

**Foraging with Trawlers May Blur the Boundaries Between
Estuarine and Coastal Stocks of Common Bottlenose
Dolphin (*Tursiops truncatus*) off South Carolina**

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Executive Summary

In the western North Atlantic, common bottlenose dolphins (*Tursiops truncatus*) that forage in association with shrimp trawlers in ocean waters are widely assumed to be members of coastal rather than estuarine stocks. To test this assumption, I analyzed photo-identification (photo-id) images of common bottlenose dolphins collected by Justin Greenman in 2011 from North Carolina to Florida during surveys conducted aboard the South Carolina Department of Natural Resources Research Vessel Lady Lisa. During these surveys, Greenman spent 24 days aboard the R/V Lady Lisa, documenting 68 sightings of bottlenose dolphin and collecting 4100 images.

I used ACDSee to format the archived images, and then sorted them using finFindR, in accordance with protocols established by the Mid-Atlantic Bottlenose Dolphin Catalog (MABDC), to create a photo-id catalog for the 2011 surveys. This catalog has 254 unique individuals, and was uploaded into the MABDC portal within Ocean Biodiversity Information System – Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP). These 254 dolphins were documented during 56 of the 68 sightings, with the remaining 12 sightings having no identifiable individuals.

I compared these dorsal fin images to 14 regional photo-identification catalogs within the MABDC, ranging from North Carolina to Florida. I matched 82 individuals from SC-Greenman-MF to seven of these catalogs. Some dolphins were matched to multiple catalogs, resulting in a total of 116 verified matches. 105 of the verified matches were with South Carolina catalogs; most (56) matches were with SC-NOS, from Charleston.

I created a dataset with sighting records for matched dolphins seen 10 or more times to examine their stock identities, based on criteria described in National Marine Fisheries Service (NMFS) Stock Assessment Reports (SARs). I chose a threshold of 10 sightings to ensure a robust sample dataset, which included 18 of the matched dolphins. The two dolphins with the highest number of sightings were both photographed on 32 occasions. Two dolphins were first observed foraging in association with shrimp trawlers in 1998, with the most recent sighting of a matched dolphin being in 2012.

To analyze stock identity, I created polygons for stock areas in ArcGIS Pro, using the criteria described in the NMFS SARs. I then overlaid sightings records for the sample dataset on these polygons to determine the stock area in which each sighting of the sampled dolphins was documented. I also determined in which sightings these sampled dolphins were associating with shrimp trawlers. I only assigned a dolphin to a stock if it stayed entirely in coastal stock waters or estuarine stock waters; if a sighting occurred in an area of overlap, it was not considered for stock assignment.

Only two of the 18 dolphins were sighted only in coastal waters. One dolphin (Match ID 207) was assigned to the Southern Migratory Coastal Stock, and the other (Match ID 1019) was assigned to the South Carolina-Georgia Coastal Stock. Four of the remaining dolphins had most of their sightings in estuarine waters. When these four dolphins were sighted in coastal waters, most often it was in association with shrimp trawlers. A similar trend was seen in all but two of

the remaining dolphins. All sightings of the frequently sighted dolphins in estuarine waters occurred within the Charleston Estuarine System Stock.

Overall, I found that dolphins from multiple stocks forage in association with shrimp trawlers in coastal waters of South Carolina. In addition, it appears that this behavior may attract estuarine dolphins into coastal waters outside their typical stock boundaries. Bycatch mortality is underreported in the South Carolina shrimp trawl fishery (Greenman, 2012), so it is possible that trawler associated foraging may have a significant impact on the Charleston Estuarine System Stock. The movement of dolphins across stock lines to engage in this foraging behavior raises concerns about our understanding of bycatch in this fishery. Misassignment of bycatch to the wrong stock could be particularly harmful to small stocks of bottlenose dolphins.

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1. Introduction

Common bottlenose dolphins (*Tursiops truncatus*) prey on a variety of fish and invertebrates, and employ a wide range of foraging strategies and tactics depending on the habitat and prey species (Heithaus & Dill, 2008). One foraging strategy utilized by bottlenose dolphins that has been well documented is when dolphins follow commercial shrimp trawling vessels to feed on fish that are disturbed by their operations, caught in the nets, and/or are discarded (Corkeron, 1990; Fertl & Leatherwood, 1997; Chilvers and Corkeron, 2001; Fleming, 2004; Greenman, 2012). Dolphins observed engaged in such associations with trawlers have been referred to as “trawler dolphins,” in contrast with dolphins that have never been observed engaged such behavior and are referred to as “non-trawler dolphins” (Chilvers and Corkeron, 2001). Foraging around trawlers provides the dolphins with access to a concentrated food source, potentially allowing them to conserve energy by reducing the need to pursue free-swimming prey (Fertl & Leatherwood, 1997; Fleming, 2004). By spending less time foraging, trawler dolphins may be able to spend more time engaged in other behaviors, at least in some cases (Fertl & Leatherwood, 1997; Fleming, 2004). These benefits also come with a risk; the dolphins could become entangled in the trawl nets or associated lines, potentially resulting in injury or mortality (also known as bycatch), and they could become more vulnerable to shark predation (Corkeron, 1990; Fertl & Leatherwood, 1997).

A study of dolphins that associated with shrimp trawlers off the coast of Southport, North Carolina, United States, showed that this behavior was locally dictated by habitat, with trawler dolphins found exclusively in the ocean while non-trawler dolphins were found in inshore waterways or very close to the shoreline (Fleming, 2004). This finding differs somewhat from the observations of Chilvers and Corkeron (2001), who showed that trawler and non-trawler dolphins co-occurred in the same area. Dolphins from these two communities in Moreton Bay,

Queensland, Australia, rarely associated, despite their shared home ranges, with the potential rare exception of mating activity (Chilvers and Corkeron, 2001). A small proportion (0.65% of sightings-three sightings total) included both trawler and non-trawler dolphins and two of these sightings were confirmed non-trawler males with trawler females. (Chilvers and Corkeron, 2001). Fleming (2004) likewise found virtually no association between trawler and non-trawler dolphins. Both Chilvers and Corkeron (2001) and Fleming (2004) found that, regardless of feeding activity, dolphins associated with trawlers occurred in larger groups than non-trawler dolphin. In a study of trawler dolphins near Savannah, Georgia, Greenman (2013) found most of the estuarine dolphins engaged in trawler associated foraging stayed within 3km of shore and did not appear to socialize with coastal dolphins.

The United States Marine Mammal Protection Act (MMPA) of 1972 defines a “stock” as a group of marine mammals of the same species that share a common spatial area and interbreed. Bottlenose dolphins along the east coast of the United States are currently managed as 15 stocks by the National Marine Fisheries Service (NMFS); which includes ten estuarine and five coastal stocks (Waring et al., 2016). These stocks were defined based on photo-identification (photo-id), genetics, telemetry, stable isotope, and spatial distribution data (Hayes et al., 2021). Estuarine stocks predominantly reside within bays, estuaries, and sounds, but some estuarine dolphins also spend time in nearshore coastal waters extending one to three kilometers from the coast (Waring et al., 2016; Hayes et al., 2018, 2021). South of Cape Hatteras, North Carolina, coastal stocks range from the coastline out to the 200m isobath (Torres et al., 2003; Hayes et al., 2018, 2021). The MMPA classifies the status of stocks relative to their optimum sustainable population (OSP), or the population size needed for a stock to be at maximum productivity. The potential biological removal (PBR) level, or the maximum number of animals that may be removed from

the stock, excluding natural mortalities, while allowing that stock to reach or maintain its OSP, is also calculated for each stock per the MMPA (MMPA, 1972; Hayes et al., 2018, 2021).

Greenman (2012) suggested that although commercial shrimp trawlers based out of Charleston, South Carolina, would likely encounter estuarine animals traveling in and out of port, their greatest interaction would occur with dolphins of the South Carolina-Georgia Coastal Stock (SCGCS) whose putative range overlaps with shrimp trawler's fishing grounds. These trawler dolphins could also be members of the adjacent Southern Migratory Coastal Stock (SMCS) and/or the Northern Florida Coastal Stock (NFCS; Greenman, 2012; Hayes et al., 2018, 2021). During the summer, the SMCS occupies the waters of North Carolina and Virginia, but winter in northern Florida, so they are more likely to occur off South Carolina than the NFCS (Hayes et al., 2018, 2021). The migration of this stock is believed to contribute to the larger number of trawler dolphins seen off southern North Carolina in the summer and fall by Fleming (2004).

Both the SCGCS and SMCS are listed as depleted under the MMPA, meaning their population size is below OSP, and have PBR levels of 46 and 24 respectively (Hayes et al., 2018, 2021). Greenman (2012) found substantial evidence that fishery related mortality in the South Carolina shrimp trawl fishery was underreported. Additionally, this fishery has very little observer coverage (Hayes et al., 2018, 2021). If the shrimp trawlers traveling to and from Charleston Harbor encounter estuarine dolphins, they would most likely be part of the Charleston Estuarine System (CES) stock. The boundaries of the CES stock are defined to include the estuarine and intracoastal waters between Price Inlet and North Edisto River, and coastal waters within one kilometer of the shoreline (Figure 1, Waring et al., 2016). Tagging and photo-id has shown this range has a number of resident dolphins, which sometimes only use a fraction of it

(Speakman et al., 2010; Waring et al., 2016). Due to limited abundance data the CES stock has an undetermined, but likely small, PBR level that could easily be exceeded (Waring et al., 2016, Northeast Fisheries Science Center, 2022). As such, NMFS considers the CES stock strategic under the MMPA. (Waring et al., 2016, Northeast Fisheries Science Center, 2022).

