# Atlantic Coastal Fish Habitat Partnership

*Southeast Habitat Protection Mapping Project*

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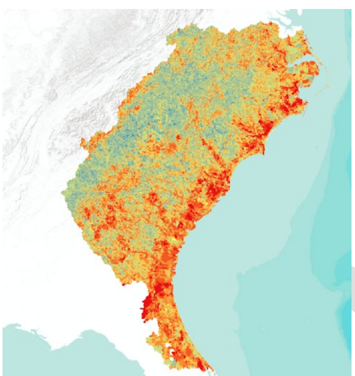

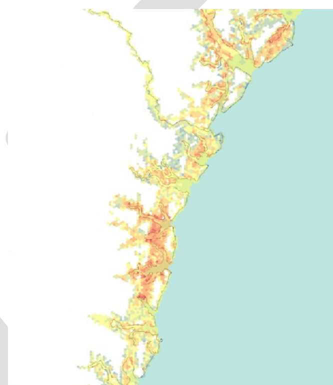

## Background

The Atlantic Coastal Fish Habitat Partnership (ACFHP) supported this project to prioritize fish habitat protection and restoration sites through GIS mapping and analyses for the southeast region of the U.S. from North Carolina to Florida. This effort was designed to be a pilot project by ACFHP with desire for expansion to the entire ACFHP geography.

As part of the National Fish Habitat Partnership (NFHP), ACFHP is expected to prioritize habitats for both protection and restoration. Habitat prioritization is an essential element of ACFHP's Conservation Strategic Plan, which covers the 2017 - 2021 timeframe. Additionally, habitat prioritization is needed to objectively evaluate proposals to ACFHP's annual RFP to fund on-the-ground restoration projects. This project focused on the southern portion of the ACFHP geography to spatially determine which riverine, estuarine, and coastal sites are optimal for fish habitat conservation based on the guidance provided by the ACFHP Steering Committee and Science and Data Committee (Table 1). The following sections outline the three main scenarios by which prioritization was desired through the compilation of existing resources and subsequent analyses.

*Table 1: Timeline of Science and Data Committee and Steering Committee project engagement.*

| Committee Engagement | Date |
|---|---|
| Science and data committee webinar to introduce the project | June 12, 2017 |
| Science and data committee in-person meeting to select variables and metrics for analyses | September 27 - 28, 2017 |
| Steering committee in-person meeting to provide project update and solicit feedback | October 16 - 17, 2017 |
| Steering committee in-person meeting to provide project update and solicit feedback | May 17 - 18, 2018 |
| Science and data committee webinar to provide project update and solicit feedback | June 15, 2018 |
| Steering committee in-person meeting to provide the final product | November 15 - 16, 2018 |



## Northern Diadromous Conservation Scenario

The Northern Diadromous Conservation Scenario targeted all NHD catchments located within watersheds that either harbored diadromous fishes or drained into these watersheds. The geographic extent of these watersheds was identified through using both The Nature Conservancy (TNC)'s Fish Habitat Decision Support Tool Alosine Prioritization results, the Southeast Aquatic Connectivity Assessment Project results, as well as expert knowledge from the ACFHP Steering Committee (Figure 1).

This scenario aimed at identifying those catchments that were the most pristine and also had access to the ocean for diadromous fish migration. All variables and metrics are outlined in Table 2.

*Table 2: Variables, Measurements and Metrics for the Northern Diadromous Scenario.*

| Variable | Measurement | Metric |
|---|---|---|
| Impervious Surface | % of area above the catchment that is impervious surface | 10 points if <5% |
| Point Source Pollution | Density of sites in catchment | 10 points if ranked lowest 25% for pollution (least polluted) |
| Non-point Source Pollution | % of catchment covered by agriculture | 10 points if catchment is ranked lowest 25% for pollution (least polluted) |
| Riparian Buffers | % of floodplain area with natural landcover | 10 points if catchment is ranked top 25% for natural coverage |
| Potential for species access | Reaches (1) with ocean connectivity x # of species in the catchment | 10 points if catchment is ranked in top 25% |
| Water Usage | Volume all reservoirs (NID_STORA in NID) per unit area of watershed (cubic meters/square km) | 10 points if catchment is ranked in top 25% for lowest volume. |
| Fragmentation | Density of road crossings + dams in catchment | 10 points if catchment is ranked lowest 25% for fragmentation (least amount of dams and crossings) |
| Sturgeon Critical Habitat | Sturgeon Critical Habitat Designation | 10 points if catchment is Atlantic sturgeon Critical Habitat |

## Methods

### Impervious Surface

The boundary for the analysis was determined based on the extent of diadromous fish habitat. The NHD catchments as well as all variable data were clipped to the boundary project boundary. Data for percent impervious surface above the catchment was pre-calculated by the Environmental Protection Agency (EPA) within their EPA StreamCat dataset (see Appendix I). To calculate this variable, EPA used the National Land Cover Dataset from 2011, and accumulated the amount of impervious surface using each catchment as a pourpoint, resulting in the attributes titled PctUrbHi2011Ws, PctUrbMd2011Ws, PctUrbLo2011WS. These three attributes were added to capture both high, medium, and low densities of urban land use. Therefore, the cumulative percentage of impervious surface above each catchment was calculated. Once these data were obtained, they were joined onto the catchment dataset via the NHD FeatureID. Once joined, a new field was calculated by sequentially ranking the data from 1 to 133216 (with the highest number being the best value). Then, these ranks were binned into 5% tiers, and those catchments in the top 5% tier were given 10 points, all else were scored zero points.

