Seagrass: Heroes of our Oceans

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Saint Joan of Arc

Are planting seagrass beds in our nearby oceans a way to slow down acidification in them?

If you want to slowly go through this slide, please scroll down to the bottom of my CYSF project page and click one of the attachments. :)

Hypothesis

Based on the information I already know, I assume that we could use seagrass beds to slow down acidification in our local oceans (Oceans that surround Canada) by using the process of photosynthesis.

In photosynthesis, plants like seagrass, use carbon dioxide (CO_2) to make their food and by doing that, they convert the gas to oxygen. They don't only use carbon dioxide for food but to vigor and grow faster.

After they become adult plants they could spread around the oceans in their own ways.

Seagrass is a flowering plant and it reproduces sexually or asexually;

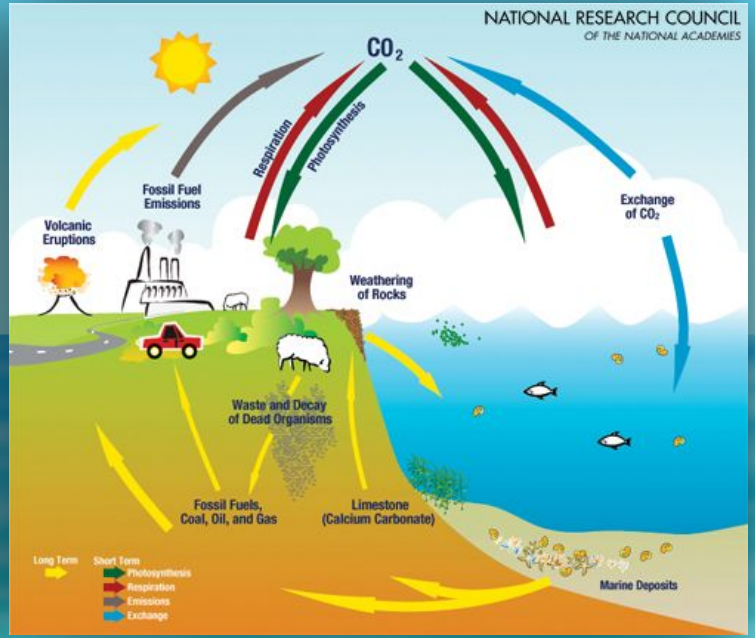
- In sexual reproduction, pollen is carried through the water to fertilize female plants
- In asexual reproduction, they shoot out rhizomes that sprout new growth which means one plant can produce a tuft of seagrasses.

For this to work, we will need to lower the amount of carbon dioxide we are putting in the atmosphere by switching to renewable resources and going green.

Ocean Acidification

Acidification is the process in which a substance gradually decreases in pH over time. This means that the acids in the substance surpasses the bases (alkali) changing its pH. Therefore, ocean acidification is when the oceans lower in pH because the amount of carbon dioxide in our atmosphere is too much to be converted into oxygen by plants

- pH is a unit of measurement used to measure how acidic or basic (alkali) a substance is. Its scale ranges from 0 (acidic) to 14 (alkaline).
- 0-6.5 is acidic, 7 is neutral and 7.5-14 is alkaline.
- The pH of the oceans could drop from it's average 8.1 down to 7.8 in 2100. Though this may seem like a small change, this could have a big impact in our marine ecosystems and such.



This diagram explains the carbon cycle and how CO2 dissolves into the ocean decreasing its pH

Ocean Acidification

<u>Effects</u>

- Aquatic Ecosystems
  - Reduces the amount of carbonate (salt of carbonic acid) which is very needed for marine life. This also makes it difficult for marine organisms to create their shells and skeletons.
  - Existing shells may dissolve.
  - A more acidic environment will harm other marine species such as molluscs, corals and some kinds of plankton.
  - Calcifying organisms might not be able to adapt to the rapid change of pH.
  - Coral reefs will be more vulnerable to storm damage and slow the recovery rate.
- Effects on Humans
  - It will affect the countries that depend on seafood as the main source of protein since most of the shellfish require calcium carbonate to form or to fortify their shells.
  - We will lose healthy coral reefs which we rely on for food, coastal protection and medicine (New medicines are being developed for cancer, arthritis, human bacterial infections, Alzheimer's disease, heart disease, viruses, and other diseases)
  - Potential job losses through declining harvest and fishery revenues from shellfish.
  - New Brunswick and Nova Scotia could see declines in resource accessibility but are not really affected by these changes unlike PEI and Newfoundland and Labrador who are more vulnerable to losses in fisheries.

