MARICULTURA PROJECT BRIEF

# SHAPING OFFSHORE MARICULTURE IN BRAZIL

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**Client:** Caio Faro, World Wildlife Fund

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## ENVIRONMENTAL PROBLEM

Food systems across the globe face intense pressure to produce enough animal protein, as the human population grows towards a projected 10 billion people by 2050. As a result, wild fish stocks, a major protein source, are overharvested and undergoing precipitous population declines. Evidence shows that fisheries management has improved and that some wild fish stocks are increasing, but this small growth rate of wild stocks falls far behind the global demand for fish.

# PROJECT SIGNIFICANCE

With rising human populations and declining wild fish stocks, offshore mariculture can provide an influx of seafood within the global market, which can assist countries with seafood supply and economic expansion in the coming decades. To meet global fish demand, and with the potential to alleviate pressure on wild fish stocks, the relatively nascent offshore marine aquaculture (mariculture) industry has been developing around the globe.

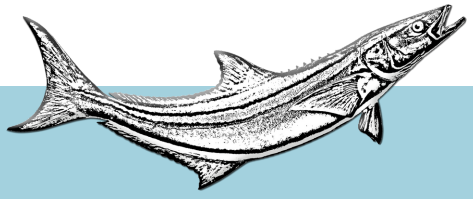
While impossible to claim a one-to-one replacement ratio between farmed and wild-caught fish, the United Nations Food and Agriculture Organization (FAO) affirms that farmed fish is the fastest-growing food sector in the world. Consequently, countries may see large economic opportunities through offshore aquaculture expansion, regardless of the effects of this budding practice on the wild-capture industry. Additionally, offshore mariculture holds environmental benefits over land-based practices, as farms located further away from coastal areas better disperse particulates, minimizing environmental pollution and the risk of disease to surrounding wild stocks.

Despite having one of the largest Exclusive Economic Zones in the world, Brazil has yet to develop an offshore mariculture industry. Brazilian commercial and recreational fisheries use unsustainable fishing practices while attempting to meet the national protein demand, which threatens the health of many of wild stocks. A recent study conducted by WWF-Brazil estimated that over 80% of Brazilian fisheries are currently overexploited. Furthermore, Brazil imports more seafood than any other Latin American country, expending over US$ 1.2 billion on seafood imports in 2019. The state of Brazil's wild fisheries and the lack of mariculture development make it a prime system for investigating the potential for offshore mariculture. With the second largest coastline of all Latin American countries, Brazil offers untapped potential to develop the industry.

Photo: InnovaSea Systems, Inc

# PROJECT OBJECTIVES

There have been no large feasibility studies of offshore aquaculture in Brazil to date. In this study, we created a marine spatial planning web-based tool for estimating the biological and economic feasibility of offshore finfish mariculture. We used Brazil and cobia (*R. canadum*) as a model system to estimate the efficiency of our tool.