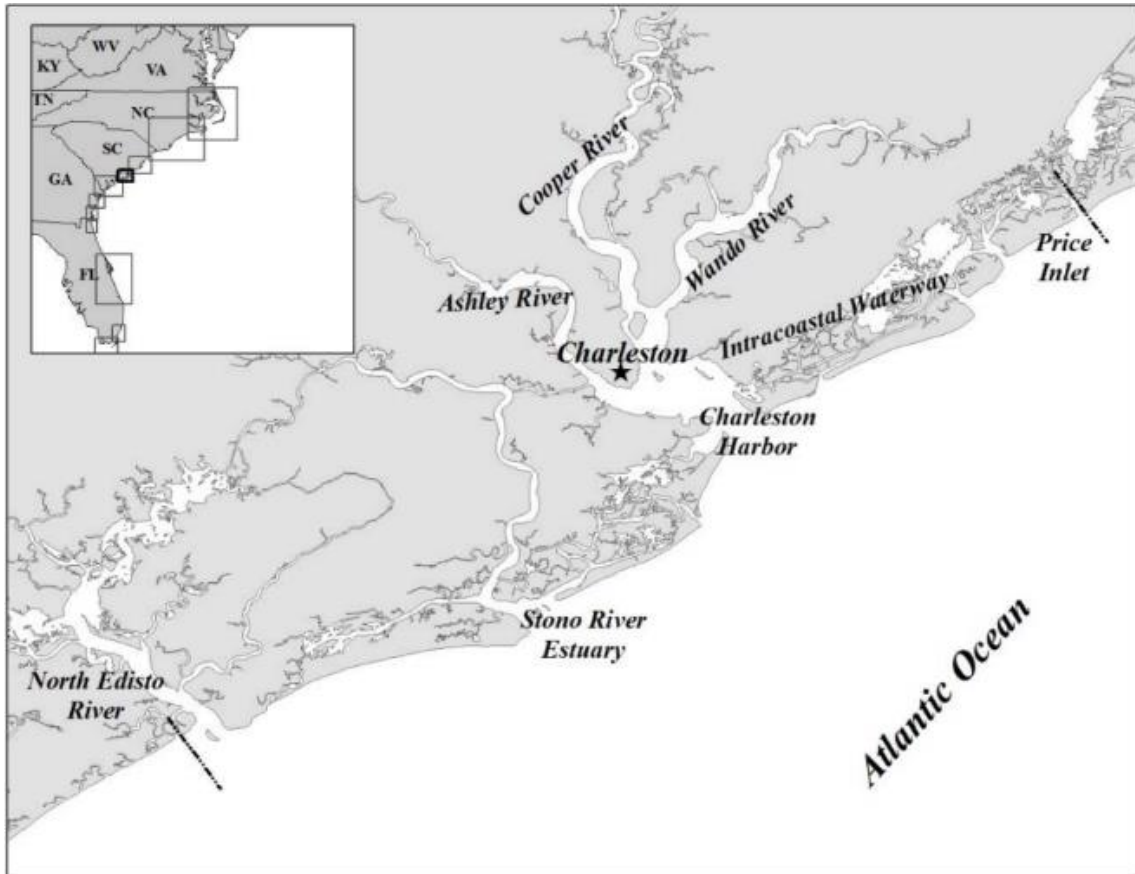


Figure 1 | Geographic extent of the Charleston Estuarine System (CES) stock. Dashed lines denote the northern and southern boundaries. Adapted from Waring et al. 2016.

An unusually high level of mixing between estuarine and coastal dolphins around Charleston could potentially be attributed to trawler associated foraging, and could have consequences for the separation of stocks (Laska et al., 2011). In this area, 17% of survey sightings, consisting of coastal or mixed groups of dolphins, were associated with shrimp trawlers (Laska et al., 2011). Dolphins were also reported following returning shrimp trawlers into Charleston Harbor (Laska et al., 2011).

The objectives for this research were to:

1. Determine how many identifiable individuals were documented during Greenman's 2011 surveys and develop a photo-id catalog ("SC-Greenman-MF") for those individuals and to be incorporated into the Mid-Atlantic Bottlenose Dolphin Catalog (MABDC).
2. Match SC-Greenman-MF to other catalogs within the MABDC to determine the sighting histories of matched dolphins.
3. Determine if matched dolphins could be assigned to specific stocks based on their sightings histories.
4. Determine if trawler associated foraging could influence dolphins to move across coastal and estuarine stock boundaries.

2. Methods

2.1 Field Methods

Greenman (2012) opportunistically collected data and photographs of bottlenose dolphin in 2011 while aboard the R/V Lady Lisa, a 75ft trawler operated by the South Carolina Department of Natural Resources. Images were taken using a Canon EOS-1 Ds Mark II digital camera with a Canon 100-400mm telephoto lens; photographs were taken while the vessel was actively trawling and dolphins were usually seen within 100 meters of the vessel's stern. This was the most common distance that the nets were towed, and dolphins were observed interacting with the fishing gear, and/or the prey items disturbed by it. Most of the trawls in which dolphins were observed and seen interacting with the vessel and/or its gear occurred off the coast of South Carolina (Figure 2), in addition to several observations off the coasts of Georgia and Florida. Every effort was made to obtain focused and perpendicular photographs of each side of each trawler dolphin's dorsal fin. In addition to identification photographs, data was collected on; the date, time, and GPS coordinates for the beginning and end of each trawl, the presence or absence

of dolphins, estimated number of mother/calf pairs, observed physical gear interactions, observed bycatch depredation behaviors, and the species collected during each trawl.

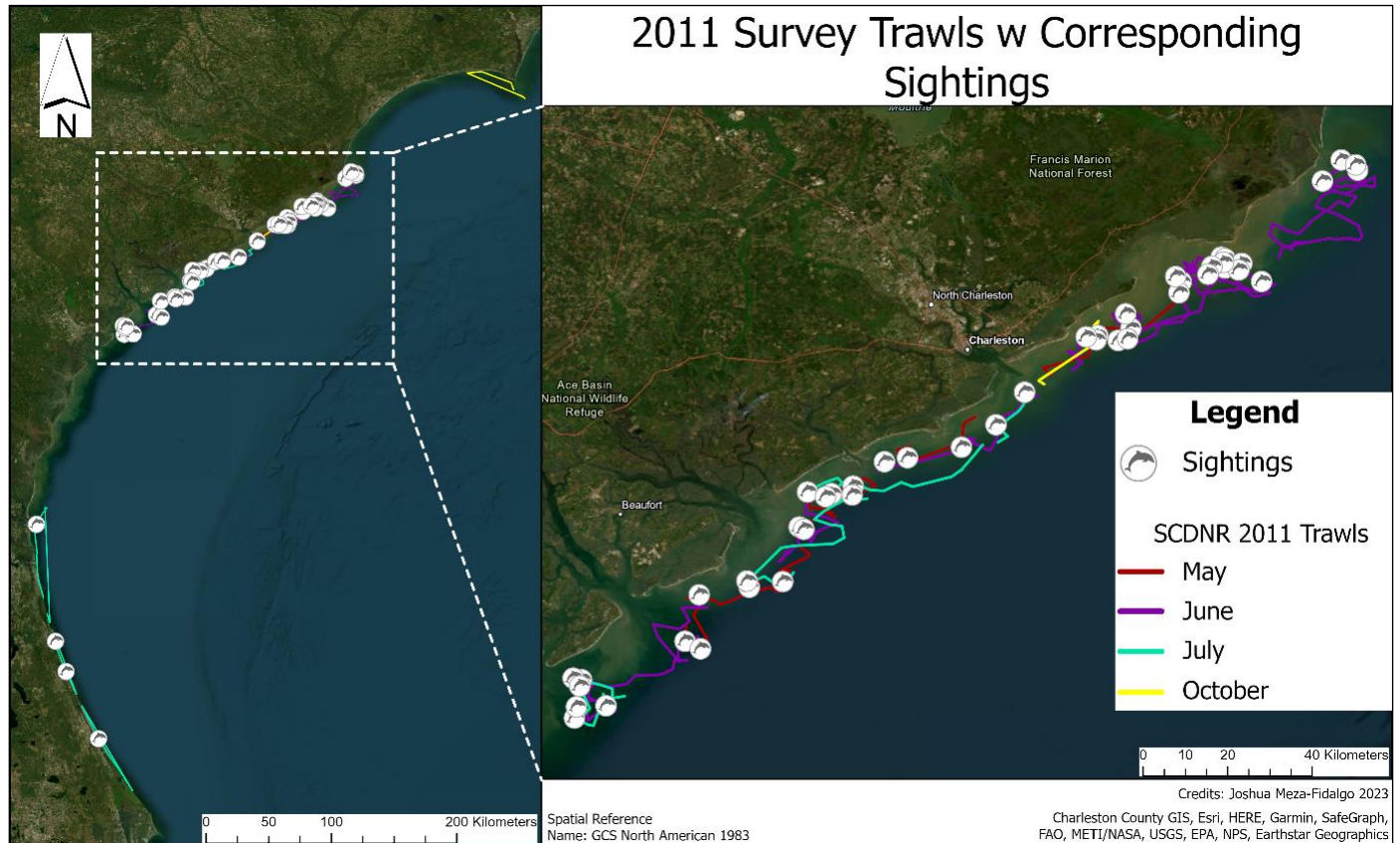


Figure 2 | Displays the 2011 survey trawls and associated sightings of bottlenose dolphin documented by Greenman (2012).

2.2 Photo-Identification and Catalog Development

Approximately 4100 photographs were taken during 68 sightings over the course of 24 days from May to October 2011. I organized the archived photographs and processed them using ACDSsee Photo Studio Professional 2022 and the matching software finFindR (Thompson et al., 2021). Then I evaluated all images for image quality and dorsal fin distinctiveness (Urian et al., 2013). Photographs unsuitable for identification purposes were not included in the analysis. Within each sighting I compared the photographs that met the criteria for identification, and selected for the best identification photograph of each distinct individual. I compared these photographs between sightings, and the best identification photograph of each individual across

all sightings was used to develop a “Best of” catalog of identification photographs, using finFindR and visual comparisons to ensure no individual was represented in the “Best of” catalog more than once. The resulting catalog (SC-Greenman-MF) was uploaded into the MABDC database, stored within the Ocean Biodiversity Information System – Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP), along with sightings records for each distinctive individual (Halpin et al., 2009; OBIS-SEAMAP, 2023).

I used the MABDC matching portal in OBIS-SEAMAP to compare the SC-Greenman-MF catalog to 14 regional catalogs in the MABDC (Table 1). When a potential match between SC-Greenman-MF and another catalog was found, it was referred to both the catalog contributor and Kim Urian, curator of the MABDC. All three parties were required to agree to confirm a potential match. After matching was completed, sightings data (date, location, & trawler association) were requested from the contributors on all matched dolphins.

Catalog	Location	Active Period
NC-NCMM	Beaufort, NC	1985-Ongoing
NC-DUML-UNCW	Estuarine/Coastal NC	1995-Ongoing
NC-GR	Wilmington, NC	1991-1994
NC-NMFS	Estuarine/Coastal NC	2001-Ongoing
NC/SC-CCU	Southern NC & Estuarine/Coastal SC	2013-Ongoing
NC-NOS	Southern NC	2014
SC-NOS	Charleston, SC	1994-2011
SC-Greenman	NC & SC	2010
SC-NMFS	Charleston, SC	2002-2005; 2018
SC-RY	Murrells Inlet, SC	1997-Ongoing
GA-NMFS	Savannah, GA	2004
GA-Sailor	Savannah, GA	2012-Ongoing
GA-UNCW	Brunswick/Sapelo Island, GA	2004-2008
FL-NMFS	Jacksonville, FL	2004

Table 1| Details the MABDC catalogs compared with SC-Greenman-MF by catalog name, location, and period of data collection.

2.3 Geospatial Analysis

I plotted the sighting data for SC-Greenman-MF and all matched dolphin sightings in ArcGIS Pro. If a dolphin was sighted multiple times in a single day, only the first sighting was used for analysis to ensure independence of sampling. Using the stock definitions described in the NMFS Stock Assessment Reports I created GIS shapefiles for relevant stocks in ArcGIS Pro (Figure 3; Waring et al., 2016; Hayes et al., 2018, 2021; U.S. Census Bureau, 2022).

