

**Exploring Rehabilitated Sea Turtle Tracking Along the Eastern Coast of the United
States**

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Abstract:

This project utilizes Python coding in conjunction with a geospatial data set containing tracking information for rehabilitated cold-stunned sea turtles that were released near Long Island, New York to identify where these turtles' appear along the eastern coast of the United States. The geoprocessing tools used in this project include creating new layers by attributes, buffering, clipping, and intersecting. Using Python allows for more efficient execution of organizing data by location and distance, allowing for user input in order to customize research to what the user is interested in looking at. Coding enables quick and accurate creation of new layers of data, whether it be identifying turtle locations within certain distances from coastlines and/or ports, or within specified state boundaries of interest.

Keywords: Sea turtles, Rehabilitated turtles, Turtle migratory patterns, Sea turtle tracking, Northeastern United States coastal sea turtle tracking, United States sea turtles

Introduction:

My personal motivation for this work was inspired by my experience in Trinidad and Tobago, where I was able to observe leatherback sea turtles create nests on the beach in Grande Riviere, Trinidad. So many factors influence how and where these enormous and beautiful creatures migrate and nest, such as ocean temperatures and currents, and human factors such as light pollution and beach renourishment (“Information about Sea Turtles: General Behavior”). While sea turtles have natural life

spans ranging from fifty to one-hundred years, as few as one in 1,000 to one in 10,000 sea turtle hatchlings live to reach adulthood (*News: Sea Turtles*). Being able to gather data about sea turtles, and effectively use that data, means that it is possible to help ensure their survival and even help them thrive. The purpose of this project is therefore to demonstrate effective use of geospatial technologies and coding to collect, analyze, and utilize sea turtle migratory data.

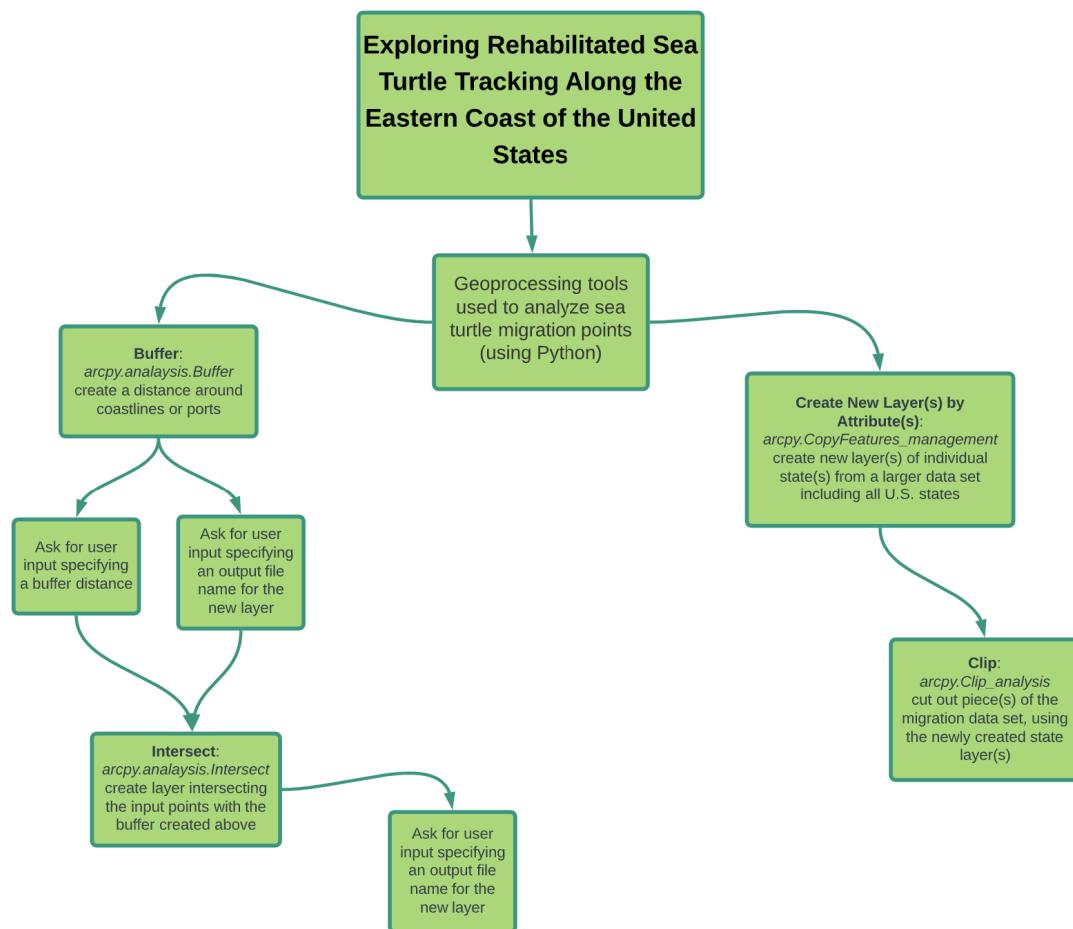
Materials and Methods:

