A Systems Experiment in Environment, Technology, and Economy:
Creating a Market for Wild Algae to Incentivize Bloom Cleanup

It is hypothesized that the countering of eutrophication through the harvesting of wild algae blooms can be expanded and made financially regenerative by selling mixed algae biomass as a paperboard pulp additive.

Abstract

Inputs of NPK and toxins increasingly lead to harmful algal blooms around the world. The algae removed from the water carries the eutrophying chemicals. Filamentous algae species types can be easily collected and have demonstrated an application in green paper pulp. This systems experiment is being conducted to test the ability of economic drivers to sustain and expand the existing practice of algae harvesting. This is being done by creating a business, Greener inc. (tm), which receives free algae harvests from public service harvesters, and coordinates with cardboard manufacturers and their customers to produce algae paperboard products. These eventually cycle to the landfill, where they are permanently sequestered.

Introduction

NPK and toxins aggregate in the soil and watershed due primarily to agricultural runoff, industrial effluent, and VOCs. The abundance of Nitrogen in freshwater systems and of Phosphorus in saltwater systems creates an imbalance that results in fast-growing algae blooms. Often, these thick mats can double in size in a few days. Thus they block out the sun from underwater aquatic plants and alter the aquatic food web. The blooms die off all at once, consuming oxygen and creating hypoxic dead zones that affect the surrounding ecosystem.

As a service to fishermen and boaters, the Fish and Wildlife services department in Delaware operates a small fleet of Aquamarine algae harvesting machines. They steer through algae blooms and collect as much as 40 cubic yards of material per day, and generally there is more available than they can harvest. This mix of algae and aquatic plant material is usually dumped on fish and wildlife land to decompose.

The green signaling value of algae cardboard boxes is hypothesized to be capable of sustaining the existence of an algae pulp supplier, which would initially receive algae harvests freely from the state of Delaware and eventually expand operations of its own. The pulp is purchased by cardboard manufacturers to satisfy customer orders.

Methods

Three components are being tested independently, which comprise of a functioning business system: harvesting logistics, processing and manufacturing, and sales avenues.

Harvesting logistics are being studied through a partnership with the Delaware Division of Fish and Wildlife, which already harvests hundreds of cubic yards of wild algae per year as a public service. Algae biomass can be obtained for free by redirecting the currently dumped harvests on public land. This will fill the needs of a fledgling business, and enable the direct study of harvesting logistics further to pursue an eventual independent harvesting operation.

Several paperboard products were created and tested to verify wild algae's usefulness as a pulp additive, using wild algae taken from a pond at the University of Maryland. Handmade paper sheets used variable ratios of algae and paper/cardboard, yielding viable writing paper. Drink coasters were made by pressing and drying pure algae pulp in a 3D printed apparatus. A sample chip of cardboard was made by pressing a piece of algae paper in a corrugated 3D printed mold and gluing it between flat sheets of paper. These prototypes were subjected to use as art paper, coasters, and cardboard in situ. Storing and processing fresh harvests will be explored with algae received via the Delaware Division of Fish and Wildlife.

Green companies are being contacted to form a strategy for sales and implementation adaptively. One company is now reaching out to their cardboard box supplier to request their cooperation with us to produce prototypes because this company wishes to buy algae cardboard boxes. Once our algae pulp is converted to metrics that the machines at cardboard manufacturing mills require, we can negotiate with the manufacturers to fulfill box orders from green-signaling companies. Our value proposition is the green-signaling feature of a box, which is the color green, and made from algae that cleaned nearby water bodies. This adds value to a user's company's image with the increasing interest in eco-friendly marketing. The net effect of sales is the expansion of a business that will clean eutrophic algae blooms not out of charity but for profit.

Results

The Delaware Department of Fish and Wildlife is enthusiastically willing to support Greener's (tm) efforts, so long as it does not interfere with their efficiency. It remains to be seen whether the quality of all or some of their harvests will be usable. Small sample batch tests with handmade paper indicate that it can be successfully applied, increasingly so with smaller ratios.

A startup company, Algenair, produces air-purifying algae reactors and is excited to try our algae boxes. They are willing to advocate in discussions with their box manufacturers to create prototype boxes with Greener's Pulp (tm) for Algenair's monthly subscription shipments.

Unused chicken houses have been identified as a useful and economical facility for both drying and storing algae in a large scale manner. Mid-scale paper recycling grinders were identified as a probable candidate for preparing the refined pulp, in conjunction with pulp mixing machines.

Discussion

Selectivity and sorting may have to be employed with the harvests from Delaware bays, as some harvests are largely detrimental, full of plastics, or otherwise unusable. Fish and wildlife are easily redirected from the harvesters by the operators.

