Role of Primary Production in Coastal Ecosystems

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Introduction

Phytoplankton makes up about half of the earth's photosynthesis. They are the foundation of aquatic ecosystems because they are primary producers. The energy produced by plankton works its way up trophic levels to sustain life in the ocean. Planktons play a vital role in ecosystems by performing the biogeochemical processes that regulate nutrient and CO_2 levels in the ocean. However, a high biomass of these producers can cause hypoxia and anoxia, placing marine life at risk. Eutrophication continues to be a major problem facing coastal ocean and marine systems. Algal blooms off the coast of China, have expanded during recent years in geographic extent and duration because of nutrients from fertilizers (Heisler et al., 2008). In addition, phytoplankton growth is determined by the amount of sunlight, water, and nutrients available. Nutrients play a key role in the biomass of phytoplankton. Most research is focused on the species of phytoplankton and their dynamics. This study focusing on how these dynamics affect organisms on an ecosystem scale using Gulf of Maine as a case study.

Sources: Rutgers's University; The Rising

Objectives and Hypothesis

Aim: to study plankton community and dynamics as related to abiotic fluxes

Specific Objectives

1. Study roles of phytoplankton in coastal ecosystems.
2. Identify the impacts of land use and climate change on phytoplankton dynamics and its effects on the coastal ecosystem and human society.
3. Develop effective solutions to decrease frequent algal blooms.

Hypotheses

H1: Phytoplankton communities are critical to coastal ecosystem functions.

H2: Land use and climate change can impair the phytoplankton dynamics.

H3: Land use and climate change can impair coastal economies.

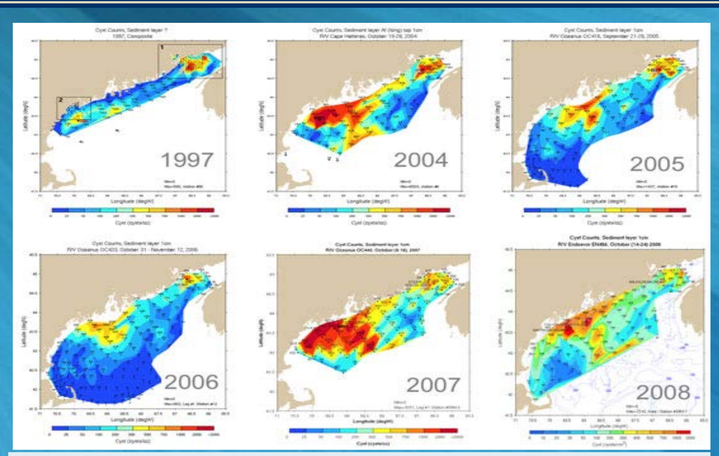
H4: It is possible to identify specific strategies to mitigate occurrence of algal blooms.

Background

Planktonic bacteria are a fundamental component of the organic carbon cycle in aquatic systems (Del Giornio et al., 1997). It sustains trophic levels because it serves as energy (Falkowski et al., 1998). Land use regulate sediments delivered marine environments, contributing to the aquatic bioavailable nutrient pool. Climate change affects the sediments and ruin the water quality (Garzon-Garcia et al., 2018). The changes in concentration from land use can lead to algal blooms in the coast. This contaminates the water, killing off marine species. (What is a harmful algal bloom?, 2016).

Study Area

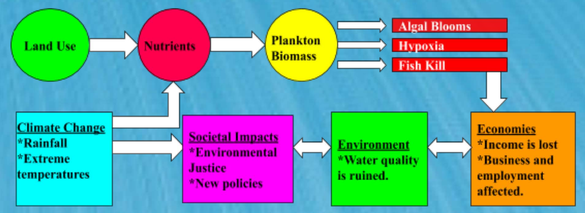
The Gulf of Maine is a coastal ecosystem covers 93,240 Km^2 In the Atlantic Ocean. It is home to more than 3,000 species. The border of the gulf includes the state of Massachusetts, New Hampshire, Maine, and some of Canada.



Levels of the phytoplankton *Alexandria Catanella* in the gulf of Maine (Anderson et al., WHOI)