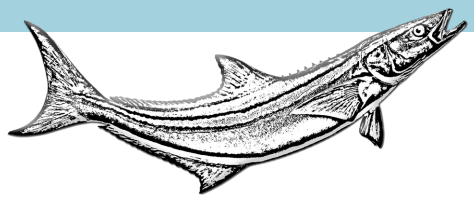
# APPROACH

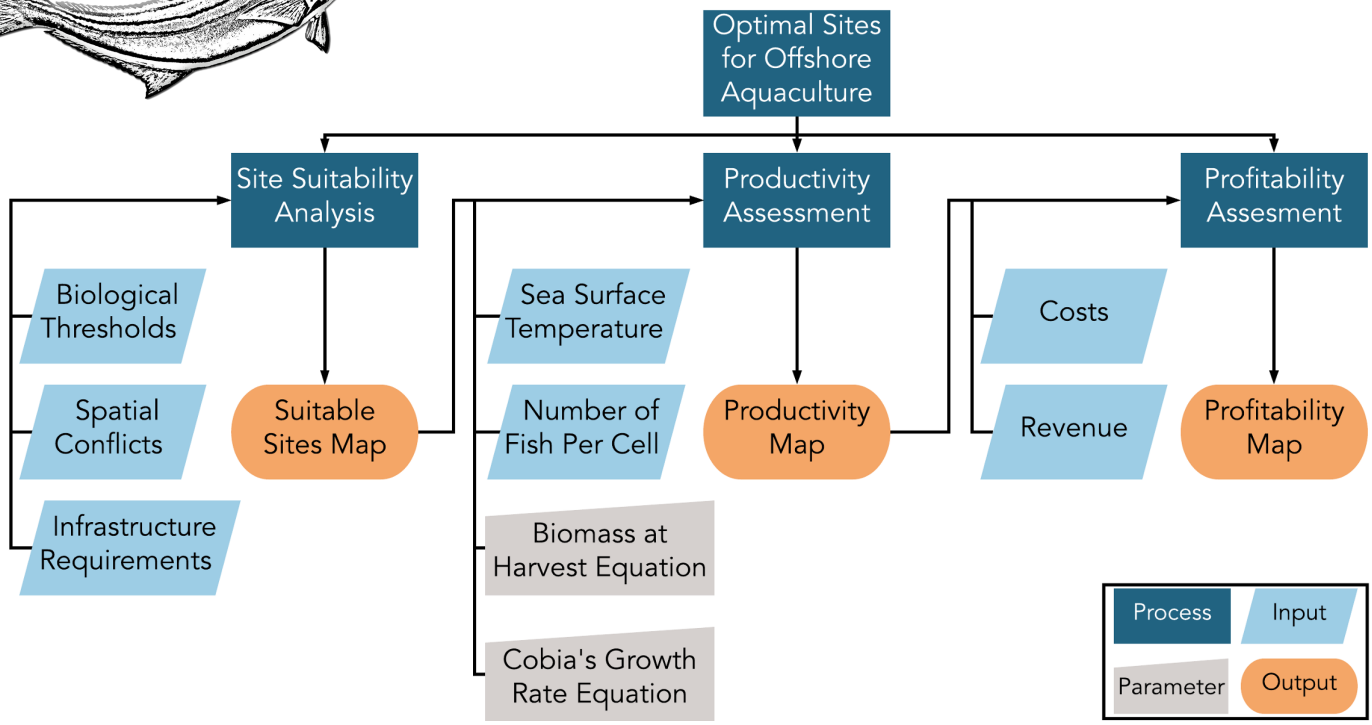
1. We identified potential locations for offshore cobia aquaculture by excluding unsuitable areas from Brazil's Exclusive Economic Zone (EEZ). The spatial analysis excluded areas with key physical spatial conflicts and areas outside of biological tolerances, in addition to considering placement feasibility with the selected infrastructural specifications.

2. We estimated potential biomass productivity of the determined suitable sites by scaling the potential growth rate at each site relative to the growth rate at cobia's optimal temperature. Biomass was derived by multiplying the modeled growth rate at each site by the stocking density, cage volume, number of cages per site, and the expected mortality rate.

3. We determined the potential profitability of the suitable sites through economic models accounting for the potential biomass yield per site, as well as capital, operational, other variable and fixed costs dependent on labor requirements and distance to shore.

4. We developed an interactive web-based tool using the Shiny package in R for the application of this analysis to other species and/or various parameters. Tool users can input customized parameters and thresholds, allowing for this tool to be adapted for other locations and marine spatial planning uses.

