MARINE MAMMAL HABITAT SENSITIVITY TO TANKER-BASED OIL SPILLS

5/3/18

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Problem Formulation:

Marine mammals, specifically the West Indian manatee (*Trichechus manatus*), tend to inhabit and forage in coastal ecosystems. Manatees are especially bound to this environment due to their reliance on seagrass as a major food-source which grows in shallow water due to reliance on surface irradiance. This places them into direct contact with the same waterbodies used for navigational, commercial and recreation purposes. This increased contact has increased their susceptibility to coastal disasters such as oil spills. The problem attempting to be quantified is the environmental impacts of tanker-based oil spills on West Indian manatees and their feeding grounds. A sub-question also being pursued is how changes in tanker size, as rated by the Average Freight Rate Assesment (AFRA), affect the intensity and spread of oil spill interactions on the environment. The results can be quantified and will be measured via the percentage of manatee habitat caught within oil spills in varying tanker-spill scenarios.

Data Collection:

The data collection for this particular study largely was provided via the Florida Fish and Wildlife Conservation Commission's GIS download hub/repository. All data used has unrestricted access and is open to public use. The data was collected by trained biologists and natural resource specialists before being transferred into ArcGIS-compatible formats by GIS professionals. In the data collection phase, most data was supplied in a user-friendly format and readily attachable after decompression of the files. Most metadata present was in the form of supplemental summaries present in the original download webpages. Associated metadata such as the feature definitions and age of data provided an increased accuracy and allowed conclusions drawn to pertain to current assumptions on manatee's habitat range. Data collection and updates for seagrass habitat range extended through 2017 (Figure 1).

OBJECTID	DESCRIPT	SOURCEDATE	METADATA	SEAGRASS	SHAPEarea	last_edite
37292	Patchy (Discontinuous) Seagrass	2007	seagrass_naples_2007	Discontinuous	1.281467	2017-12-04T19:27:00.000Z
37303	Patchy (Discontinuous) Seagrass	2007	seagrass_naples_2007	Discontinuous	1.281916	2017-12-04T19:27:00.000Z
51626	Patchy (Discontinuous) Seagrass	2011	seagrass_Gulf_Islands_National_	Discontinuous	1.362065	2017-12-04T19:27:00.000Z
51738	Patchy (Discontinuous) Seagrass	2011	seagrass_Gulf_Islands_National_	Discontinuous	1.362068	2017-12-04T19:27:00.000Z
51483	Patchy (Discontinuous) Seagrass	2011	seagrass_Gulf_Islands_National_	Discontinuous	1.362201	2017-12-04T19:27:00.000Z
52082	Patchy (Discontinuous) Seagrass	2011	seagrass_Gulf_Islands_National_	Discontinuous	1.36231	2017-12-04T19:27:00.000Z
51620	Patchy (Discontinuous) Seagrass	2011	seagrass_Gulf_Islands_National_	Discontinuous	1.362371	2017-12-04T19:27:00.000Z
51597	Patchy (Discontinuous) Seagrass	2011	seagrass_Gulf_Islands_National_	Discontinuous	1.362453	2017-12-04T19:27:00.000Z
51340	Patchy (Discontinuous) Seagrass	2011	seagrass_Gulf_Islands_National_	Discontinuous	1.36254	2017-12-04T19:27:00.000Z
83864	Patchy (Discontinuous) Seagrass	2011	seagrass_Gulf_Islands_National_	Discontinuous	1.367139	2017-12-04T19:27:00.000Z

Figure 1. Depicts the value attribute table (VAT) and associated metadata for the seagrass shapefile.

Data Preprocessing:

For the data preprocessing all shapefiles downloaded were inspected for their coordinate system used and the projection type. The data was ubiquitously found to be projected in the Lambert Conformal Conic projection. The only preprocessing step involved with the data was to transform the seagrass habitat shapefile from the 1983 North American Datum to the 1984 World Geodetic System coordinate system to ensure accuracy of analysis. This was done due to the majority of the data collected being in the WGS 1984 coordinate system and to reduce error in the map by converting one shapefile instead of three.

ArcGIS Processing:

1. Insert the downloaded U.S map, and label as necessary.

Figure 2. Depicts the shapefile of the entire U.S.

2. The Area of Interest (AOI) was isolated. A full sized continental map was used to provide an aesthetic appeal and briefly view the potential for oil spills to spread in the Gulf.

Figure 3. Depicts the AOI.

