USER GUIDE

Access

This Maricultura Brazilian Aquaculture Planning tool was developed utilizing R (version 3.6.1). The application is coded with the “Shiny” package. It is accessible through RStudio and directly from a web browser. To run the Shiny App in RStudio, fork, clone, and download the `maricultura-app` repository on GitHub: (https://github.com/maricultura).

To access from a web browser, use the url: (https://maricultura-gp.shinyapps.io/maricultura-app/)

Tool Navigation

This tool is equipped with a Navigation bar. Upon opening the application, only the “About,” “Site Suitability,” “Metadata,” and “User Guide” tabs are available. These tabs can be accessed on the toolbar. Productivity and Profitability analyses are available, but only after running the primary site suitability analysis. This is because the productivity and profitability analyses are functions of the site suitability analysis outcomes.

Site Suitability

The site suitability analysis considers physical and infrastructural constraints, as well as biological thresholds, to determine which parcels within Brazil’s EEZ are available for marine aquaculture development. As a user, you can select different constraints and thresholds for your analysis. Some tooltips are variable, and some are binary. Under Oceanographic Conditions tab, the user can manipulate a few different inputs including: Sea Surface Temperature (°C), Current Velocity (m/s), Minimum Dissolved Oxygen (mol/m_3), Depth (m), and Maximum Distance to Shore (Nautical Miles). On the Spatial Constraints tab, the user can choose to include or omit from the analysis the following parameters: Marine Protected Areas (MPAs), Artificial Reefs, Natural Reefs, Oil Pipelines, Oil Production, and Shipping Lanes.

You can navigate through the site suitability constraints within the two tabs in the left side panel of the “Site Suitability” tab. Once you have selected your inputs for variable and fixed constraints, press the “Run” button. This will load a map of suitable sites for marine aquaculture development in Brazil. You may also choose to download the map as a .tif image file, which can be uploaded for further analyses and visualization in spatial mapping programs, such as RStudio and ArcGIS.

Site Productivity

Once you have run the site suitability analysis, the productivity analysis will become

available to you on the Navigation Bar. The tab is titled “Biomass.” This application feature will utilize the output from your site suitability analysis to determine which of your generated sites will produce the most fish biomass.There are two different tabs under “Biomass”, one is the “Species” tab and the other one is the “Farm” tab. By clicking on the “Species” tab, the user will be able to choose which species will be analyzed. While clicking on the “Farm” tab will enable the user the option to change parameters that affect the biomass productivity such as initial stocking density and number of cages per farm. The analysis uses a derived linear function using known species growth rates at different temperatures to estimate how a species’ growth rate varies spatially with temperature. Assuming a year long grow out period, we ensured both the slope and the intercept are in yearly units by multiplying by 12. Using the assumption that the maximum mass a species will grow to is at their optimal growth temperature, we called this the optimal weight at harvest (OW_h). When you divide the yearly growth rate values you estimate using the linear model by OW_h you normalize them between 0-1 effectively making a unitless scalar (Ω). We estimated the final biomass at harvest in each suitable cell by multiplying the OW_h by the scalar estimated for each cell (Ω), the stocking density (S_d), cage volume (C_v), number of cages (N_c), and the mortality rate (m

Currently this application only features one species, Cobia. Our hope is to integrate other presets of commonly cultured species that might be suitable for Brazil. Once you have selected your species and its varying parameters, press the “Run” button. This will load a map of potential biomass (Metric Tons - MT) produced in each cell utilizing a 12 month grow-out cycle for offshore marine aquaculture development in Brazil. You may also choose to download the map as a .tif image file, which can be uploaded for further analyses and visualization in spatial mapping programs, such as RStudio and ArcGIS.

Site Profitability

Once you have run the site suitability analysis and the productivity analysis, the profitability analysis will become available to you on the Navigation Bar. The tab is titled “Economics.” In this section, the user has a lot of flexibility to change a wide range of parameters. The default values shown on each category were selected using Cobia as a species model. Our data comes from extensive literature research of peer-reviewed articles and industry experts on offshore finfish aquaculture. In case you have more accurate information for a given species, you are able to do so by typing in the number you obtained. Variable inputs that you can manipulate include: Fingerling price, feed price, food conversion ratio (FCR), price of fish at market

Once you have selected your inputs for the model, press the “Run” button. This will load a map of Net Present Value (NPV) over a 10-year period for offshore marine aquaculture development in Brazil. Note that the profitability is very sensitive to these parameters. Any slight increase or decrease on those parameters and the hole

operation can become not profitable. You may also choose to download the map as a .tif image file, which can be uploaded for further analyses and visualization in spatial mapping programs, such as RStudio and ArcGIS.

Map Features

- Coordinates
  - Latitude and Longitude coordinates are displayed in the top left corner of the map to identify location of specific parcels
  - Coordinates are dependent on cursor location
- Box zoom (press the `Shift` key while dragging the mouse)
  - This enables you to zoom into a particular region of interest
- Full screen
  - This generates a full-screen version of the output map
  - Click `Escape` to exit full-screen mode
- Reset zoom and initial view
  - Click to return to original output
- Zoom in/out buttons
  - Click to for general magnification/reduction of map
- Basemaps
  - There are two available basemaps
    - The first is a ESRI map showing country borders and names and state borders and names as you zoom in.
    - The second is an Open Street map which displays all cities, roads and rivers along with the country and state boundaries.

Equations

For a comprehesive list of equations are used for the Economic and Productivity Analyses, please visit our website, and look at the Methods section on our Final Report. The Report can be accesed by clicking on the link below:

https://maricultura.weebly.com/report.html

Implications

We hope that this tool can assist with planning strategies for the development of aquaculture. It can estimate the location of suitable sites, productivity, and profitability of mariculture in Brazil. A challenge in planning for aquaculture development is that one strategy does not fit all situations. Our tool addresses this challenge by allowing for the consideration of various scenarios. For instance, it can be used to simulate scenarios with different farmed species and cage specifications. In addition, strategic planning needs to be adaptive to be able to survive changing conditions. Our tool makes it possible to explore how varying different parameters affects the overall suitability of a location. For example, it can estimate how changes in the market price

of a species can affect the profitability of farming it. Lastly, detailed planning efforts can benefit from developing their own customized tools. Our tool was designed to be easily adaptable to other regions and to include additional input parameters. The code used to build the tool is open source and can be used as a starting point for the creation of new tools that expand on our results. Researchers from any country can integrate their own physical constraints and EEZ geographic shapefiles into our published code and estimate where most suitable sites to implement aquaculture might be.