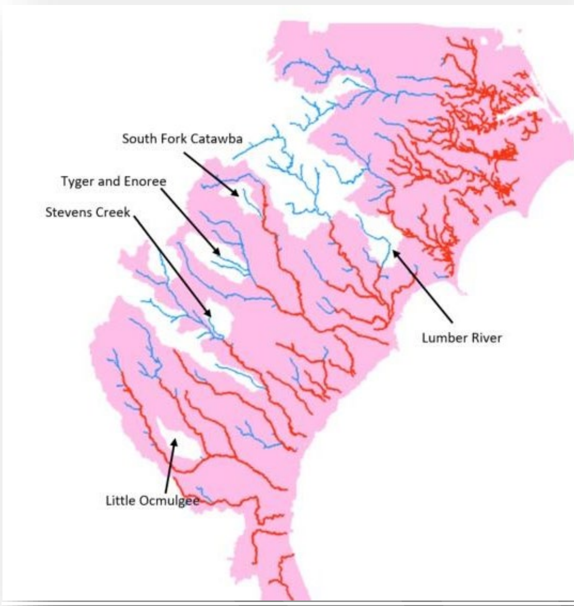

*Figure 1: Variables, Measurements and Metrics for the Northern Diadromous Scenario*

### Point Source Pollution

Like the impervious surface variable, data for point source pollution was obtained from EPA StreamCAT data, which combined toxic release inventory (TRI) site density (attribute titled TRIDensCat), comprehensive environmental response, compensation, and liability information system site density (attribute titled NPDESDensCat); and permit compliance system site density from the year 2014 (units were sites per square kilometer). Once this variable was joined to the catchments via feature id and sequentially ranked and binned, those catchments falling in the top 25%, or having the lowest density of toxic release sites, were given 10 points and all others were given zero.

### Non-Point Source Pollution

To create a variable for non-point source pollution, the USDA Cropscape raster from 2017 (30 x 30 m resolution) was used to determine the percentage of land cover within each catchment that was a type of agriculture (crops, pasture/hay). For this analysis, the tabulate area tool was used to identify the area of each land cover type present within each catchment, using the catchments as zones. Then, the area amounts of these landcover types containing agriculture were summed and divided by the total area to come up with a percentage of agriculture per catchment. Once this metric was calculated, it was sequentially ranked and binned in the same way as the above metrics, and those catchments in the top 25% for the least amount of agriculture were given 10 points.

**Riparian Buffers**

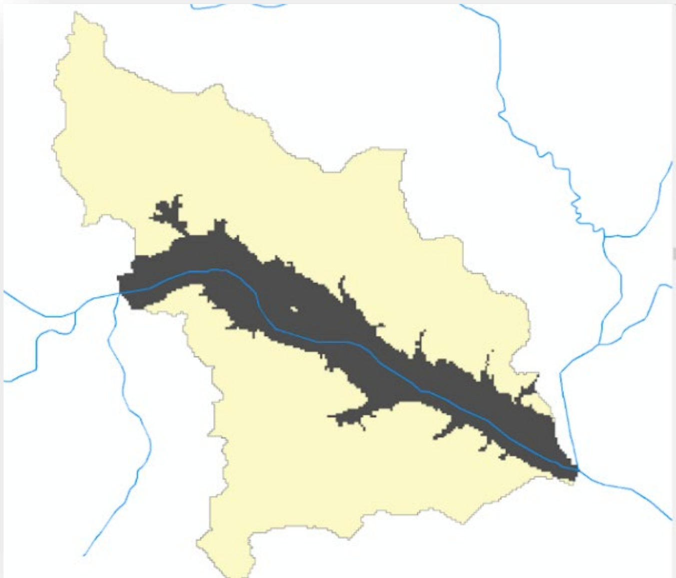

*Figure 2: An example of a floodplain boundary within a catchment used to quantify riparian buffer health.*

In addition to identifying those areas that had low impervious surface, agriculture, and point source pollution, a metric for riparian buffer coverage was calculated. In recent studies, riparian buffer coverage has been used as a proxy for the condition of a watershed. Modified floodplain boundaries were used to assess riparian buffer health, rather than applying a uniform buffer width from an NHD line, in order to capture the buffers of large rivers. To calculate this metric, a 100-year floodplain boundary was used to quantify the percentage of natural land cover within each catchment to identify those catchments that had healthy floodplains. A raster dataset delineating each stream's 100-year floodplain boundary was obtained from FATHOM (see Appendix I). Because this dataset was of lower resolution than some of the 1:100,000 resolution NHD streams and catchments, a floodplain boundary for these smaller streams needed to be delineated. To delineate this boundary, the NHD streams were converted to a raster and expanded by 90 meters using 'raster calculator,' and then the 'raster to mosaic' tool was used to merge the expanded streams onto the floodplain boundary dataset. This process resulted in a contiguous floodplain boundary dataset that encompassed all catchments in the analysis. This floodplain boundary dataset then was split at each catchment boundary using the Con tool in GIS, so that each catchment had a floodplain boundary associated with it via the catchment FeatureID (Figure 2). Finally, these floodplain boundaries were used as zones within the tabulate area tool to calculate the percentage of natural land cover (from the National Land Cover Database, 2011) within each floodplain boundary. Those catchments falling in the top 25% for highest percent natural land cover within their floodplains were given 10 points and all others were given zero points.

**Water Usage**

The ACFHP Science and Data Committee also recommended flow alteration as a variable in the analysis. In order to identify those catchments with the least amount of flow alteration accumulating from upstream, the StreamCat dataset was used. Within this dataset, EPA calculated the cumulative volume of water storage in $m^3/km^2$, from large dams upstream of each catchment, resulting in the attribute titled ‘DamNIDStorWs’. Those catchments in the top 25% for lowest volume of storage were given 10 points and all others were given zero points.