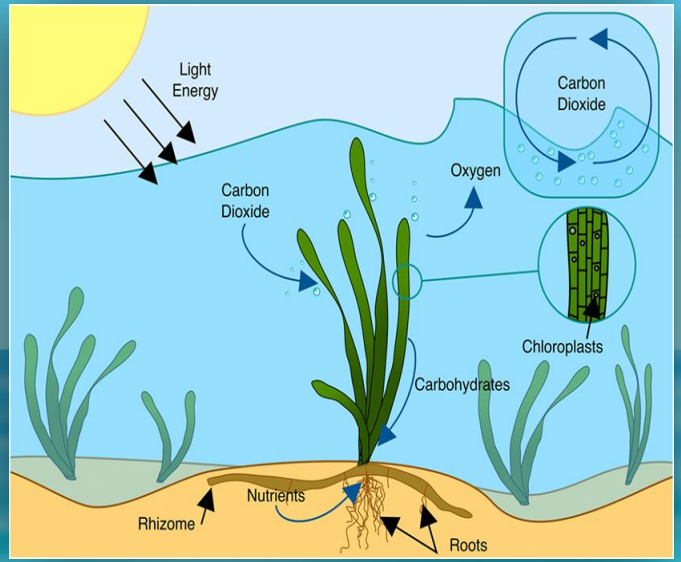
Seagrass

What is this Plant?

- Not a seaweed
- Is part of the Asteraceae
- Belongs to a group called monocotyledons (lilies, grasses, palms etc)
- Seagrasses have leaves, veins and roots, and produce flowers and seeds.

Seagrass and Photosynthesis

- Like most plants, seagrass needs sunlight to grow and photosynthesize.
- Even in the ocean, sunlight still penetrates it for about 600 ft. (This is known as the sunlight zone)
- Special cells within the seagrass, called chloroplasts, use energy from the sun to convert carbon dioxide and water into carbohydrates which are also known as sugar and oxygen through photosynthesis. Sea grass also converts CO2 into oxygen and sends this oxygen through bubbles that will rise to the surface of the ocean.

