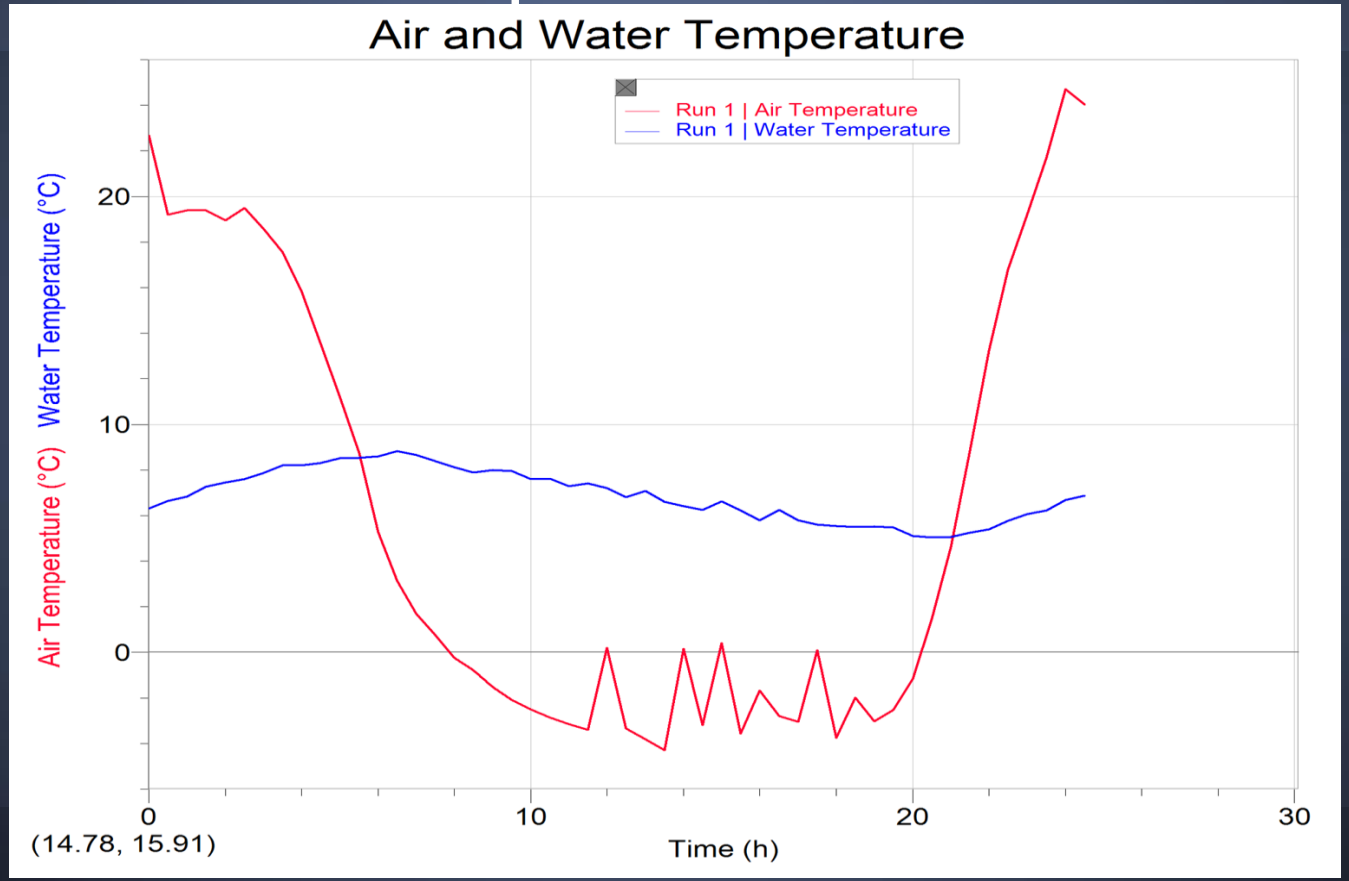
Chemical Tests: pH



Dissolved Oxygen and Water Temperature



Air and Water Temperature



Fish Survival and Growth

Twelve of the initial twenty fish were lost during November and December.

We also lost three more fish from January to March when the grow beds had frozen solid and the recirculating pump was turned off.

Example of Growth in Surviving Fish

Initial length: 6-7”
Initial weight: 5-8 oz.

Final length: 10-12”
Initial weight:10-15 oz.

Conclusion

It takes time to establish the important microbiological community at the start. This can jeopardize fish health in the earlier stages as the bacteria populations become established and plants begin to absorb nitrogen from the water.

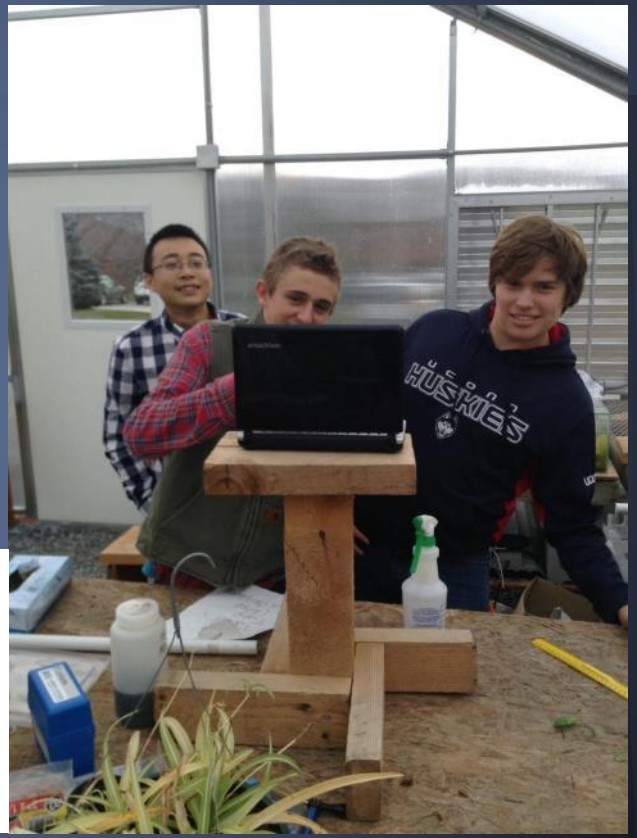
Grow beds can act as an unexpected radiator to either quickly heat water during warm and sunny days or cool it during cold nights. These fluctuations may stress the fish population.

Conclusion

Setting up and maintaining an aquaponics system can be challenging. By studying a small system we gained a greater appreciation for the critical feedback systems and relative stability that we can sometimes take for granted in our own ecosystem.

Current tests involve removing the now inoculated substrate and testing it against known concentrations of ammonia and nitrites. We also look forward to testing how tilapia might do in the warmer spring and summer months.

Many thanks for helping to make this amazing experience possible!



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Research on Adaptation to Climate Change
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Funding provided by NSF EPS Grant #1101317