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**Assessment of Behavior, Home Range, Population Size, and Intermixing Among the Atlantic Bottlenose Dolphin, *Tursiops truncatus*, in New Jersey**

by

Colleen Talty

A Master's Thesis Submitted to the Faculty of

Montclair State University

In Partial Fulfillment of the Requirements

For the Degree of

Master of Science

August 2015

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Biology and Molecular Biology

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**Abstract**

Bottlenose dolphins (*Tursiops truncatus)* are known to exhibit a range of different social structures and habitat use profiles. To investigate the structure of the population off Cape May, NJ, photo identification techniques were employed. Between April 2013 and November 2014, 209 survey days with 989 individual sightings were observed from a platform of opportunity, the whale watching vessel the American Star. The primary goals of this study were to assess the population size in this area; determine whether or not the inshore ecotype were mixing with the offshore ecotype; determine home range size for dolphins sighted multiple times; and to assess their behavior throughout the day, between trips, and between months.

Using distinct markings on the dolphin's dorsal fins, data were collected on individuals between 1-3 times daily. Data collected included weather and water conditions, GPS locations, group size, behaviors observed, and presence of calves. The program Flukebook was utilized to help determine population size and help photo identify individual dolphins. The program ArcGIS was used to map home range distances and areas.

The Cape May, NJ dolphin population was estimated at approximately 1,039 individuals. 97 of these individuals were sighted more than once, and 17 of these were observed in both inshore and offshore habitats. The linear home range average for coastal dolphins was 2.75km. The linear home range average for inshore/offshore dolphins was 30.65 km. The average home range areas (dolphins sighted three or more times) for coastal dolphins were 4.1km$^2$, while the average for inshore/offshore dolphins was 217.22km$^2$.

The Cape May population of bottlenose dolphins was observed traveling most often in September in 2013. In both years, traveling had comparable observations. Feeding was observed more often during the morning during 2013, and during the morning and evening trips in 2014. In both years feeding observations decreased as it got later in the season. Mating was observed more often during the morning and during July and August, and fell in September 2013. In 2014, mating was observed more often during the evening, and also decreased after June. Surfing and breaching behaviors showed little to no variation in both years.

This study shows that this population may be less habitat-limited than other populations and that the individuals are utilizing both inshore and offshore habitats. Interactions may be occurring between the two ecotypes, which may include mating, behavior, and culture transfer, especially during the months of June, July, and August. The home range analysis has provided insights into the habitat use of the animals in the area, which is relatively consistent with the published literature. Behaviors were found to be significantly different throughout the day, as well as seasonally. Traveling was seen more during the later months in 2013, which may indicate the dolphins preparing to travel down south. Feeding was seen more often in the mornings in 2013, and more often during the morning and evenings in 2014. Mating was seen more often in the mornings in 2013, and during the evenings in 2014. In both years less mating was seen later in the season, most likely due to females already being pregnant or not wanting to calve during that time the following year. Future research should include a more detailed photo-identification analysis of dolphins sighted in 2014, which focuses on population size, differences in habitats, and behavioral changes from different years.

ASSESMENT OF BEHAVIOR, HOME RANGE, POPULATION SIZE, AND INTERMIXING AMONG THE ATLANTIC BOTTLENOSE DOLPHIN, *TURSIOPS TRUNCATUS,* IN NEW JERSEY

A THESIS

Submitted in partial fulfillment of the requirements

For the degree of Master of Science

by

COLLEEN MARIE TALTY

Montclair State University

Montclair, NJ

August 2015

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I would also like to thank Paul Bologna for advising me for almost two years on this project and supporting me when I decided to choose a topic no one in Montclair specializes in. I would also like to thank my other committee members, Dr. Kight and Dr. Galster, for giving me some much needed guidance and support throughout this entire experience. I would like to thank Dr. Andrew Wright for unexpectedly dropping into my life last summer and agreeing to help and advise me on this project. Your advice and experience in the marine mammal field has been invaluable. I would also like to thank Jake Levenson, who coached me through the process of using the new software Flukebook for cetacean identification and population studies.

Lastly, I would like to thank the two undergraduate students here at Montclair, Carmeria Hunter and Johnny Hoang, who have spent countless hours cropping photos and identifying dolphins this past year.

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## Introduction

The bottlenose dolphin is in the Kingdom *Anamalia*, Phylum *Chordata*, Class *Mammalia,* Order *Cetacea*, Family *Delphinidae,* and Genus and Species *Tursiops truncatus* (Waring et al. 2011). These animals exhibit various complex social behaviors (Felix 1997) and use sophisticated echolocation techniques used for foraging (Kenney 1990, Gazda et al. 2005). This globally-distributed species utilizes a wide range of habitats and employs numerous foraging techniques, sometimes with behaviors being restricted to certain individuals within a given population (Torres & Read 2009). Biological drives, such as hunting for food and finding mates, are strongly associated with behaviors of both individuals and groups of cetaceans (Wells et al. 1980). For example, bottlenose dolphins in Florida show subpopulation specializations in foraging techniques, as do bottlenose dolphins in Australia. Dolphins in Australia use sponges to help with hunting by fastening the sponges on their rostrums to protect themselves while digging in the ocean floor (Smolker et al. 1997, Torres & Read 2009). The extent to which bottlenose dolphins display variability in behaviors has in some locations contributed to divergence into various morphological ecotypes, with dolphins that forage in shallow water occurring along the coast, while dolphins that forage in deeper water being more pelagic (Toth et al. 2012).

Bottlenose dolphin foraging techniques include: mud ring feeding, in which the dolphins slap the bottom floor to form a mud ring that causes prey fish to panic and jump straight out of the water into the dolphin's mouths (Torres & Read 2009); tail slapping; cooperative foraging (Gazda et al. 2005); bubble netting (creating bubbles with their mouths that act as a sort of net to the fish); deep diving with erratic surfacing (Torres & Read 2009); and herding and chasing (Gazda et al. 2005, Torres & Read 2009). The size and abundance of food, as well as the environment in which they live, are strongly associated with the way they hunt. For example, in Florida there are more muddy bottoms, which is why bottlenose dolphins use the foraging technique of mud ring feeding.

In New Jersey, potential foraging techniques observed include tail slapping, bubble netting, cooperative hunting, and deep diving (Talty pers.obs.). Tail slapping is a behavior that has been documented in many populations of cetaceans. The cetacean will slap the fish or the water surface very near the fish with their tail fin to stun the fish, which makes them an easier prey target (Wells et al. 1987). It is important to note however, that this behavior is also seen when boats approach animals and is also used as a display of aggression or a warning (Würsig & Würsig 1979). Cooperative hunting is a common technique made possible by the bottlenose dolphin's social nature. Cooperative hunting may include forcing the fish into bait balls, fish driving, or attacking the fish together from different sides (Gazda et al. 2005). Erratic surfacing behavior, in which dolphins show their fluke before diving back down (Torres & Read 2009) has also been observed off of Cape May, NJ and may represent other foraging efforts (Talty pers.obs).

When not foraging, bottlenose dolphins may be travelling, which they almost always do in family units or large groups (Wells et al. 1987). Bottlenose dolphins also exhibit a great deal of social fluidity, yet certain individuals within a population have been noted to form groups of close associates with well-defined home range patterns (Wells et al. 1987, Felix 1997, Urian et al. 2009). A home range is roughly defined as the area routinely used by a group of organisms (Burt 1943). The sizes of bottlenose dolphin home ranges, as well as their movement patterns are thought to depend on their food resources (Scott et al. 1990, Defran & Weller 1999), habitat distinctions (Defran & Weller 1999), and their reproductive requirements (Scott et al. 1990). Ribble and Stanley (1998) have found that both the size and distribution of mammal home ranges are important for their mating and social structures.

The size and use of bottlenose dolphin home ranges vary among individuals and between study areas. For example, Scott et al. (1990) reported a mean home range for bottlenose dolphins in the Sarasota Bay area of about $125km^2$, and strong site fidelity. Resident dolphins in South Carolina have smaller home ranges and show very moderate levels of mobility, with a maximum range up to $100km^2$ (Gubbins 2002). While home ranges help define the spatial patterns of individuals on a local scale, dolphins also make seasonal migrations where multiple individuals may interact socially. Social groupings can then lead to individuals forming intraspecific communities.

When defining a social group, noting association patterns and relationships among individuals is important (Wells 1986, Wells et al. 1987, Rossback & Herzing 1999). A social group, or intraspecific community, is described as a grouping of individuals that are interacting with one another within the same species (Urian et al.

2009). Bottlenose dolphins may form close bonds with associates that frequently interact and travel together, while spending much less time with other individuals from different groups (Wells et al. 1987, Rossback & Herzing 1999). Wells (1986, 1991) found evidence of group structure in Sarasota Bay, Florida bottlenose dolphins and these groups stayed within specific home ranges. The development of similar group formations has also been found in populations in South Carolina, Portugal, the Bahamas, and other areas of Florida (Wells 1986, Rossback & Herzing 1999, Gubbins 2002, Urian et al. 2009). Variation in social group structure, like that of home range patterns, may be due to environmental influences such as the density and distribution of food sources, predators, and habitat resources (Wells et al. 1980).

Bottlenose dolphin's social range is placed somewhere between a random associations of individuals (Urian et al. 2009) and the highly structured, closed, perpetual matrilineal pods exhibited by killer whales (*Orcinus orca)* (Bigg 1982). It has been found that dolphin relations are usually associated with sex, age, family relationships, reproductive abilities, habitat, and food resources (Wells et al. 1987, Smolker et al. 1992, Urian et al. 2009).

The New Jersey dolphins are part of a larger population called the Western North Atlantic Northern Migratory Coastal Stock (Waring et al. 2011), which extends from southern New York to southern Florida (Toth et al. 2012). Bottlenose dolphins come to New Jersey from mid-April to early November and then migrate south to North Carolina and sometimes as far as Florida, either along the coast or offshore during November through early April (Hohn 1997, Toth et al. 2012). Their breeding season is from September-January in tropical water (Mann 1999) and their gestation period is around one year. In New Jersey, they have been observed breeding more often during May and June (Talty pers. obs.).

In the Atlantic coast population there are two ecotypes of bottlenose dolphins, inshore or coastal and offshore (Rossbach & Herzing 1999, Toth et al. 2012). Coastal ecotypes exhibit varying degrees of movement and can range from permanent residential dolphins to transient dolphins with erratic movement patterns (Barco et al. 1999). They usually display small schools and high site fidelity within their social groups (Wells 2003, Wiszniewski et al. 2010). However, coastal bottlenose dolphins can be found at some distance from shore in areas with a wide continental shelf (Kenney 1990), as is the case in New Jersey. The offshore ecotypes are usually in much larger groups and have low site fidelity (Bearzi 2005, Silva et al. 2008).