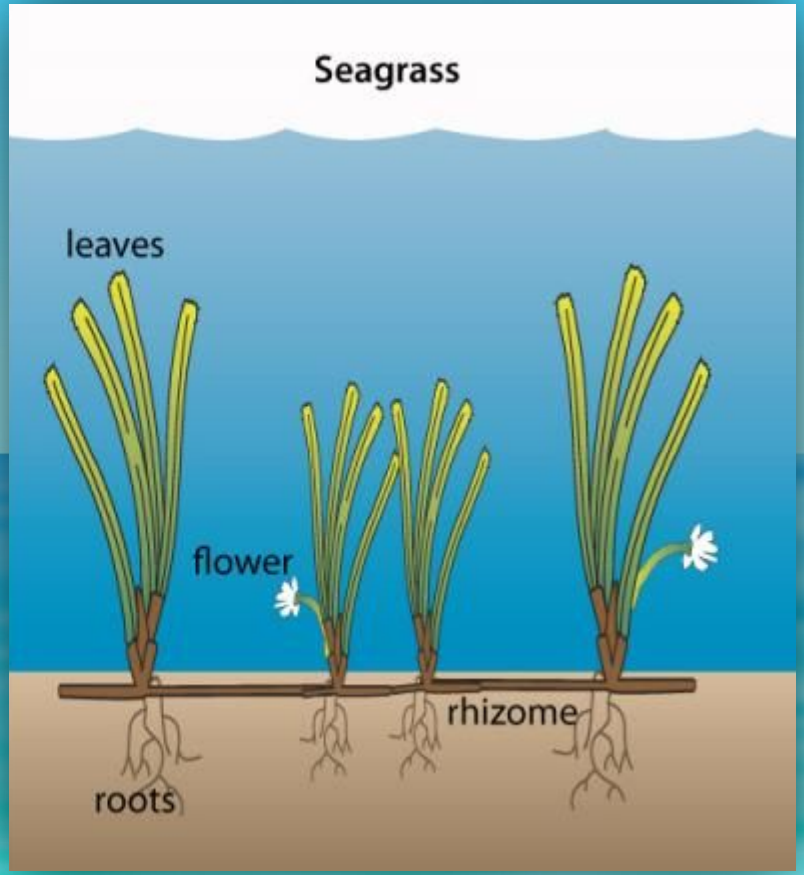


This diagram shows how seagrass photosynthesizes

Seagrass

Parts of Seagrass

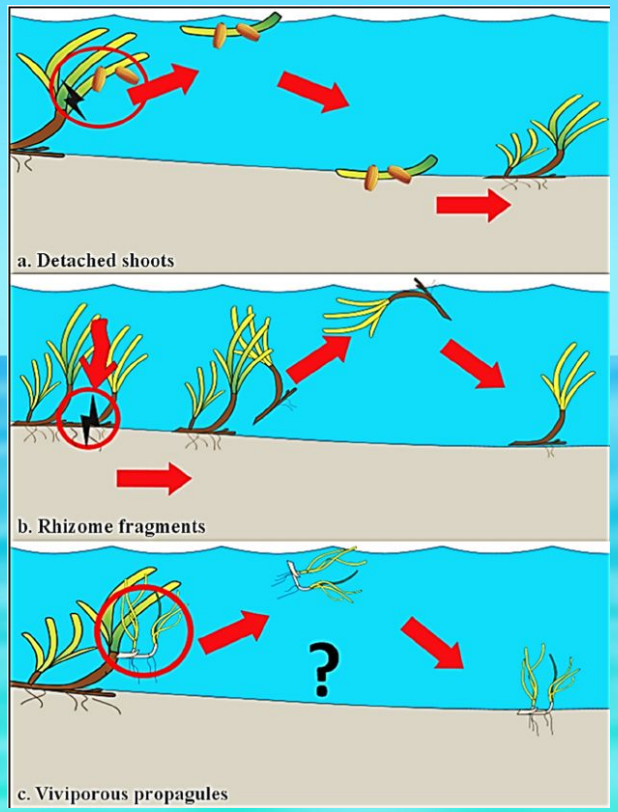
- Their stems, called rhizomes, anchor the plant.
- Roots grow down from the rhizome to also anchor the plant to the seabed
- Flexible blades grow straight up and can bend to the current.
- Fast-growing grasses form a mat that traps sediment (solid material that settles at the bottom of a liquid) and stabilizes the seabed, allowing taller, slower-growing varieties to establish roots.
- Flowers that carry pollen and seeds.



