Potential areas to locate *Gracilaria tikvahiae* and *Sargassum polyceratium* macroalgae mariculture systems in marine waters around Puerto Rico: A Geographic Information Systems (GIS) Approach.

Quiñones-Vilches, N.; Melendez, J; Barreto, M.

BINGHAMTON UNIVERSITY
State University of New York

Abstract

In this study, we identified the potential geographic sites to locate macroalgae cultivation for *Gracilaria tikvahiae* and *Sargassum polyceratium* in marine waters around Puerto Rico. Three ArcGIS models were developed to define suitable sites for *Gracilaria tikvahiae* and *Sargassum polyceratium* macroalgae mariculture sites in Puerto Rico: 1) the Human/Physical Constraint model 2) the Ocean Wave and Current Model; and 3) the Macroalgae's Optimal Environmental Characteristics Model. Results showed that the Human/Physical Constraint model eliminated nearly 99% of the Puerto Rico's Exclusive Economic Zone (EEZ). According to this model, depth, which is related to the regional tectonic formation of the study site, is the most restrictive variable to conduct *G. tikvahiae* and *S. polyceratium* macroalgae mariculture activities in Puerto Rico waters. The Macroalgae's Optimal Environmental Characteristics Model showed that SST (Sea Surface Temperature) could reduce *G. tikvahiae* optimal growth around Puerto Rico during winter season to 0.07% of the EEZ.

Introduction

- Puerto Rico is ideally suited to facilitate the development of macroalgae mariculture systems based on Puerto Rico's tropical climate and oceanic location with easy access to water.
- A location assessment for macroalgae mariculture is required for the development of an algaebased bioenergy system in Puerto Rico.
- The study developed three GIS model to analyze possible locations for macroalgae mariculture operations for biofuels systems.
- Human/constraint and environmental variables were analyzed to identify potential sites.
- The models were applied to all marine waters around Puerto Rico within the EEZ. (U.N., 2012).
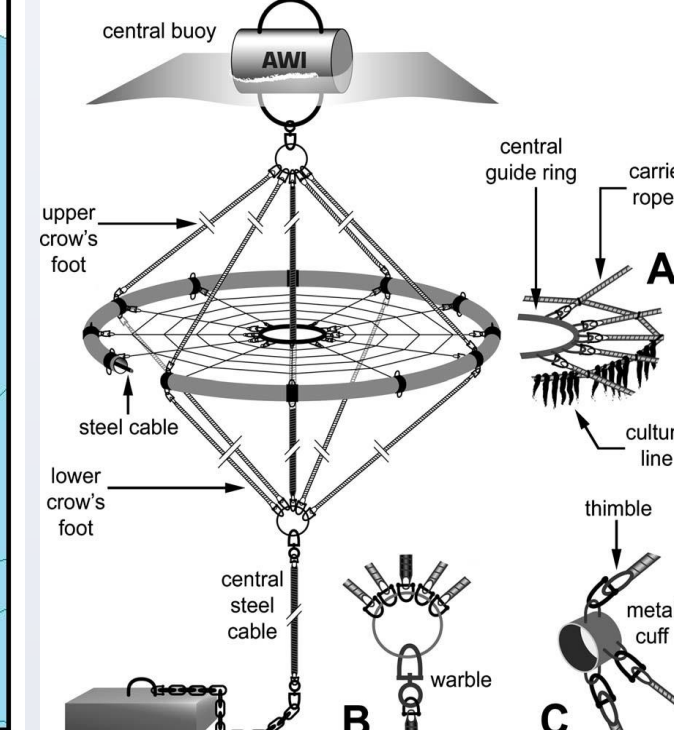- Example of Macroalgae Mariculture in Indonesia:

Rex Features. (Photo Credits). (2012). *Aerial view of a seaweed-harvesting village on the bukit peninsula in Bali, Indonesia.* [Web Photo]. Retrieved from http://www.guardian.co.uk/environment/2012/jan/19/gm-microbe-seaweed-biofuels