Inshore and offshore dolphins have also been previously identified by morphological differences (Hersch & Duffield 1990, Perrin et al. 2011), ecological differences (Kenney 1990, Bearzi et al. 2009), and genetic differences (Hoelzel et al. 1998, Natoli et al. 2004, Louis et al. 2014). Inshore dolphins are smaller in length, slimmer, lighter in color, and have larger pectoral fins (Wang et al. 2000, Rodgers 2013). Offshore dolphins also have a higher concentration of hemoglobin in their blood for potentially deeper dives for foraging (Hersh & Duffield 1990). These differences between inshore and offshore dolphins are seen globally such as in Florida (Rodgers 2013), South Carolina (Gubbins 2002) and in China (Wang et al. 2000).

In many studies it has been found that shallow and deep water dolphins rarely ever intermingle (Shane 1990, Odell and Asper 1990, Wursig and Lynn 1996, Gubbins 2002). However, in one study performed in Ireland, the coastal and offshore dolphins were observed moving between the same habitats, although there were no definite interactions between the two populations observed (Oudejans et al. 2015).

The bottlenose dolphin population in Cape May has never been observed mixing between inshore and offshore habitats. Their home ranges have also never been determined, and there is only a general stock estimate for all of Western North Atlantic Stock (Waring et al. 2011). The purpose of this study was to monitor the size of the bottlenose dolphin population that visits Cape May, NJ and to examine potential home ranges and behavioral characteristics within the population. Particular questions include: What is the population size? Do the inshore dolphins ever mix with the offshore dolphins? What are the average home range sizes for this population? Are there behavioral differences throughout the day, between trips, and between seasons that these dolphins display?

## Materials and Methods

### *Study Area*

The primary study area consisted of the water immediately surrounding the island of Cape May, NJ, including the coastal Atlantic Ocean and the Delaware Bay (Fig. 1). This area is a shallow neritic zone with a sandy bottom (outside the surf zone) and strong estuarine influences. Periodically, surveys ventured further into the Delaware Bay and Atlantic Ocean, up to 25 kilometers from the island. These areas thus represent open bay and open ocean environments respectively. The depth in the nearshore waters ranges from 3-7 meters and in the offshore waters from 8-28 meters.

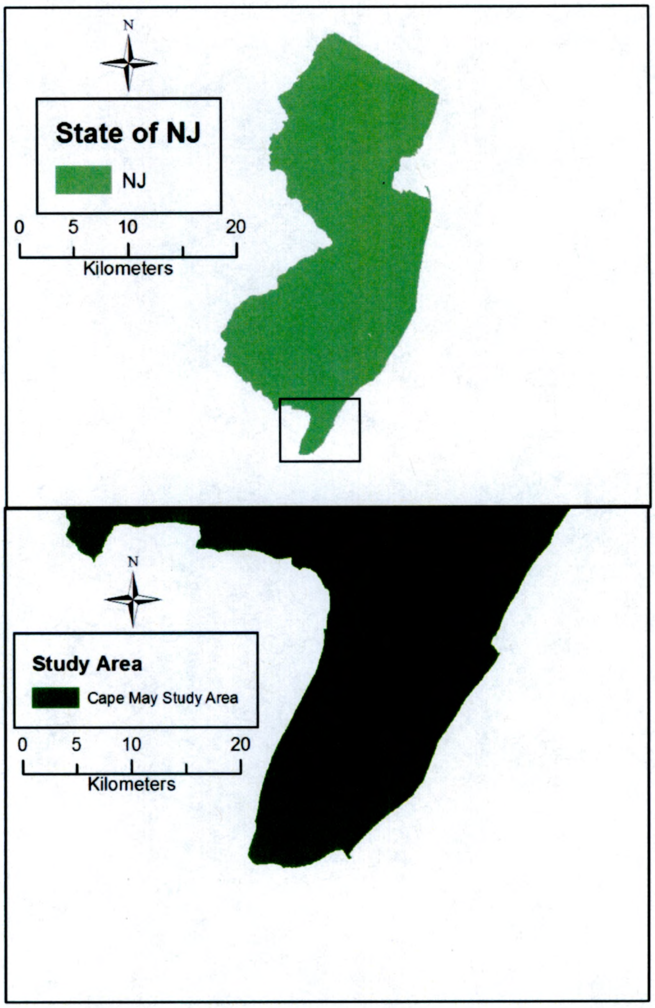


Figure 1. Study area: Cape May, NJ. The Cape May Canal is not shown.

*Survey Method and Data Collection*

Observations were made from a platform of opportunity: the American Star of the Cape May Whale Watch and Research Center (CMWW&RC). Surveys were scheduled daily, weather and trip patronage permitting, from mid-April through early November in 2013 and 2014. The boat was 90 feet long and had at least the captain and two other crew on board at all times (a naturalist and deckhand), with at least two additional people (staff and/or interns) at a time searching for dolphins and other marine life. Interns and naturalists collected data and took photographs.

The boat was scheduled to go out seven days a week, three times a day from June to August. In April, May, September, October, and November, trips were limited to either once or twice a day, or only on the weekends. On morning and evening trips (10am-12pm and 6pm-8pm, respectively, local time), the boat went around the entire island of Cape May, which constituted the survey area (designated as AM and SS, respectively). During the afternoon trips (1pm-4pm, local time), the boat would travel along the shoreline to find dolphins, then further offshore in search of dolphins, whales, and other marine life up to 25 kilometers off the coastline of Cape May (designated as PM). There is thus a sampling inequality based on total trips taken, but all statistical analyses were conducted on data standardized to observations per hour of planned defined trip length.

Typically, the vessel would follow its assigned track until bottlenose dolphins were located and then the boat would slow and stay close, but at least 100 feet away from the dolphins unless they approached the vessel. Most sightings lasted between one minute and twenty-five minutes. However, larger groups of dolphins were sometimes observed for up to forty-five minutes. Using a boat to observe dolphins is the most practical approach since the boat is able to move with the dolphins and maneuver around them (Hammond et al. 1990). Using this method, however, can also disrupt the dolphin's behavior. At times when the vessels approached the dolphins they would exhibit the behavior of tail slapping, which can be used as a territorial warning as well as for feeding, (Wells 1991). It was therefore imperative that the American Star complied with the Marine Mammal Protection Act of 1972 (Eberheardt 1977) to minimize the impact of the research platform. These marine mammal watching guidelines include rules such as staying 150 feet away from dolphins, and 300 feet away from whales.

During each dolphin encounter, photos of dorsal fins were taken for purposes of photo identification. A Cannon Digital 60D with a 70-300mm f/4-5.6 telephoto zoom lens was used. The boat would sequentially move along both sides of a group of dolphins to facilitate efforts to obtain photographs of both sides of each individual. Other data collected included:

- date observed
- start and end times and positions (latitude and longitude)
- weather and water conditions (cloud cover, precipitation, temperature, depth, etc.)
- the general location of sighting
- species
- minimum/maximum estimated size of the group during the of sighting
- all behaviors observed (feeding, mating, breaching, surfing, tail slapping etc.)
- whether the individuals were residential or transient (based on body size, color, and location)
- presence of calves at the end of sighting
- data collector name
- photographer name
- picture numbers
- and any names of dolphins identified by naturalists and staff

Behaviors recorded included traveling, feeding, mating, breaching, surfing, and tail slapping. Traveling was defined as individuals moving in a relatively consistent single direction and not exhibiting feeding or mating behavior. Feeding included behaviors such as bubble netting, cooperative feeding, and tail slapping. Mating was recorded when individuals appeared to be copulating with one another. Surfing behavior was defined as any time a dolphin surfed along in the natural waves of the ocean or the waves being created by the boat. Breaching behavior included individuals jumping either half way or completely into the air. Individuals that were one-half to three-quarters the size of an adult, a lighter color than the adults, continual surfacing with one particular adult, and had the possible occurrence of fetal folds (folds in the body from being in the mother's womb) were identified as calves (Fernandez and Hohn 1998, Wells & Scott 1999).

A group is defined as individuals in proximity to one another and also includes dolphins that separate from their original group, which is common (Defran and Weller 1999). Individuals moving in the same general direction, interacting with each other and dolphins within a 100m diameter of all individuals being viewed at one time were also included in the group (Defran & Weller 1999, Wells & Scott 1999). When a distinct group of dolphins was found, that was considered a sighting. A sighting was characterized by a particular group of individuals found at a certain longitude and latitude, which represents the entire group (Toth et al. 2012). The latitude and longitude coordinates were recorded with a standard GPS device.

To determine the identity of individual dolphins, individual photographs were initially cropped in Adobe Photoshop Elements (Defran et al. 1990) or in Mac TM Photo

Previewer. Once cropped, the photos and associated data were entered into the program Flukebook (Flukebook.org) and matched by sight. The photo identification process consisted of noting and matching unique nicks, notches, scars, and disfigurements on the dorsal fins of each individual dolphin, which is a standard practice (Würsig & Würsig 1979, Defran et al. 1990, Scott et al. 1990, Felix 1997, Simões-Lopes & Fabian 1999, Mazzoli et al. 2008, Toth et al. 2011). Sex was not determined, unless an adult dolphin was repeatedly seen with a smaller animal, which was then presumed to be her calf. An inshore dolphin was noted due to its close proximity to shore (within 3km), as well as appearing smaller and slimmer than offshore dolphins Wang et al. 2000, Rodgers 2013).

*Data Analysis*

Sightings of bottlenose dolphins were separated by year (2013 and 2014) for statistical analysis. For photo identification purposes, social analysis, and the population estimate, dolphins sighted for the entire 2013 season through June 15$^{th}$, 2014 were utilized. This was due to the time constraints of manual fin matching arising from the delayed implementation of automatic fin matching functionality in Flukebook. June, July, and August are the busiest months for trips, while only very few trips went out in September, October, and November

The Geographic Information System Arcmap 10.1 and Flukebook through Google Earth were used to create maps of the latitude/longitude sighting positions of the dolphins and inshore and offshore dolphin position. Bottlenose dolphin behaviors were pooled and analyzed after being proportionately for the trip length, yielding number of behaviors observed per hour. Behavior analyses were conducted using 2-Way ANOVA for each year separately. The trip time (AM, PM, SS) and month of observation were used as independent variables with standardized behaviors as the dependent variables (e.g. traveling, feeding, mating, surfing, and breaching). Significance was accepted at $\alpha = 0.05$.

*GIS Analysis*

In order to calculate home range areas effectively, only dolphins that were sighted three or more times, generating a complete polygon, were included in this analysis (e.g. >3 sightings not in a line). There were 28 dolphins included in this analysis that met these criteria. Dolphin sightings were mapped using their GPS coordinate locations. Polygons were then digitized connecting the sightings for each individual dolphin with ArcGIS (10.1). The Erase tool was used to remove the areas of the polygons that overlapped with land. The home range areas were then calculated in $km^2$.

Linear distances in kilometers were also calculated for the coastal and inshore/offshore dolphins sighted only two times to assess general home range lengths. 64 dolphins were included in this analysis. Again, dolphin sightings were mapped using their GPS coordinate locations. Polylines were then drawn between points, and linear distance was calculated in km. For consistency with the polygon home range maps, the areas crossing over the island were erased. Therefore, many of the home range polylines will be underestimates due to dolphins needing to go around the island to travel, and therefore the lengths will be longer.

