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PhosForUs: Recovery of phosphorus from polluted water systems using Biofilm Sequencing Batch Reactors

Butler Research

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Abstract

Wastewater treatment systems remove phosphorus through chemical precipitation or Enhanced Biological Phosphorus Removal (EBPR), but does not address non-point pollution-sources. Instead, Harmful Algal Blooms (HABs) are combated by dosing waterbodies with alum, but this is temporary and outdated. Alternatives are difficult and costly to implement, but economic feasibility can be increased by generating an added-value product through resource recovery.

Although EBPR cannot be applied to open waterbodies, biofilm systems containing phosphate accumulating organisms have emerged as a new strategy to remove phosphorus from synthetic wastewater to be used again as a resource. This study investigates the role that the ecology of these biofilms plays on their performance, efficiency and scalability. I hope to advance this technology for phosphorus recovery not only from wastewater, but also from polluted waterbodies such as local ponds, and evaluate the recovered phosphorus for use as a more sustainable fertilizer.

Introduction

Phosphorus from runoff causes Harmful Algal Blooms

Environmental

- Current alum treatment approach is unsustainable
- Phosphorus mining is unsustainable (<100 years)
- Eutrophication causes ecosystem collapse

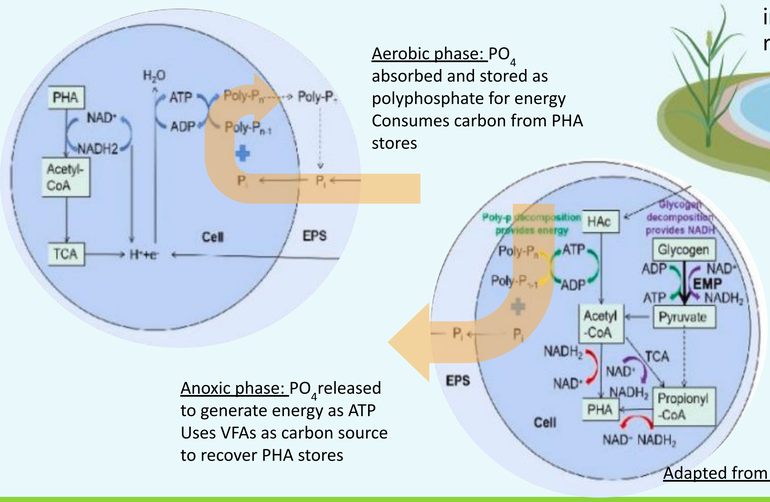
Social

- Cyanotoxins bioaccumulate and interrupt drinking water systems

Economic

- Damage to tourism, drinking water supply and fisheries cost millions
- Since 1995, *Cape Cod* has alum-dosed at least 13 lakes at avg ***$500k*** per treatment

Phosphate accumulating organisms (PAOs) can selectively absorb, concentrate, and release PO_4



Aerobic phase: PO_4 absorbed and stored as polyphosphate for energy
Consumes carbon from PHA stores

Anoxic phase: PO_4 released to generate energy as ATP
Uses VFAs as carbon source to recover PHA stores

Adapted from Chen et al 2020

Methodology

1) Remove phosphorus from polluted water

How will the BSBR microbial community change with pondwater?

