Variable effects of *Ulva* spp. on Dissolved Oxygen Dynamics

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Abstract

Increased nutrient loading in Elkhorn Slough from surrounding watersheds is the presumed cause of observed increases in primary productivity. This eutrophication has resulted in negative ecological consequences, such as night time hypoxia and anoxia. *Ulva lactuca* and *Ulva intestinalis* are the two most abundant algal species in the slough. The purpose of this study was to compare the effects of *U. lactuca* and *U. intestinalis* on dissolved oxygen (DO) variability in Elkhorn Slough. We established three algal biomass to water volume ratios based on previously collected data in Elkhorn Slough determining natural abundances. We conducted a light:dark mesocosm experiment of three biomass treatments (high, medium, and low) for both species, and a control in 15 gallon buckets. The buckets were kept outside in the sun under temperature controlled conditions for three hours to measure daytime photosynthesis. Buckets were then moved to a dark room to simulate night time conditions. Daytime productivity for all three *U. lactuca* biomass treatments were significantly different from each other while there were no significant effects of *U. intestinalis* biomass on DO dynamics. This result is due to the higher surface area:volume of *U. lactuca*, which gives it higher primary productivity potential. Neither of the low treatments were significantly different than the control, which contained no algae. While most areas within the slough are eutrophic (high primary productivity), only tidally restricted areas go hypoxic. Therefore, management efforts should focus on areas that are poorly flushed and hypoxic.

Study Objectives

-Compare Surface Area : Volume ratios of *U. lactuca* and *U. intestinalis*

-Compare primary productivity rates of *U. lactuca* and *U. intestinalis*

Fig. 1. All treatment buckets outside the research lab for the light treatment

Fig. 2. All treatment buckets in the room used for the dark treatment

Methods

1. Surface Area : Volume Ratio
   -Determined volume with water displacement methods
   -Analyzed surface area with Image J application
2. Primary Productivity Rates
   - Two light treatments: natural sunlight (Fig. 1) and darkened room (Fig. 2)
   -Three fresh weight biomass treatments