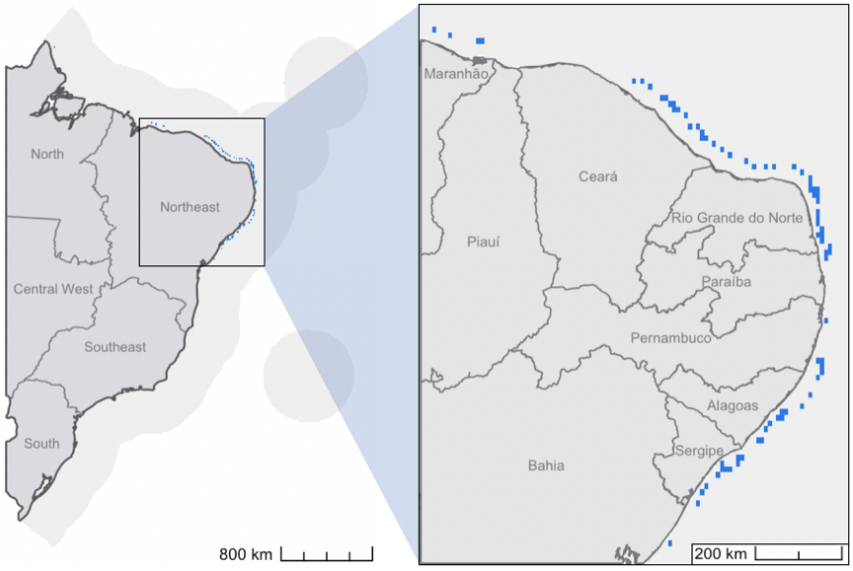




# MAJOR FINDINGS

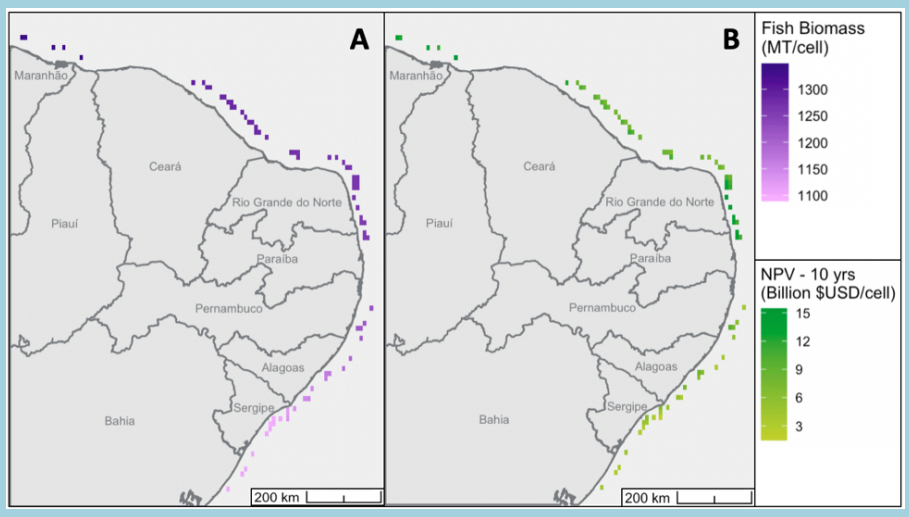
## SITE SUITABILITY ANALYSIS

Our analysis determined that a total area of 9380 $km^2$ was available for offshore marine aquaculture. The majority of these suitable sites are located in the Northeast region of Brazil where there is less heavy ship traffic along the coast. This region is home to over 50 million inhabitants, in which over 70% live in coastal cities.




## PRODUCTIVITY ASSESSMENT

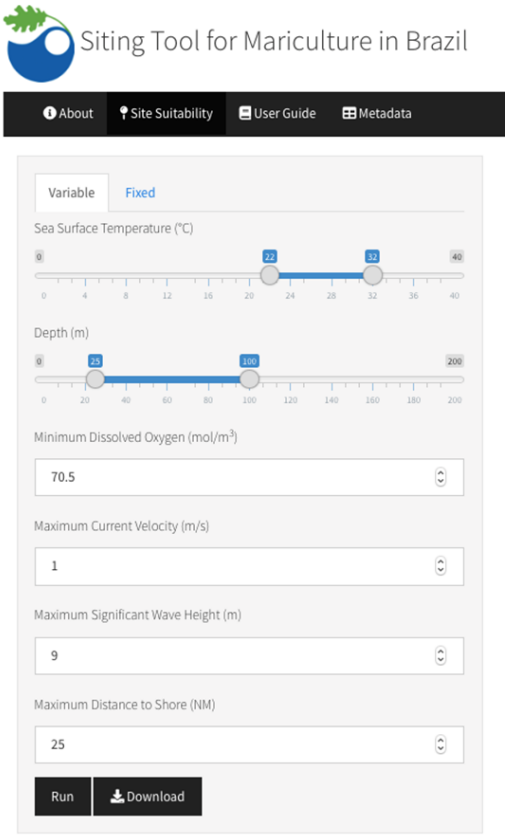
Placing only a single farm in each suitable cell, we estimated a total productivity of approximately 94,000 metric tons/year. This amount of fish is mass equivalent to 25% of all seafood imports that Brazil purchased in 2019. Furthermore, if we utilize previous studies estimates, where one farm was placed every 1 $km^2$, Brazil could produce as much as 40 times the amount of seafood it is currently importing, in an area smaller than 1/10 of Portugal. The most productive cells were in Rio Grande do Norte and Ceará, where sea surface temperature (SST) is closest to cobia's optimal growth temperature (29˚C) and the average Cobia farm yielded an annual biomass of 1,235,633 kg.




## PROFITABILITY ASSESSMENT

Farms that were located closest to shore, within the same SST range, presented higher profitability. The further out in the EEZ, the more fuel is spent, the more labor is required, and the higher the cost of anchoring a farm. Profitability showed extreme sensitivity to two factors: feed price and Cobia market price. Feed accounts for over 90% of current costs, making it essential to monitor its variations. Second, the revenue of the offshore operation is a direct relationship between biomass produced and price of fish at market. Thus, the higher price you sell your fish, the higher the profit margin your mariculture farm will have.

# ADAPTIVE MAPPING TOOL




We built an interactive web application that can guide planning efforts for aquaculture development. First, we defined preset values for the input parameters based on a literature review of peer-reviewed articles and industry expert interviews, optimized for our model system. Then, we integrated these parameters into our three suitability models (site suitability, productivity, and profitability).

Based on inputs provided by the user, the tool:

- Estimates the location of suitable sites, their productivity, and profitability
- Creates downloadable georeferenced maps
- Calculates the total area of suitable cells for each analysis

Developed with Shiny from RStudio

Access the tool

# IMPACT & CONCLUSION

Estimating the feasibility of aquaculture decreases major challenges for its development

- Abundance and location of sites can guide investors
- Estimated production can meet growing seafood demand
- Understanding potential profits minimizes investment risk
- Incentivizes development of local mariculture technology

Our tool can assist with planning strategies for the development of offshore mariculture

- A single strategy does not fit all situations
- Explore sensitivity of model to different inputs
- Starting point to build similar tools
- Adaptability for other locations across the world

# ACKNOWLEDGEMENTS

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