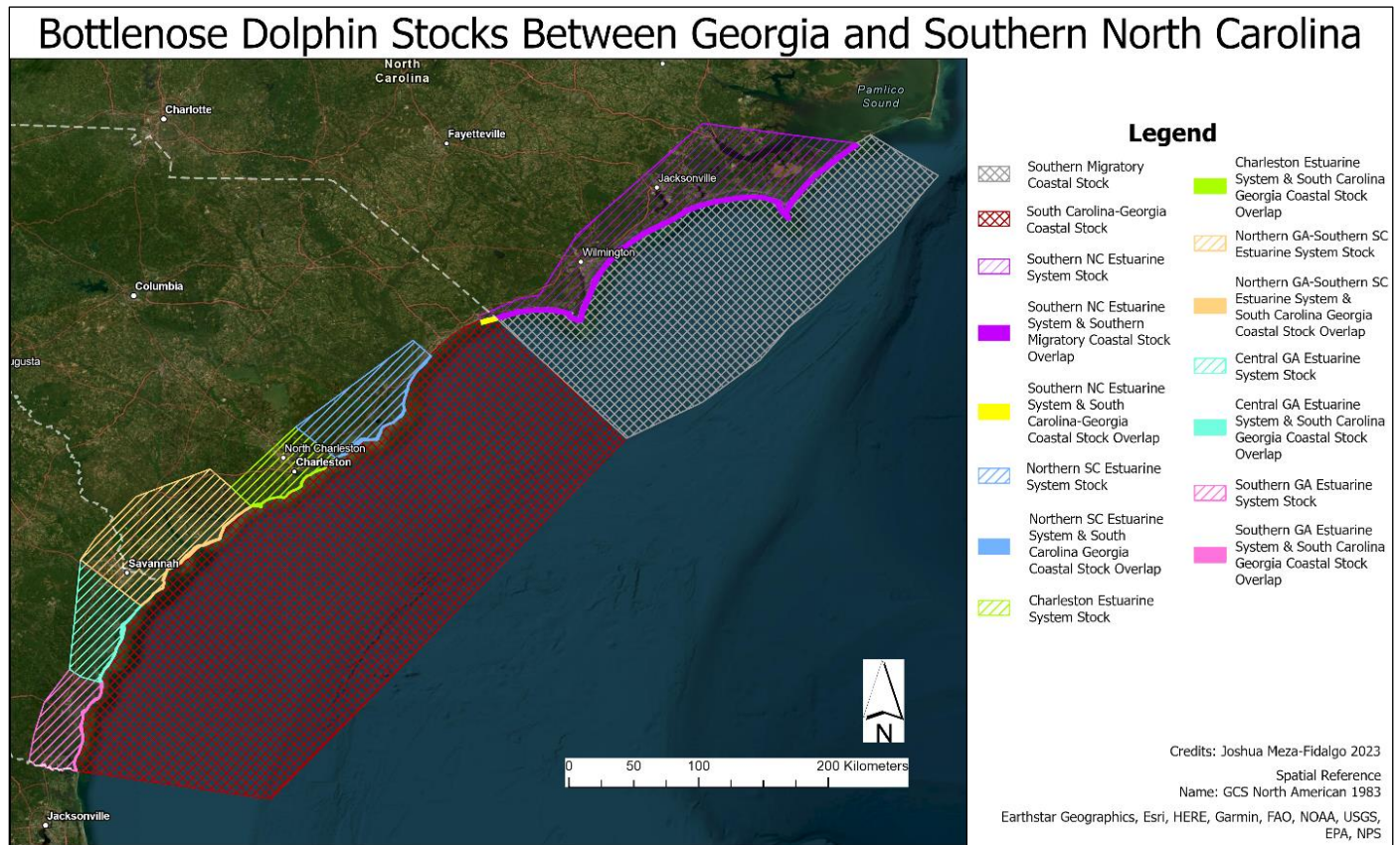


Figure 3 | Displays the bottlenose dolphin stock area shapefiles created in ArcGIS Pro.

These stock shapefiles ranged from Cape Hatteras to Georgia, and included areas of overlap between estuarine and coastal stocks. I overlaid the sightings data for the sampled dataset on top of the stock areas in ArcGIS Pro to visualize their spatial relationships, and used this visualization to attempt to assign each dolphin to a particular stock. To ensure a robust dataset for this stock evaluation I selected a ‘sample dataset,’ using the criteria of dolphins with 10 or

more sightings, which resulted in 18 individual dolphins being chosen. I symbolized the sightings of these 18 dolphins based on their association with shrimp trawlers to determine if trawler associated foraging may have influenced individuals to cross the line between coastal and estuarine stock areas. If a dolphin was sighted in both estuarine and coastal stock areas, its stock was undetermined. I did not consider sightings in the areas of overlap between estuarine and coastal stocks when assigning the dolphins to stocks.

3. Results

3.1 Field Methods

I identified 254 distinct individuals across 56 sightings from the 2011 trawler surveys and incorporated them into the SC-Greenman-MF catalog. No distinct identification was possible from the remaining 12 sightings. The average distance from shore for the 68 sightings was approximately 7+/- 0.5km. The number of days an individual was sighted during the surveys ranged from one to four; some individuals being sighted multiple times in a day.

3.2 Photo-Identification and Catalog Development

82 of the 254 individuals from SC-Greenman-MF were matched to other catalogs within the MABDC, mostly with other South Carolina catalogs (Table 2). These 82 individuals were matched a total of 116 times to seven catalogs, with 18 individuals matched to two catalogs, seven individuals matched to three catalogs, and one individual matched to four catalogs. The total number of sightings for each matched dolphin across all catalogs can be seen in Figure 4.

3.3 Geospatial Analysis

The 18 individuals of the sample dataset were sighted a combined 356 times. When I plotted these sightings records in ArcGIS Pro, it became apparent that many of these dolphins had been sighted well inside Charleston Harbor, in addition to several miles offshore (Figure 5). Given the average distance from shore for the SC-Greenman-MF sightings was approximately 7km, it was surprising that these dolphins were generally seen in estuarine waters.

Catalog	# of Individuals	# Matches w SC-Greenman-MF
NC-NCMM	3950	0
NC-DUML-UNCW	1239	4
NC-GR	46	0
NC-NMFS	2707	0
NC/SC-CCU	1504	7
NC-NOS	208	0
SC-NOS	85	56
SC-Greenman	2267	25
SC-NMFS	233	21
SC-RY	967	3
GA-NMFS	332	1
GA-Sailor	1005	0
GA-UNCW	473	0
FL-NMFS	17	0

Table 2| Details the number of individuals within each MABDC catalog and the number of matches between those catalogs and SC-Greenman-MF.

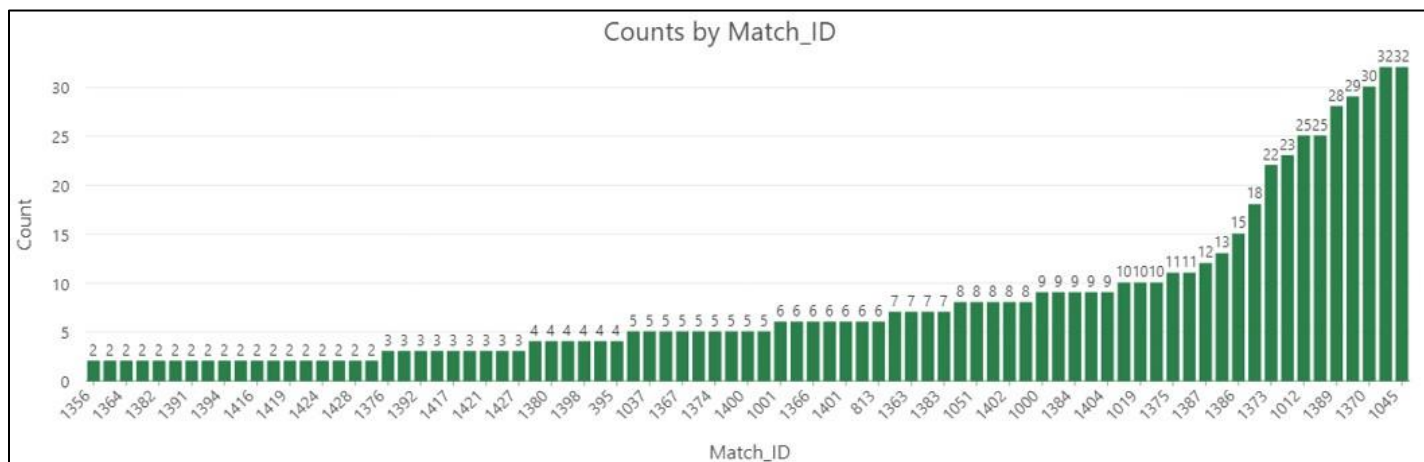


Figure 4 | Displays the sightings counts of the sample dataset bottlenose dolphin by Match ID.

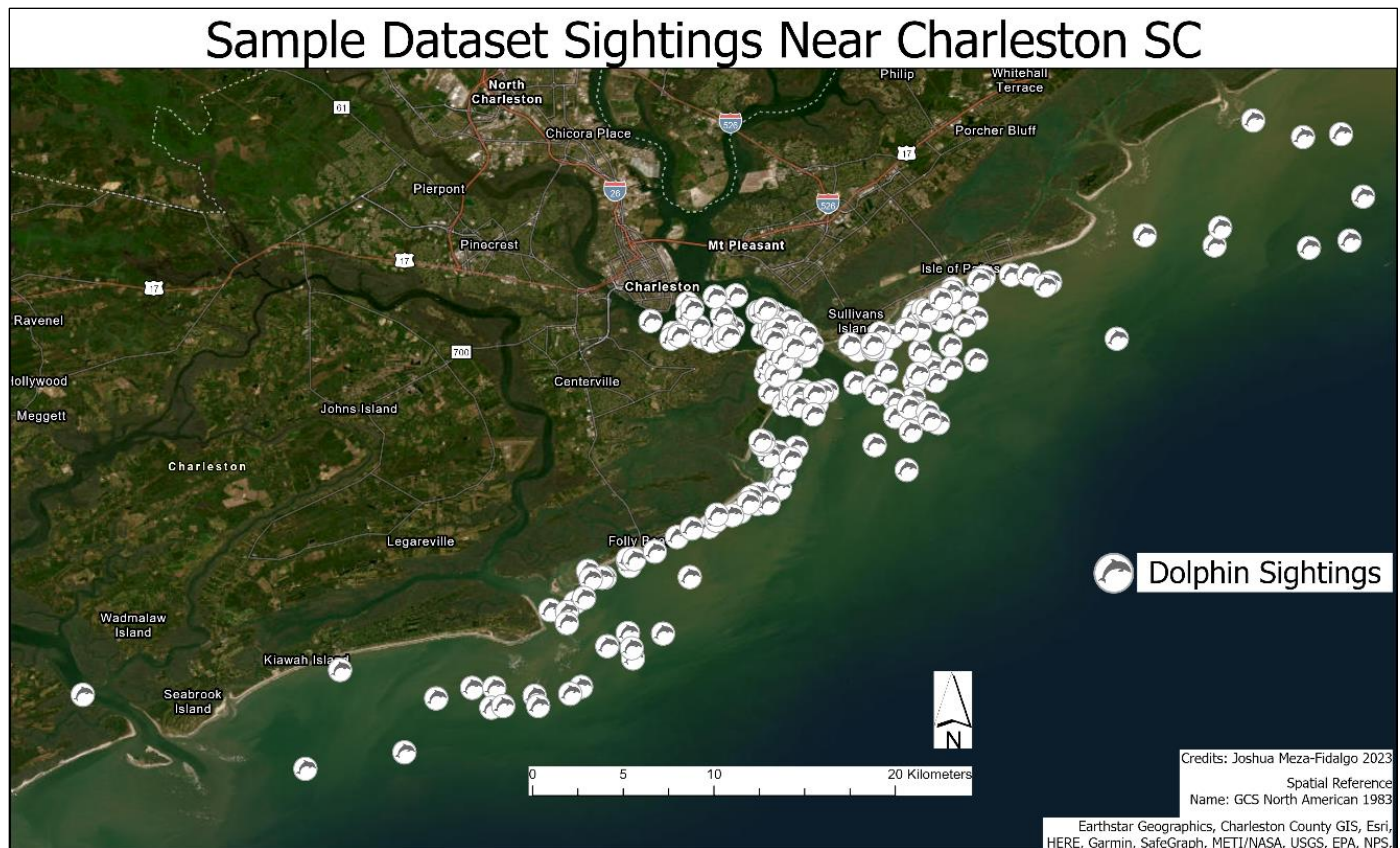


Figure 5 | Displays the sightings of the sample dataset bottlenose dolphin near Charleston, South Carolina.

