Effect of Harvesting Frequency on Microalgal Productivity

Brett Higgins[1] and Ann C. Wilkie[2]

[1] Microbiology and Cell Science Major

[2] Faculty Adviser, Soil and Water Sciences Department, University of Florida-IFAS, Gainesville, Florida

Abstract

Many factors contribute to algal productivity including availability of light and nutrients, pH, temperature, algae species, and retention time. The objective of this study was to evaluate the effect of harvesting frequency on microalgal productivity. Microalgal polycultures were maintained in two 1000-L outdoor raceway ponds with periodic addition of nutrients, an on-demand supply of carbon dioxide for pH control and carbon addition, and removal of 50% of the biomass during regular harvest intervals. Representative samples were collected (in triplicate) during harvest and evaluated for pH, temperature, and total and volatile suspended solids (VSS). Predominant algae genera were identified using light microscopy. Algal productivity was calculated based on the accumulation of VSS over the specific algal growth period (i.e. time between harvests) and is expressed as gVSS/m^2-day. The results indicate that when the harvesting frequencies were increased from 2 to 3 to 4 times per week, average productivity increased from 8.3 to 11.7 to 16.1 gVSS/m^2-day in Pond A and from 9.0 to 13.3 to 16.3 gVSS/m^2-day in Pond B. Thus, nearly twice as much biomass can be produced from microalgal ponds when harvesting frequencies are increased from 2 to 4 times per week.

Introduction

Algae biomass reproduces very quickly if adequate light, nutrients and carbon dioxide are provided. Algae consists of carbohydrates, lipids, and proteins than can be converted into various biofuels including biodiesel, bioethanol and biogas. The advantages of growing algae in **open raceway ponds** include the following [1]:

- Relatively inexpensive
- Easy to maintain
- Require low energy inputs
- Utilize marginal lands not viable for traditional agriculture

One of the primary challenges associated with open raceway ponds is that cultures can be easily contaminated resulting in low biomass productivity.

The overall goals of this research are to:

- Improve microalgal productivity in open raceway ponds
- Understand the microbiological changes that occur in open raceway ponds over time.

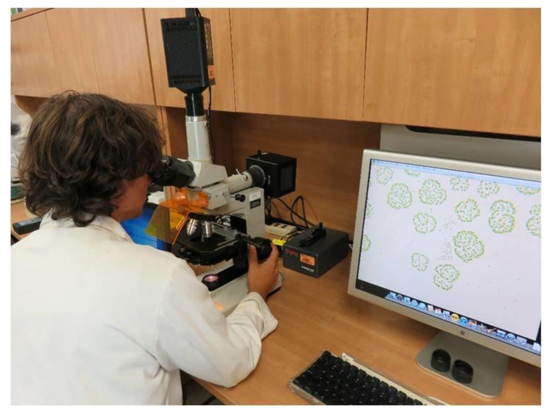
Microalgae sample collected from SWSD outdoor raceway ponds

Objective

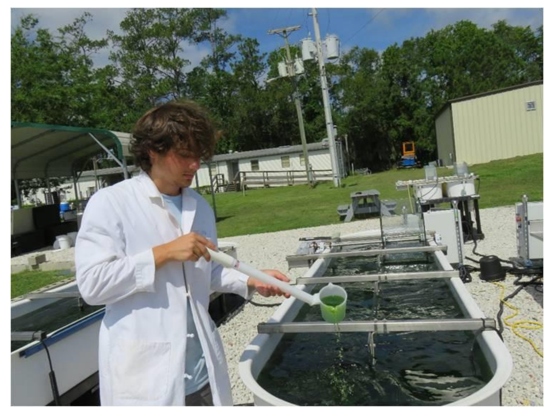
Optimize microalgal productivity in outdoor raceway ponds by increasing the harvesting frequency.

Methods

- Maintain microalgal polycultures in two 1000-L open raceway ponds
- On-demand supply of CO_2 for pH control (pH 8) and carbon addition
- Fertilize ponds with 41.6g of Miracle Gro after each harvest
- Apply different harvesting frequencies for a test period of two weeks for each trial. Harvesting frequencies were:
  - 2x per week
  - 3x per week
  - 4x per week
- Use light microscopy to evaluate biodiversity of microalgal cultures
- Measure field parameters (i.e. pH and temperature) on each pond prior to each harvest.
- Collect representative samples and measure total and volatile suspended solids (VSS) in triplicate and in accordance with Standard Methods [2]
- Calculate algal productivity as a function of VSS produced in a specified area per day.