3. Data point values, lines and polygons were inserted, each representing manatee observations, Florida waterways, and seagrass habitats respectively.

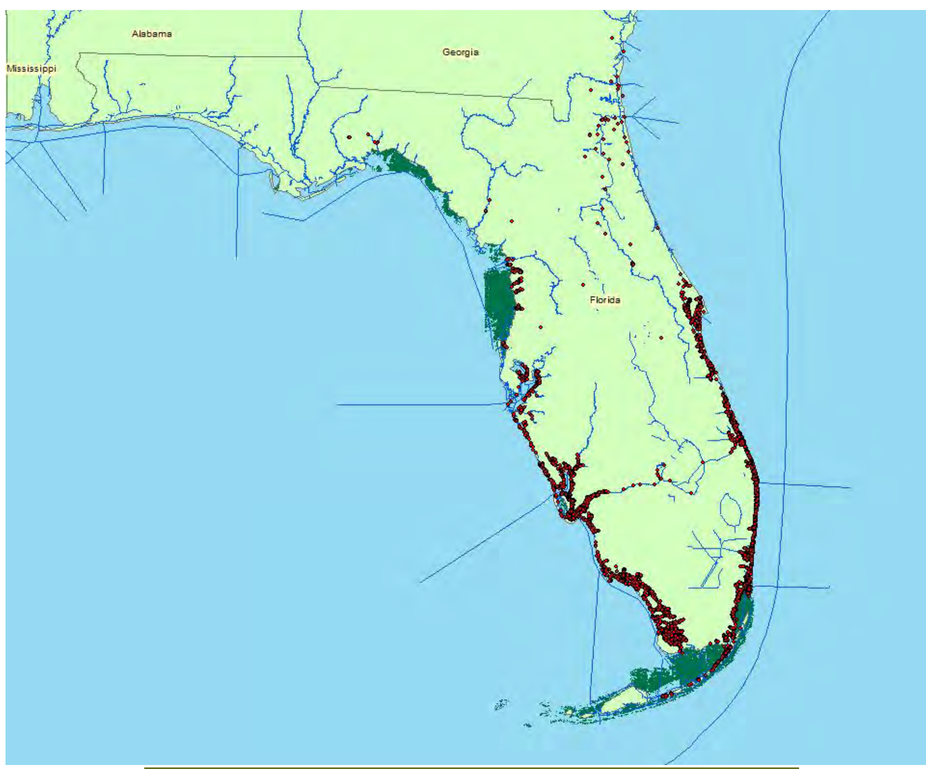
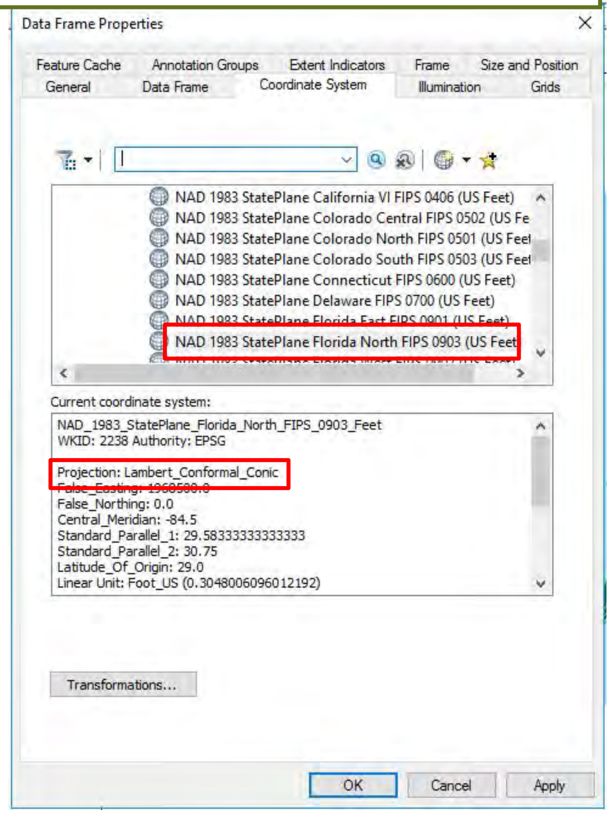


Figure 4. Includes the initial map composition and raw data points.