Seagrass

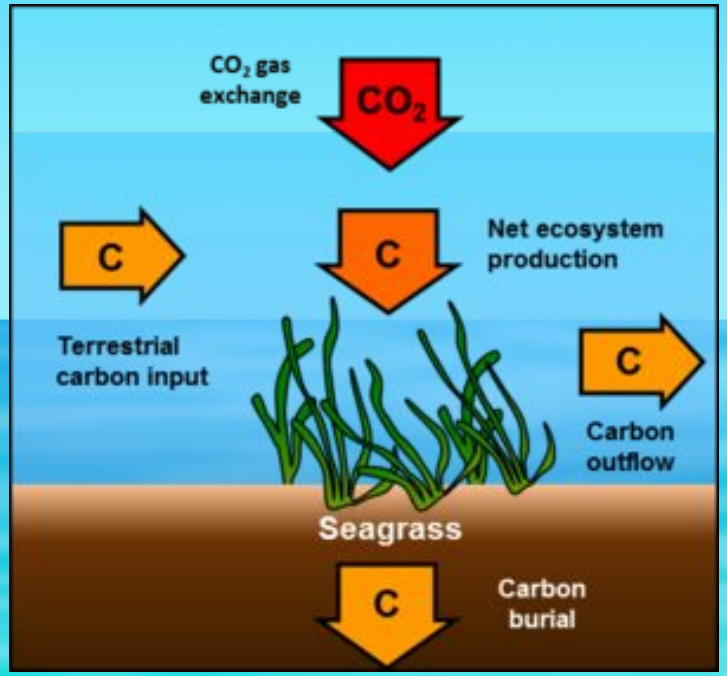
<u>Reproduction</u>

- Seagrass reproduces in 2 ways:
- Asexual Reproduction
  - Send out rhizome roots that can grow new plants, so a single plant is capable of producing an entire underwater meadow.
  - Or a rhizome root could detach and land on the sand then begin it's growth.
  - Seagrass can also break a propagule which will begin to grow into a new plant
  - This is known as clonal growth.
- Sexual Reproduction
  - Pollen is carried through the water to fertilize female flowers.
  - Or seagrass can send out a fruit that will bring out a seed which will sink when it is a week old.
  - Then it will anchor unto sand and fiber and begin its growth.



How Can Seagrass Affect Ocean Acidification

- A single square meter of seagrass can produce ten litres of oxygen per day
- This plant is photosynthetically productive; Seagrass can absorb huge amounts of carbon from the atmosphere.
- Each square metre of seagrass can absorb 83 grams of carbon per year
- Seagrass meadows hold 15% of the oceans carbon but only make up only 0.1% of the ocean floor.
- If a plant dies, the leaves sink to the seabed and decay. The carbon trapped inside the leaves and rhizomes of the seagrass will become buried by sediment, and trapped - that is if it has not been tampered with.



This picture shows how seagrass takes in carbon dioxide

An Endangered Plant

- We are losing an acre of seagrass habitat every 30 seconds and an estimated 29% of seagrass meadows have disappeared over the past century.
- Seagrass is endangered. Here are some of its threats:
- **Natural Threats**
  - Climate change due to global warming threatens both marine and terrestrial ecosystems. Storms, earthquakes and tsunamis can rip up seagrass fields and fill the water with mud and debris.
  - High levels of plant nutrients. High nutrient levels, often due to agricultural and urban runoff, cause algae blooms that shade the seagrass. Reduction in light decreases seagrass growth and can kill whole populations.
- **Man Made Threats**
  - Global warming
  - Sewage, oil spills and agricultural and industrial waste pollute the water and make it murky.
  - Seagrass needs clear, sunlit water for photosynthesis. Without it, the plants die and rot, resulting in more greenhouse gases, as well as loss of habitat for the other plants and animals that depend on the grass.
  - Coastal development; dredging harbors and building seawalls and jetties can destroy seagrass meadows and disrupt currents.
  - Boat propellers can also tear up seagrass, leaving deep scars.

How to Protect This Plant

- Prevent damage to seagrass meadows
- Create protected areas of seagrass
- Reduce overfishing
- Reduce stress from coastal development
- If you live near the coast or along a river, be careful when applying fertilizers and pesticides to your lawn
- Wear polarized sunglasses when boating to help you see shallow areas and seagrass beds.
- Support those who are trying to support this plant
- Spread the word.

Q and A with Professors

To get opinions on my theory, I decided to contact Prof. Kim Juniper from the University of Victoria and Prof. Nancy Williams from the University of South Florida.