Only two dolphins from the sample dataset were not documented in estuarine waters and were therefore assignable to coastal stocks (Figures 6 & 7). The remaining 16 individuals were documented in both estuarine and coastal stock waters on numerous occasions, so could not be assigned to a specific stock. Four of the 18 individuals had the majority of their sightings within the CES stock area (Table 3, Figures 8-11). 16 of the 18 individuals were associated with trawlers in at least half of their sightings in coastal waters (Table 3). The earliest and most recent sightings of the sample dataset occurred in 1997 (this sighting was not associated with a trawler) and 2012, respectively, with the earliest documented trawler association occurring in 1998 (Table 4). Maps for the remaining sample dataset dolphins can be seen in the appendix (Figures 12-23).

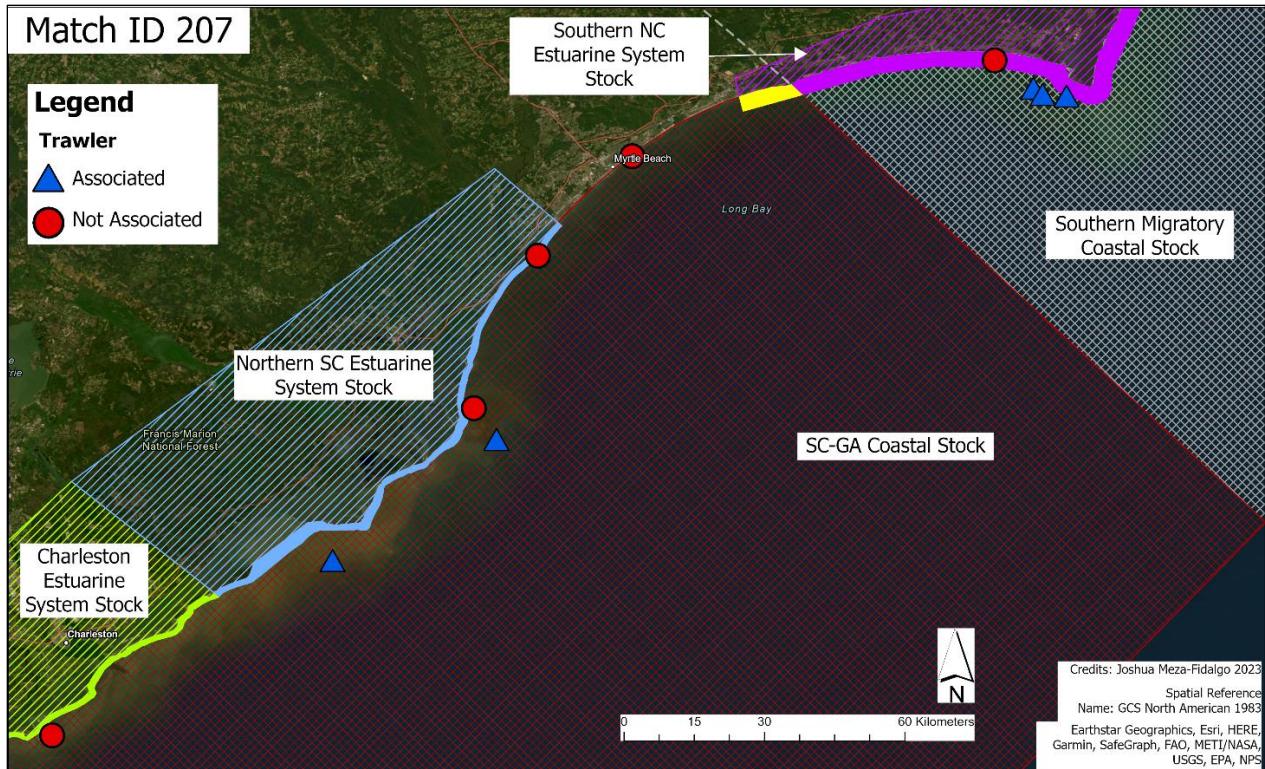


Figure 6 | Displays the sightings of the dolphin MABDC Match ID 207 with trawler associations. MID 207 was assigned to the Southern Migratory Coastal Stock.

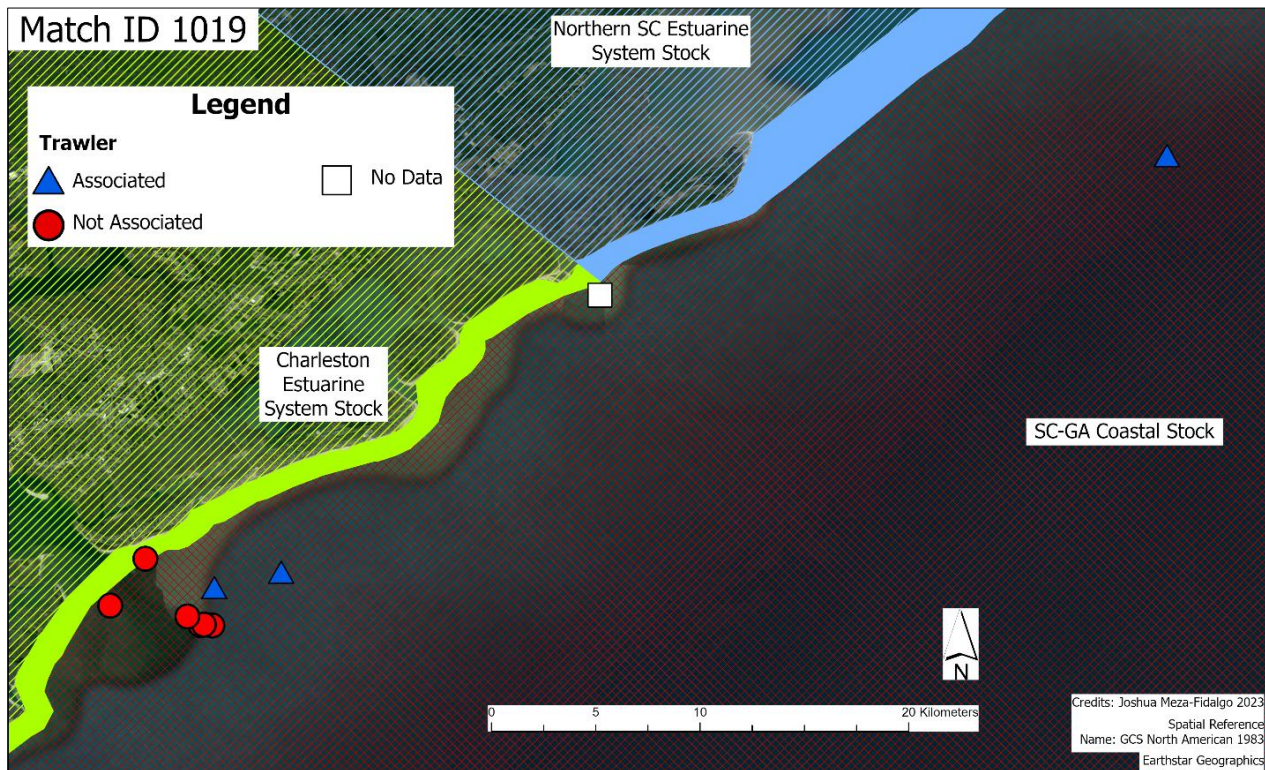


Figure 7 | Displays the sightings of the dolphin MABDC Match ID 1019 with trawler associations. MID 1019 was assigned to the South Carolina-Georgia Coastal Stock.

Match ID	% Sightings in Estuarine Stock Waters	% Sightings in Coastal Stock Waters	% Sightings in Overlap	% Coastal Sightings w Trawler	Stock
207	0%	70%	30%	57%	SMCS
1019	0%	90%	10%	33%	SCGCS
1395	9%	46%	45%	80%	Undetermined
1403	15%	39%	46%	80%	Undetermined
1005	17%	40%	43%	64%	Undetermined
1375	18%	55%	27%	100%	Undetermined
1045	22%	40%	38%	58%	Undetermined
1386	27%	40%	33%	50%	Undetermined
1018	30%	40%	30%	50%	Undetermined
1035	34%	52%	14%	53%	Undetermined
1385	39%	22%	39%	57%	Undetermined
1373	45%	41%	14%	78%	Undetermined
1389	46%	22%	32%	86%	Undetermined
1387	50%	42%	8%	40%	Undetermined
1397	52%	32%	16%	63%	Undetermined
1033	59%	25%	16%	63%	Undetermined
1012	60%	8%	32%	88%	Undetermined
1370	70%	17%	13%	100%	Undetermined

Table 3 | Displays the sightings percentages in estuarine stock, coastal stock, and overlap waters for the sample dataset, as well as the percentage of trawler association for each individual's coastal sightings.