4. Once all data had been added to the Table of Contents it was aggregated under a spatial reference into a singular datum. Using Layers>Data Frame Properties>Coordinate System “florida” was searched and under the “State Plane” folder the appropriate datum was selected. Note that the northern state plane was chosen arbitrarily since seagrass distribution tends to follow the western coast and encompasses both northern and southern boundaries. Also note that the entirety of the ToC will now also be projected on the Lambert Conformal Conic projection.

Figure 5. The red boxes indicate the specific projection and CS used.



5. Specific layers needed to be transformed as well. ArcGIS prompted a warning message prior to completion of the transformation asking for a specific transformation to be selected for layers not containing the data set’s original spatial referencing. The most suitable transformation being at the top of the list was chosen.

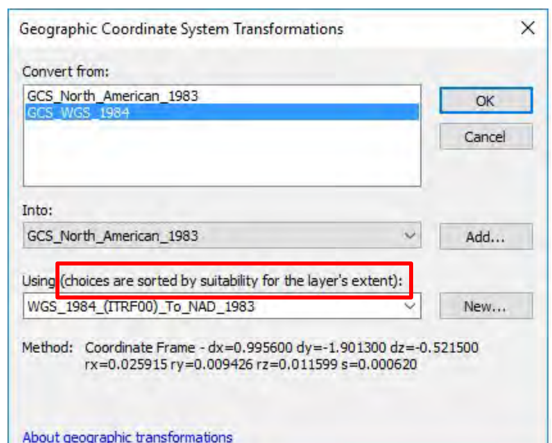


Figure 6. The specific transformation chosen was done so under software recommendation.

6. Using the Average Freight Weight Assessment Scale, the mean values for differing tankers were identified. Once identified, identified, volumes were converted to barrel volume which is 90% of deadweight tonnage. After the barrel volume was identified the barrel volume was converted to total gallons. This gives the maximum amount of crude oil that a given tanker type can carry. In this step, the amount of oil that can cover 1 mile 1 micrometer thick was calculated and converted for a 1/10 inch thickness oil slick.

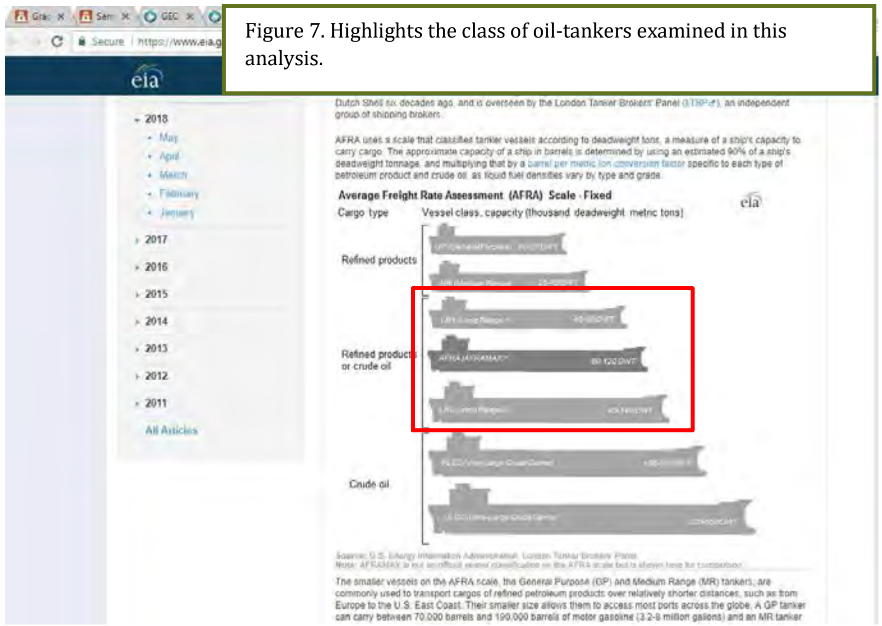


Figure 7. Highlights the class of oil-tankers examined in this analysis.