The materials utilized in this project include a geospatial data set containing tracking information for rehabilitated cold-stunned sea turtles that were released near Long Island, New York, which was obtained from the Marine Geospatial Ecology Lab at Duke University, dataset number 2133: Satellite tracking of rehabilitated juvenile loggerhead, green, and Kemp's ridley turtles in the northeastern USA collected by Fundacion Oceanografic, in Esri Geodatabase file format. This data set is free to download and includes a sufficient number of points (3,827 points) for thirty-one rehabilitated turtles, including three species: seven loggerhead turtles (*Caretta caretta*), twelve green turtles (*Chelonia mydas*), and twelve Kemp's ridley turtles (*Lepidochelys kempii*). This data set was used in research to determine that rehabilitated turtles seem to return to their usual migratory and diving behaviors, indicating that rehabilitation efforts are successful to a point in reintroducing rehabilitated turtles to the wild (Robinson et al. 2020).

My application of the data involved using Python to perform the following geoprocesses: buffers, clips, the creation of new layers by attributes, and intersections.

The flowchart (Image 1) below shows the geoprocesses used and their descriptions. In addition to the sea turtle migration points, I also used a shapefile of coastlines from Natural Earth, a shapefile of shipping ports, again from Natural Earth, and a shapefile of county boundaries provided in this course. The advantages of implementing my analysis in Python include the ability to have all of my actions documented and referenced in the future.

Image 1: Flowchart showing geoprocesses.



Results:

The images in this section serve to demonstrate the interactivity of the code and the output it created as layers in ArcGIS Pro. Image 2 is an ArcGIS Pro screenshot showing U.S. county data (polygons), sea turtle points (teal points), shipping ports (red points), and coastlines (blue lines), without any modifications made by the code yet. Image 3 shows the output generated by running the code in IDLE. The output shows the ability for users to provide input to determine what the code will execute. Image 4 shows the buffer created around the coastlines, and all the sea turtle points, whereas Image 5 shows those the same coastlines buffer with the sea turtle points clipped to the buffer. Image 6 shows the same buffer tool used on ports instead of coastlines, and all the sea turtle points; not shown is a screenshot of the ports buffer with the sea turtle points clipped to the buffer. And Image 7 shows a state chosen by the user with the sea turtle points clipped to the boundary of just that state.

Image 2: ArcGIS Pro screenshot showing U.S. county data (polygons), sea turtle points (teal points), shipping ports (red points), and coastlines (blue lines).