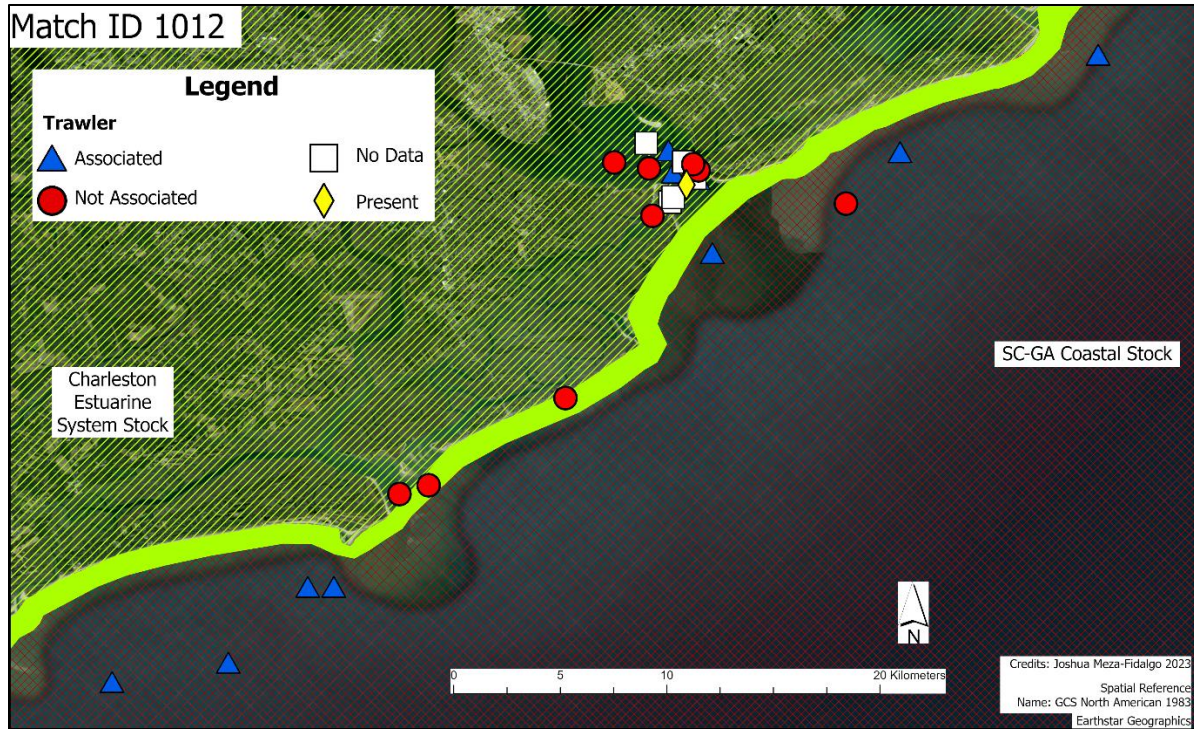


Figure 8 | Displays the sightings of the dolphin MABDC Match ID 1012 with trawler associations. MID 1012 was one of the four sample dataset dolphins with the majority of its sightings within estuarine stock waters.

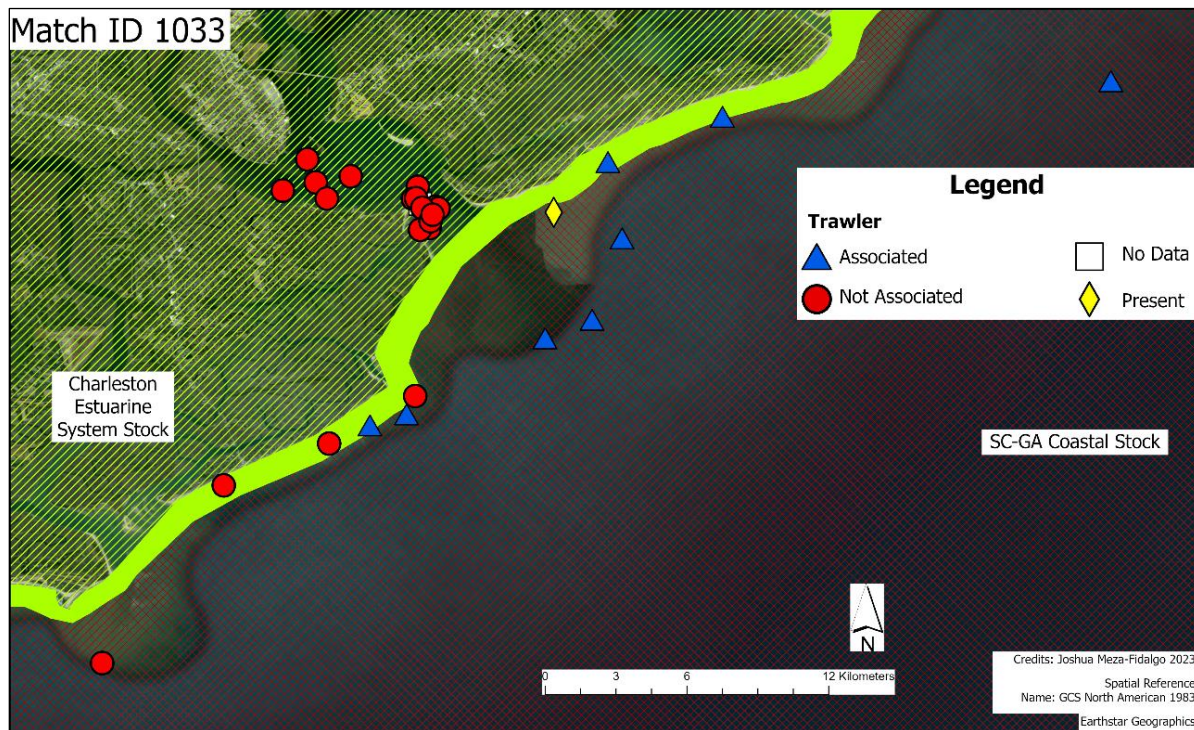


Figure 9 | Displays the sightings of the dolphin MABDC Match ID 1033 with trawler associations. MID 1033 was one of the four sample dataset dolphins with the majority of its sightings within estuarine stock waters.

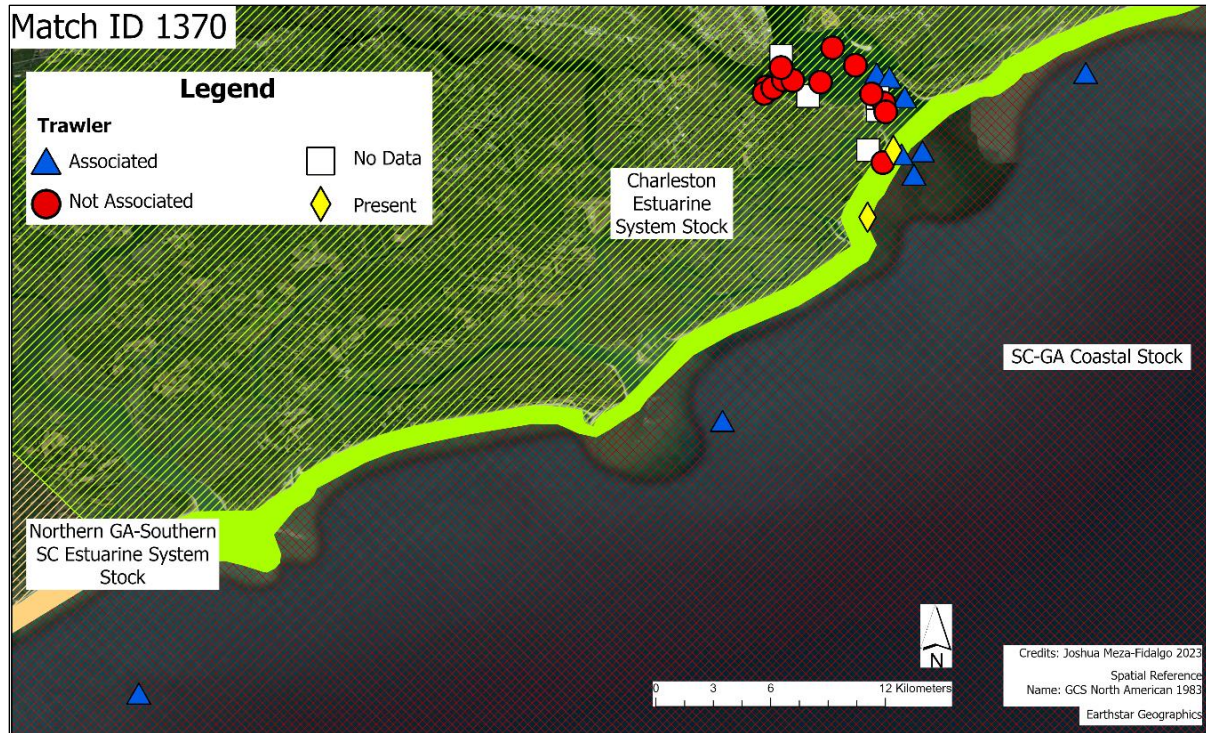


Figure 10 | Displays the sightings of the dolphin MABDC Match ID 1370 with trawler associations. MID 1370 was one of the four sample dataset dolphins with the majority of its sightings within estuarine stock waters.

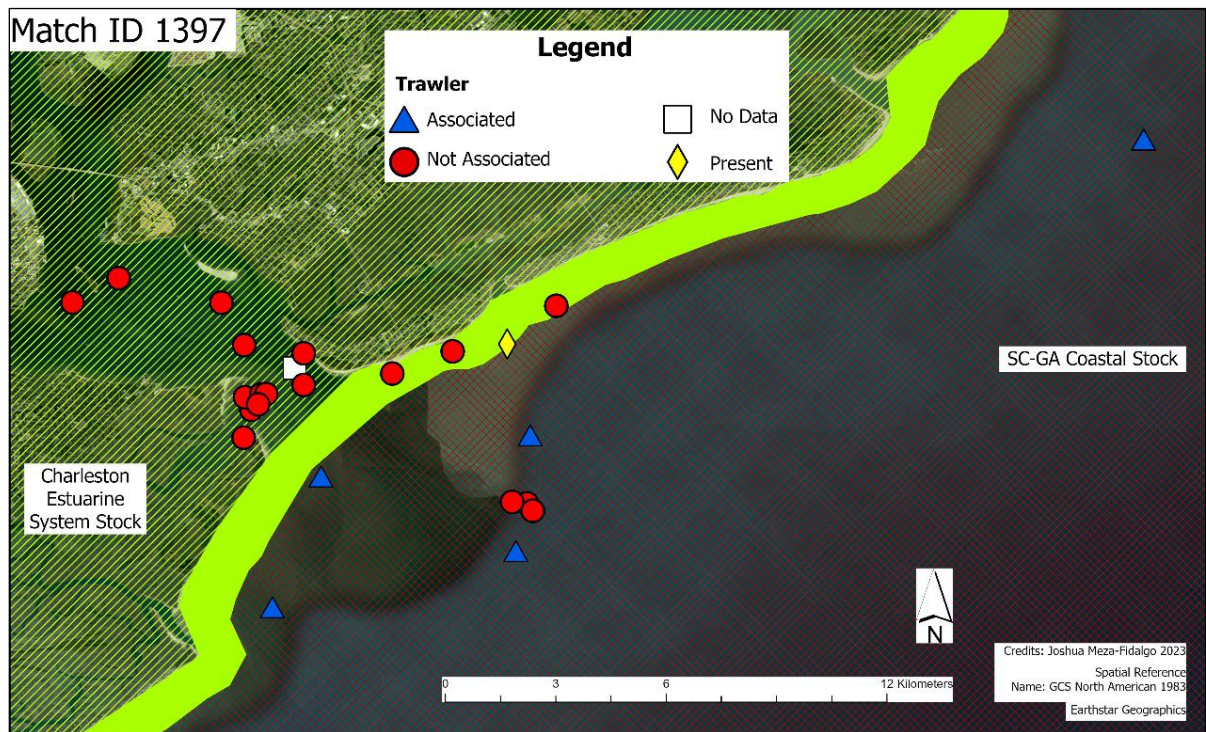


Figure 11 | Displays the sightings of the dolphin MABDC Match ID 1379 with trawler associations. MID 1397 was one of the four sample dataset dolphins with the majority of its sightings within estuarine stock waters.