## Results

*Field Surveys and Observational Sightings*

84 useable survey days (156 trips; 349 sightings within those 84 days) occurred from June-November in 2013, with another 125 useable survey days (242 trips; 658 sightings within those 125 days) added from April-November in 2014 (Fig. 2). There could be multiple sightings within a trip (seeing dolphins multiple times within that trip), with possible trips running from 1-3 times a day. The month of June had the most average sightings per trip for both years (aside from November in 2014), and the least number of sightings per trip in November (Fig. 3). The lack of sightings is reflective of the few survey days completed in November (Fig. 2). In 2013, the most sightings per trip were found during the morning trips, while in 2014 the most sightings were found during the afternoon trips (Table 1).

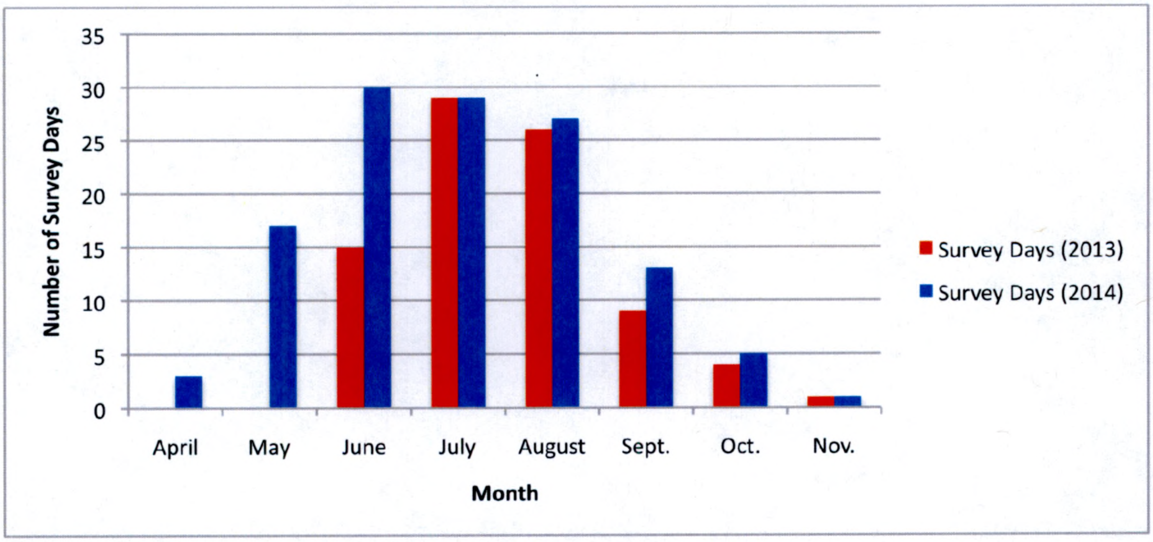


Figure 2. Survey days conducted per month for years 2013 and 2014.

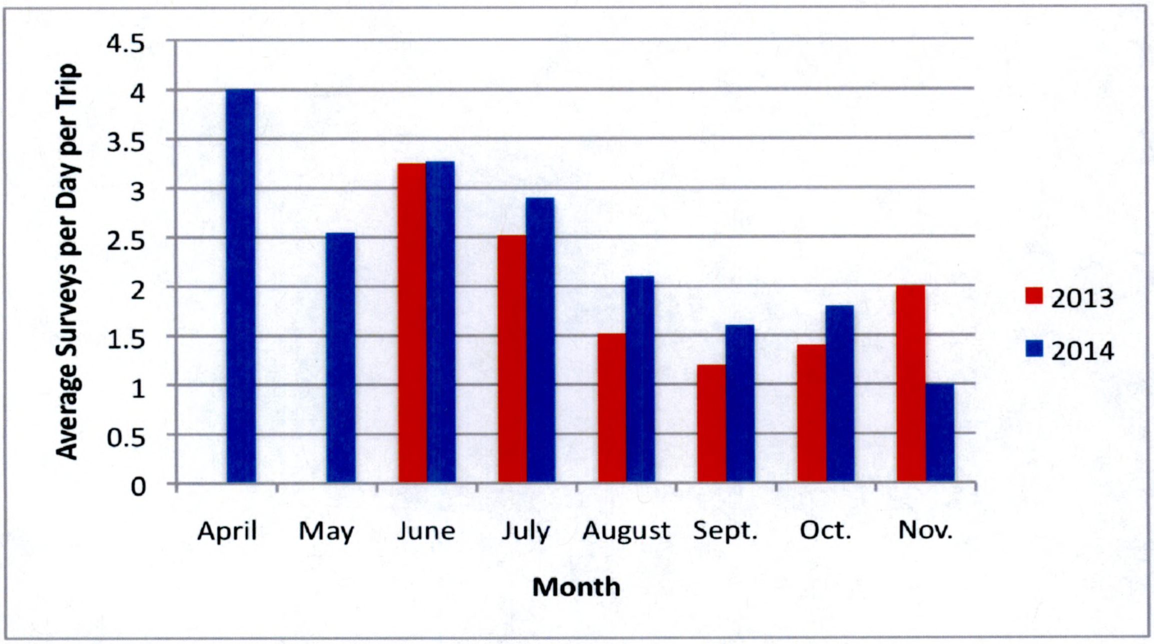


Figure 3. Average sightings per trip per month for 2013 and 2014.

Table 1. Total sightings per sampling period during surveys. AM indicates morning surveys (10am-12pm), PM indicated afternoon surveys (1pm-4pm), and SS indicates sunset surveys (6pm-8pm). N = the total number of trips for that particular trip during the day.

| **Trip** | **N** | **2013** | **N** | **2014** |
|---|---|---|---|---|
| AM | 62 | 148 | 93 | 212 |
| PM | 66 | 141 | 103 | 305 |
| SS | 28 | 60 | 46 | 123 |
| **Total** | 156 | 349 | 242 | 640 |

*Seasonal Sighting Patterns*

Bottlenose dolphins were observed in the Delaware Bay, the Atlantic Ocean, and the Cape May Canal. During 2013, a total of 208 sightings occurred within nearshore waters and 141 sightings occurred offshore. In 2014, a total of 335 sightings occurred in nearshore waters and 305 occurred in offshore waters. Figure 4 displays all bottlenose dolphin sightings (including unidentified animals) for both 2013 and 2014. Figure 5 displays the minimum and maximum range of the number of dolphins observed per trip for each month.

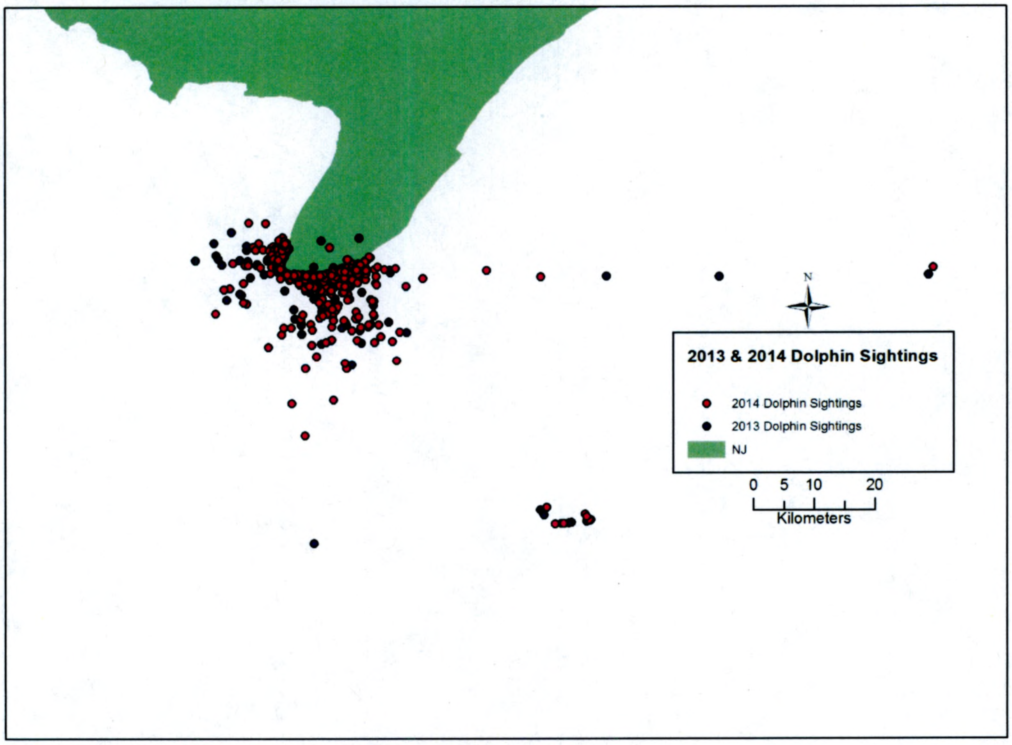


Figure 4. 2013 and 2014 bottlenose dolphin sightings. The dolphins that appear to be observed inland were actually observed in the Cape May Canal.

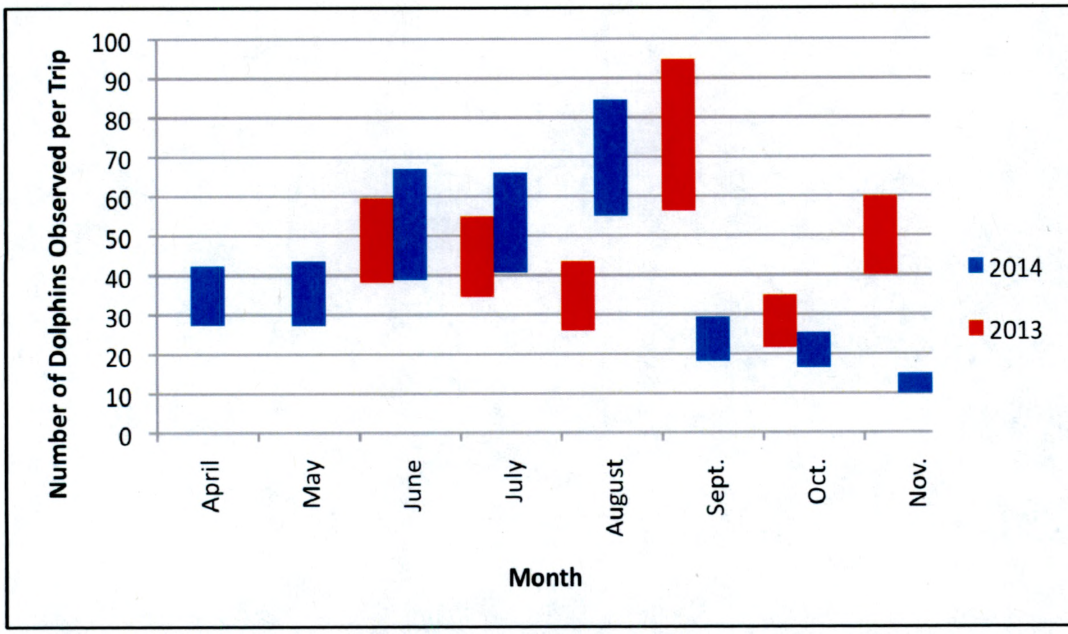

Figure 5. Range of dolphins observed per trip within a month for 2013 and 2014.