- Professor Kim Juniper's reply:
  - *Interesting question. All plants can help reduce global atmospheric CO2 by fixing it into biomass, and this will eventually help reduce acidification caused by atmospheric CO2 dissolving in the oceans. However, this global effect does not scale down very well. Planting seagrass beds in one of our local oceans is unlikely to have much of a local effect on acidification because CO2 usually enters oceans from the atmosphere faster than it can be removed by the seagrass.*
- Professor Nancy Williams' reply:
  - *I do think that this strategy of using seagrass to create local OA refugia locally can be a short-term solution, but I do not see it as a long-term solution to OA. These plants eventually die and break down and their carbon is released back into the water, so the storage of carbon is not forever, and we still need to work to reduce anthropogenic CO2 emissions...*

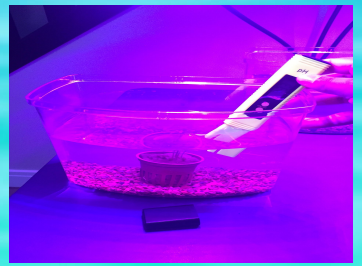
Demonstration

To show how seagrass takes in carbon dioxide and converts it into oxygen underwater, I am going to use a demonstration. In this demonstration, I am going to use aquatic plants Java Fern (Microsorum pteropus) and Gulf Swampweed (Hygrophila costata) as alternatives to seagrass.

- Materials
  - Plants used
    - Microsorum pteropus (Java Fern)
    - Hygrophila costata (Gulf Swampweed)
  - Three 0.8-Gallon Tanks
    - 2 with plants
    - 1 control
  - Carbonated water
  - Water
  - pH meter
  - Grow lights
  - Sea gravel (optional)
- Variables
  - Controlled:
    - Temp of water and carbonic acid
    - Amount of water and carbonic acid
    - Size of tubs
    - Time the tubs are left out
    - Amount of light each tub gets
  - Manipulative:
    - 2 tanks have a plant, the other does not
  - Responding:
    - pH of the water.