Match ID	# of Sightings	Earliest Known Sighting	Earliest Known Sighting w Trawler	Most Recent Sighting
207	10	8/6/1998	8/6/1998	6/15/2011
1005	23	3/14/2002	3/14/2002	5/31/2011
1012	25	9/29/1997	7/25/2003	6/10/2011
1018	10	1/29/1999	11/9/2010	6/2/2011
1019	10	1/29/1999	7/6/2007	6/2/2011
1033	32	10/21/2002	10/28/2002	6/3/2011
1035	29	8/3/1999	6/30/2003	6/3/2011
1045	32	7/19/2002	7/19/2002	6/14/2012
1370	30	8/21/1997	7/25/2003	7/13/2012
1373	22	9/30/2003	10/6/2003	6/14/2012
1375	11	7/31/2002	7/31/2002	7/18/2012
1385	18	7/7/2004	7/7/2004	7/11/2011
1386	15	8/3/1999	6/18/2004	6/2/2011
1387	12	4/4/2005	7/11/2006	6/29/2012
1389	28	6/29/1997	11/18/2002	8/23/2012
1395	11	5/12/2004	9/20/2005	7/31/2012
1397	25	5/16/2003	6/30/2003	7/31/2012
1403	13	7/20/2004	7/20/2004	7/31/2012

Table 4 | Displays the sightings histories for each dolphin within the sample dataset; their earliest sighting, earliest sighting associated with a trawler, and most recent sighting.

4. Discussion

The final count of 254 individuals in the SC-Greenman-MF catalog is almost certainly an underestimate compared to the number of dolphins seen since 12 of the sightings were without usable identification photographs. Additionally, numerous photos from the remaining sightings were deemed unsuitable for reliable identification and removed from consideration. During the matching process there were instances where potential matches were rejected because the three

parties involved could not come to a consensus, so it is possible that not every potential match was confirmed.

The SC-Greenman-MF catalog is not a comprehensive catalog of all trawler dolphin off the coast of South Carolina. Opportunistic data collected in 2010 by Greenman (2012), predominantly from commercial shrimp trawlers, cataloged 232 distinct trawler dolphin which were incorporated into the MABDC as the SC-Greenman catalog. 25 individuals were matched between SC-Greenman and SC-Greenman-MF, while 149 individuals from SC-Greenman were documented off South Carolina. This indicates that there are at least several hundred bottlenose dolphins known to engage in trawler associated foraging off South Carolina. How much time these dolphins spend in these waters and how much of their diet depends on trawler associated foraging is unknown and warrants further study. If the South Carolina shrimp fishery significantly declines or collapses there could be serious consequences for dolphins that are dependent on trawler associated foraging and/or would be unable to adapt to new feeding strategies.

There is evidence to suggest that trawler associated foraging causes bottlenose dolphin off South Carolina to move between estuarine and coastal stock areas, particularly around Charleston. Greenman (2012) assumed that the dolphins encountered in the 2011 trawl surveys were from coastal stocks, which was only confirmed for two of the 18 sample dataset dolphins in this study. While it is possible that coastal dolphins follow trawlers into Charleston Harbor, it is at least as likely to be the opposite, if not more so. Most observations of dolphins included in the sample dataset associated with trawlers coastal stock areas. While there were sightings of dolphins that weren't associated with trawlers in coastal waters, it is possible that those dolphins followed a trawler offshore and had broken away by the time they were sighted.

The movement of dolphins across estuarine and coastal stock boundaries raises questions about how bycatch of dolphins in the South Carolina shrimp trawl fishery are assigned to a particular stock. It has long been assumed that dolphins taken in this fishery are coastal and not estuarine dolphins, and thus bycatch would be attributed to the coastal stocks, most likely the SCGCS, and count against the corresponding PBR. However, as I have documented, if members of the smaller CES stock are taken in by the shrimp trawl fishery, then the low PBR level may be exceeded, and could put this stock at significant risk. Updating the population estimates for the estuarine stocks in these waters and taking advantage of a collaborative approach using photo-id data would greatly improve our understanding of the impact this fishery may have on both coastal and estuarine stocks. Additionally, observer coverage should be increased for the shrimp trawl fishery to better protect trawler dolphins from any stock.

Acknowledgements

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Appendix

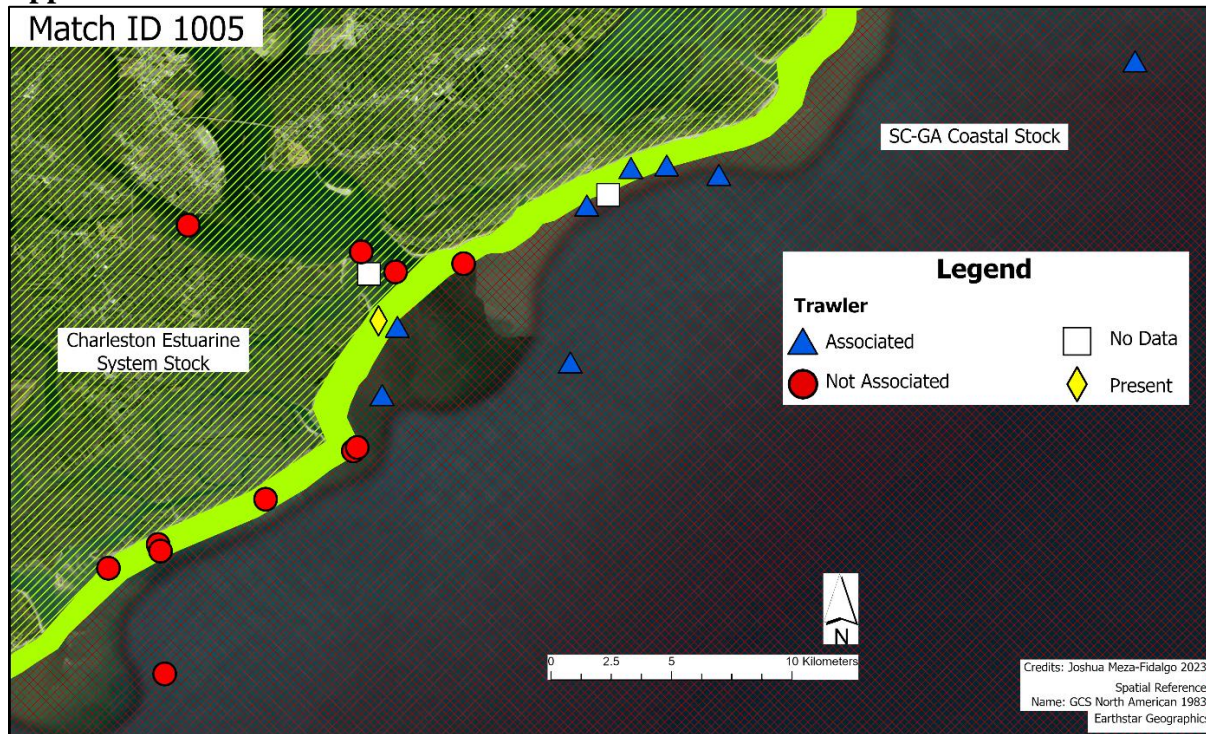


Figure 12 | Displays the sightings of the dolphin MABDC Match ID 1005 with trawler associations. MID 1005 was not assigned to a stock.

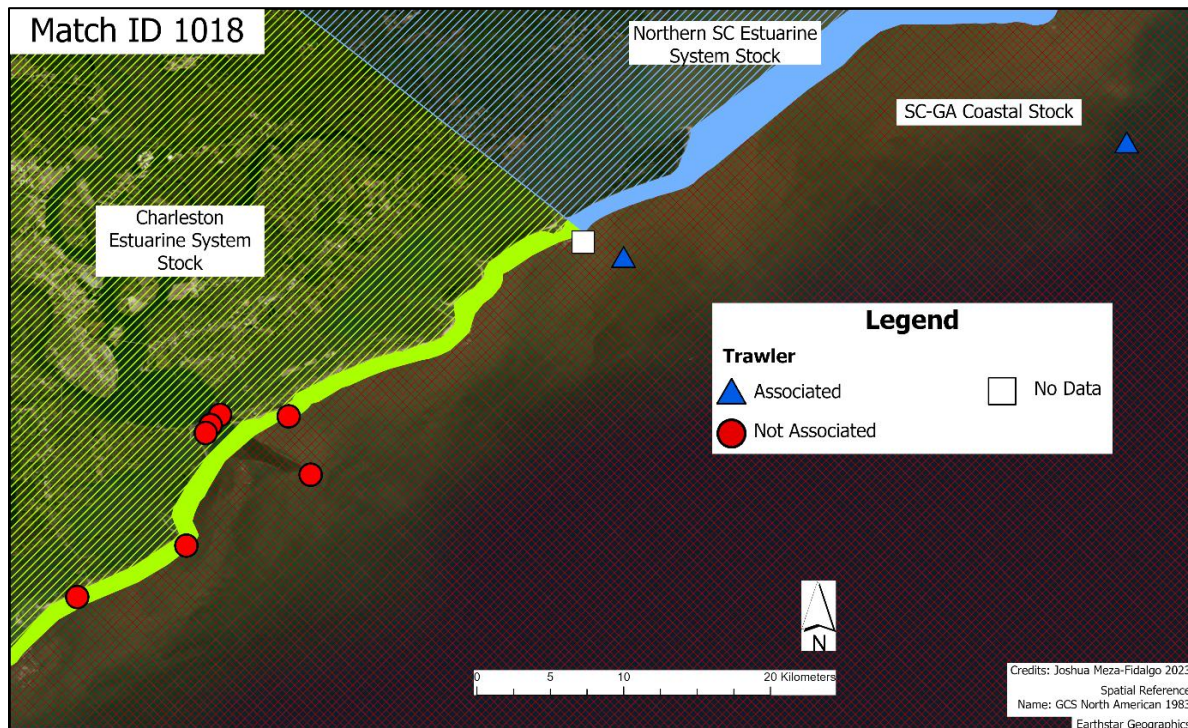


Figure 13 | Displays the sightings of the dolphin MABDC Match ID 1018 with trawler associations. MID 1018 was not assigned to a stock.