**Species**

To target catchments that had the most benefit to diadromous fishes if conserved, potential for species access was considered. The number of diadromous species present in each NHD stream (calculated in the SEACAP project) (http://maps.tnc.org/seacap/) were used to identify those catchments with the most species. All catchments with a species present was given 10 points, all others were given zero points.

**Sturgeon Habitat**

The potential for catchments to be located in sturgeon Critical Habitat was included in the analysis. Sturgeon critical habitat data were obtained from NOAA, and the ‘select by location’ tool was used to identify those catchments that intersected Atlantic sturgeon Critical Habitat. Those catchments that intersected sturgeon habitat were given 10 points and all others were given zero points.

**Potential for Species Access**

Habitat fragmentation resulting from dams and road crossings were also added to the analysis. The SEACAP project identified stream reaches/catchments with zero downstream dams, or those with open access to the ocean. All of these catchments were given 10 points. Because off stream dams and road crossings can also have an impact, SARP’s Southeast Aquatic Barrier Inventory was used to identify those higher resolution dams and road crossings within each catchment. The number of points per square mile were calculated, and those in the top 25% for fewest barriers were given 10 points, all others were given zero points.

### Results

Once all of the metrics were calculated, they were added together to produce a final score, highlighting those catchments on pristine streams harboring diadromous fish species.

The results of the Northern Diadromous Conservation Scenario show that larger mainstem rivers having little development, and often times protected lands, are best suited for conservation (Map 1). One example of this is in the catchment titled Northeast Cape Fear River. This stretch of river was listed as having five species downstream, and the top score for the conservation prioritization scenario. The Angola Gameland is also present within the catchment. However, not all of the catchment is protected, providing restoration and protection opportunities are still possible in the area.

## Estuarine Conservation Scenarios

Estuarine Conservation Scenarios were split into a northern and a southern scenario at the border of Cape Canaveral, based on the ACFHP priority habitat subregional designations. However, all methods for metric calculation and scoring were identical for each, except for the Estuarine-Marsh-Water Edge variable which was available for the northern portion only. All variables and associated metrics are outlined in Table 3.

*Table 3: Variables, Measurements and Metrics for the Estuarine Scenarios*

| Variable | Measurement | Metric |
|---|---|---|
| Seagrass and oyster reef habitat | % of polygon covered by seagrass or oyster reef | 10 points if the polygon ranks in the top 25% for coverage |
| Wetland habitat | % of polygon covered by wetlands | 10 points if the polygon ranks in the top 25% for coverage |
| Estuarine-marsh-water edge | Length of estuarine-marsh-water edge in the polygon | 10 points if the polygon ranks in the top 25% for length |
| Proximity to protected habitat | Distance to inlet (an HAPC in the south Atlantic) | 10 points if the polygon is within 1/2 km of an inlet |
| Proximity to development | Distance from marinas and ports | 10 points for the 25% of polygons farthest from marinas and ports |
| Water quality | Total # of NPDS permit sites in the inlet | 10 points for the 25% of polygons with the least number of NPDS sites/inlet |
| Hardened shoreline | Length of hardened shoreline within the polygon | 10 points for the 25% of polygons with the least amount of hardened shoreline |
| Habitat Fragmentation | Linear ft. of causeway (causeway defined as having marsh on at least 1 side) within a polygon | 10 points if the polygon has 0 ft. of causeways |

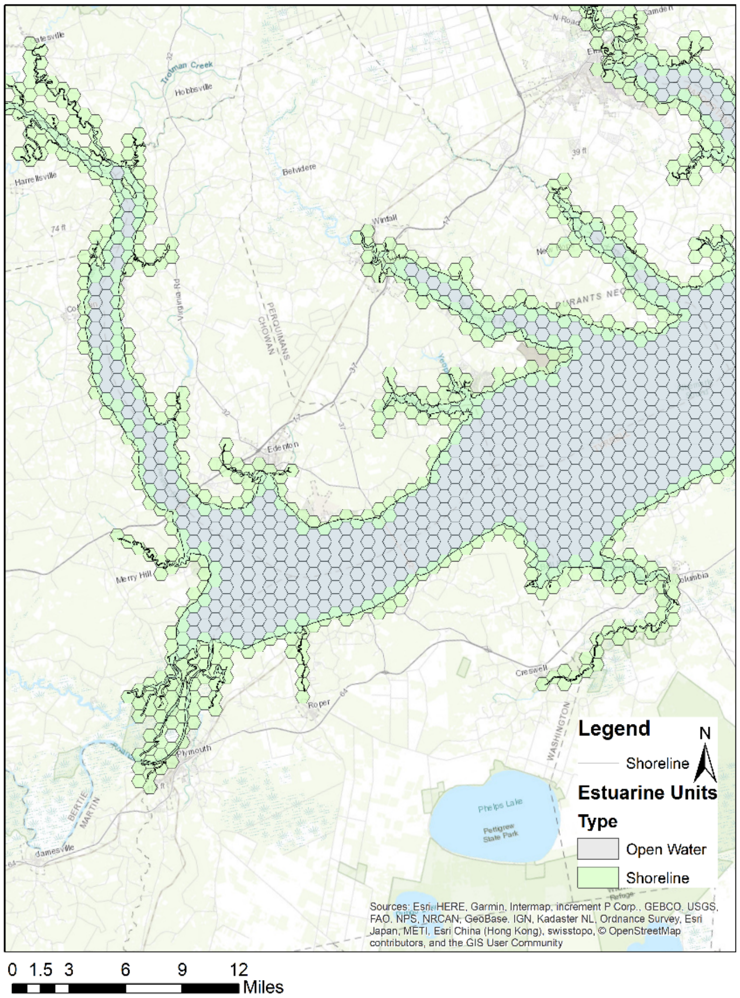


*Figure 3: Hexagons generated for the estuarine analysis.*

## Methods

To calculate the unit of analysis for the estuarine scenario, 1-km$^2$ hexagons were created using the 'create hexagon tessellation' tool within ArcGIS. Once generated, hexagons that intersected the NOAA medium resolution shoreline were selected for the analysis (Clingerman et al. 2015) (Figure 3).