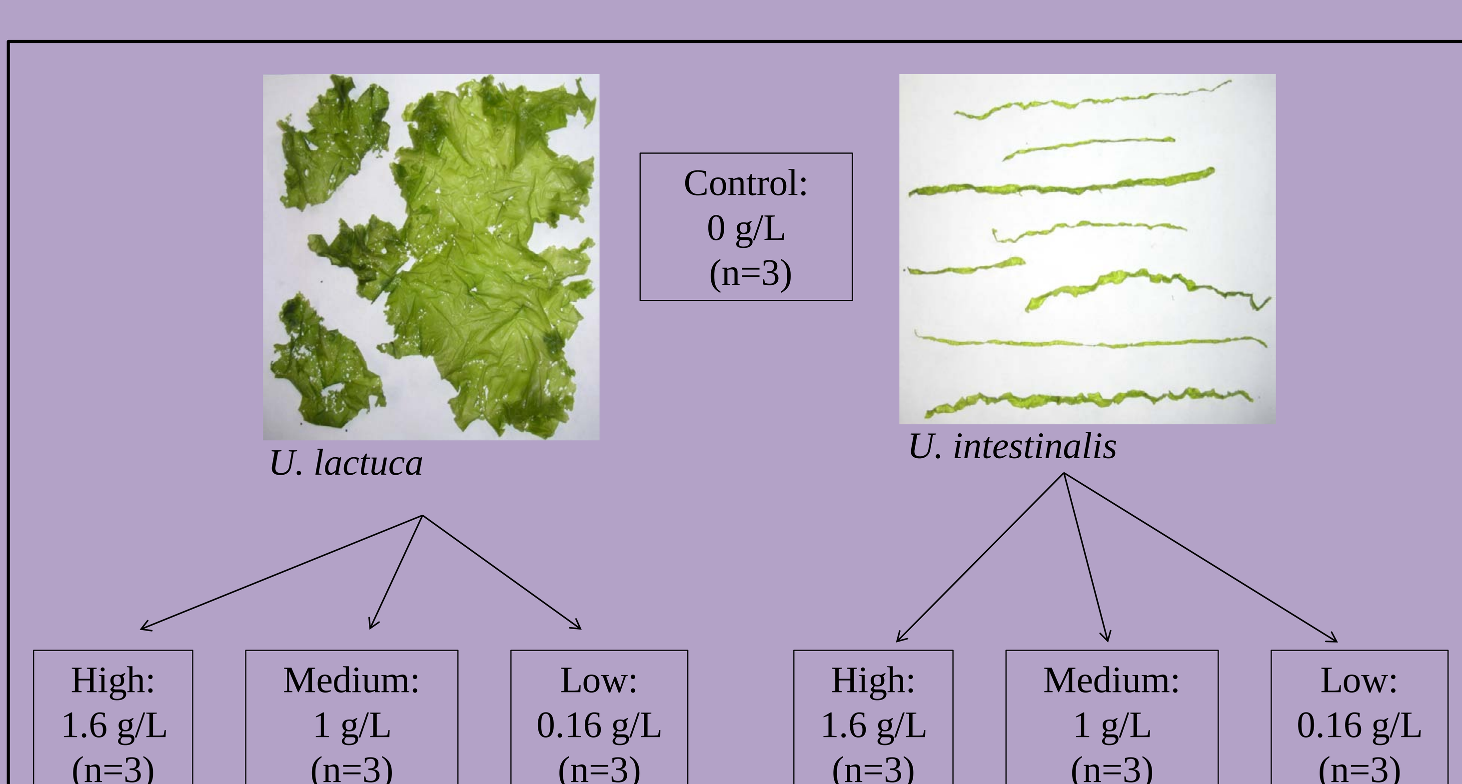

Fig. 3. Diagram of biomass treatments

- Mean DO production of controls were subtracted from treatment means to account for water column productivity

Samples:
-*U. lactuca* collected from Whistle-stop Lagoon (Fig. 5)
-*U. intestinalis* collected from North Marsh Tide Gate (Fig. 6)
-Estuarine water collected at South Marsh

Results

U. lactuca and *U. intestinalis* surface area:volume ratios were significantly different from each other (Fig.6, t_{20}=3.28, p<0.005).

In the light treatment there was a significant species effect on DO dynamics. *U. lactuca* had greater primary production than *U. intestinalis*(Fig.7, $F_{1,17}$=207.15, p<0.005). There was a significant biomass treatment effect on DO dynamics (Fig.7, $F_{2,17}$=238.32, p<0.005), and there was a significant species-treatment interaction (Fig.7, $F_{2,17}$=71.13, p<0.005).

In the dark treatment, none of the treatments were significantly different from each other (Fig. 8).

Fig. 4. North Marsh

Fig. 5. Whistle-Stop Lagoon

Discussion

The results indicated that there was a significant difference in primary productivity rates between *U. lactuca* and *U. intestinalis.* *U. lactuca* had higher primary production and SA:V than *U. intestinalis*. This could mean *U. lactuca* has a higher potential for creating hyperoxic events than *U. intestinalis.*

The light treatment results indicate that the variable biomass of *U. lactuca* had a significant affect on dissolved oxygen levels. The development of large algal mats could be causing extreme hyperoxia during the day.

Results from the dark treatment are inconclusive. None of the treatments were significantly different from each other, suggesting *U. lactuca* and *U. intestinalis* are not the direct cause of hypoxia or anoxia in Elkhorn Slough. It is more likely that microbial populations in the sediment, that are facilitated by decomposing *Ulva* spp., are the cause of extremely low levels of dissolved oxygen.