Study Area
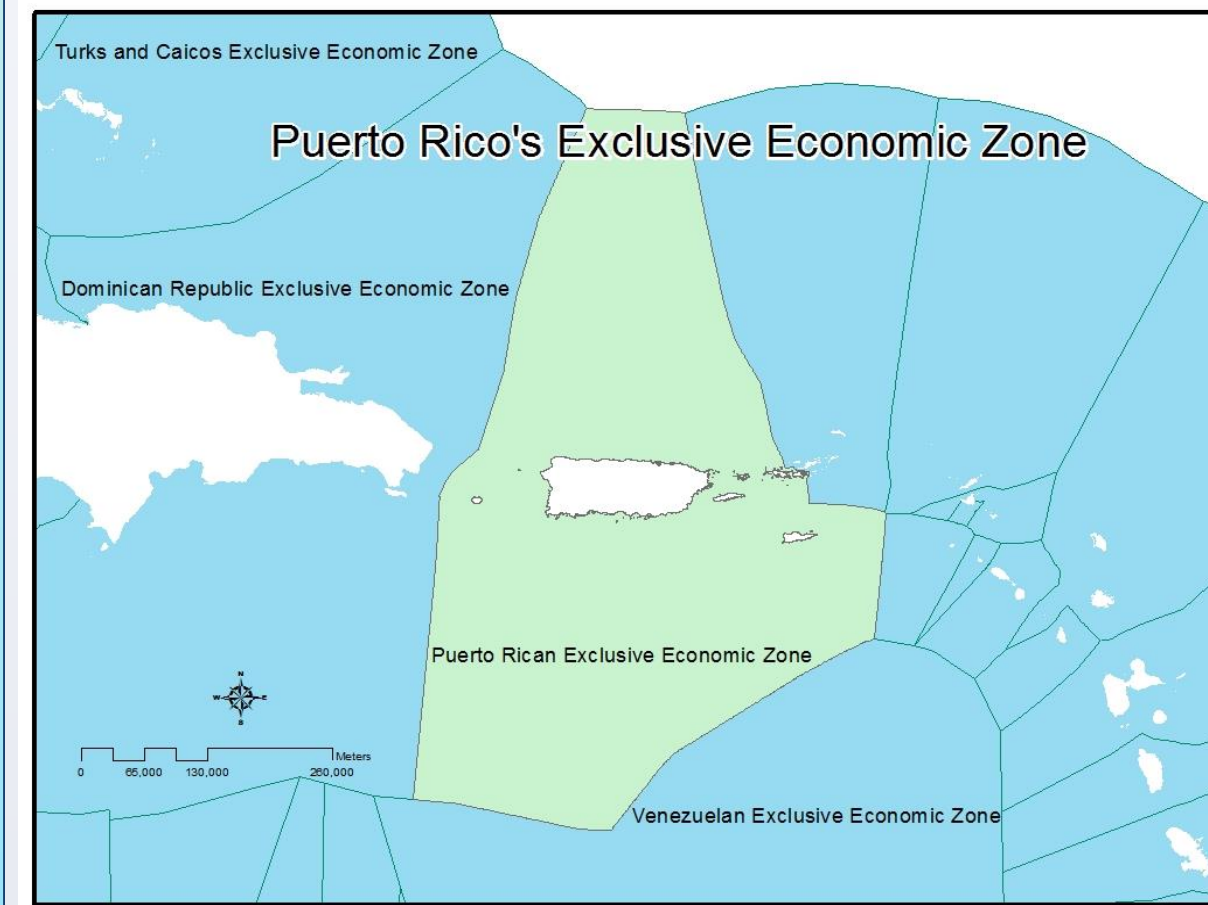