**Seagrass and Oyster Reef Habitat**

Data pertaining to the locations of seagrass and oyster reef habitat were obtained from TNC's South Atlantic Bight Marine Assessment (SABMA). Because both habitat types were considered to be of equal value for the analysis, both datasets were merged together and the resultant feature class was converted into a raster dataset. Finally, the tabulate area tool was used, with the hexagons as zones, to identify the area (m$^2$) of each hexagon that was composed of either seagrass and/or oyster reef. These areas were divided by the total area of each hexagon to come up with a percentage for each. The hexagons were ranked sequentially, and then binned into 5% tiers. Those hexagons that fell into the top 25% tier for oyster and seagrass coverage were given 10 points, all others were given zero points.

**Wetland Habitat**

Like the analysis for seagrass and oyster reefs, the percent of each hexagon covered by tidal wetlands was quantified. Wetland data was obtained from the National Wetlands Inventory (NWI), and only those wetlands considered 'tidal' by the NWI were retained using a 'select by attribute' function. This processed dataset was converted to a raster, and the 'tabulate area' tool was also used to identify the area in m$^2$ of tidal wetlands present in each hexagon. These areas were divided by the total area, and hexagons were ranked and binned in 5% tiers. Those hexagons in the top 25% for wetland coverage were given 10 points and all others were given zero points.

**Estuarine-Marsh-Water-Edge**

This variable was only present within the Northern Estuarine Conservation Scenario, as the data were only available for the South Atlantic Landscape Conservation Cooperative (SALCC) region, which does not cover the peninsula of Florida where the Southern Estuarine Conservation Scenario was analyzed. This analysis was performed by the SALCC to identify the length of the water's edge that intersects wetlands. The data were in raster format, with a rating of 1-4 for each 30 x 30-$m^2$ cell representing the length of marsh. To use these data in the analysis, the average score for each hexagon was calculated using the 'zonal statistics as table' tool and the hexagons as zones. The hexagons were then ranked and binned into 5% tiers identifying those hexagons with the highest average score. Those in the top 25% were given 10 points, all others were given zero points.

**Proximity to Protected Habitat**

Protected habitat for this analysis was designated through using the Habitat Areas of Particular Concern (HAPC) dataset obtained from the NOAA Marine Cadastre. A planar distance from each hexagon to an HAPC was calculated using the Near Tool in ArcGIS. It is important to note that for this variable, the majority of estuaries are considered to be inlet HAPCs, so very few hexagons were outside of these boundaries. All hexagons within 0.5 km of an HAPC were given 10 points, and all others were given zero points.

**Proximity to Development**

Marinas and ports were used to represent development. Ports and marinas were obtained from the TNC SABMA, and supplemented with state data where available. Marinas and ports were point datasets, however, some state data came in polygon format. These polygons were converted to points and merged into the master dataset. Once merged, the 'near' Tool was used to calculate the planar distance from each hexagon to the nearest marina or port. Those hexagons in the top 25% (farthest away) from marinas and ports were given 10 points, all others were given zero points.

**Water Quality**

Identifying a suitable measurement to assess water quality within estuaries was particularly challenging, given multiple sources of non-point source pollution, as well as the large area covered by estuaries. To create a metric for this variable, 303D listed waters were used. These data were obtained from the EPA website and were in the form of polygons. These polygons were converted to a raster, and the area of each hexagon that was considered impaired waters was calculated using the 'tabulate area' tool. Those hexagons in the top 25% for the least amount of impaired waters were given 10 points, all others were given zero points.

**Hardened Shoreline**

Hardened shoreline data were obtained from the TNC SABMA. To quantify the length of the hardened shoreline (in km) within each hexagon, the 'intersect' tool was used to split the hardened shoreline polylines at the hexagon boundaries. The resultant split polylines were dissolved by Hexagon GridID to quantify the number of km of hardened shoreline within each hexagon. Ten points were given to those hexagons in the top 25% tier for least amount of hardened shoreline within their borders, all others were given zero points.