Microscopic evaluation of microalgal polycultures



Sample collection from raceway ponds

Field measurements on outdoor raceway ponds

Results

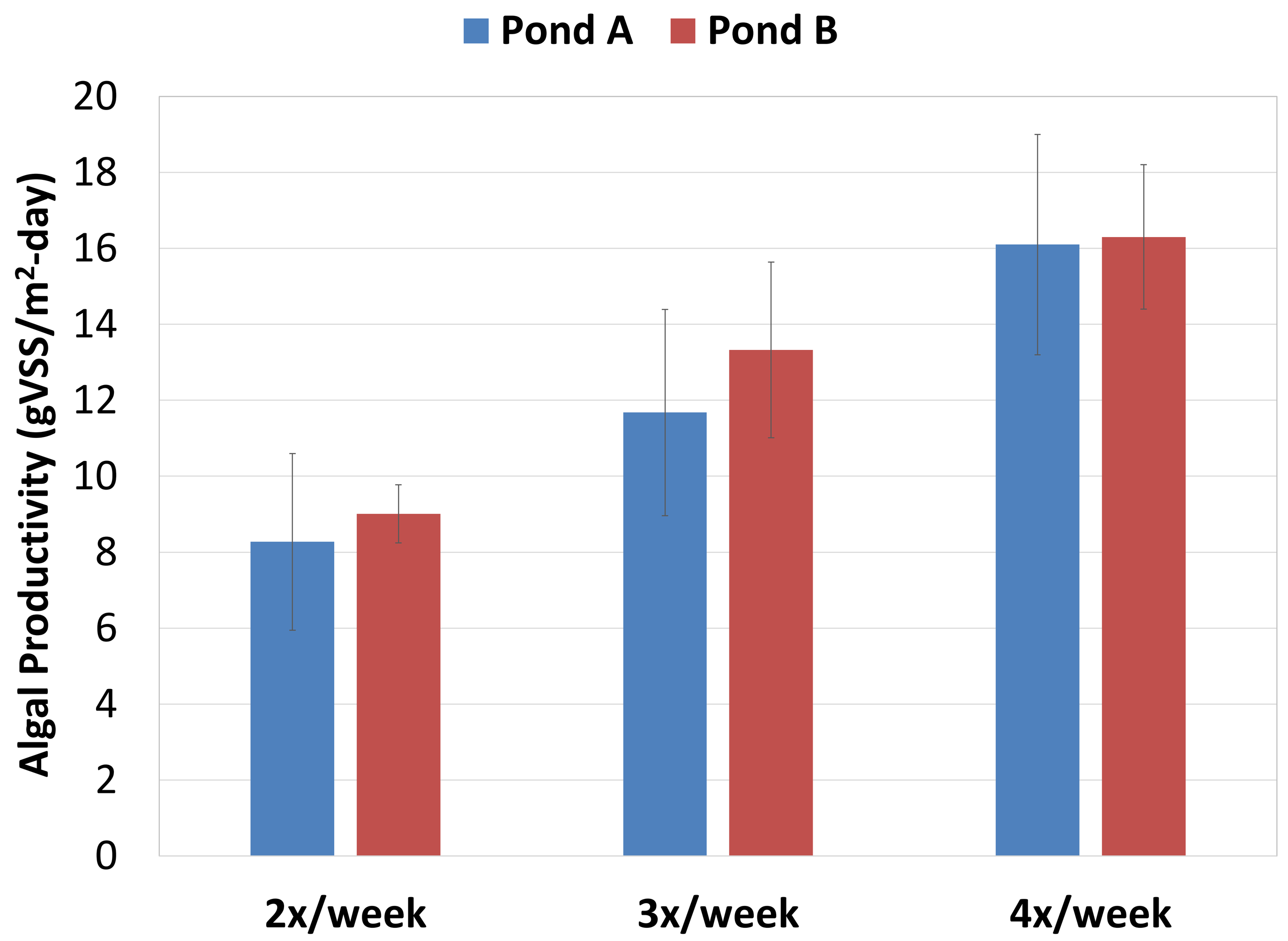
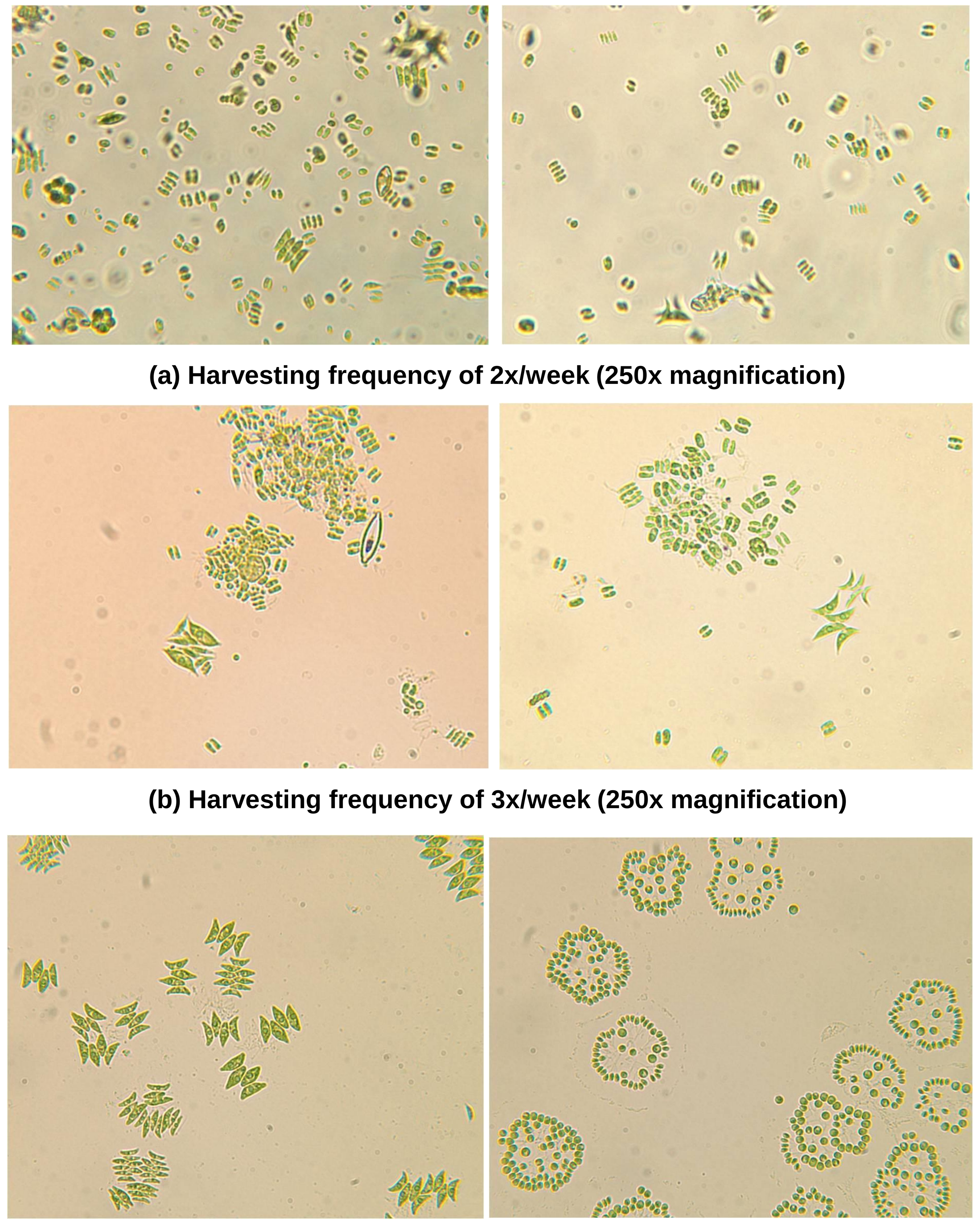


