

# Assessing Brazil's Marine Aquaculture Potential

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## Proposers:

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Master's Candidates, 2020

## Client:

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## I. Objective:

This project aims to evaluate the potential for marine aquaculture along the Brazilian coastline. The analyses will explore the potential for profitable domestic production of seafood, the optimum locations for production, and the ideal species to propagate. Specifically, students will:

1. Conduct a species assessment of the most commonly imported finfish and shellfish species in Brazil, that could potentially be profitable to grow in Brazilian coastal waters,
2. Assessment of the main barriers to expansion of marine aquaculture in Brazil,
3. Development of a heat map, to identify the areas where marine aquaculture would be feasible and profitable for both bivalves and finfish species along the coast of Brazil

## II. Significance:

As the human population is expected to reach 10 billion people by 2050<sup>1</sup>, our food systems will be under ever more intense pressure to produce animal protein for an increasing population.<sup>2</sup> Faced with stagnant wild fishery stocks<sup>3</sup> and large impacts from land-based agriculture<sup>4</sup>, momentum is building to look towards marine aquaculture to meet the growing protein demand<sup>5</sup> in the most planet friendly way. The relative sustainability of marine aquaculture compared with land-based meat production<sup>6</sup>, and the human health benefits of diets rich in fish<sup>7</sup> make it even more pressing that we consider aquaculture's potential. Oceans represent an immense opportunity for food production, yet the open ocean environment is largely untapped as a farming resource, especially in Brazil. Less than 10% of Brazil's seafood production comes from marine aquaculture, and most of it is targeted toward very specific crustacean and shellfish species<sup>3</sup>.

The majority of existing aquaculture takes place on land, in freshwater, and in nearshore marine waters<sup>8</sup>. However, problems such as high resource use, pollution, and habitat destruction have created a generally negative reputation for land-based aquaculture<sup>9</sup> and poses challenges for continued expansion of aquaculture. Open ocean aquaculture appears to have several advantages over the more traditional, land-based, culturing methods, including fewer spatial conflicts and a higher nutrient assimilation capacity<sup>10,11</sup>, highlighting the opportunities for sustainable marine aquaculture development. Nevertheless, large-scale open-ocean farms are not yet common, making adaptive management and careful research an essential element of sustainable marine aquaculture expansion.

Most of the research on marine aquaculture potential has focused on developed nations<sup>12,13</sup> and/or specific species<sup>14</sup>, and there remains an important need to assess the potential in developing countries. Brazil, for instance, has the second largest coastline among all the Latin American countries (LAC)<sup>15</sup>, yet, it imports

more than US\$ 1.3 billion worth of seafood products every year<sup>16</sup>. To address this need, this project will seek to use open-source oceanographic data to map the biological and economic potential for marine aquaculture, for both finfish and bivalves, across the Brazilian coastline, in order to provide stakeholders with the optimum places and species to invest in marine aquaculture in Brazil.

### **III. Background:**

Brazil has historically benefited from large natural fish stocks and saw no need to cultivate an aquaculture industry<sup>17</sup>. Aquaculture has been on the rise in Brazil since the early 1990's, but remains a small contributor to national food production. The six main aquaculture sectors in Brazil are: freshwater fish, marine shrimp, clams, oysters, freshwater shrimp and frogs<sup>18</sup>. The only cultivation that is present in all of Brazil's states are freshwater fish farms. The existing marine aquaculture cultivations are mainly small-scale finfish pens apart from some select marine shrimp farms<sup>17</sup>.

Aquaculture has a contentious reputation with many people regarding it as harmful to the environment due to farming of higher trophic level finfish in coastal waters, habitat destruction, in nutrient loading<sup>19</sup>, spread of disease, and escapes of exotic species. However, such impacts occur from all forms of food production, and comparisons scaled to a unit of protein production suggest that aquaculture may be much more efficient than land-based alternatives. Recent advances in techniques, and innovations such as multi-trophic level aquaculture, are continuing to grow these potential benefits<sup>20</sup>.

Brazil lacks a current framework to implement broad scale aquaculture, but has enormous potential and sizeable needs. The opportunity to create a comprehensive spatial plan that takes into account ecosystem conservation, fisheries and agricultural interactions, projected growth in demand, and lessons learned from other global settings could have enormous impact. An overarching investigation of potential aquaculture implementation along the Brazil coastline will also create a model for similar efforts across the developing world.

### **IV. Available Data**

To meet these objectives we will build a model using biological, geospatial, and environmental datasets, to assess Brazil's potential to cultivate both finfish and bivalves, on its coastline. Previous researchers have been successful in mapping global coastlines for potential aquaculture production<sup>13,14,21</sup>, utilizing open-data sources available online. This effort will enhance the resolution of these prior efforts and couple production potentials to other country specific data.

For the environmental constraints and potential spatial conflicts that may constrain aquaculture production, data will be collected from a variety of different sources, that are already available online. These include:

For ocean depth: Satellite geodesy data<sup>22,23</sup>. For dissolved oxygen: World Ocean Atlas<sup>24</sup>. For chlorophyll availability: Vertically generalized production model (VGPM) chlorophyll - based primary production estimate<sup>25</sup>. For marine protected areas (MPAs): 2010 World Database of Protected Areas<sup>26</sup>. For oil rigs: Halpern *et al*<sup>27</sup>.