**Habitat Fragmentation**

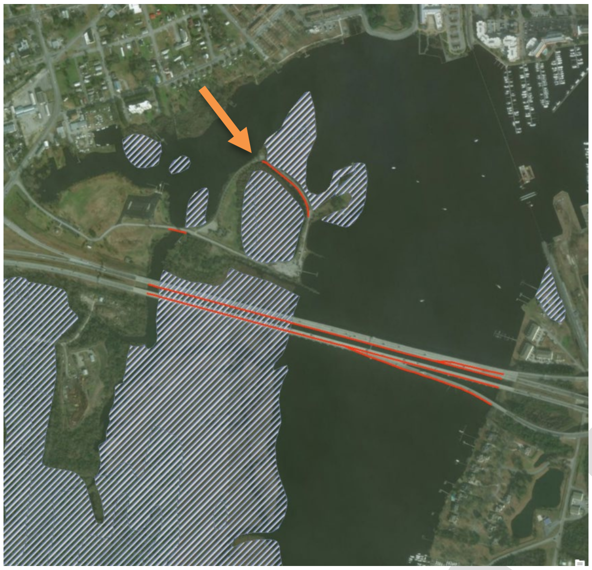

*Figure 4: Causeways (red) generated for the habitat fragmentation variable.*

Hexagons with the least amount of habitat fragmented by causeways were identified for this variable. Causeways were defined as a road having marsh on at least one side. To create these causeways, Tiger Roads data were used to first identify all roads within estuarine areas. These roads were then clipped by the hexagon boundaries using the 'clip' tool. Tidal wetlands previously generated from NWI data were then aggregated using the 'aggregate polygons' tool with a distance of 300 m to remove any small gaps from within them that would erroneously identify an area of road as being devoid of wetlands all together. The orange arrow in Figure 4 depicts this error, when road fill on either side of the wetland creates a gap between the road line and the wetlands data. Despite the road fill, this is still considered a causeway. By aggregating the wetland polygons, this road fill gap was filled in. Once the wetlands were aggregated, the clipped roads were split by the wetlands boundaries using the intersect tool, resulting in those roads that crossed wetlands, or causeways. The dissolve tool was then used to dissolve the causeways by hexagon GridID, specifying 'shape length' and 'SUM' in the statistics field in order to quantify the length of causeway within each hexagon. Lengths were converted to linear ft, and those hexagons with 0 linear ft of causeway were given 10 points, all others were given zero points.

## Results

Results of the estuarine scenarios highlighted many pristine areas that were already protected, such as Roanoke Island and Elizabeth River, North Carolina. However, other clusters of hexagons that are not protected also fell into the top tier for protection, highlighting the need to further protect pristine habitat in the region. It is important to note that this analysis also prioritized open water for protection. Many times, open water hexagons ranked higher than shoreline hexagons because they tended to be furthest from development. In the future, including information on open water impacts such as trawling, as well as species, should be included when updating this analysis. In addition, subsetting the analysis to include only those hexagons marked as 'shoreline' and re-ranking and scoring the hexagons could be completed if a shoreline-only scenario is desired.

# Southern Coastal Conservation Scenario

The goal of the Southern Coastal Conservation Scenario was to identify coastal areas south of Cape Canaveral that contained coral habitat. The ACFHP Science and Data Committee decided that all coral habitat was in need of conservation, regardless of quality, due to the slow growth and immediate threats to South Florida reefs (including bleaching, pollution, and disease).

## Methods

To identify this priority coral habitat, the Unified Reef Map from the Florida Fish and Wildlife Commission was obtained. In addition, HAPCs were included in the analysis only those HAPCs listed as 'coral reefs and hard bottom' were selected using 'select by attribute.'. These two datasets were then merged together using the 'merge' tool in GIS, to show all of those areas considered to be important for corals.

## Results

The resulting protected areas for the Southern Coastal Conservation Scenario highlights both HAPCs and known coral and hard bottom habitat. Originally, for this scenario, 10' squares were the target unit of analysis. However, after identifying coral habitat and realizing the area covered, the squares were too large and resulted in a swath of priority area that covered the entire coast. As a result, the combined dataset of the Unified Reef Map and coral HAPCs were used as the final areas for protection (Appendix 2). If more data becomes available in the future, another unit of analysis may be more appropriate.

# Appendix I: Data Sources

Clingerman, J., T. Petty, and F. Boettner. 2015. Estuarine Fish Habitat Assessment: A General Framework and Winter Flounder Pilot Studies. http://www.downstreamstrategies.com/documents/reports_publication/winter-flounder-report_final.pdf

Conley, M.F., M.G. Anderson, L. Geselbracht, R. Newton, K.J. Weaver, A. Barnett, J. Prince and N. Steinberg. 2017. The South Atlantic Bight Marine Assessment: Species, Habitats and Ecosystems. The Nature Conservancy, Eastern Conservation Science. https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/marine/sabma/sabma/Pages/Reports-and-Data.aspx

Environmental Protection Agency. 2015. 303D Listed Waters. https://www.epa.gov/waterdata/waters-geospatial-data-downloads#303dListedImpairedWaters

Florida Fish and Wildlife Commission. 2018. Unified Florida Reef Tract Map. Retrieved from: http://geodata.myfwc.com/datasets?q=unified%20florida%20reef%20tract%20map

Hill, R.A., M.H. Weber, S.G. Leibowitz, A.R. Olsen, and D.J. Thornbrugh. 2016. The Stream-Catchment (StreamCat) Dataset: A Database of Watershed Metrics for the Conterminous United States. Journal of the American Water Resources Association (JAWRA) 52:120-128. DOI: 10.1111/1752-1688.12372. ftp://newftp.epa.gov/EPADataCommons/ORD/NHDPlusLandscapeAttributes/StreamCat/WelcomePage.html#streamcat_documentation

Kritzer. J.P., M.B. Delucia, E. Greene, C. Shumway, M.F. Topolski, J. Thomas-Blate, L.A. Chiarella, K.B. Davy, and K. Smith. 2016. The importance of benthic habitats for coastal fisheries. BioScience 66: 274–284.

Martin, E.H., K. Hoenke, E. Granstaff, A. Barnett, J. Kauffman, S. Robinson, C.D. and Apse. 2014. SEACAP: Southeast Aquatic Connectivity Assessment Project: Assessing the ecological impact of dams on Southeastern rivers. The Nature Conservancy, Eastern Division Conservation Science, Southeast Aquatic Resources Partnership. http://www.maps.tnc.org/seacap

Martin, E. 2015. Atlantic Coast Whole System Diadromous Fish Prioritization. The Nature Conservancy. http://www.fishhabitattool.org/tnc-atlantic-coast-alosine-prioritization.html

McKay, L., T. Bondelid, T. Dewald, J. Johnston, R. Moore, and A. Rea. 2012. NHDPlus Version 2: User Guide. http://www.horizon-systems.com/NHDPlus/NHDPlusV2_data.php

National Oceanographic and Atmospheric Administration National Marine Fisheries Service. 2014. Habitat Areas of Particular Concern. Retrieved from: http://www.habitat.noaa.gov/protection/efh/habitatmapper.html

South Atlantic Landscape Conservation Cooperative. Marsh Water Vegetation Edge. https://salcc.databasin.org/datasets/00ecbf6049d4481db1f1416e4e3b8cc2

USDA National Agricultural Statistics Service Cropland Data Layer. 2017. Published crop-specific data layer [Online]. Available at: https://nassgeodata.gmu.edu/CropScape/ (accessed April 2018). USDA-NASS, Washington, DC.