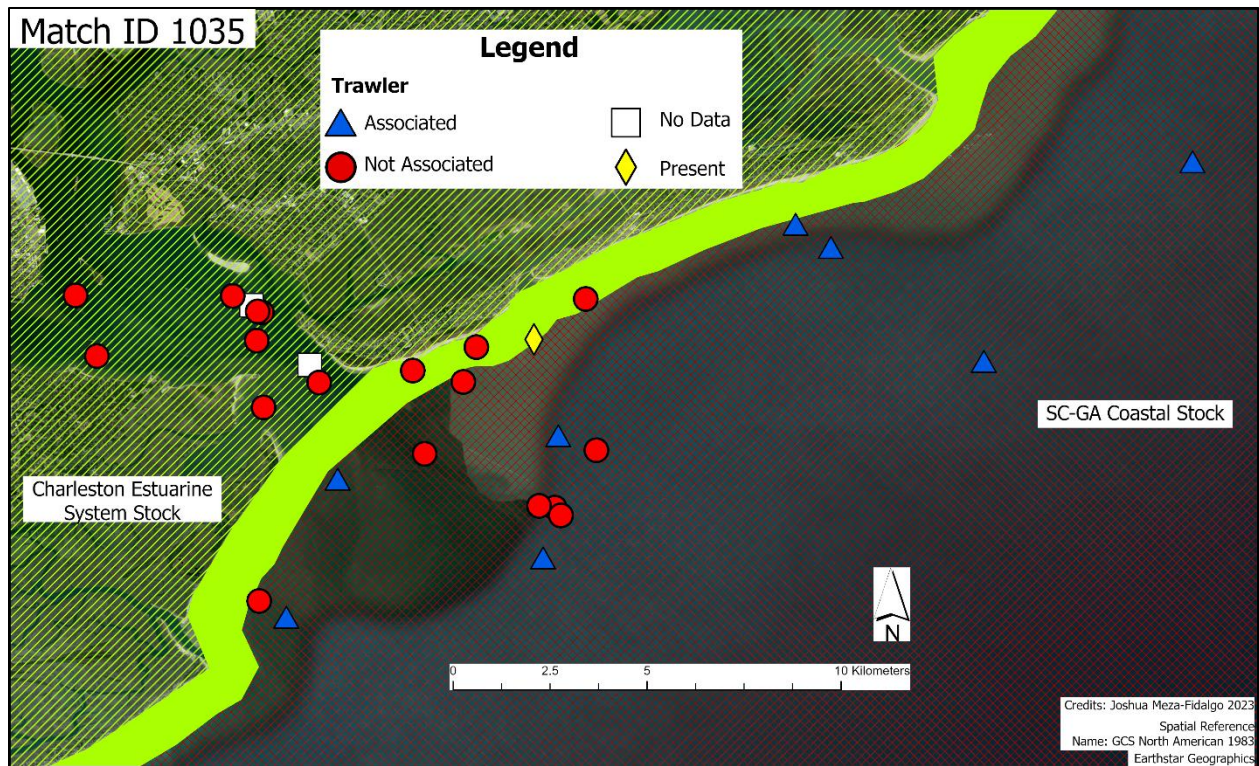


Figure 14 | Displays the sightings of the dolphin MABDC Match ID 1035 with trawler associations. MID 1035 was not assigned to a stock.

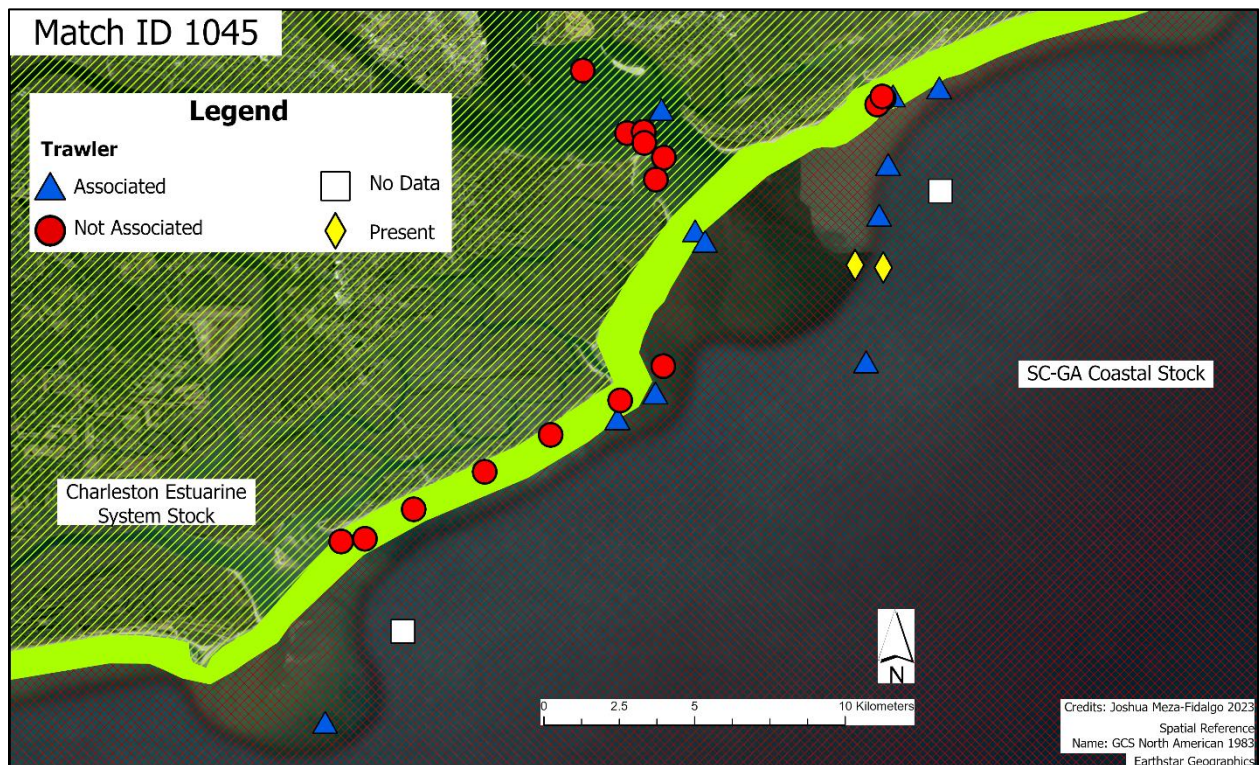


Figure 15 | Displays the sightings of the dolphin MABDC Match ID 1045 with trawler associations. MID 1045 was not assigned to a stock.

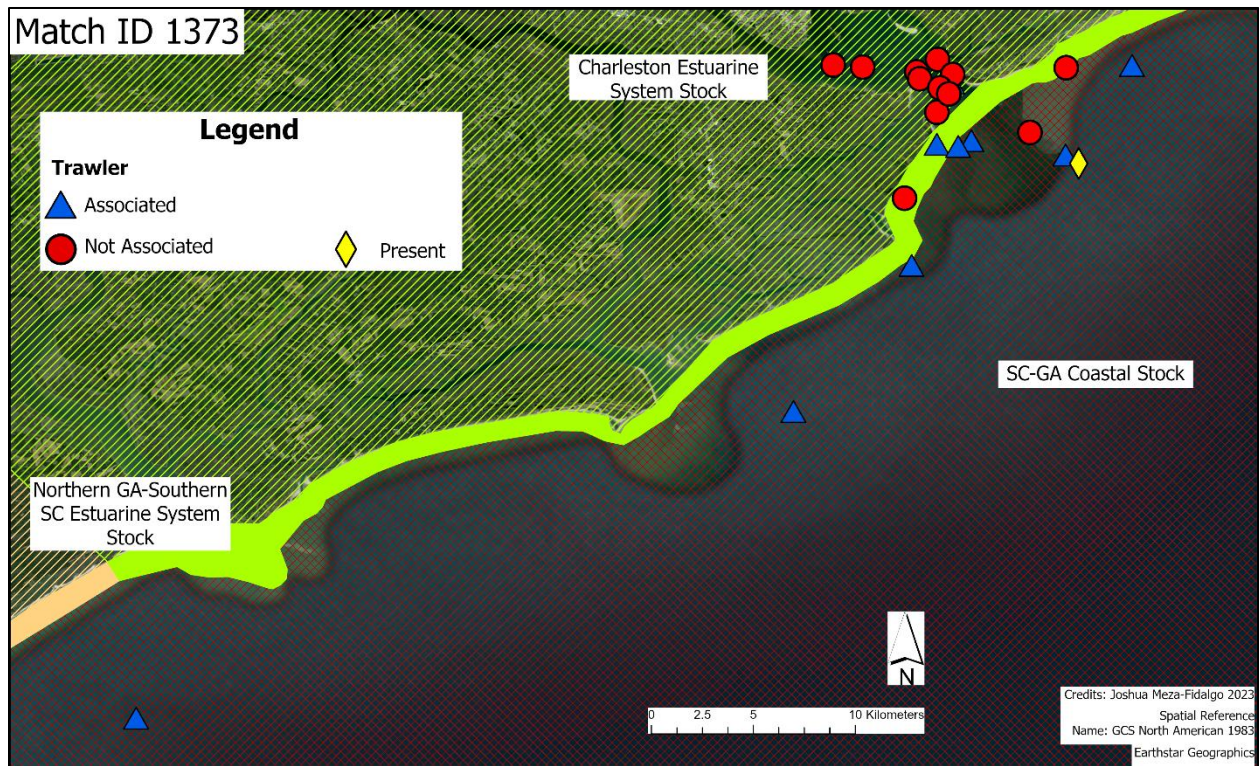


Figure 16 | Displays the sightings of the dolphin MABDC Match ID 1373 with trawler associations. MID 1373 was not assigned to a stock.

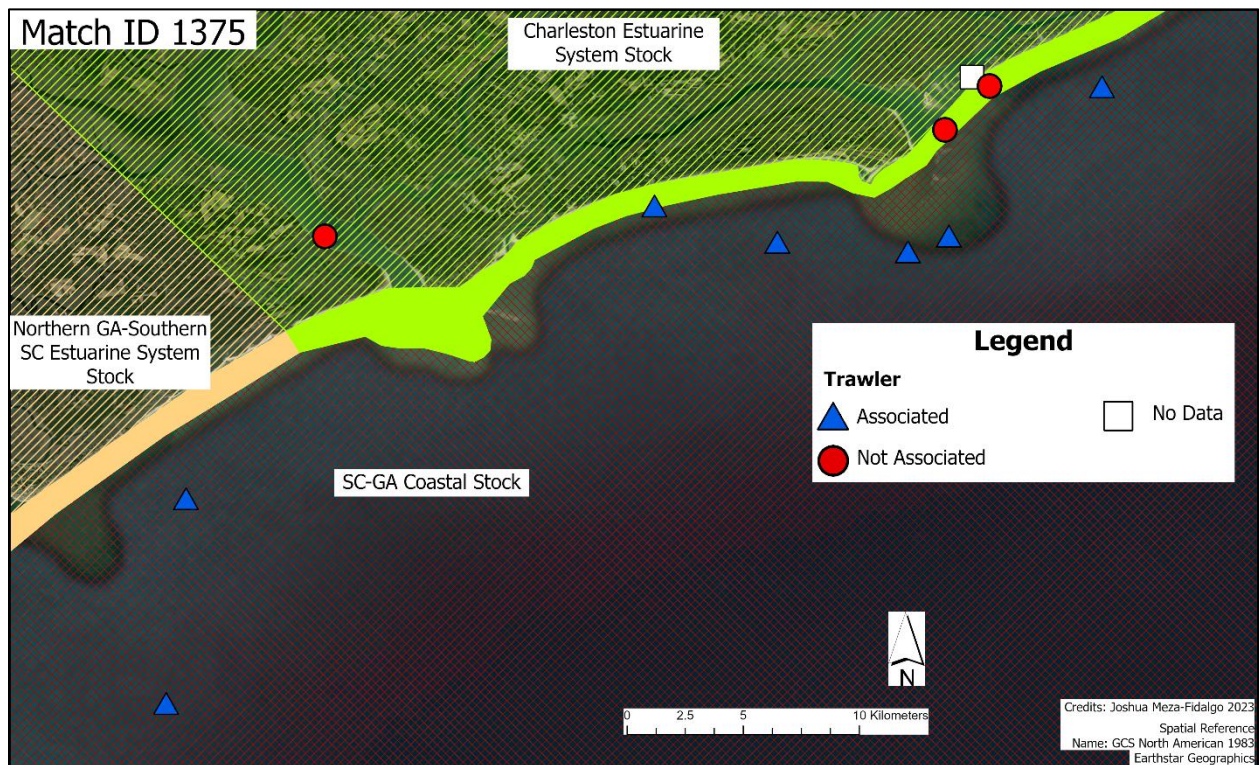


Figure 17 | Displays the sightings of the dolphin MABDC Match ID 1375 with trawler associations. MID 1375 was not assigned to a stock.