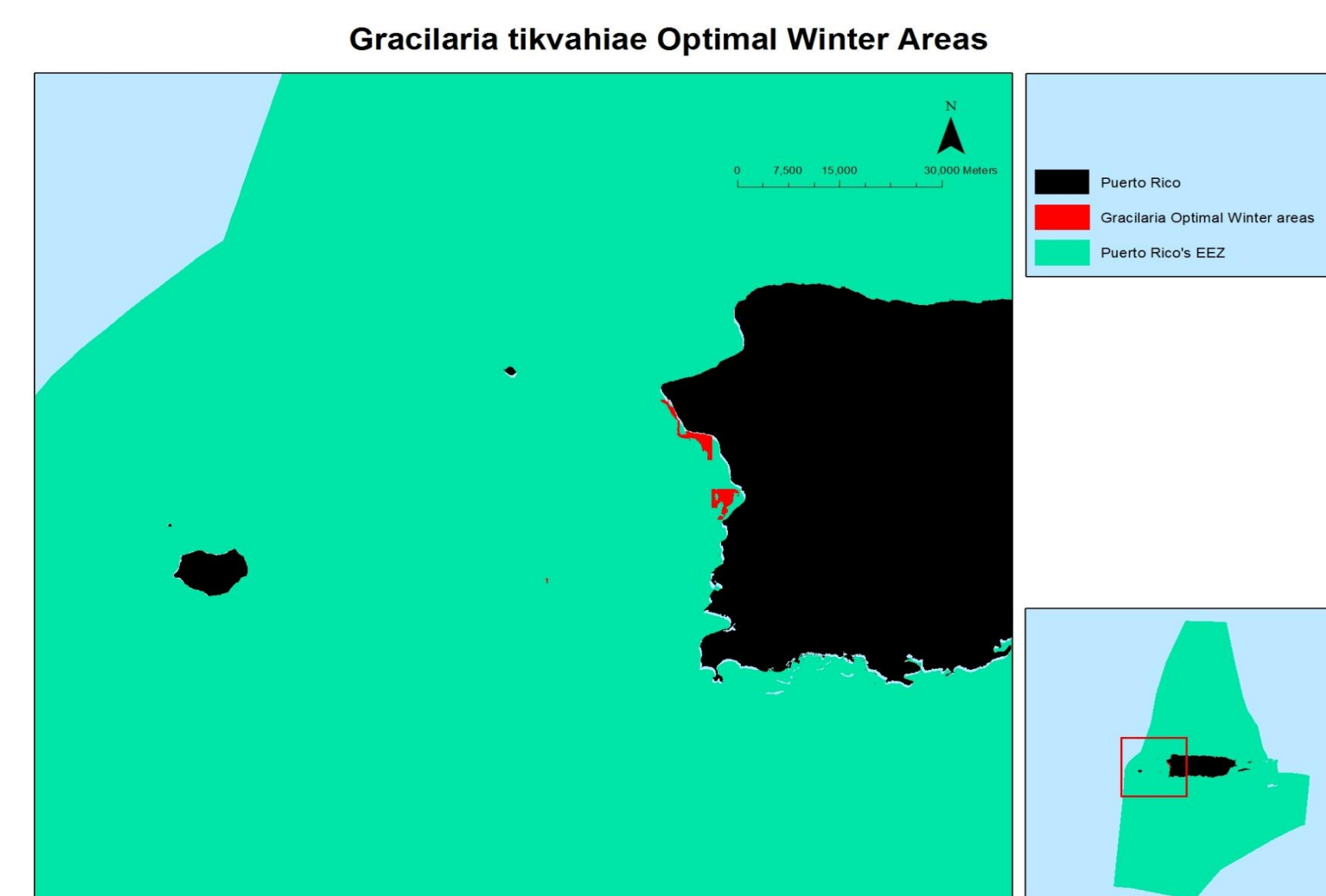