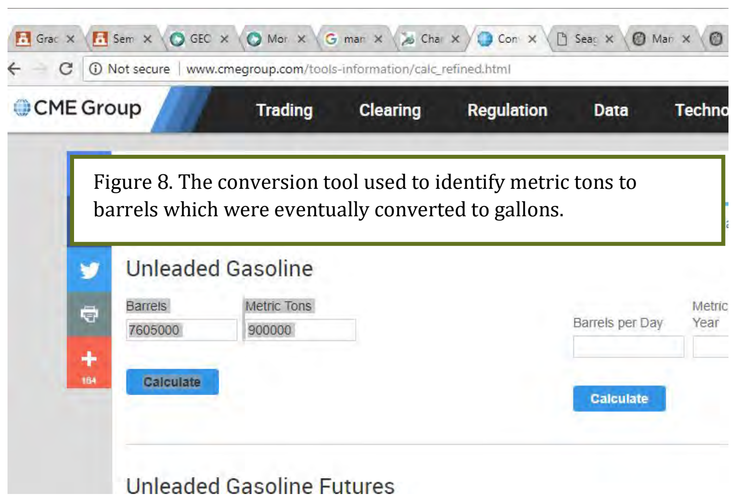


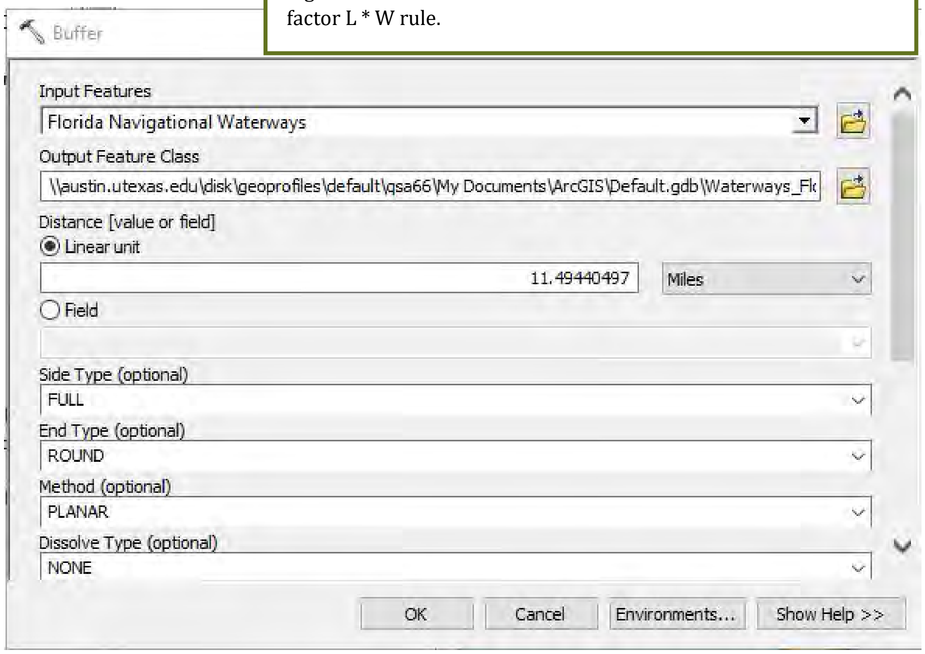
Figure 8. The conversion tool used to identify metric tons to barrels which were eventually converted to gallons.

Tanker Type	Average Deadweight Tons Carryable (1000's	Crude Capacity in Barrel Weight (90% of Avg. DWT Carryable	# of Barrels Carryabl	Gallons of Oil	Square Miles Coverable (0.1 inch Oil Slic
Long Range 1 (LR1)	62.5	56.25	475313	19963146	11.49440497
AFRA (AFRAMAX)	100	90	760500	31941000	18.39102861
Long Range 2 (LR2)	120	108	912600	38329200	22.06923433

Tanker Spill Type	% Seagrass in Risk Zone
Long Range 1 (LR1)	99.272%
AFRA (AFRAMAX)	99.951%
Long Range 2 (LR2)	100.000%

Figure 9. Provides a view of the tabulated data used throughout the entire analysis.

Figure 10. Buffer screen was set at the surface area due to first-factor L * W rule.



7. To begin analysis of potentially impacted areas, the navigational waters shapefile was buffered with three separate buffers deriving their distance from the square miles coverable column (Figure 9). Potentially, the maximum distance at any given point along the spill range oil could cover at .1 inch is the same as the square miles due to the unlikely but mathematically correct possibility whereby the oil could slick 11.49 square miles by 1 mile thus producing the surface area. The reason for separate buffers and not a multiple ring buffer was justified by the clipping of the seagrass shapefile.