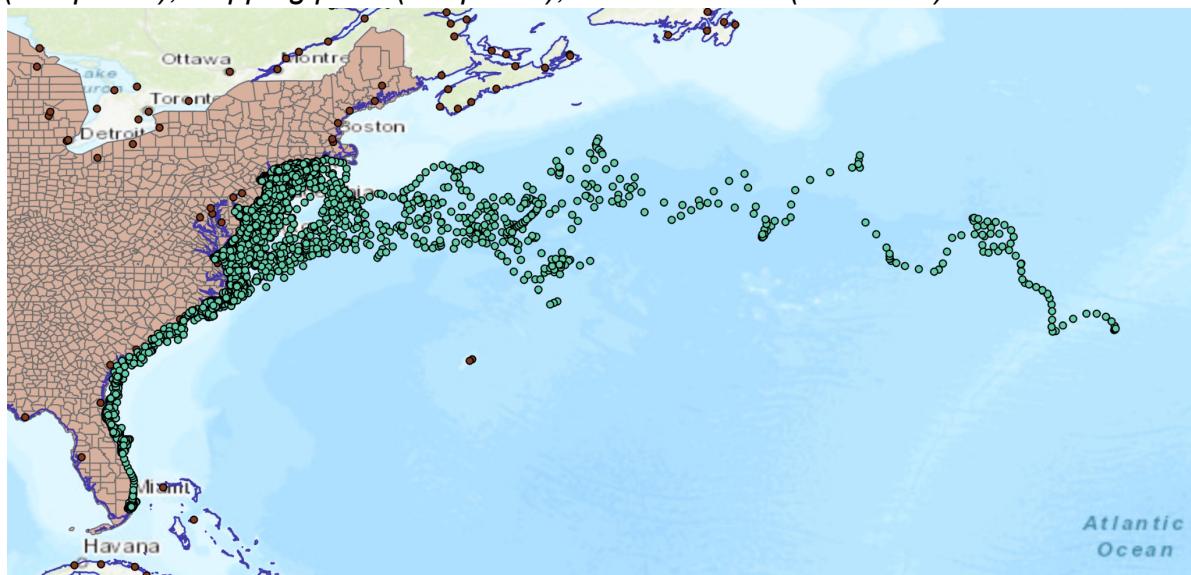


Image 3: IDLE Shell output of code.

```
== RESTART: C:\Users\dmbro\Documents\GIS5653\Term_Project\brow0604_main.py ==
Enter a state by FIPS code: 34
"STATEFP" = '34'
Created chosen state in seperate layer.
Specify output file name for ports in clip area: clip_ports
Clip completed.
Specify search radius for turtles near ports including units: 10 miles
Near distance created in sea_turtle_points attribute table.
Specify output file name for buffer: coastline_buffer
Specify buffer distance including units: 5 miles
Buffer completed.
Specify intersect output file name: intersect_turtle_buffer
Intersect completed.
Indicate whether you would like to perform a buffer around ports or coastlines: ports
Specify output file name for buffer: buffer_ports
Specify buffer distance including units: 10 miles
Buffer around ports completed.
Enter the common name for a turtle species: green
The scientific name for this turtle species is Chelonia mydas.
"STATEFP" = '23'
C:/Users/dmbro/Documents/GIS5653/Term_Project/states/state_23.shp
"STATEFP" = '33'
C:/Users/dmbro/Documents/GIS5653/Term_Project/states/state_33.shp
"STATEFP" = '25'
C:/Users/dmbro/Documents/GIS5653/Term_Project/states/state_25.shp
"STATEFP" = '44'
C:/Users/dmbro/Documents/GIS5653/Term_Project/states/state_44.shp
"STATEFP" = '09'
C:/Users/dmbro/Documents/GIS5653/Term_Project/states/state_09.shp
"STATEFP" = '36'
C:/Users/dmbro/Documents/GIS5653/Term_Project/states/state_36.shp
"STATEFP" = '34'
C:/Users/dmbro/Documents/GIS5653/Term_Project/states/state_34.shp
"STATEFP" = '10'
C:/Users/dmbro/Documents/GIS5653/Term_Project/states/state_10.shp
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"STATEFP" = '45'
C:/Users/dmbro/Documents/GIS5653/Term_Project/states/state_45.shp
"STATEFP" = '13'
C:/Users/dmbro/Documents/GIS5653/Term_Project/states/state_13.shp
"STATEFP" = '12'
C:/Users/dmbro/Documents/GIS5653/Term_Project/states/state_12.shp
Created state shapefiles.
>>>
```

Image 4: Coastlines with buffer and sea turtle points.