Behavior of the biofilm

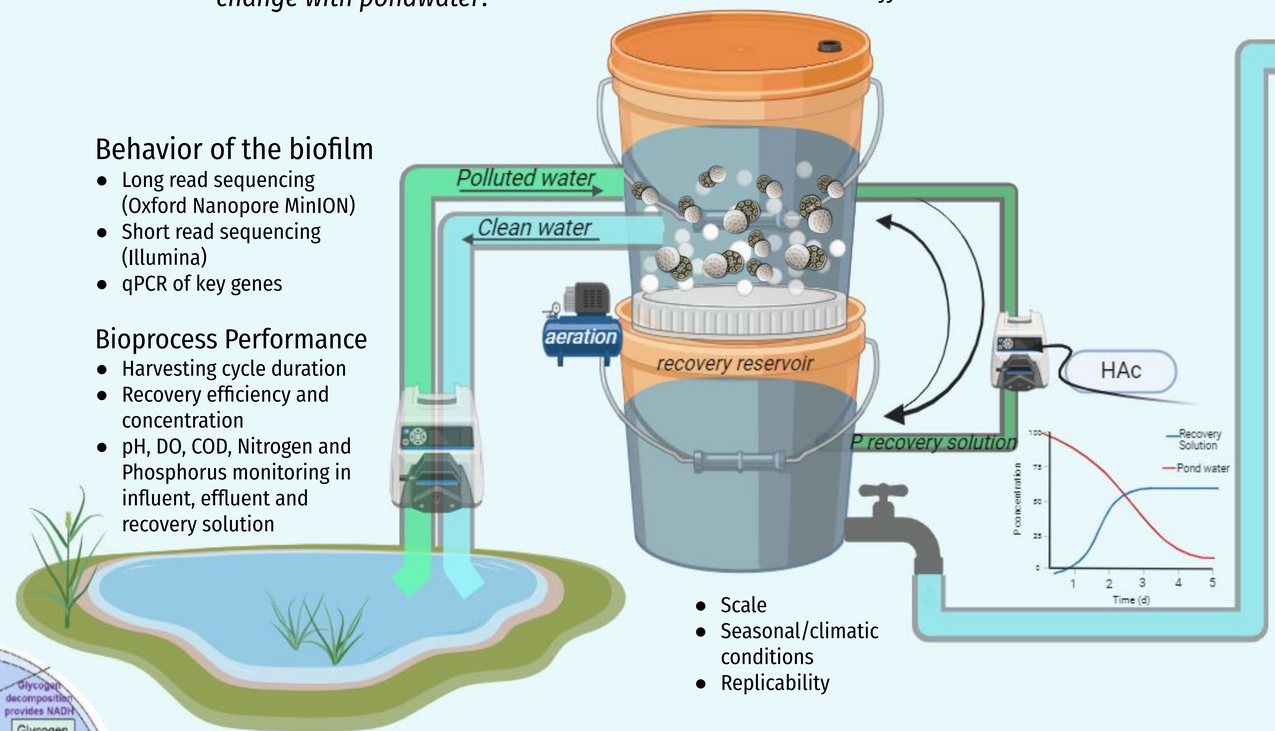
- Long read sequencing (Oxford Nanopore MinION)
- Short read sequencing (Illumina)
- qPCR of key genes

Bioprocess Performance

- Harvesting cycle duration
- Recovery efficiency and concentration
- pH, DO, COD, Nitrogen and Phosphorus monitoring in influent, effluent and recovery solution

2) Recover concentrated phosphorus solution

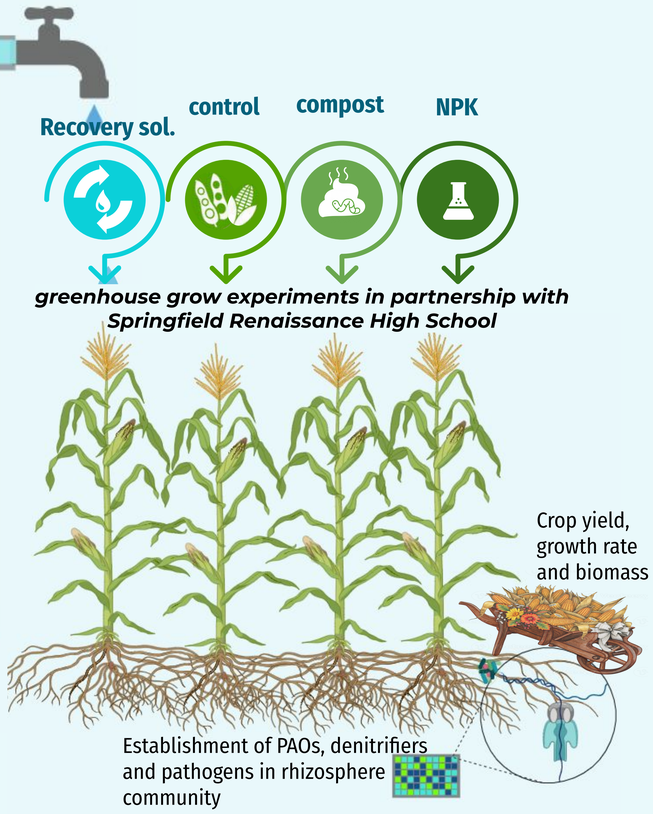
How will environmental and experimental factors of in-situ installment affect the microbial communities?



- Scale
- Seasonal/climatic conditions
- Replicability

3) Recycle phosphorus back into the economy

How will the recovered phosphorus fertilizer affect rhizosphere health and crop yield?



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