For data on the species that are currently being cultivated in aquaculture around the world, as well as their temperature thresholds, online databases such as FishBase, SeaLifeBase<sup>28</sup> and Encyclopedia of Life (EOL)<sup>29</sup> have widely available resources. Seafood quantity and species imported in Brazil are available from PeixeBR<sup>16</sup>. Data for water temperature and current intensity and direction can be found from the National Oceanic and Atmospheric Administration (NOAA)<sup>30</sup>, National Buoy Program (GOOS-Brasil)<sup>31</sup> and Brazilian Coast Monitoring System (SiMCosta)<sup>32</sup>.

## **V. Possible Approaches:**

Objectives will be achieved through a combination of a literature review, model frameworks and empirical analyses. Specifically, the project team will:

1. Conduct a species assessment of the most commonly imported finfish and shellfish species in Brazil, that could potentially be profitable to grow in Brazilian coastal waters and compare the list to those that are currently being cultured in captivity.
  - a. Explore data available from the Brazilian Fish Association to determine the most imported marine species
  - b. Review literature to determine which of the above species are already being aquacultured around the world
2. Assessment of the main barriers to expansion of marine aquaculture in Brazil
  - a. Analyze the scientific and grey literature to evaluate the most commonly described barriers
  - b. Collect qualitative data, through interviews with key groups (industry, government), to supplement existing quantitative data
3. Develop a heat map, to identify the areas where marine aquaculture would be feasible and profitable for both bivalves and finfish species along the coast of Brazil
  - a. Explore methodologies applied to previous scientific works that sought to map potential marine aquaculture
  - b. Constrain the potential species to areas within their respective upper and lower thermal thresholds using sea surface temperature data
  - c. Exclude areas with unsuitable growing conditions, such as low dissolved oxygen (finfish), low phytoplanktonic food availability (bivalves), high depths (>200m where anchoring farms is too expensive), oil rigs and (MPAs), shipping lanes and key fishing sites.
  - d. Modeling of the heat map using RStudio

## **VI. Deliverables.**

Final deliverables will include the required presentation, poster, policy brief, and written report. Final deliverables for the client will include:

1. Species-level heat maps showing hotspots for marine aquaculture production (biomass and revenue) along the Brazilian coastline, presenting an opportunity for endeavors and government to develop aquaculture in a way that aligns with their economic, environmental and social objectives
2. Pathways to implement aquaculture more efficiently
3. Recommendations for best practices in the management of marine aquaculture products, with reference to pragmatic options for market entry and traceability

## **VII. Internships.**

A 2019 summer internship in Sao Paulo, Brazil will be hosted by WWF-Brazil, focused primarily on advancing on the goals of the group project, and supported with mentorship and additional opportunities to engage in other initiatives of professional interest at the WWF-Brazil Sao Paulo headquarters. This internship is tentatively non-paid, yet WWF-Brazil is seeking funding to support the costs of travel and living through a stipend should this project be selected. Furthermore, a second full-time intern will be hosted with the same structure, mentorship and objectives, yet supported with funding from the Latin American Fisheries Fellowship (LAFF) should that intern be a LAFF fellow.

## X. Supporting Material:

### Budget

Item	Cost (USD)	Funding Source
Proprietary Database, Model Access	50 - 200	Bren
Printing	150 - 300	Bren
Presentation Materials	200 - 400	Bren

### Timeline

	Spring 2018	Summer 2018	Fall 2018	Winter 2019	Spring 2019
<b>Modeling</b>	Data, Literature Exploration; Model Development		Data Analysis	Finalize Model, Outputs	
<b>Communication</b>	Website Development		Outline Report, Presentation	Finalize Report, Presentation and Complete Defense	Present to public
<b>Client</b>	Meet WWF; Identify Needs, Resources, Joint Timeline		Communicate with WWF on Deliverables		Finalize Client Deliverables

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January 24, 2019

**Group Project Committee**  
**Bren School of Environmental Science & Management**  
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Dear Group Project Committee:

It is with great excitement that I write this letter, on behalf of WWF-Brazil, to support the Group Project proposal "*Assessing Brazil's Marine Aquaculture Potential*". The proposal was written in partnership with Caio Vianna and Kirby Bartlett, MESM 2020 Candidates. As a Latin American Fisheries Fellow (LAFF) and Bren School alumnus, I look forward to engaging with Bren again, now as a Group Project client, and help finding interdisciplinary solutions to this environmental problem.

Since its creation, WWF-Brazil's Marine Program have been working extensively with the seafood supply chain, from projects with producers to campaign with consumers. Currently, the estimative is that 80% of fisheries stocks in Brazil are either overfished or fully fished, and fisheries management is nowhere near to improve this status. We believe that this project will contribute to the development of marine aquaculture in Brazil, creating alternative livelihood for fishers, and reducing fishing pressure on wild stocks.

As the client for this project, we would like to commit to provide relevant data, consultation and supervision during its development. We would also like to commit on hosting a non-paid intern in our office in São Paulo, over the summer. An additional paid internship is currently being discussed. In respect to the cost of the project, we expect that it will not require more funding than the budget allocated by the Bren School.

If there is any additional information we can provide to support this project, please contact us. We are very interested in this collaboration with the Bren School, and we look forward to moving ahead with this project.

Best Regards,

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