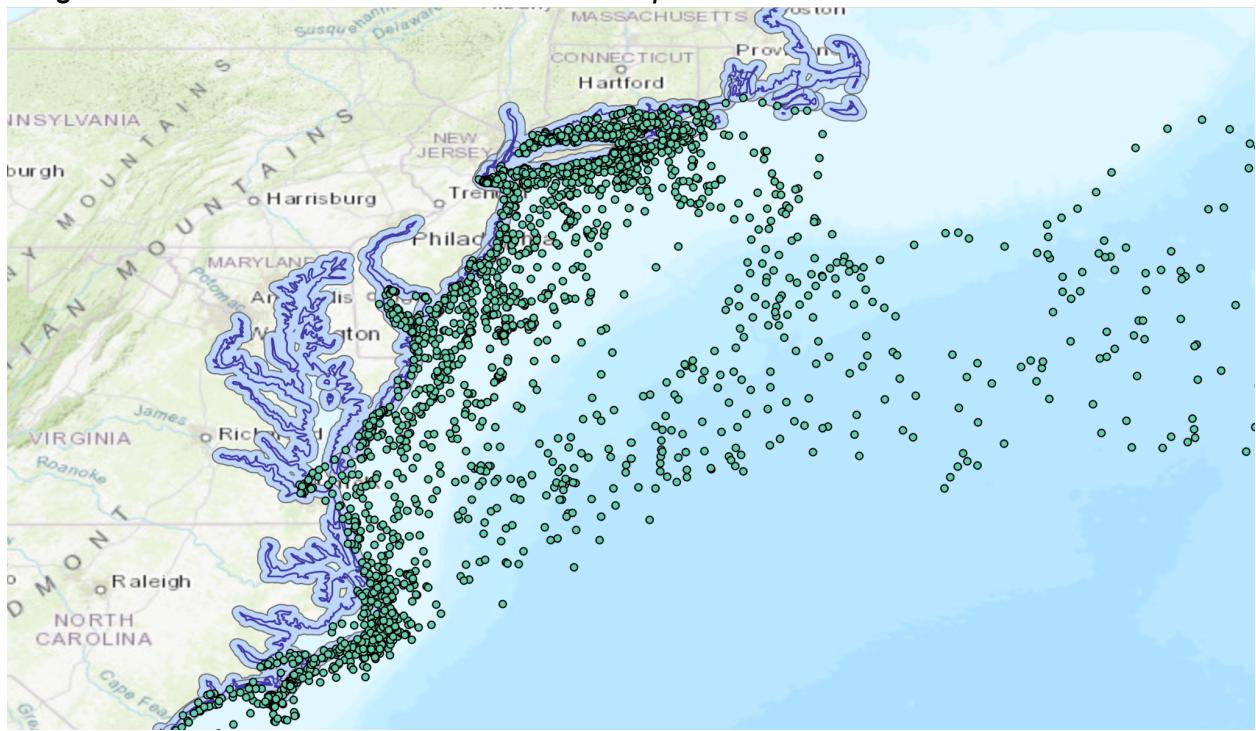


Image 5: Coastlines with buffer and sea turtle points clipped to the buffer.