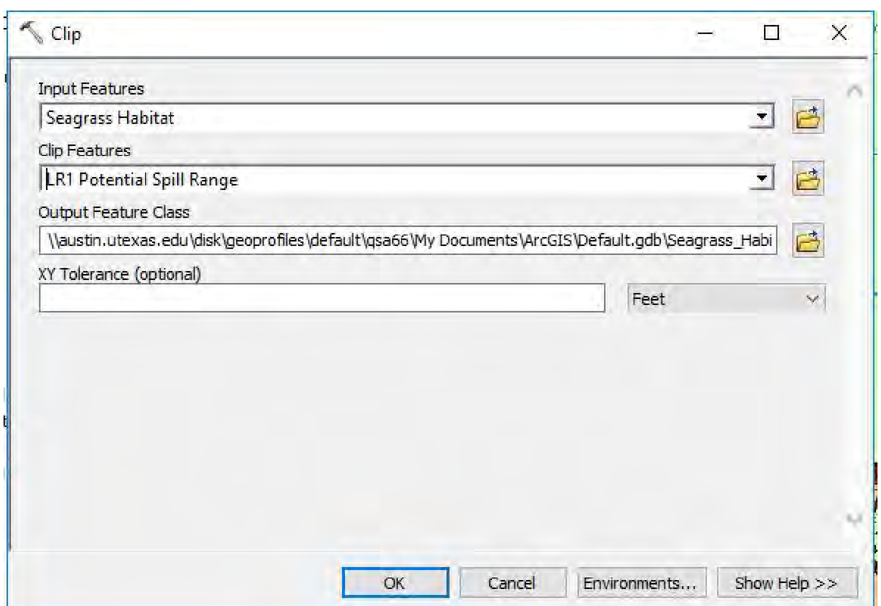


Figure 11. Clip was used to isolate seagrass beds by respective potential buffer zone risk.

8. After the buffer zones were individually created for all three tanker types, the seagrass habitat shapefile was clipped to each buffer zone. This created three seagrass habitat copies, each extending out only as far as the buffer zone did.

9. After each seagrass habitat buffer value was calculated, each zone was taken as a percentage of the original, unbound seagrass habitat. This percentage was then used to delineate the potential maximum habitat which would be affected by oil spills from three tanker types loaded with their respective average carrying capacities.

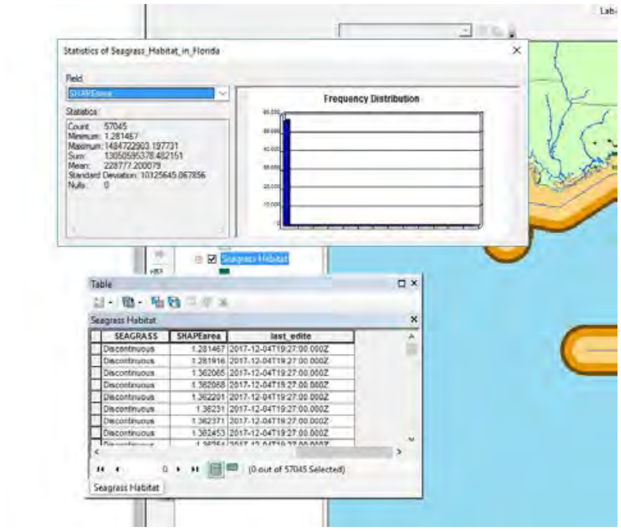


Figure 12. A table summary showing the total sum value of all seagrass used for later calculations.

Data Presentation:

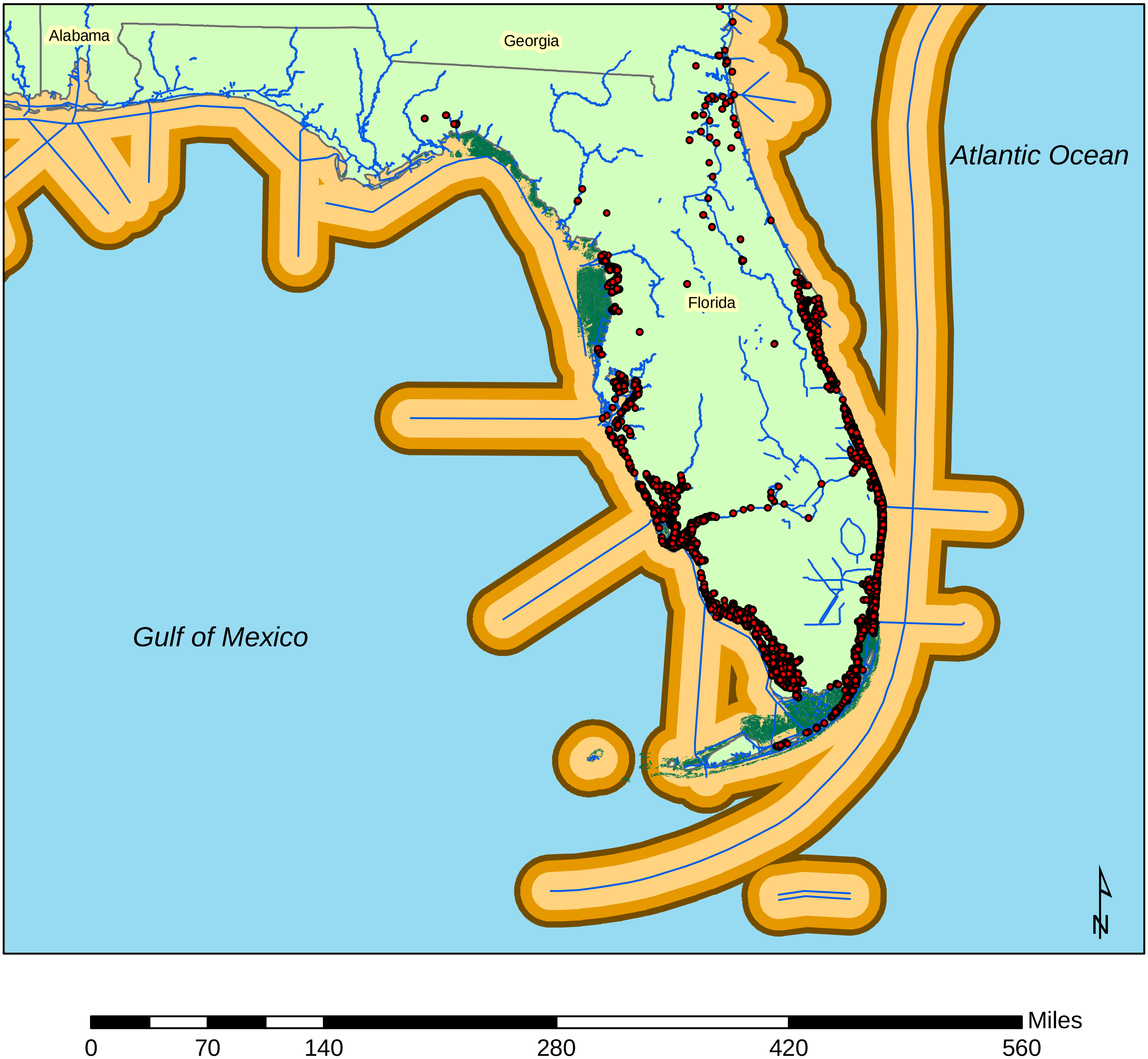
Figure 13. The final at risk habitat depending in oil-tanker size at time of spill. Not a percentage of certainty, but a display of

Tanker-Spill Type	% Seagrass in Risk Zone
Long Range 1 (LR1)	99.272%
AFRA (AFRAMAX)	99.951%
Long Range 2 (LR2)	100.000%

The conclusions for the project are noted in Figures 13 and the habitat assessment map. The smallest tanker certified to carry crude oil through Florida's waterways is more than capable of contaminating manatee's primary coastal resource. 99.272% of seagrass beds were theorized via the percentage analysis to be at risk of some sort of oil contamination. It is important to note that the percentages expressed do not explicitly indicate in the event of an oil spill the percentage that will be affected. Rather, it explains the amount of seagrass that is within the potential spill range of a tanker travelling along Florida navigational waterways.

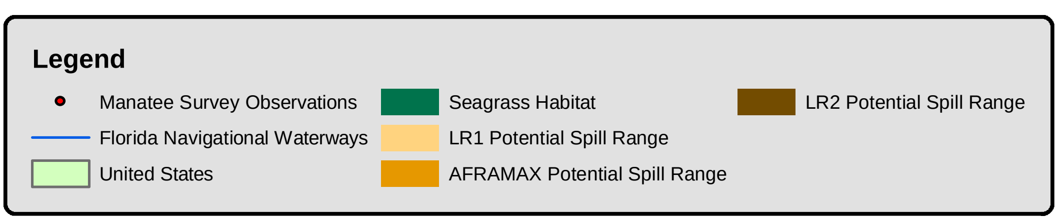
Mapped by: Quanit Ali

West Indian Manatee Habitat Risk Assessment



Coordinate System: WGS 1984

Projection: Lambert Conformal Conic



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