United States Census Bureau. 2017. TIGER/Line Shapefiles (machine readable data files) / prepared by the U.S. Census Bureau. https://www.census.gov/geo/maps-data/data/tiger-line.html

United States Fish and Wildlife Service. 2016. National Wetlands Inventory. Retrieved from: https://www.fws.gov/wetlands/data/mapper.html

## Appendix II: Static Results Maps

All datasets are hosted online on Databasin that the following Links:

Northern Diadromous Scenario: https://databasin.org/datasets/1319cc9dec6c4bb188cbc3e9e5e719b0

Northern Estuarine Scenario: https://databasin.org/datasets/0d21c83295984c3c89d7edf60d046ec8

Southern Estuarine Scenario: https://databasin.org/datasets/89314044554344bd98b1e099d52cc74d

Southern Coastal Scenario: https://databasin.org/datasets/80119a55b4c34aec95604c3e06dddd5a

In addition, all layers are viewable via web map at the following link:
https://databasin.org/maps/e8327d587c1a4eb583cf9a007361dc8c/active

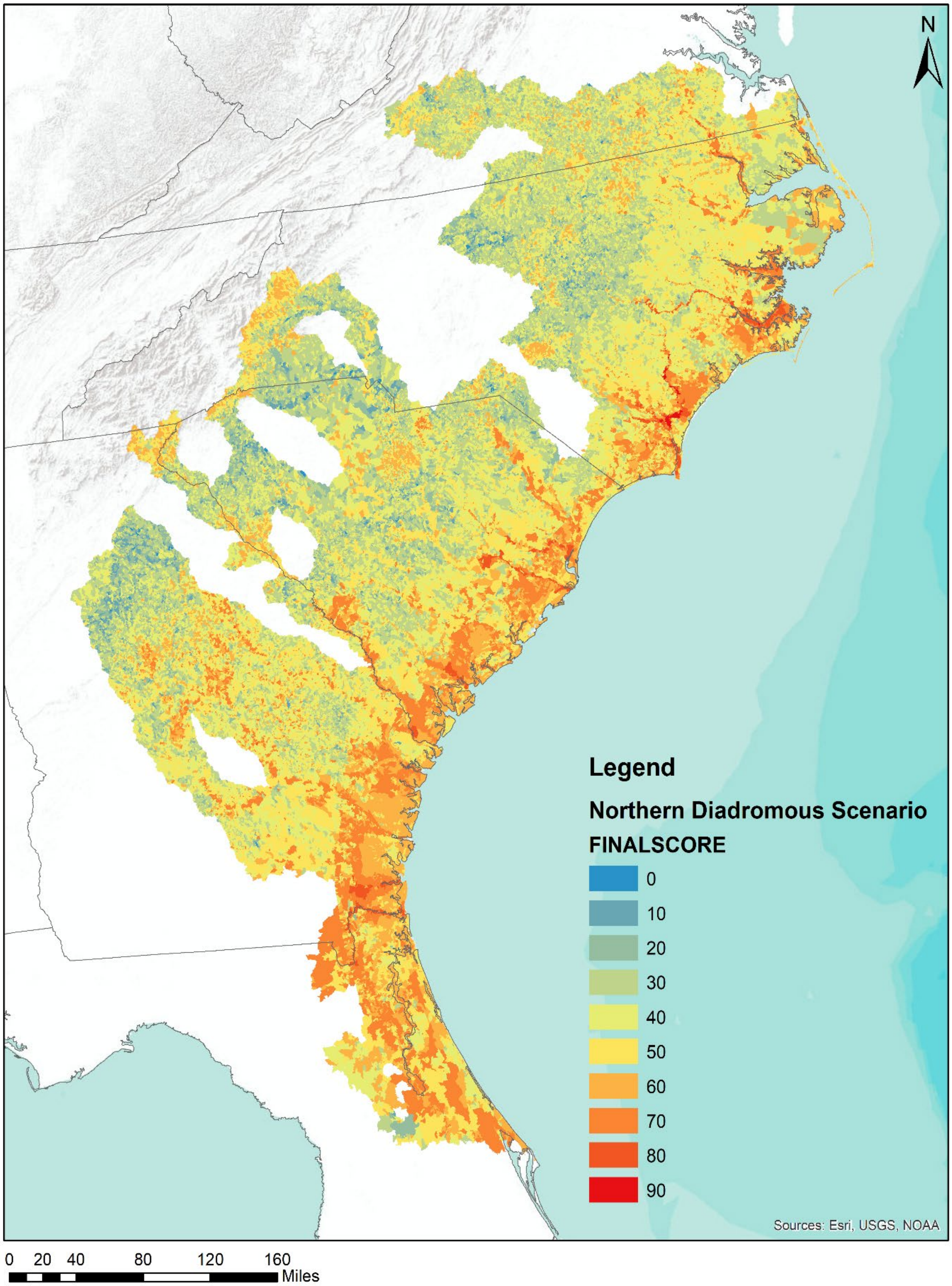


*Figure 5: Results of the Northern Diadromous Conservation Scenario available at:*