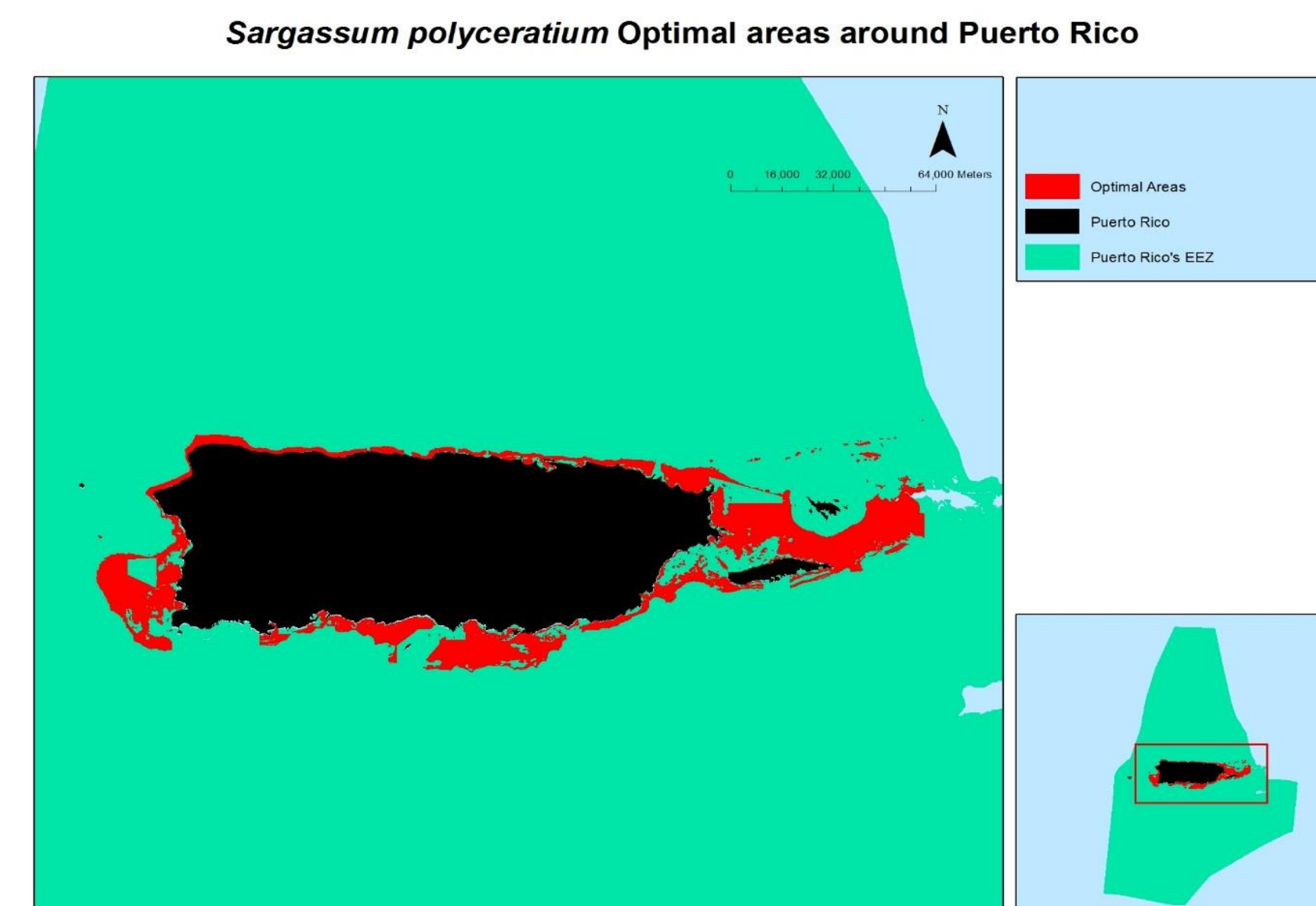