Figure 18| Displays the sightings of the dolphin MABDC Match ID 1385 with trawler associations. MID 1385 was not assigned to a stock.

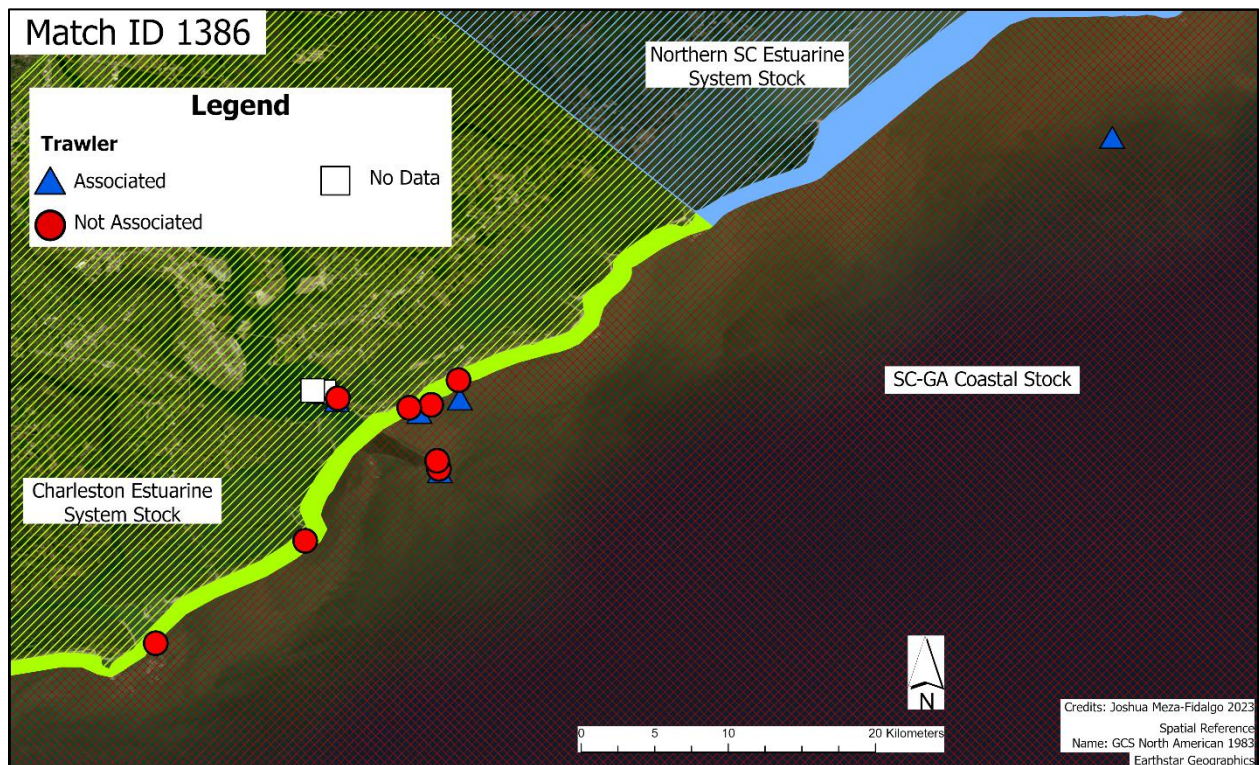


Figure 19| Displays the sightings of the dolphin MABDC Match ID 1386 with trawler associations. MID 1386 was not assigned to a stock.



Figure 20| Displays the sightings of the dolphin MABDC Match ID 1387 with trawler associations. MID 1387 was not assigned to a stock.

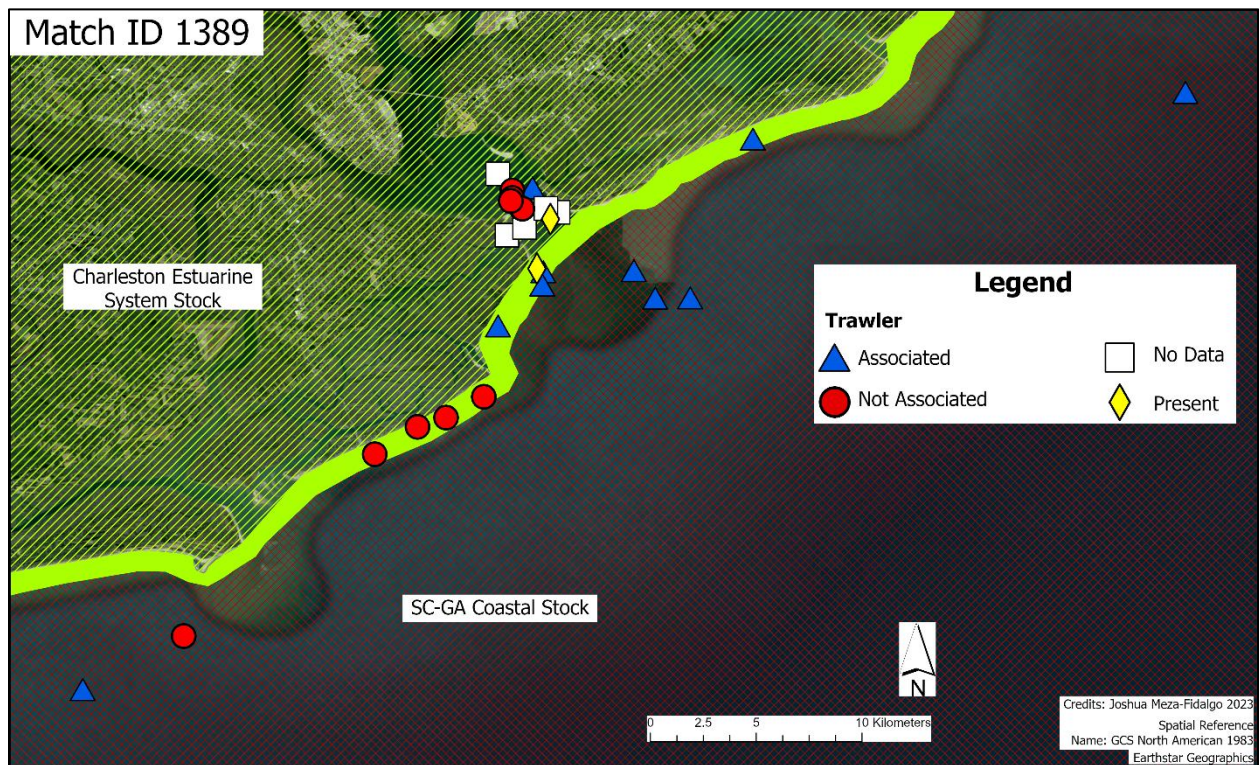


Figure 21| Displays the sightings of the dolphin MABDC Match ID 1389 with trawler associations. MID 1389 was not assigned to a stock.

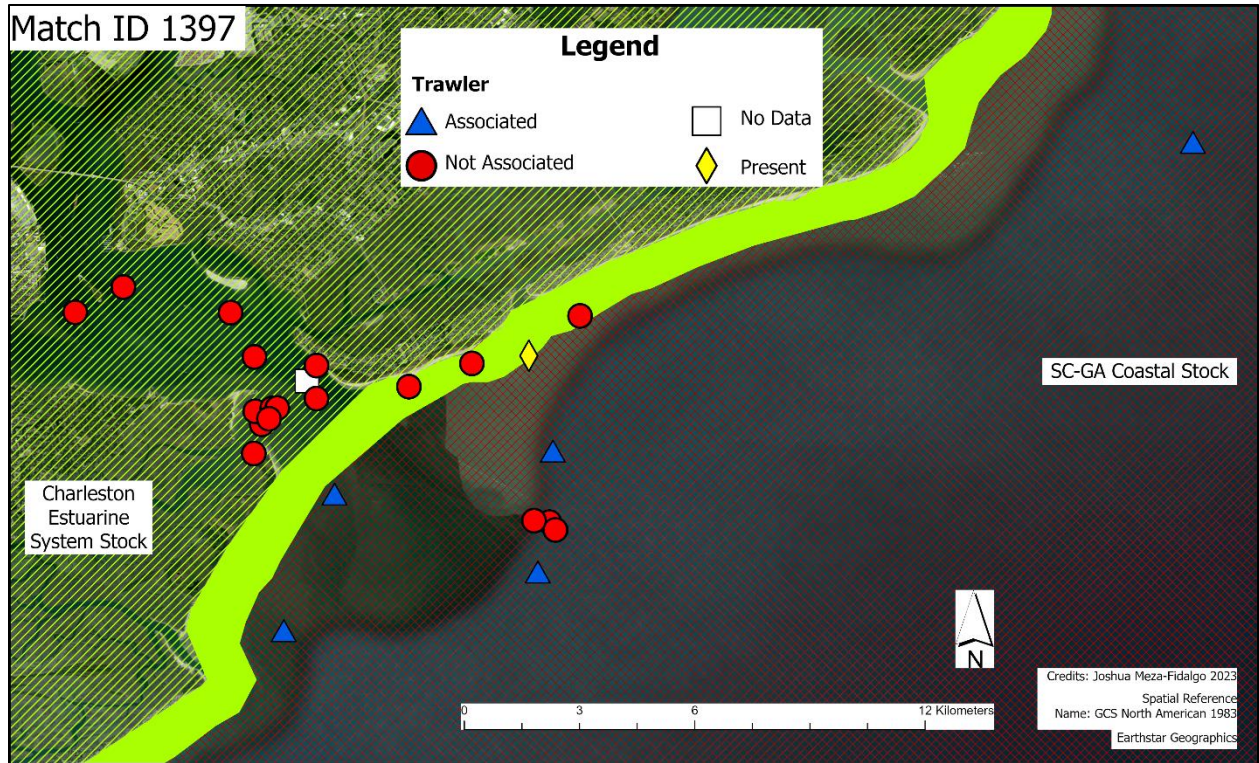


Figure 22| Displays the sightings of the dolphin MABDC Match ID 1397 with trawler associations. MID 1397 was not assigned to a stock.



Figure 23| Displays the sightings of the dolphin MABDC Match ID 1403 with trawler associations. MID 1403 was not assigned to a stock.

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