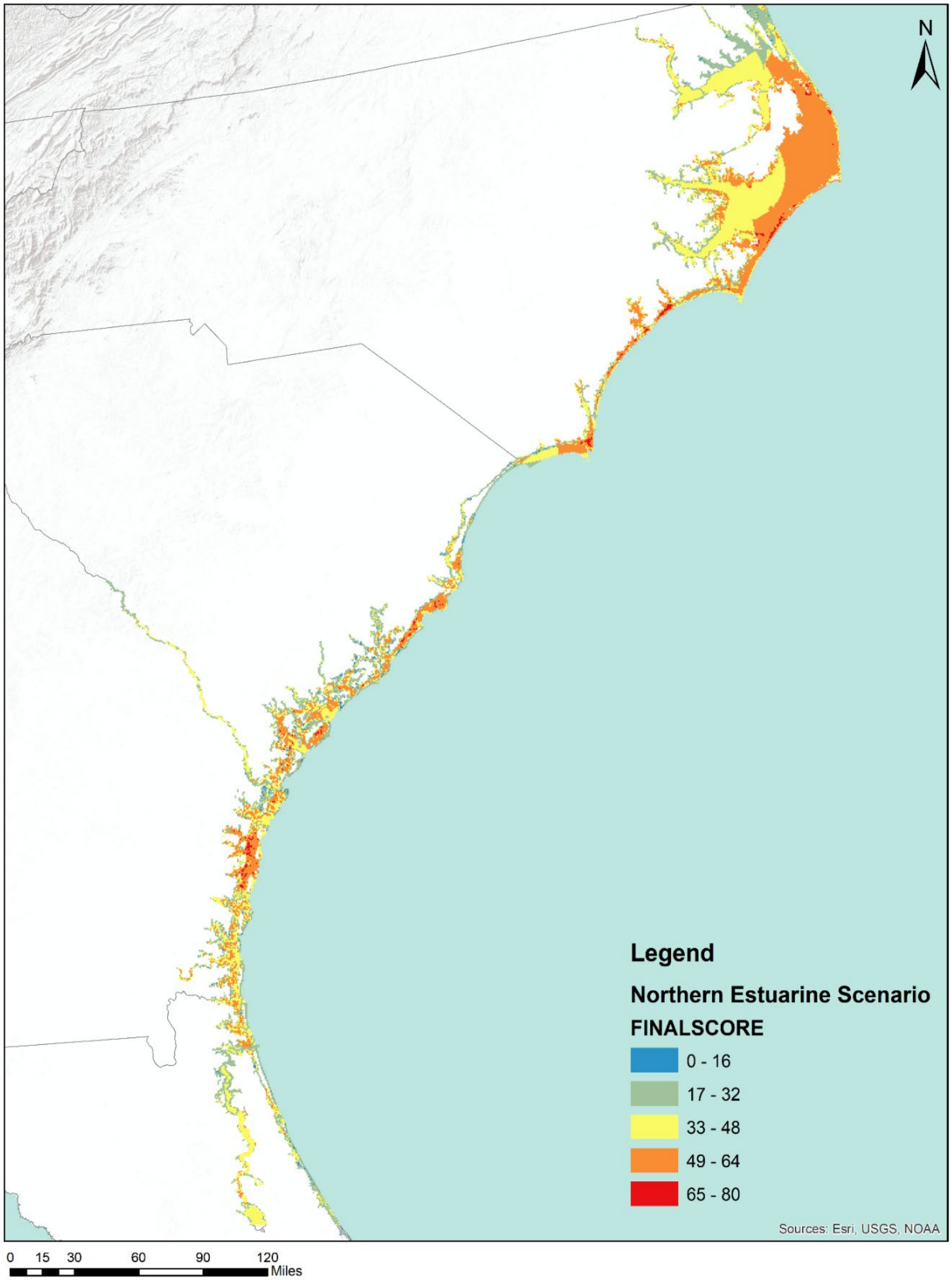


*Figure 6: Results of the Northern Estuarine Conservation Scenario*

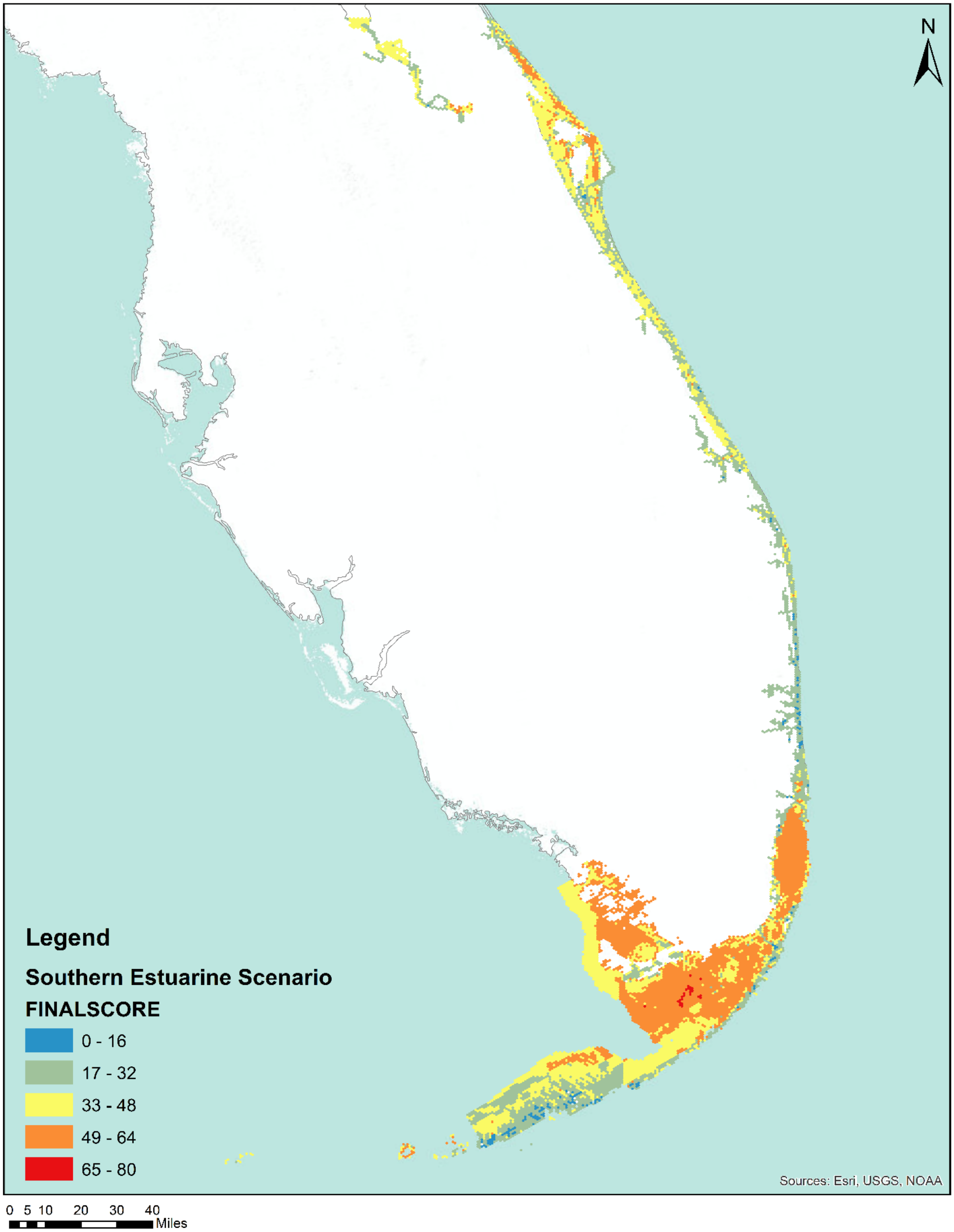