Ring Design Platform (25 m²)

Buck, B. H. & Buchholz, C.M. (2004). The offshore-ring: a new system design for the open ocean aquaculture of macroalgae. *Journal of Applied Phycology*, 16, 355-368.
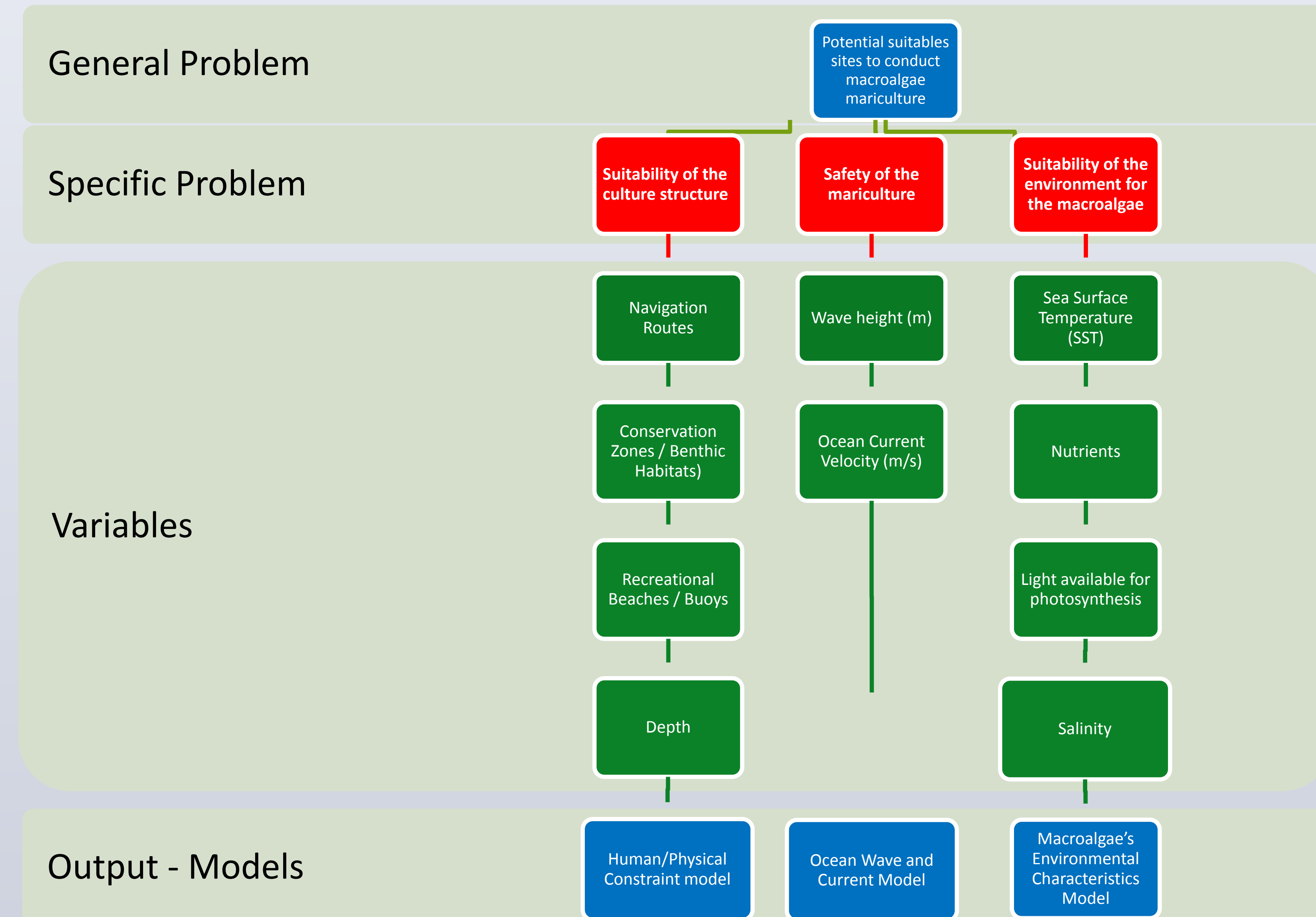
Methodology