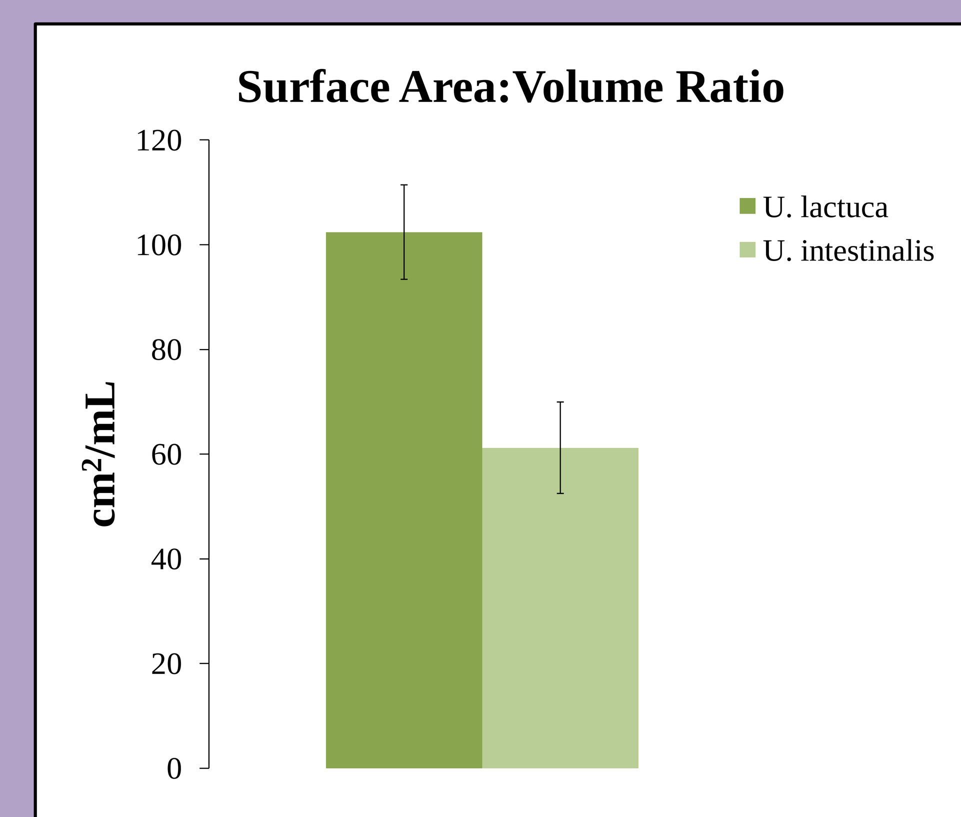

Fig. 6. Bar graph of average surface area : volume ratios with standard error bars for *U. lactuca* and *U. intestinalis, analyzed with a t-test.*