*Population Estimate and Photo Identification Analysis*

From April 2013 through June 15th 2014, 1,039 individual bottlenose dolphins were identified by their distinct markings on their dorsal fins (Fig. 6). This number includes dolphins seen both inshore and offshore (Fig. 7). Of these animals, 97 individuals were seen on multiple occasions, together totaling 263 times and ranging from a minimum of 2 sightings to a maximum of 12 (Fig. 8 and see Appendix A). Based on the positive identifications, the estimated minimum population is 1,039. However, over 1,800 pictures still need to be evaluated (after discarding thousands of unusable photos), which will yield a much higher actual population size.

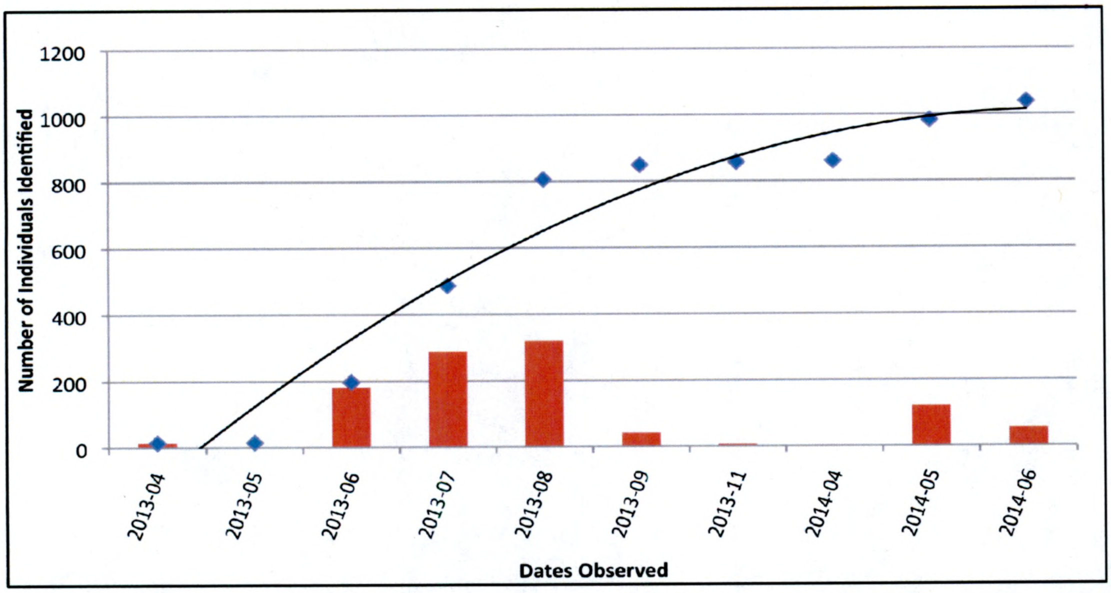


Figure 6. The number of new dolphins that were discovered each month, which shows the discovery of new individuals leveling off in June 2014.

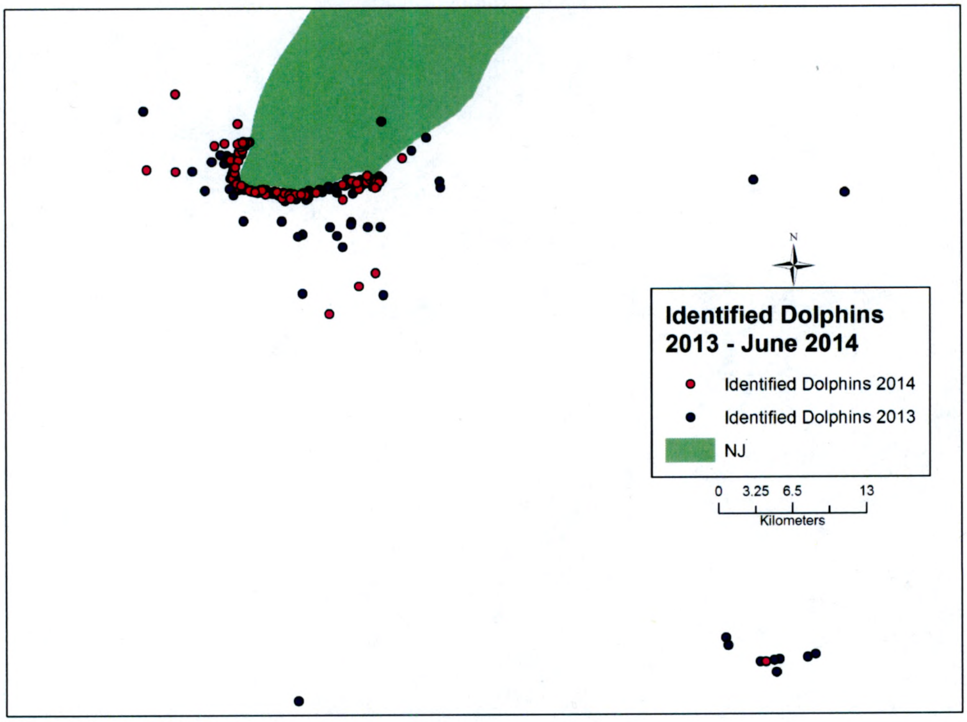


Figure 7. Plotted locations of the 1,039 identified dolphins during surveys, including both inshore and offshore dolphins. The location that appears to be on land is a dolphin using the Cape May Canal (not shown) to traverse between the bay and the ocean.

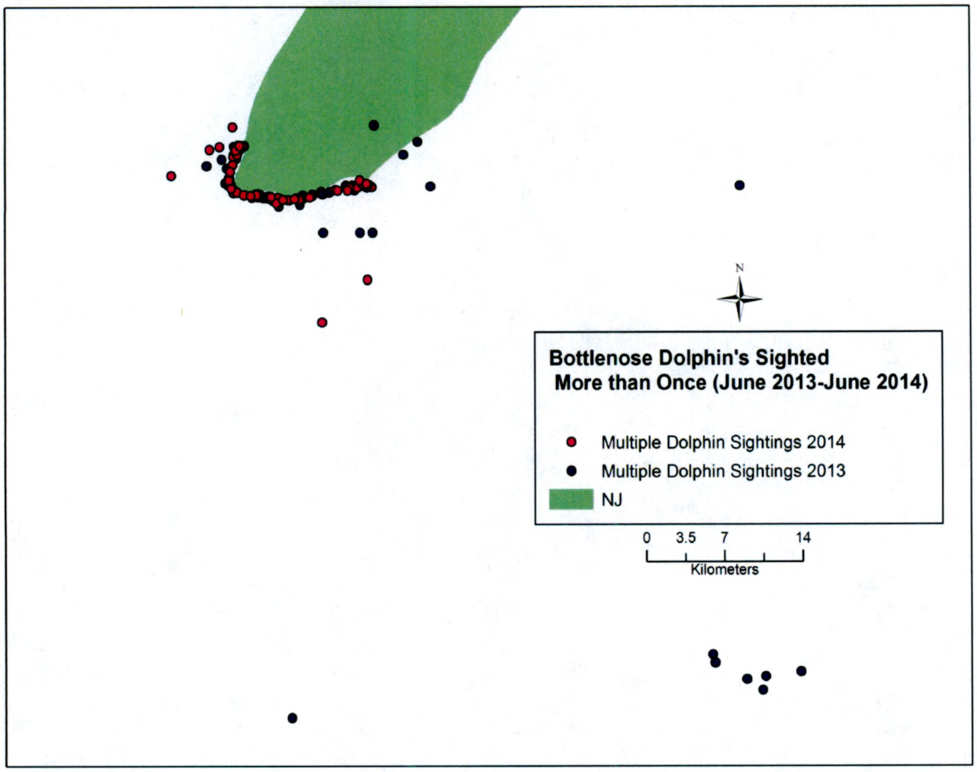


Figure 8. Plotted locations of the 97 dolphins observed and identified multiple times during surveys. The location that appears to be on land is a dolphin using the Cape May Canal (not shown) to traverse between the bay and the ocean.

*Population Intermixing and Same Sighting Occurrence*

Out of the 97 dolphins sighted more than once, 17 dolphins (17.5%) showed substantial traveling (at least one sighting in each habitat) between inshore and offshore habitats (See Appendix B). Inshore dolphin locations were within 3km of the coastline, and offshore dolphin locations were between 3.7 and 24.5km offshore (Oudejans et al. 2015). Out of these 17 dolphins, Tt0137 was observed 12 times, which was the maximum amount of times any photo-identified dolphin was sighted. Based on the collected information, three dolphins (Tt0137, Tt0577, and Tt0802) can be identified as coastal individuals who traveled and intermixed with offshore populations. These dolphins were never seen alone and always seen in large groups of at least 25 other individuals. These animals also seemed smaller in size when compared to other dolphins in the group. The other identified dolphins could not be specified into either population since they had equal sightings between inshore and offshore habitats (Fig. 10). Future image analysis may be able to distinguish which population these individuals belong to, but it is evident that a good proportion of dolphins move and integrate between the populations. The other dolphins that were traveling between coastal and offshore areas were sighted anywhere between 2 and 7 times (Fig. 9).

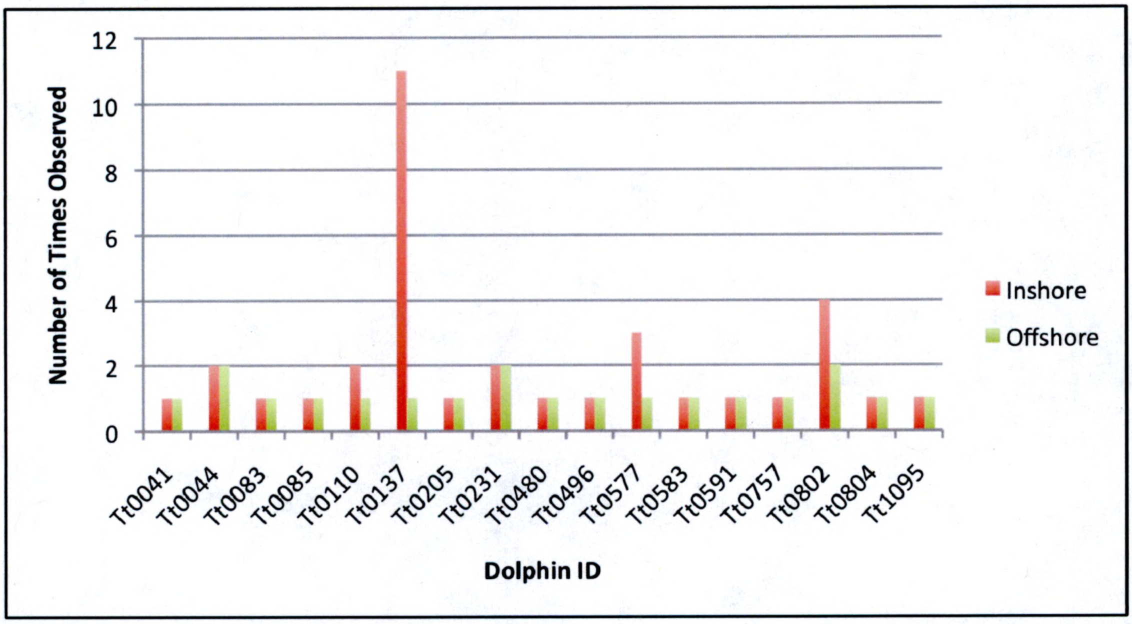


Figure 9. The number of times indentified dolphins were observed in both inshore and offshore sites.