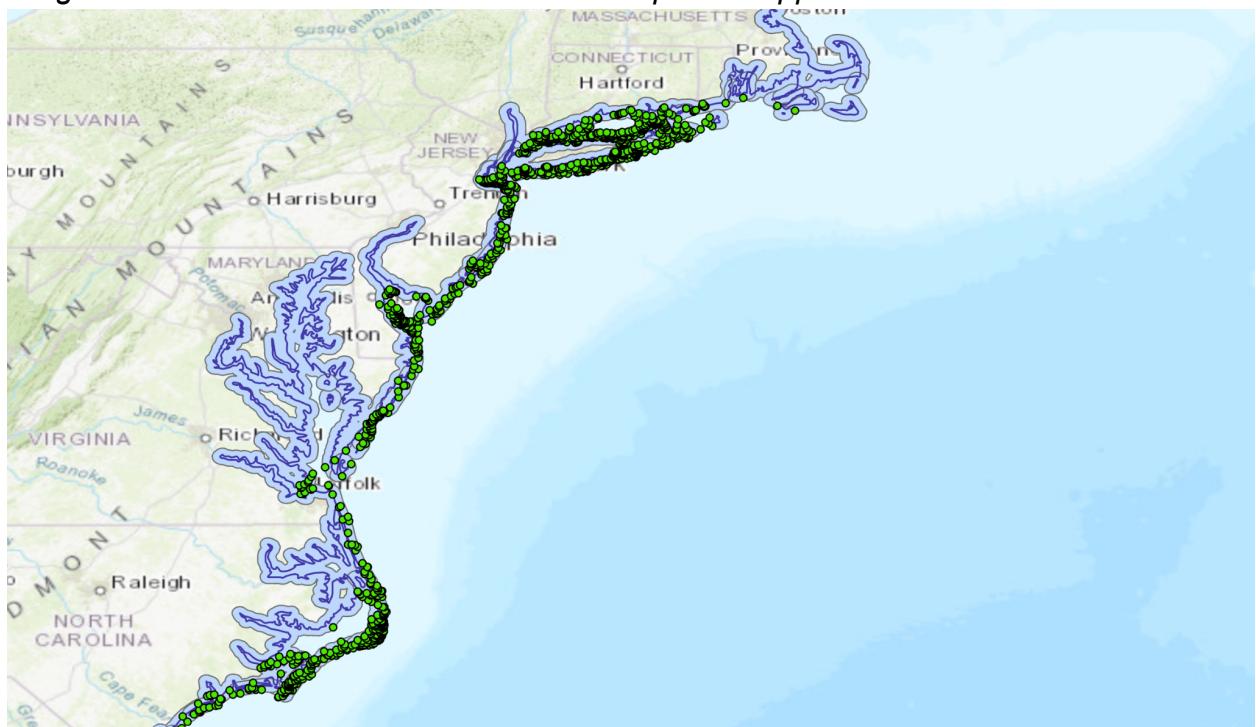


Image 6: Ports with buffers and sea turtle points.

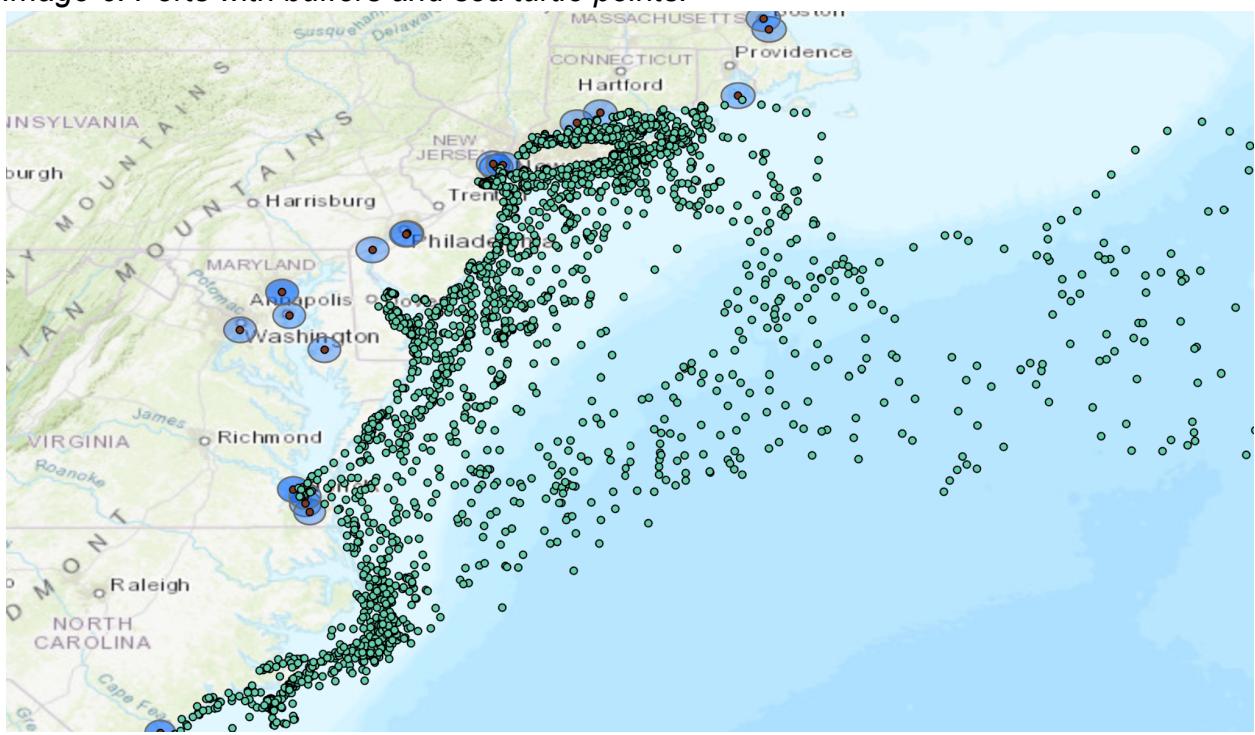
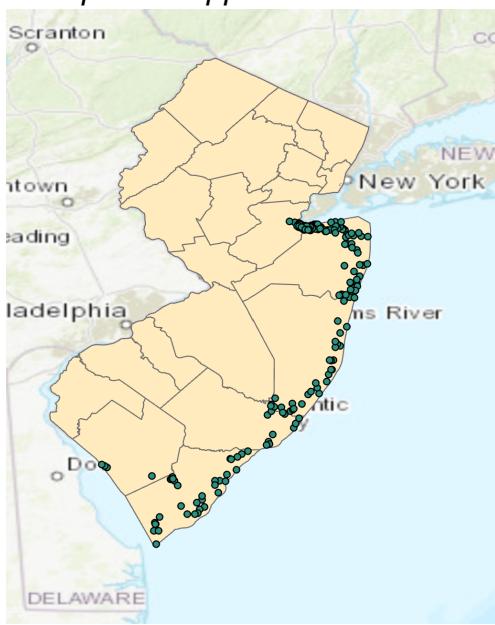


