Evaluating the bioextractive capacity of a South Florida native macroalga, *Agardhiella subulata*, for use in integrated multitrophic aquaculture

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Introduction

- As a mass production industry, finfish aquaculture can discharge high concentrations of dissolved inorganic nutrients – particularly nitrogen and phosphorus – into the environment that can cause eutrophication and ecosystem collapse.
- Removal of introduced nutrients from wastewater can require specialized equipment, skilled labor, and high monetary input.

Integrated multitrophic aquaculture (IMTA) systems combine the culture of finfish species with cultures of bioextractive macroalgae or suspension feeders to organically remove introduced nutrients from effluent water while producing additional marketable biomass from the filtering organisms.

- IMTA systems have not been broadly explored in the Gulf of Mexico or Caribbean Regions, particularly in the context of compatible native species for efficient nutrient reduction and growth within the system.
- *Agardhiella subulata* is a South Florida native red macroalga species (Fig. 1a) chosen for use in this project due to its compatibility for year-round tank culture in the region and potentially high bioextractive nutrient capabilities.

We aim to quantify the nitrogen and phosphorus bioextractive capacities of *A. subulata* in an IMTA system with American red snapper (*Lutjanus campechanus*) – a South Florida native red macroalga producing species in the IMTA project.

Methodology

- Culture system (Fig. 2) contained one primary tank of juvenile *L. campechanus* culture and six secondary tanks of *A. subulata* culture.
- Three secondary tanks were supplied with control water from the Culture system (Fig. 2) contained one primary tank of juvenile *L. campechanus* culture and six secondary tanks of *A. subulata* culture.
- Two identical, 16-day trials were run from March 8-April 2, 2020.

Every third day during each trial consisted of an identical sampling procedure:

- A. subulata tissue samples collected from each tank and frozen for later elemental analysis.
- Temperature, dissolved oxygen concentration, pH, and irradiance for each tank were recorded.
- Water samples from inflow and outflows of each tank tested for dissolved nitrogen and phosphorus concentrations.

Results

- Average growth rates (% dry weight) for *L. campechanus* were significantly different than those of control groups in both trials (Table 2).

Future steps:

- Establish market value of *A. subulata* to determine the revenue gained per kg of algae produced.
- Longer-term projects to get an idea of *A. subulata*’s seasonal viability.
- Investigate correlations between nutrient reduction and flow rates to determine ideal ratios for long-term reduction efficiency of the system.

Conclusions

- The results of this project confirm that *A. subulata* would be an ideal candidate for regional IMTA projects due to its high nutrient bioextractive and growth capabilities.

- Reduced mean values of 65% of NH4, 8% of NO3, 98% of NO2, and 98% of PO4 from effluent water (Fig. 4, Table 1).

- Based on *L. campechanus* feed composition, *A. subulata* was able to absorb up to 16.7 kg P from effluent water between the two trials.

- Mean N and C tissue concentrations (Fig. 5, d13N, d13C) of experimental groups were significantly different than those of control groups in both trials (Table 2).

- Experimental groups also maintained lower C:N ratios (Fig. 7, Table 2) that are optimal for downstream use as feed for model organisms compared to control groups.

- Mean growth rates of experimental groups (Trial 1: 9.4 ± 3.27%/d; Trial 2: 7.80 ± 2.84%/d) were significantly different from those of control groups (Trial 1: 3.99 ± 3.03%/d; Trial 2: 2.38 ± 2.85%/d) in both trials (Fig. 4).

- Growth and nutrient reduction exhibited signs of density-dependence.

- Both experimental tissue growth and percent nutrient reduction peaked at stocking densities of around 17-25 kg/m3 in each trial (Fig. 8).

- This point of growth illustrates the existence of a carrying capacity for the system, and the density at which biomass should be harvested in commercial systems in order to retain the most efficient growth and nutrient reduction in *A. subulata*.

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