*Figure 7: Results of the Southern Estuarine Scenario*

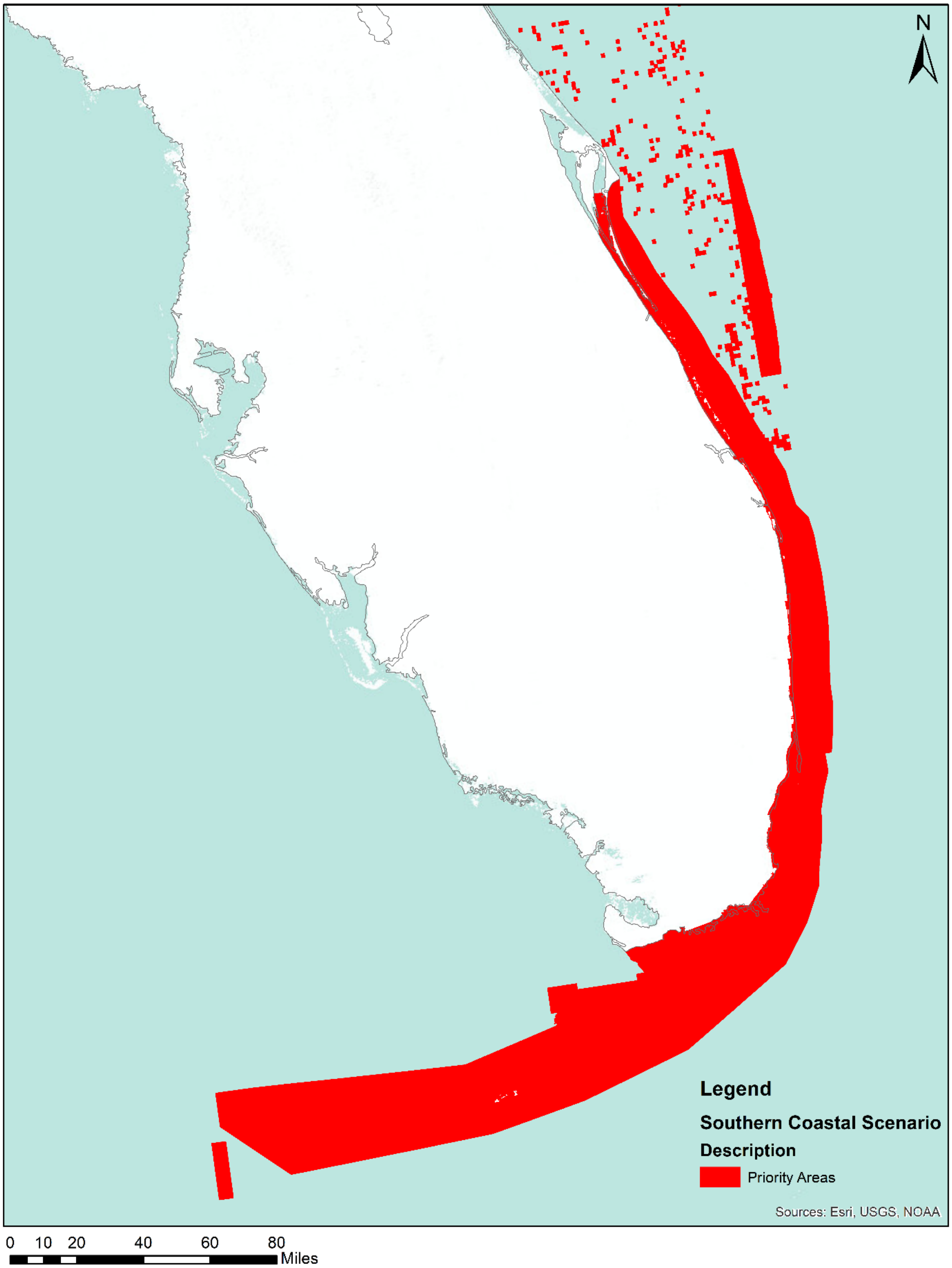


*Figure 8: Results of the Southern Coastal Scenario*