General Problem · Specific Problem · Variables · Output - Models

Potential suitables sites to conduct macroalgae mariculture

Suitability of the culture structure → Navigation Routes → Conservation Zones / Benthic Habitats) → Recreational Beaches / Buoys → Depth → Human/Physical Constraint model

Safety of the mariculture → Wave height (m) → Ocean Current Velocity (m/s) → Ocean Wave and Current Model

Suitability of the environment for the macroalgae → Sea Surface Temperature (SST) → Nutrients → Light available for photosynthesis → Salinity → Macroalgae's Environmental Characteristics Model

Results

Union of the three models areas

Specie	Temporal Scale	Area km²
G. tikvahiae	Annual	2486
G. tikvahiae	Winter	17
G. tikvahiae	Summer	2486
S. polyceratium	Annual	2486
S. polyceratium	Winter	2486
S. polyceratium	Summer	2486

Final Outcome

Sargassum polyceratium Optimal areas around Puerto Rico

Gracilaria tikvahiae Optimal Winter Areas

Conclusions

- There is a better macroalgae specie option to develop large scale *S. polyceratium* macroalgae production in a safe and sustainable industry on the tropical coast of Puerto Rico. Suitable sites were mainly identified in the east (42% of total area) and south (25% of total area) coastal waters of Puerto Rico.
- Suitable sites to conduct *G. tikvahiae* mariculture activities during winter period are: near Mayaguez municipality (west area of Puerto Rico)
- Depth variable restrict **98.8%** of the area to conduct *G. tikvahiae* and *S. polyceratium* macroalgae mariculture activities in Puerto Rico waters.
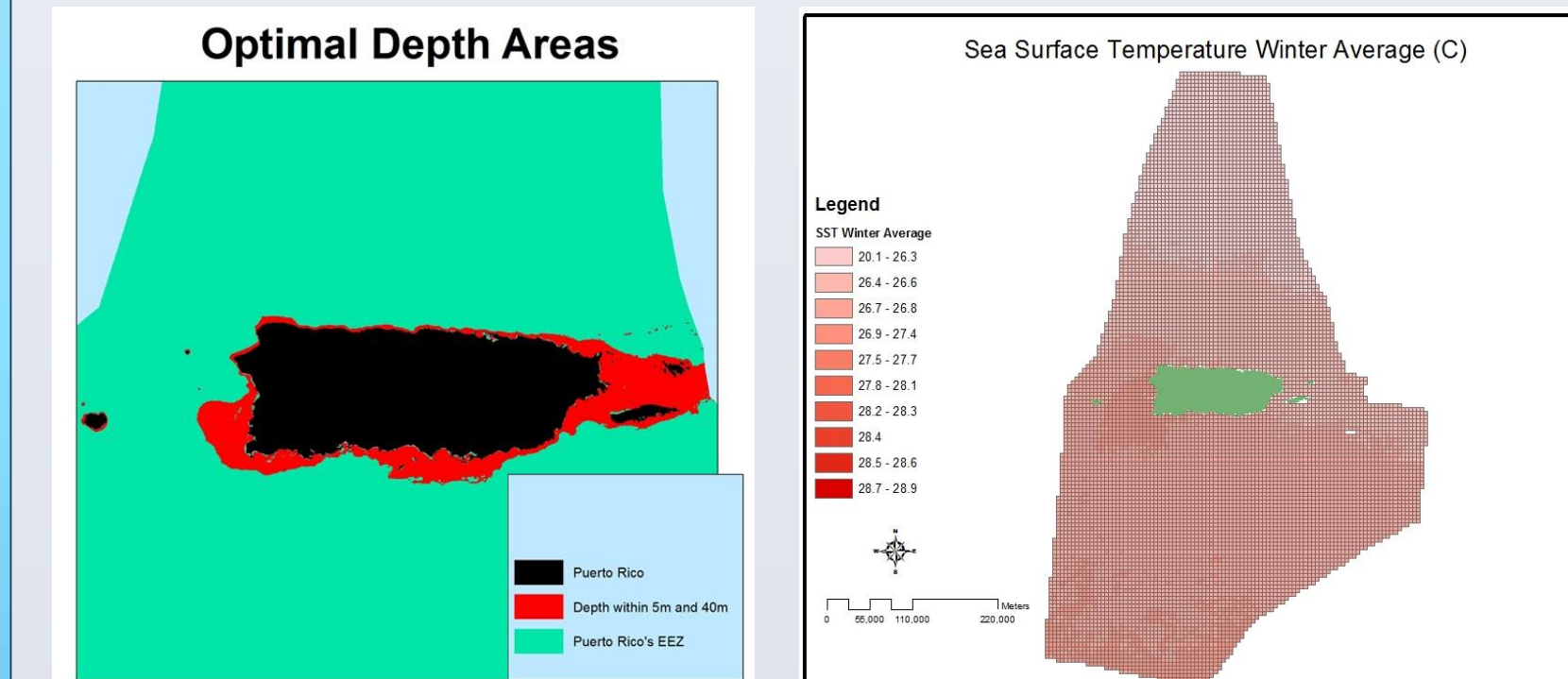
- Only **0.07%** of the Puerto Rico's Exclusive Economic Zone met the SST average that *G. tikvahiae* need to have for optimal growing conditions in the winter temporal scale.

Acknowledgments

Contact

Norberto Quiñones Vilches
nquinon2@binghamton.edu