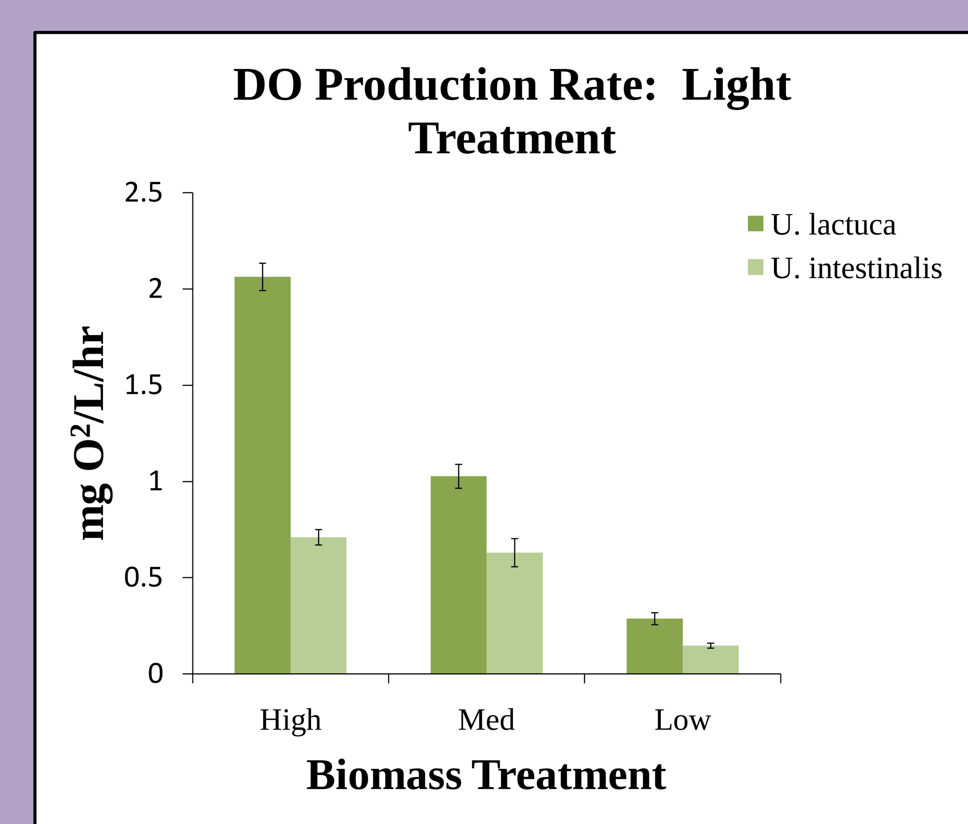

Fig. 7. Bar graph of average DO production rates in mg O²/L/hr with standard error bars for all light biomass treatments, analyzed with a two-way ANOVA.

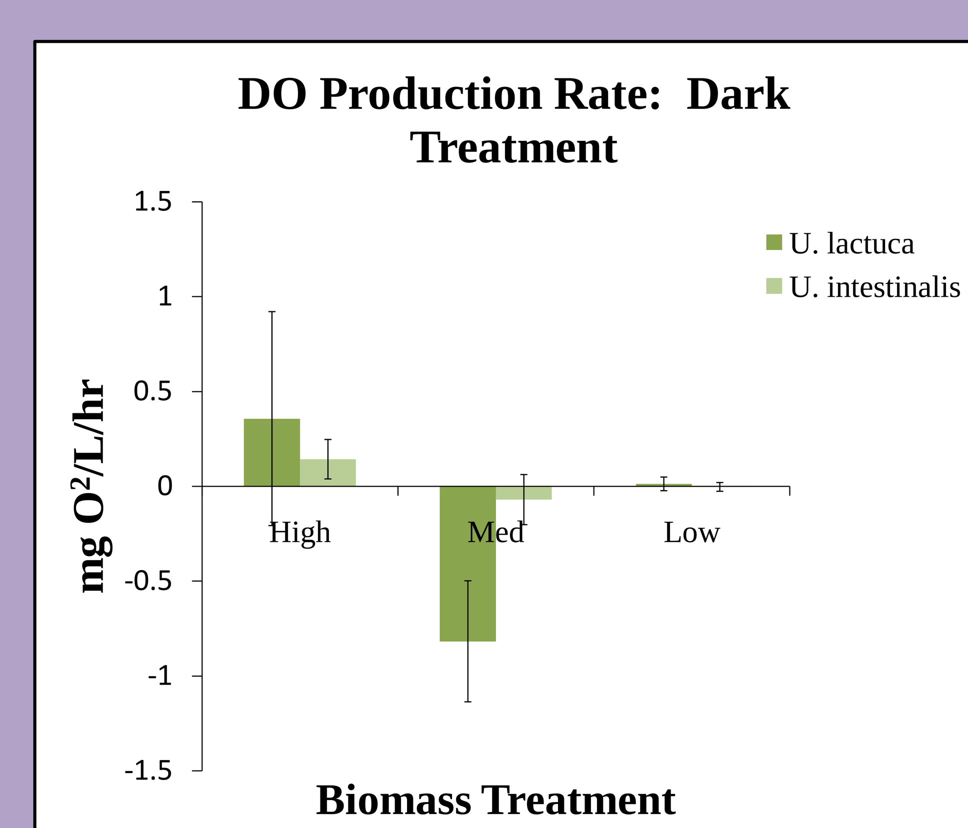

Fig. 8. Bar graph of average DO production rates in O²/L/hr with standard error bars for all dark biomass treatments, analyzed with a two-way ANOVA.

Acknowledgments

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