When analyzing any evidence of group formation, only 20 dolphins out of the 97 individuals were seen more than once with at least one other identified individual. 11

different groups were found. Almost all of the groups only consisted of two dolphins and all of the groups were only sighted two times together. Three dolphins, Tt0699, Tt0090, and Tt0231 were seen in more than one group (Table 2). Out of the 11 groups discovered, six groups were sighted in both 2013 and 2014, providing observations of long term interactions.

Table 2. Group formation listed with dolphin ID numbers and the two different dates they were sighted together.

| Group | 1st Date | 2nd Date | # of Times Sighted |
|---|---|---|---|
| Tt0129 | 6/25/13 | 7/9/13 | 2 |
| Tt0293 | | | 2 |
| | | | |
| Tt0331 | 7/1/13 | 6/8/14 | 2 |
| Tt0350 | | | 4 |
| | | | |
| Tt0110 | 7/8/13 | 6/10/14 | 3 |
| Tt0699 | | | 5 |
| | | | |
| Tt0707 | 8/8/13 | 8/23/13 | 3 |
| Tt0699 | | | 5 |
| | | | |
| Tt0648 | 8/6/13 | 8/23/13 | 2 |
| Tt0696 | | | 2 |

| | | | |
|---|---|---|---|
| Tt0724 | 8/10/13 | 6/9/14 | 6 |
| Tt0090 | | | 4 |
| | | | |
| Tt0794 | 8/10/13 | 5/30/14 | 2 |
| Tt0090 | | | 4 |
| | | | |
| Tt0802 | 8/23/13 | 8/26/13 | 6 |
| Tt0851 | | | 3 |
| Tt0852 | | | 2 |
| | | | |
| Tt0231 | 8/23/13 | 9/4/13 | 4 |
| Tt0333 | | | 5 |
| | | | |
| Tt0231 | 9/14/13 | 6/8/14 | 4 |
| Tt0591 | | | 2 |
| | | | |
| Tt0691 | 8/30/13 | 6/10/14 | 2 |
| Tt0451 | | | 7 |

*Home Range Analysis*

Bottlenose dolphin home ranges were grouped and mapped by the number of sightings (2-12) and whether they were observed inshore or offshore. 53 dolphins observed twice inshore had a home range average of 2.75km. 11 dolphins sighted two times both inshore and offshore had a home range average of 30.65km. The 28 dolphin home range areas included in this analysis are displayed in Table 3. The average home range area for 22 dolphins sighted three or more times inshore is 4.1km$^2$ (SD = 6.06, $n$ = 20). The average home range area for 6 dolphins observed in both inshore and offshore habitats was 217.22km$^2$ (SD = 118.9, $n$ = 8). Tables 4 and 5 show a break down of coastal versus inshore/offshore dolphin home ranges. Figures 10-13 display home range area polylines and polygons for the dolphins included in this analysis.

Table 3. Home range areas in km$^2$ for all 28 dolphins included in this analysis.

| **Dolphin ID** | **# of Sightings** | **Area km$^2$** | **Dolphin ID** | **# of Sightings** | **Area km$^2$** |
|---|---|---|---|---|---|
| Tt0008 | 5 | 6.91 | Tt0350 | 4 | 0.92 |
| Tt0044 | 4 | 801.92 | Tt0400 | 4 | 1.22 |
| Tt0075 | 4 | 4.75 | Tt0451 | 7 | 6.07 |
| Tt0090 | 4 | 11.6 | Tt0522 | 3 | 0.74 |
| Tt0110 | 3 | 137.88 | Tt0577 | 4 | 143.83 |
| Tt0137 | 12 | 56.73 | Tt0603 | 3 | 0.48 |
| Tt0231 | 4 | 46.5 | Tt0676 | 4 | 1.24 |
| Tt0253 | 4 | 1.65 | Tt0699 | 5 | 15.77 |

| | | | | | |
|---|---|---|---|---|---|
| Tt0268 | 3 | 0.65 | Tt0707 | 3 | 0.49 |
| Tt0270 | 3 | 0.11 | Tt0724 | 6 | 6.28 |
| Tt0274 | 3 | 0.067 | Tt0802 | 6 | 116.49 |
| Tt0307 | 4 | 0.69 | Tt0851 | 3 | 0.64 |
| Tt0317 | 3 | 0.49 | Tt0908 | 4 | 9.23 |
| Tt0333 | 5 | 19.72 | Tt0984 | 3 | 0.31 |

Table 4. A summary of coastal dolphin home ranges.

| **Number of Times Observed** | **Home Range** | **Sample Size** |
|---|---|---|
| 2x | 2.75 km | 53 |
| 3x | 0.49 $km^2$ | 10 |
| 4x | 4.21 $km^2$ | 5 |
| 5x | 17.74 $km^2$ | 3 |
| 6x | 4.626 $km^2$ | 3 |
| >6x | 6.07 $km^2$ | 1 |

Table 5. A summary of the inshore/offshore dolphin home ranges.

| **Number of Times Observed** | **Home Range** | **Sample Size** |
|---|---|---|
| 2x | 30.65 km | 11 |
| 3x | 137.88 $km^2$ | 1 |
| 4x | 330.75 $km^2$ | 4 |
| 5x | 0 | 0 |
| 6x | 116.42 $km^2$ | 1 |

| | | |
|---|---|---|
| >6x | 56.73 $km^2$ | 1 |

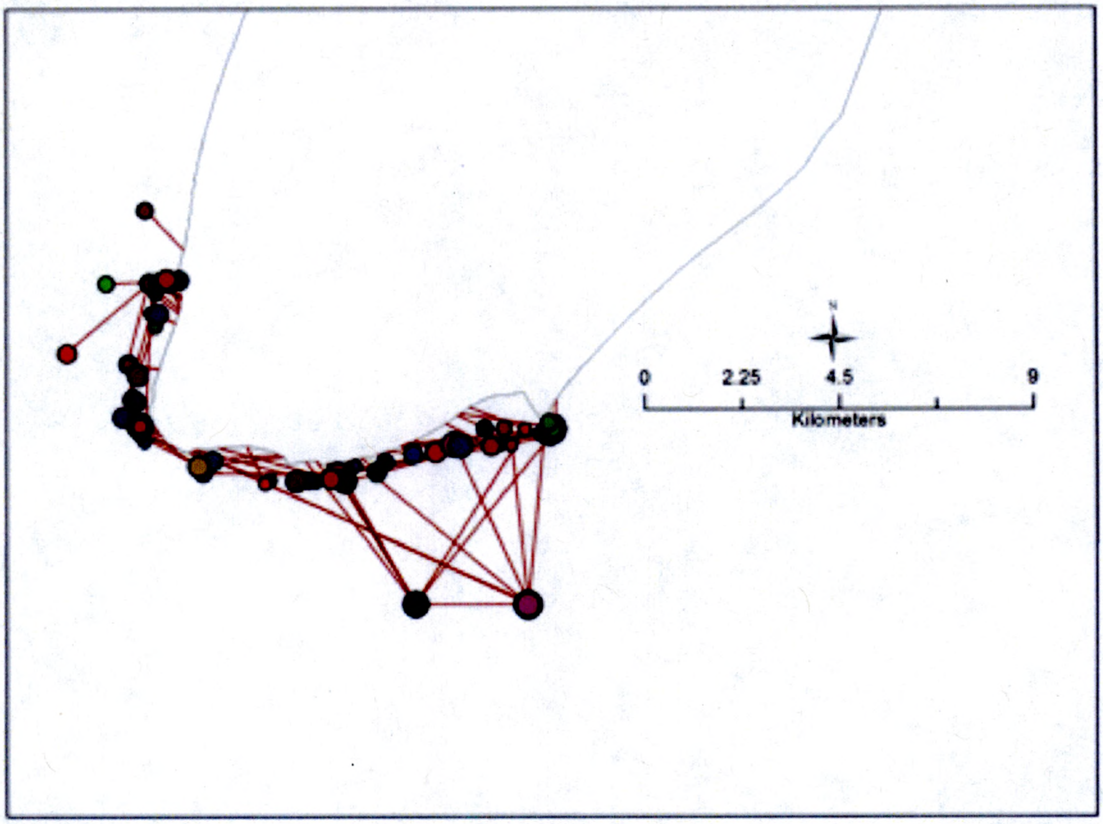


Figure 10. Linear distance home ranges for the 53 coastal dolphins observed coastally two times during the study period.

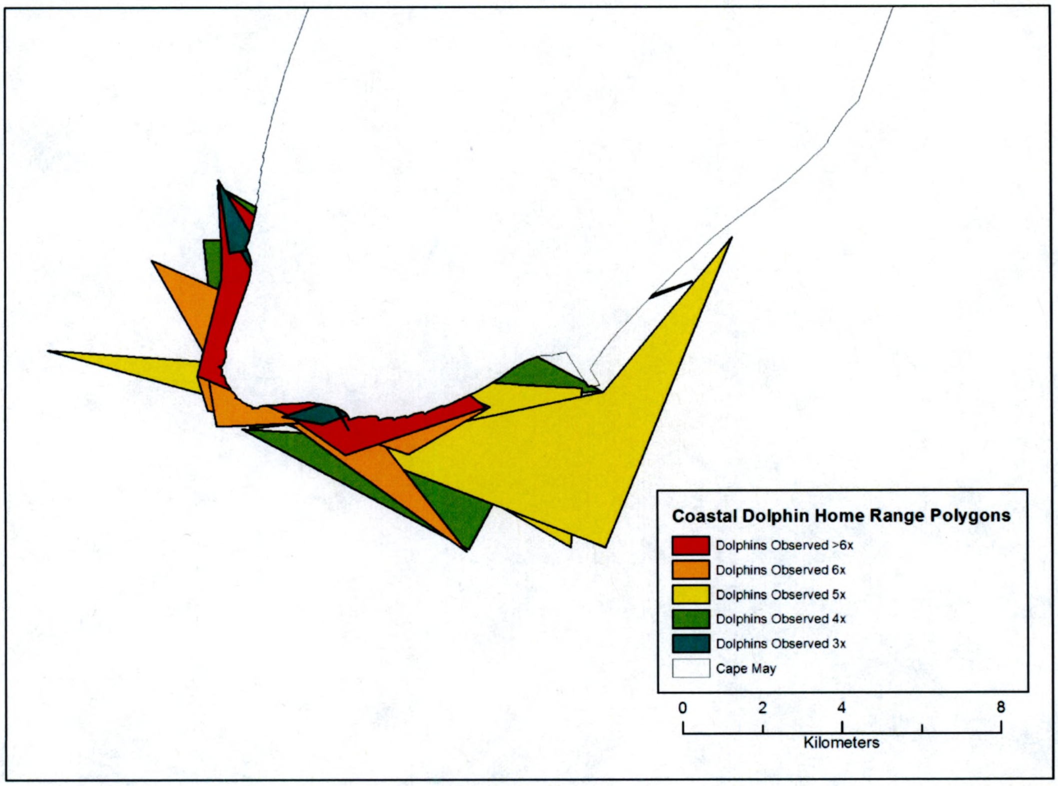


Figure 11. Home range area polygons for the 20 dolphins observed coastally more than two times, shown by the number of times they were sighted.