Methods

Conceptual Model



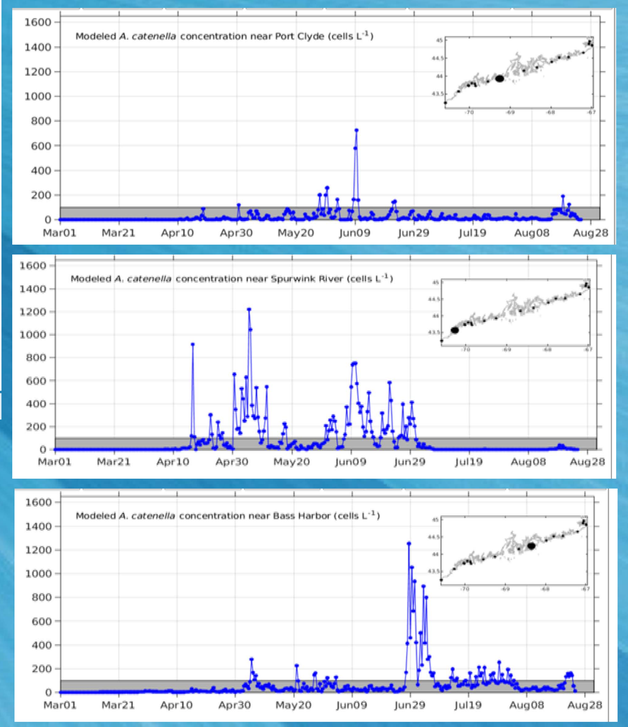
The study focuses on using literature review to study the role of phytoplankton in coastal ecosystems, the impacts of land use and climate change on phytoplankton dynamics and its effects on the coastal ecosystem and human society. By analyzing the potential issues, effective solutions are identified to decrease frequent algal blooms in the bay.

Results and Discussion

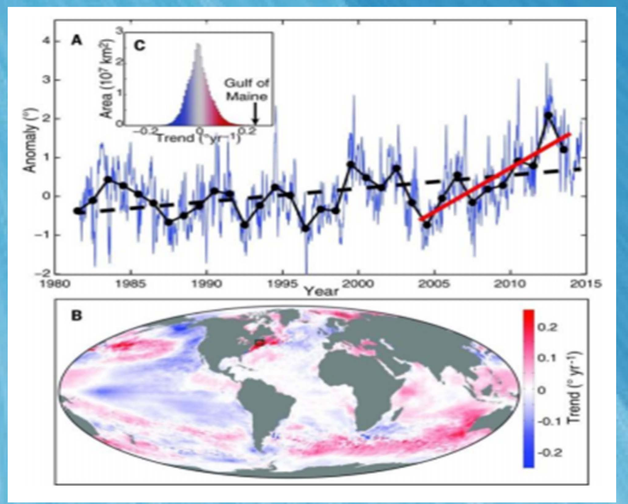
Phytoplankton is responsible for essential biological processes in the ocean.

Photosynthesis	With the chlorophyll pigment, phytoplankton can turn sunlight into energy and organic compounds. C02→O
Nitrogen Fixation	In areas of low nitrogen, microbes like phytoplankton can take in nitrogen from the atmosphere and turn it into organic compounds. N2→NH4+
Biological Carbon Pump	Phytoplankton diatoms turn carbon dioxide into organic carbon. They sink to the bottom of the ocean where the carbon is "pumped" out and out of contact with the atmosphere. CO2→C

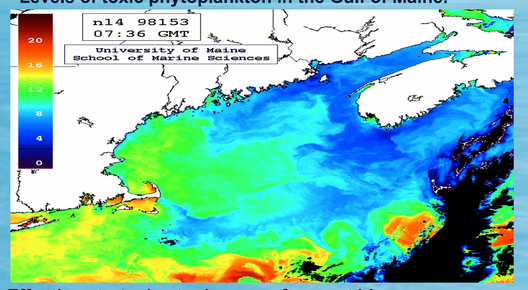
Levels of Phytoplankton *A. Cantanella* in 2019 from various sites in GOM.



Global warming trend and the effects on sea surface temperature levels on a global scale vs the gulf of Maine.



Levels of toxic phytoplankton in the Gulf of Maine.



Effective strategies to decrease frequent blooms.

Strategy	Specifics
Managing Spills	Leak detection, structural improvements in industries, water bypass process, reducing toxic materials, drainage systems, fertilizer reduction, and spill maintenance.
Monitoring	Ocean fluxes, flow dynamics, frequent testing of waters, cell concentration in sediment, storm predictions, sea surface temperature, wind flow, and chemical concentrations in water.
Natural processes	Increase bioremediation, Natural buffers – wetlands.
Restoration	Isolation and clean up, Bioremediation techniques: microbial bioremediation, phytoremediation, and mycoremediation.
Policies	Incentives for affected people, spreading information, early warning systems, compensation, Research and Development, and regulations.

Nutrient availability impacts the plankton biomass population, the biomass has subsequent effects on coastal ecosystems and human society. Nitrogen Fixation can help with the growth of microbes. Lastly, the biological carbon pump turns CO_2 from the atmosphere into organic carbon that can be used for energy in microbial communities. When there are too many nutrients available (e.g. toxic phytoplankton levels in GOM), harmful algal blooms happen. HABs cause areas of hypoxia where coastal systems cannot be sustained due to oxygen depletion. Climate and land use impacts can accelerate eutrophication process and comprehensive strategies can help mitigate the issue.

Conclusions

- Primary producers are critical to coastal ecosystems.
- Land use and climate change have a critical impact on the dynamics of phytoplankton and could have harmful effects on the communities, negatively impacting the human society outside the coastal systems.
- Future research can focus on the dynamics of phytoplankton and other organisms to understand how they are impacting the blooms.

Acknowledgements

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