Figure 1. Algal Productivity at Different Harvesting Frequencies in Ponds A & B
(Error bars represent standard deviation among all samples collected within the two-week interval for each harvesting regime)

Pond A **Pond B**



(a) Harvesting frequency of 2x/week (250x magnification)

(b) Harvesting frequency of 3x/week (250x magnification)

(c) Harvesting frequency of 4x/week (250x magnification)

Figure 2. Micrographs of the algal polycultures in each pond at different harvesting frequencies

The dominant microalgal genus was *Scenedesmus* in both ponds during the 2x and 3x per week harvesting frequencies. However, *Dictyosphaerium* became the dominant organism in Pond B during the 4x per week harvesting frequency. The cultures transitioned into pure monocultures in both ponds with more frequent harvests.

Conclusions

- Average algal productivity increased in both ponds with more frequent harvest intervals.
- The microalgal cultures transitioned into more pure cultures of *Scenedesmus* (Pond A) and *Dictyosphaerium* (Pond B) with more frequent harvest intervals.

References

1. Brennan, L., Owende, P., 2010. Biofuels from microalgae-A review of technologies for production, processing, and extractions of biofuels and co-products. *Renewable & Sustainable Energy Reviews* 14, 557-577.
2. APHA. (2012). *Standard Methods for the Examination of Water and Wastewater*. 22nd ed. Washington DC: American Public Health Association/American Water Works Association/Water Environment Federation.

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