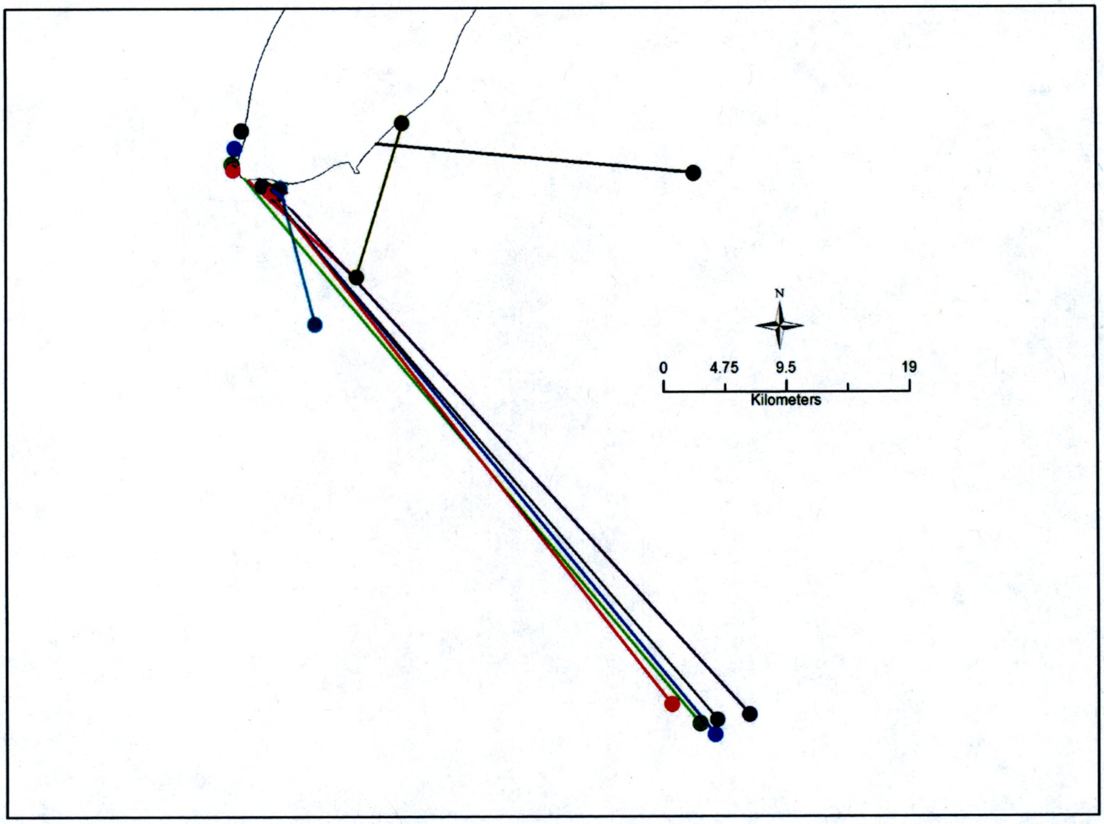


Figure 12. Linear distance home ranges for the 11 dolphins observed in both inshore and offshore habitats.

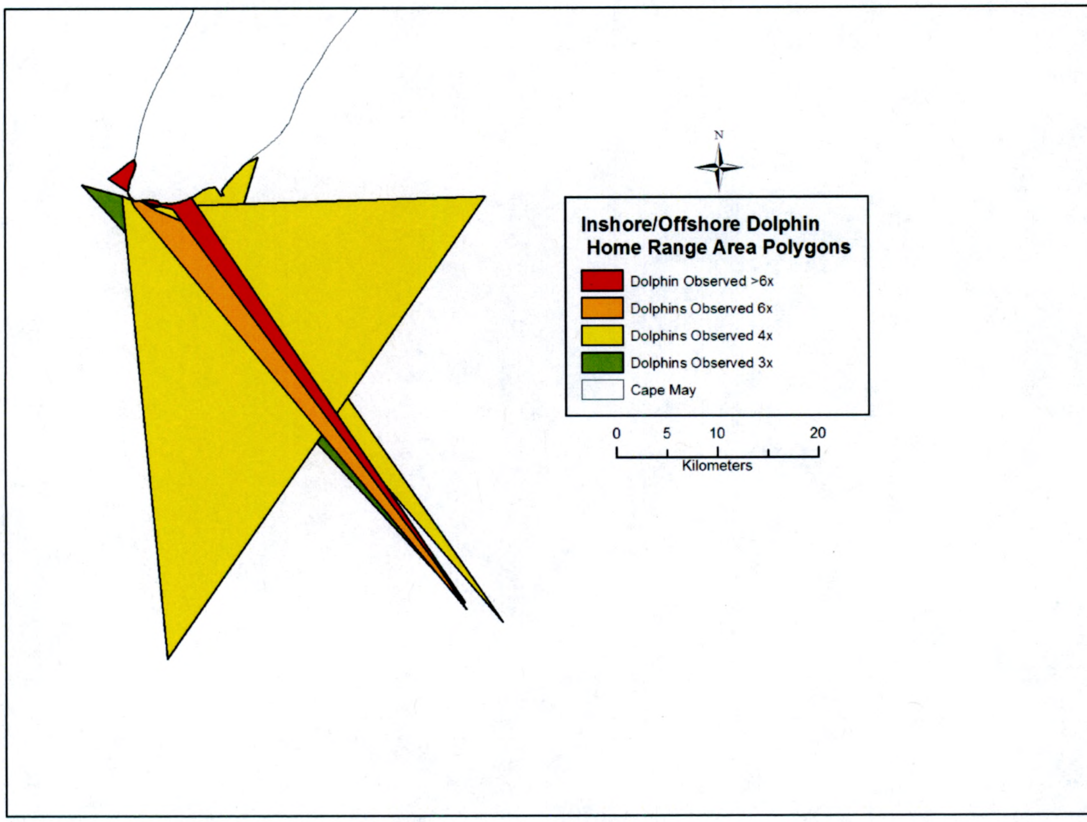


Figure 13. Home range area polygons for the eight dolphins observed multiple times in both inshore and offshore regions designated by the number of times they were sighted.

*Behavioral Assessment*

Dolphins displayed five prevalent behaviors including traveling, feeding, mating, surfing, and breaching. In 2013, six calves were identified during the months May and June. Results from 2013 showed significant variation in among months ($F_{3,138} = 6.28$, $P \leq 0.0005$). During September, traveling was seen significantly more often than during the other months (Fig. 14). For feeding, there were significant differences among the three daily scheduled trips in 2013 ($F_{3,138}$ = 11.82 $P \leq 0.0001$), with feeding observed more often in the morning than during the later trips (Fig. 15). Feeding was also observed decreasing in August and September. Significant differences in mating was observed both across months ($F_{3,138}$ = 3.76, P $\leq$ 0.0123) and between trips ($F_{2,138}$ = 4.51, P $\leq$ 0.0127). July had significantly more mating observed than other months, while the morning and evening trips showed the most mating behavior compared to the mid-day trips (Fig. 16). There were no significant differences in surfing or breaching behavior in 2013 (Figs. 17 & 18).

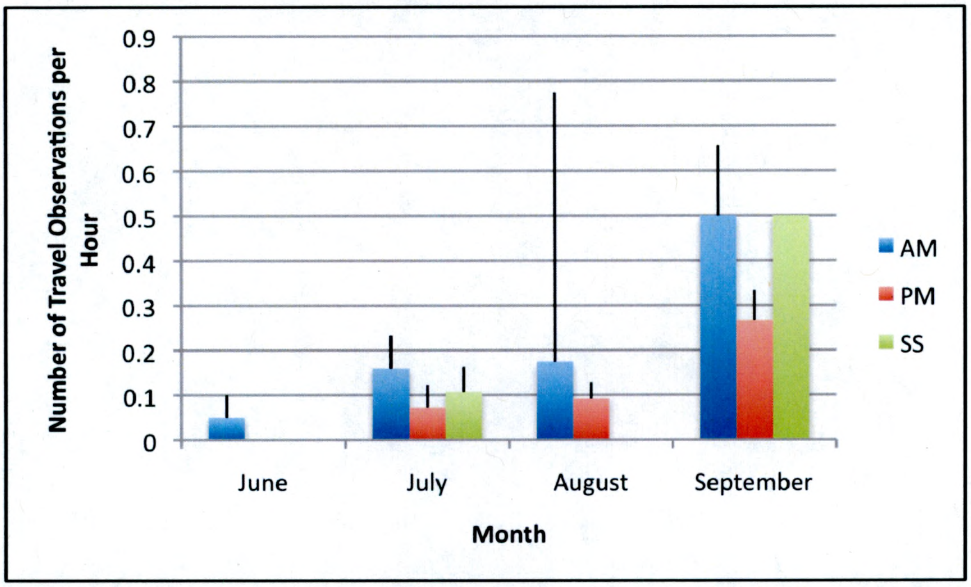


Figure 14. Travel observations per hour of sampling trip +/- the standard error during 2013.

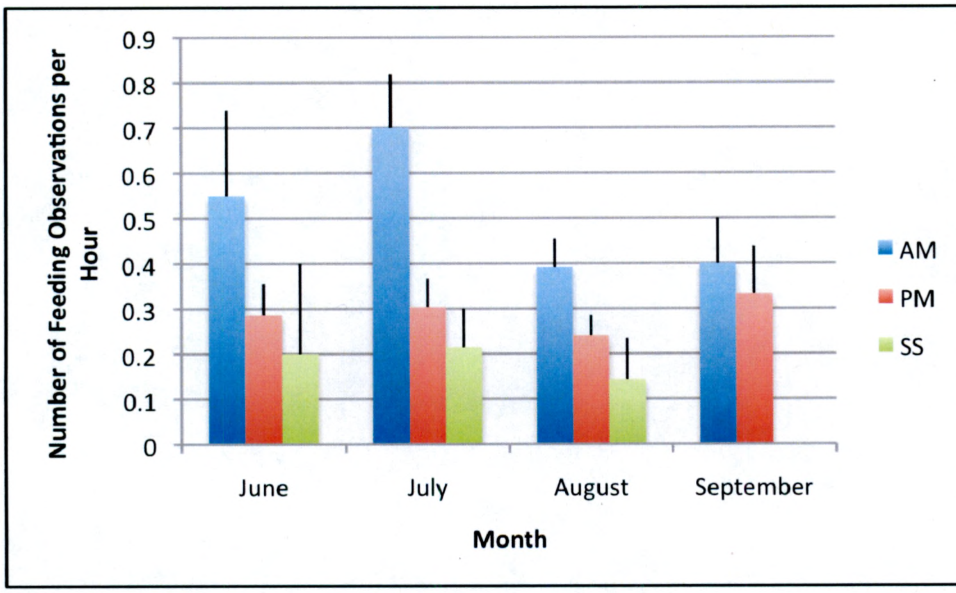


Figure 15. Feeding observations per hour of sampling trip +/- the standard error during 2013.