Image 7: County data clipped to just the state of New Jersey (FIPS code 34), and sea turtle points clipped to the state.



Discussion and Conclusions:

This project shows that coding can be used to quickly create new layers based on user-provided input to target areas of interest. Using sea turtle migratory tracking data, a user can look at specific areas where these points can be found. A user can create a buffer around a feature of interest, like coastlines and/or shipping ports, and identify turtles within those buffer areas. The same can be done by state; if a user wants to see the turtles that appear within the state boundaries of New Jersey, they can create a new layer of just New Jersey, and then create a clip of the turtles within its boundaries. While no analysis has been done in this project regarding the turtles' migratory behaviors with relation to the various shapefiles brought in, it does demonstrate that analysis can be performed more easily and efficiently thanks to the quick execution that coding enables, and that the code can be reused as it is customizable based on the users' interests.

Next steps would be to look deeper into the three different species tracked in this data set, and consider dates of release and how many times and where the same turtle is located. Similarities and differences between species can be explored this way in terms of where and when they migrate, how closely they come to coastlines and for how long, and if they venture near shipping ports. Further research into turtles' proximity to shipping ports and chances of being inadvertently caught and/or harmed would be interesting as well. I would also like to be able to use sea surface temperature data, especially since this data set tracked turtles who were rehabilitated after being cold-stunned due to cold ocean temperatures. There are so many directions that this

data can be taken and so many ways it can be more deeply explored, and coding can aid in these explorations in ways that I did not really understand until now.

Sources:

Coastline (shp download). Natural Earth. Retrieved July 25, 2021 from
<https://www.naturalearthdata.com/downloads/10m-physical-vectors/10m-coastline/>

“Information about Sea Turtles: General Behavior”, Sea Turtle Conservancy.
<https://www.conserveturtles.org/information-sea-turtles-general-behavior/>

News: Sea Turtles. National Ocean Service, National Oceanographic and Atmospheric Administration (NOAA), U.S. Department of Commerce.
<https://oceanservice.noaa.gov/news/june15/sea-turtles.html>

Ports (shp download). Natural Earth. Retrieved July 25, 2021 from
<https://www.naturalearthdata.com/downloads/10m-cultural-vectors/ports/>

Robinson NJ, Deguzman K, Bonacci-Sullivan L, DiGiovanni Jr. RA, Pinou T. 2020. Rehabilitated sea turtles tend to resume typical migratory behaviors: satellite tracking juvenile loggerhead, green, and Kemp’s ridley turtles in the northeastern USA. *Endangered Species Research*. 43:133-43.