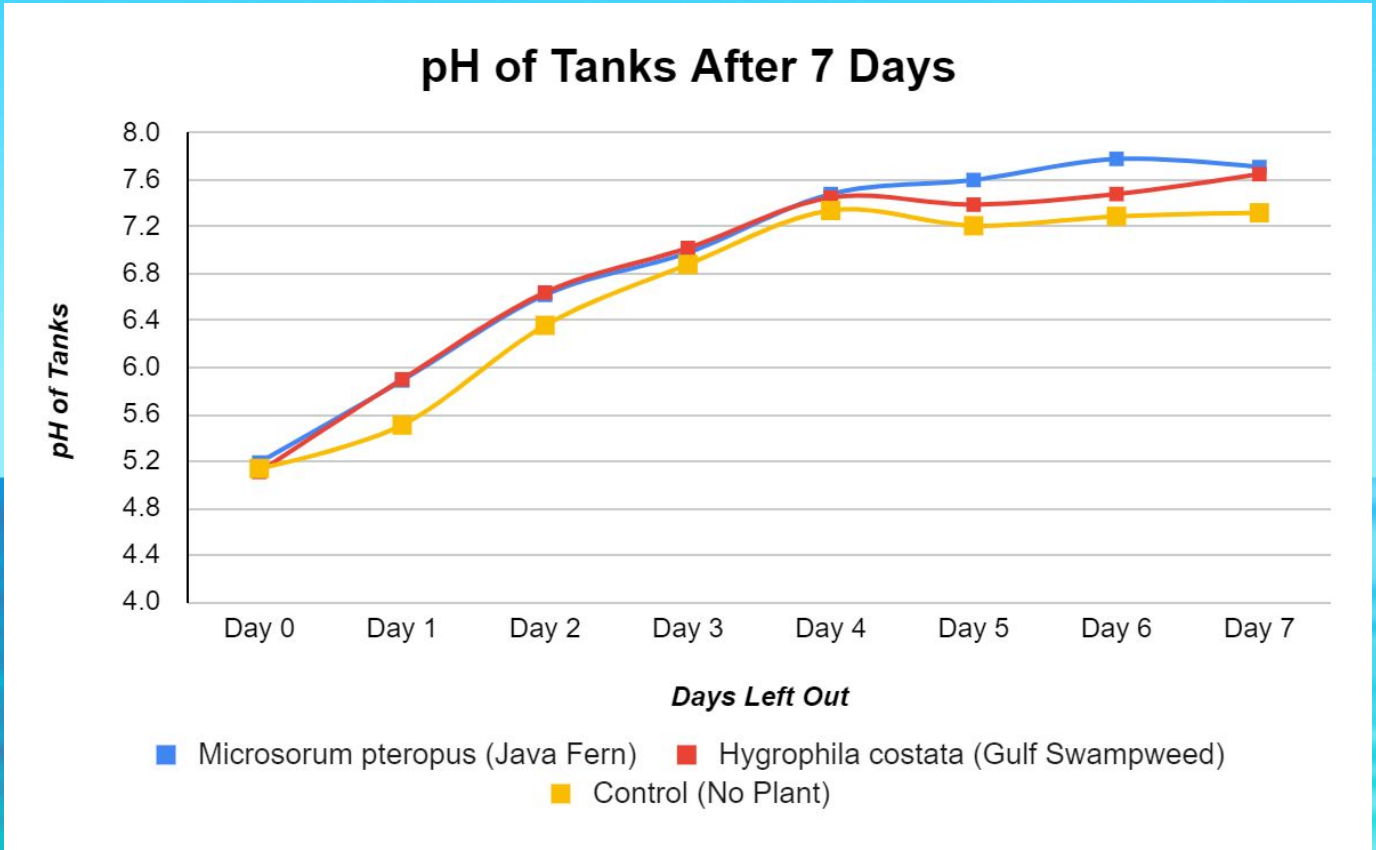
Demonstration

- Procedure
  - Wash each tank
  - Fill each tank with 1L of lukewarm water.
  - Pour in 1L of carbonated water (carbonic acid) and mix.
  - Put sea gravel at the bottom of the tank (sea gravel is not needed for this experiment. It only keeps the plant in place)
  - Put a plant in one of the tanks and put the second one in a different one.
  - Leave one tank with no plant (Control)
  - Record the pH of the water for each tank
  - Put each tank under a grow light and leave overnight for a week after that night
  - Every night at 8:30, record the pH of each tank
  - Put the information gathered into a graph and table



Results

Days Left Out	Microsorum pteropus (Java Fern)	Hygrophila costata (Gulf Swampweed)	Control (No Plant)
Day 0	5.19	5.11	5.14
Day 1	5.89	5.9	5.51
Day 2	6.62	6.64	6.36
Day 3	6.98	7.02	6.88
Day 4	7.48	7.45	7.34
Day 5	7.6	7.39	7.21
Day 6	7.78	7.48	7.29
Day 7	7.71	7.65	7.32


pH of Tanks After 7 Days
8.0
7.6
7.2
6.8
6.4
6.0
5.6
5.2
4.8
4.4
4.0
pH of Tanks
Day 0
Day 1
Day 2
Day 3
Day 4
Day 5
Day 6
Day 7
Days Left Out
Microsorum pteropus (Java Fern)
Hygrophila costata (Gulf Swampweed)
Control (No Plant)

Conclusion

- In conclusion, I found out that my hypothesis was right and wrong at the same time. Planting seagrass beds in our local oceans can be a way to slow down ocean acidification because they take in a good amount of carbon dioxide (83 grams per square metre) and convert it into oxygen even though they only make 0.1% of the ocean.
- Even if this could work, seagrass is becoming endangered and if they were only to remain untouched and untampered with, this could actually work.
- For this to succeed, we will need to reduce anthropogenic carbon emissions first, then save seagrass. Without us doing so, this could only be a short term solution to this global problem.

What's Next

- If I could continue my project, I would begin to look at this at a larger scale by looking at all the oceans. I would find out if a specific type of seagrass is invasive and how it will affect OA and organisms in the ocean.
- I would like to research other plants that take in large amounts of carbon dioxide and look at the pros and cons of that.
- I would also like to look for land based options to slow down ocean acidification and how realistic this plan would be.

Acknowledgements

I would like to thank:

Both Prof. Kim Juniper and Nancy Williams for feedback on my project

My teacher, Mrs Tara Hobart for great advice

My parents for helping me through the way.

Bibliography is in my CYSF project.
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