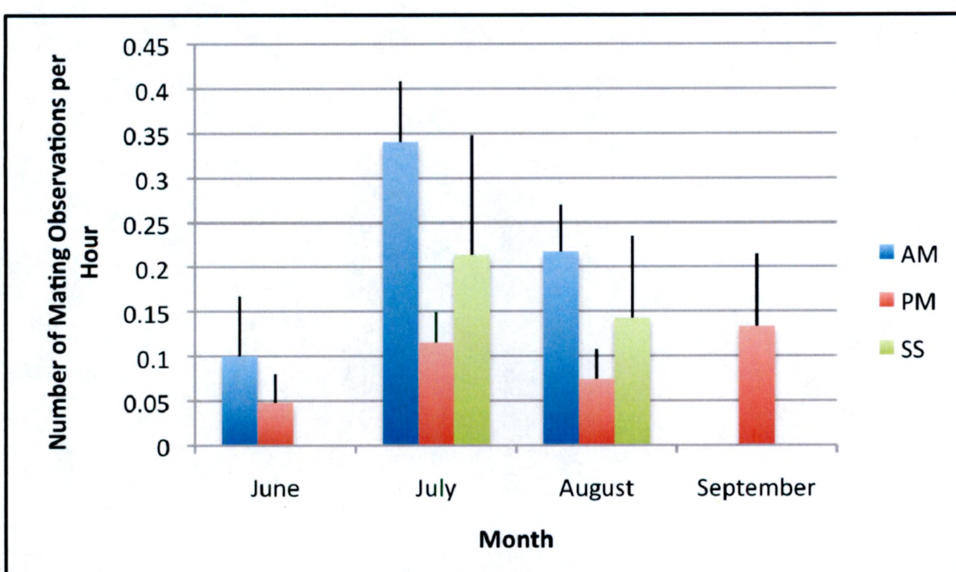


Figure 16. Mating observations per hour of sampling trip +/- the standard error during 2013.

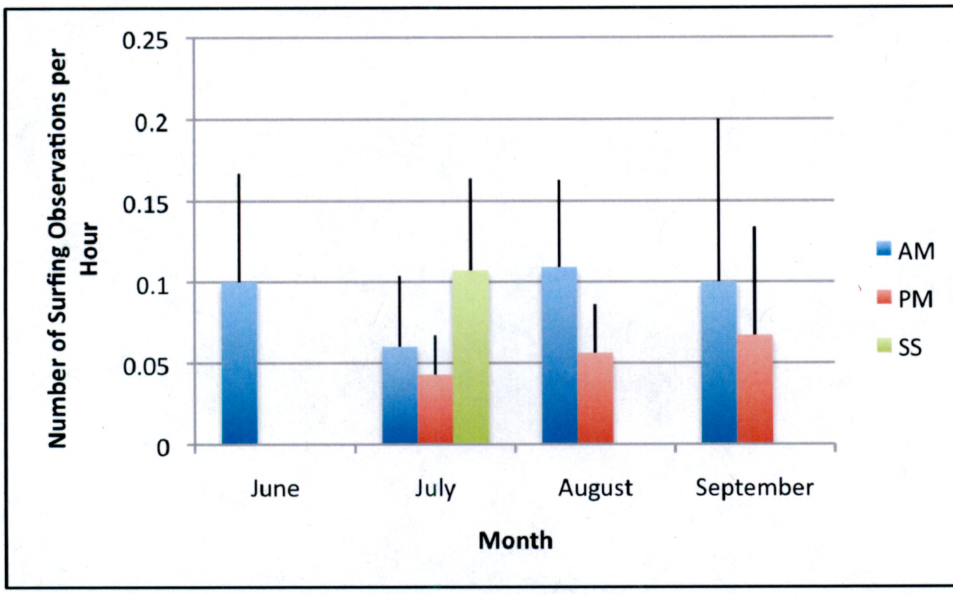

Figure 17. Surfing observations per hour of sampling trip +/- the standard error during 2013.

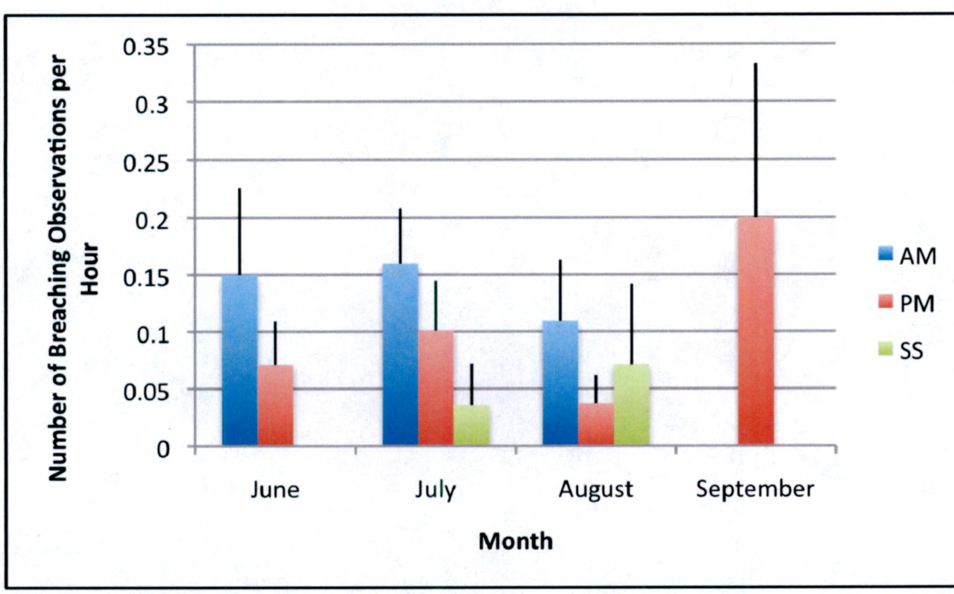

Figure 18. Breaching observations per hour of sampling trip +/- the standard error during 2013.

Four calves were identified during the months May and June in 2014. There were significant differences in traveling behavior observed among months ($F_{3, 206} = 3.97$, P ≤

0.0089). Traveling was observed significantly more often during the months of July and August compared to May and June (Fig. 19). The occurrence of feeding behavior showed significant differences among both months ($F_{3, 206} = 9.11$, $P \leq 0.0001$) and trips ($F_{2, 206} = 5.57$, $P \leq 0.0044$). Figure 20 depicts more feeding being observed during June and a continued decrease as it became later in the season. Feeding was observed more often during the morning and evening trips as well. For mating behavior, there was a significant difference for both month ($F_{3, 206} = 3.73$, $P \leq 0.0121$) and trip ($F_{2, 206} = 7.93$, $P \leq 0.0005$) (Fig. 21). Specifically, significantly more mating occurred in the months of May and June, particularly during the morning and evening trips. There were significant differences in surfing behavior between trips ($F_{2, 206} = 2.80$, $P \leq .0221$), but not between months (Fig. 22). There was some significant variation in breaching between trips ($F_{2, 206} = 4.86$, $P \leq 0.0087$) with breaching being observed more during the evening trips in all four months than any of the other trips (Fig. 23).

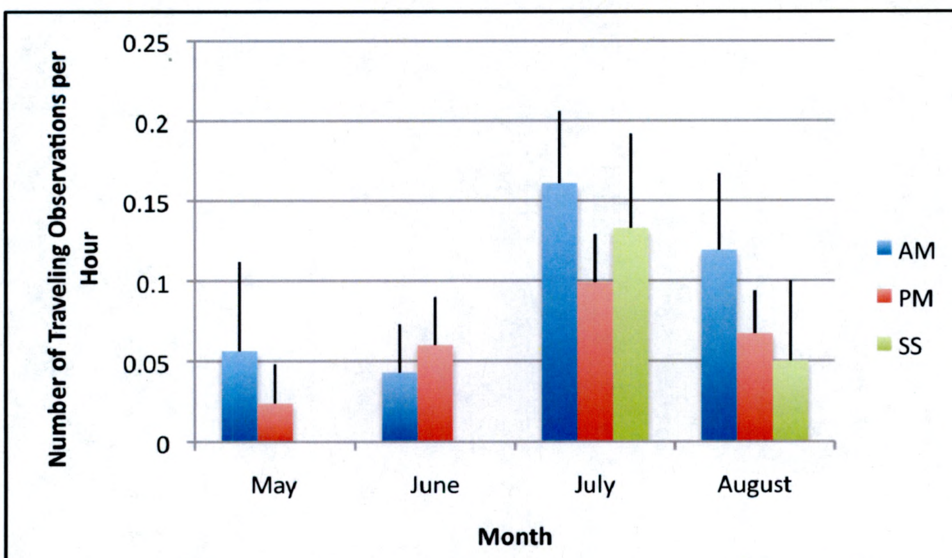


Figure 19. Travel observations per hour of sampling trip +/- the standard error during 2014.

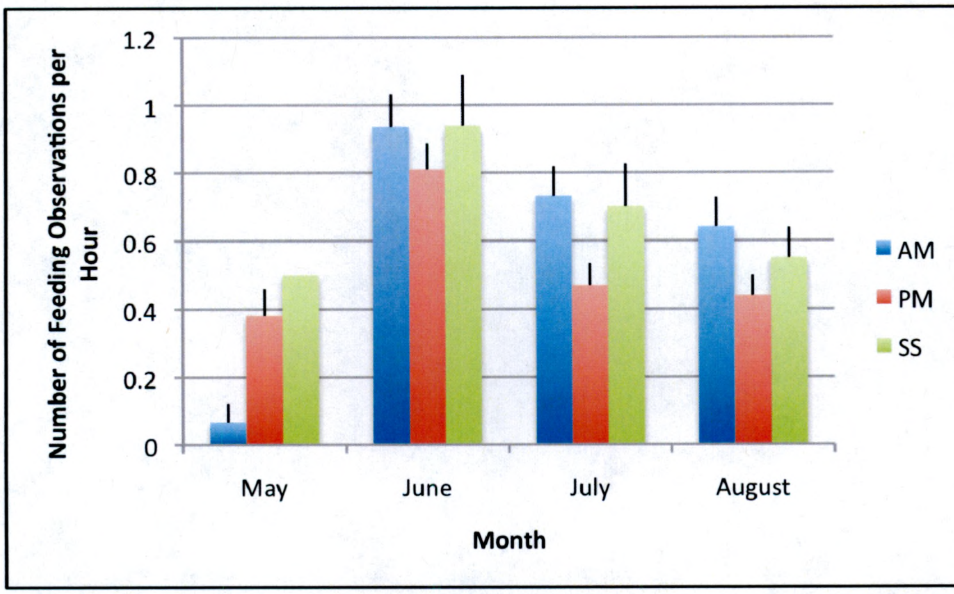


Figure 20: Feeding observations per hour of sampling trip +/- the standard error during 2014.