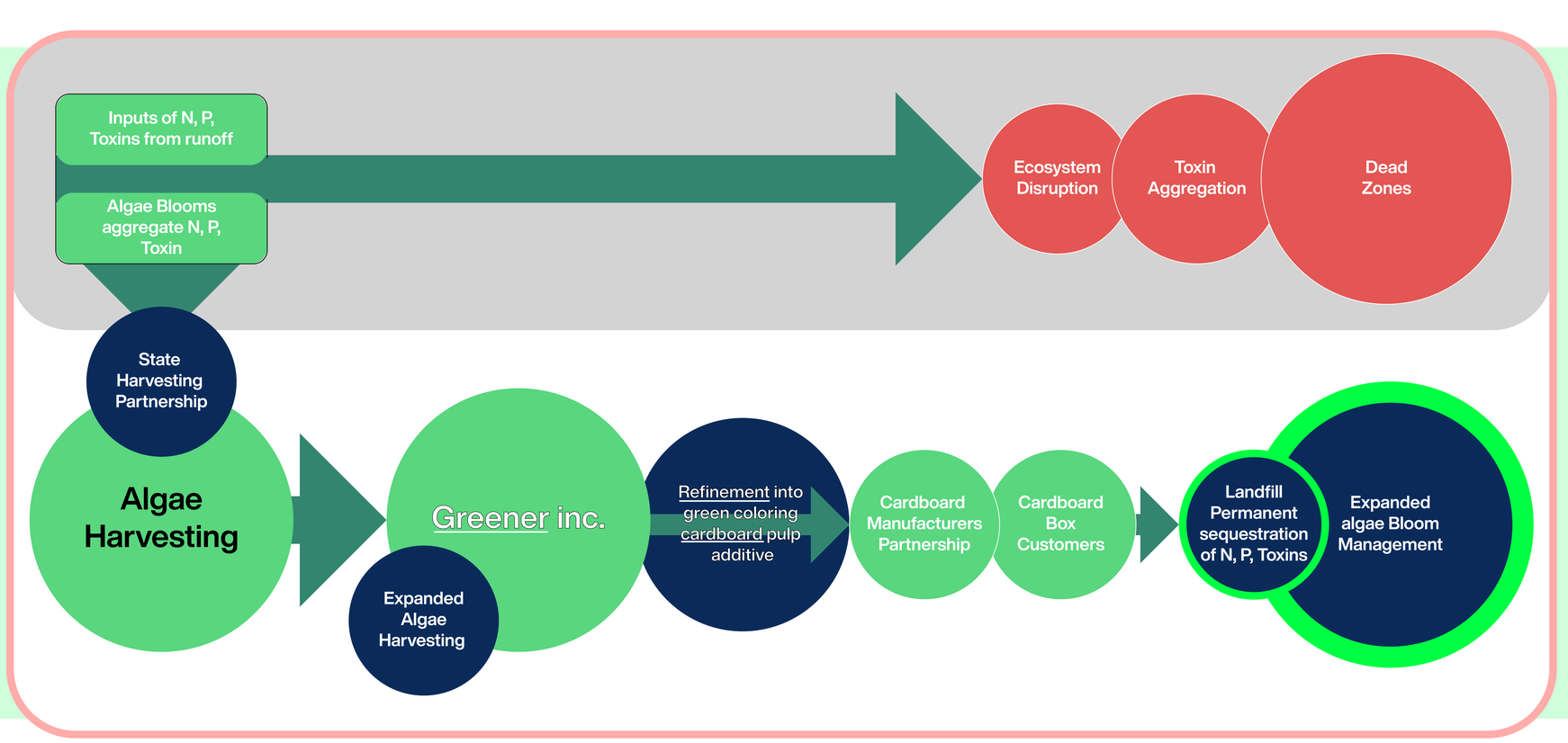
Storage and processing of pulp at scale remain mostly unexplored. Drying large quantities of algae requires large areas for spreading the biomass thin, and ideally, air movement to prevent decomposition. This process may prove to be too economically inefficient, and the scaling of the process through machinery will have to be navigated.

The successful demonstration of prototype boxes lends itself to future sales. It is unknown whether the driver for sales comes through a partnership with a paperboard manufacturer, wherein Greener (tm) supplies pulp only, or if Greener (tm) also makes sales and manages orders to a manufacturer. It is unknown yet to what extent algae harvests will need to be refined to be used in large scale cardboard manufacturing machines.

Conclusion

No insurmountable inhibitions to the function of Greener (tm) have been identified. If the business can function, there will be an economic reward for algae harvesting beyond public services provision, which can be leveraged to expand harvesting operations.

Space should be identified for receiving and processing algae harvests, likely an unused chicken house with an integrated fan system. The cost and operational logistics of cardboard manufacturing will make it impractical not to have a manufacturing partner. The output of operations will outweigh the financial inputs in the long run with strategic implementation and partnerships. The degree of processing performed by Greener (tm) will follow an understanding of this manufacturing partner's needs.



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