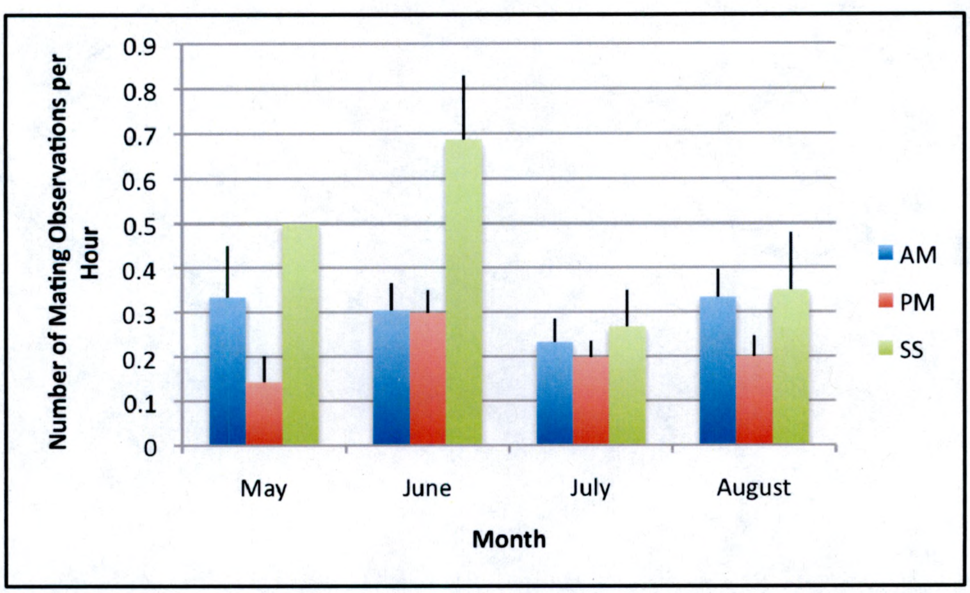


Figure 21: Mating observations per hour of sampling trip +/- the standard error during 2014.

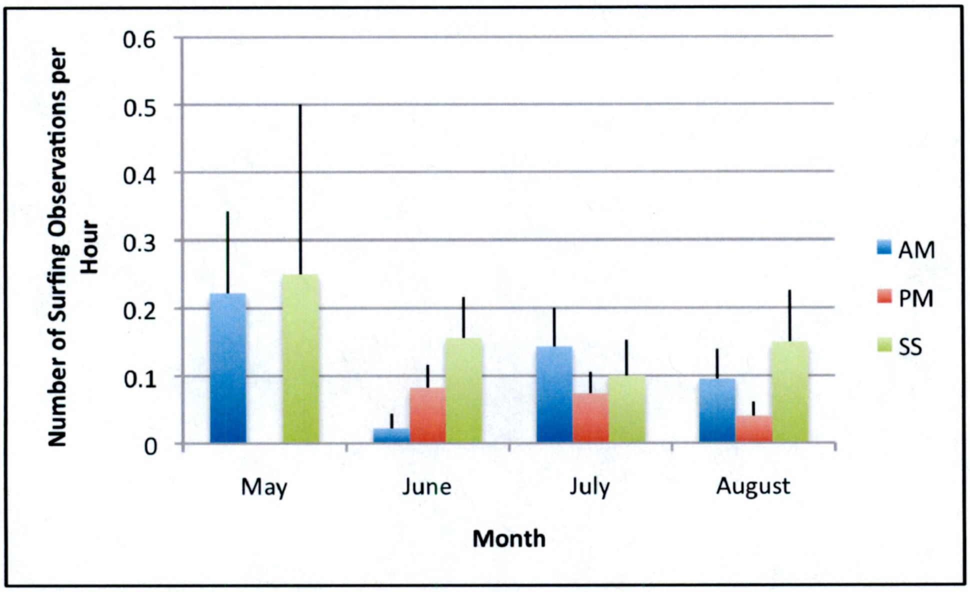

Figure 22: Surfing observations per hour of sampling trip +/- the standard error during 2014.

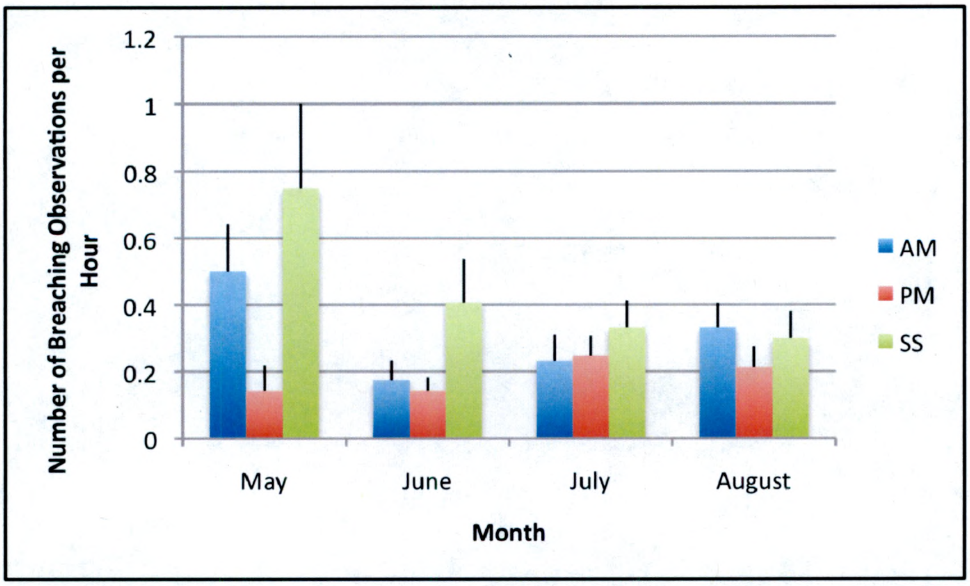

Figure 23: Breaching observations per hour of sampling trip +/- the standard error during 2014.

## Discussion

Cape May, NJ's population of bottlenose dolphins appear to be very versatile. When looking at field surveys and observational sightings, the results suggest that most dolphins are seen during the months of June and July, while the fewest number of dolphins are seen during the month of November. This may imply that June and July are the dolphins primary months to be in the area or that they are more active during those two months. In 2013, June had the most sightings per trip within the month, which is during the peak season. In 2014, April had the most sightings per month, but the least number of dolphins per sighting. This may be because the dolphins are just beginning to move back into the area from down south, and are not forming large groups yet. Therefore, there may be several separate sightings with small numbers of dolphins (Fig. 3). However, the survey effort was also greatest during June and July, which may be why more dolphin were seen during those two months. Bottlenose dolphins in the area are also believed to migrate south starting in late September (Toth et al. 2012), which is supported by these findings. This may possibly be because dolphins from other areas of New Jersey north of Cape May are starting to travel down south and happen to be passing through the area. There also may be a change in food distribution as the weather starts to get cooler, which creates different grouping arrangements within the bottlenose dolphin population.

1,039 individual dolphins were identified from April 2013 – June 15th 2014, which can indicate the possible size of the population that comes to Cape May, NJ every summer. Although this study did not include the entirety of the 2014 data for identification purposes, the rate of discovery of new individuals peaked in late summer

2013 and remained low throughout June 15th 2014, despite a small increase as summer began (Fig. 6). This indicates that the size of the catalogue is likely approaching an accurate representation of the size of the population. This is because the reduced rate of discovery of new individuals indicates that the majority of the marked individuals are known already and that the smaller number of additions may in large part represent the intake of young animals into the population. This number (1,039) thus gives the minimum population estimate for the dolphins off of Cape May, NJ, but also may include some migratory animals.

Out of those 1,039 dolphins, 97 individuals were observed more than one time, (9.3%), which may indicate a predominantely transient population is present in Cape May rather than a residential population. Dolphins that were only sighted once (942 individuals) could be considered non-residents (Simões-Lopes and Fabian 1999). However, this low resighting rate may merely reflect the difficulty obtaining pictures for every dolphin in the large groups observed in this area using photo-identification from a whale-watching vessel instead of a dedicated research platform.

Out of 97 resighted individuals, 17 dolphins (17.5%) were seen mixing between inshore and offshore habitats. These results support the idea that there is some mixing between the nearshore coastal population with the offshore transient population in the area. This also suggests a potential pathway of gene flow between these two populations. Although no actual mating interactions were observed in this study, it does demonstrate that these two ecotypes are mixing at some point. Feeding interactions were observed, and this could potentially mean there is exchange of information between these two ecotypes. Observing these two ecotypes interacting is important because this would potentially increase the effective population size and genetic diversity if these dolphins were breeding together at the same time and in the same place. It could also mean that these two populations are exchanging information and learning behaviors from one another. This would be an unusual interaction and potential gene flow since other areas around the world (South Carolina, Florida, and China) have distinguished between the two ecotypes, but have not observed much, if any, interactions between the two ecotypes (Wang et al. 2000, Gubbins 2002, Rodgers 2013).

Only three of the dolphin's movements could be determined being coastal individuals traveling offshore to intermix with offshore populations (Tt0137, Tt0577, and Tt0802). The other 14 identified dolphin's movements could not be placed into a habitat category because they had equal sightings between inshore and offshore habitats (Fig. 11). However, regardless of what ecotype these dolphins are, it is clear that they are mixing between inshore and offshore habitats. Continued evaluation and data collection of photographs could resolve their identities. Regardless, individuals are clearly co-mingling in both habitats.

In many studies on bottlenose dolphins, inshore and offshore individuals have not been observed mixing (Odell and Asper 1990, Wursig and Lynn 1996, Gubbins 2002). Wursig and Lynn (1996) in Texas studied ten dolphins for two months for 24 hours a day. They did find three dolphins that had been spotted offshore once, but because of the inability to detect proper radio signals, the positions of the dolphins, and the differences in habitat structure, movement offshore may have occurred less. Gubbins (2002) in South Carolina conducted 209 surveys in a four year study. 20 dolphins were studied, and none of them were observed venturing into offshore waters. If Wursig and Lynn (1996) did in fact find three out of ten dolphins that traveled offshore, that study would be similar to this study's results. Gubbins (2002) however found no dolphins venturing into offshore waters. In both of these studies, they focused on a small group of dolphins rather than studying the entire population, like in this current study. Both of these previous studies focused on smaller groups of dolphins, rather than on the population as a whole. Therefore, since this study included studying the entire population and inshore/offshore mixing was found, the Cape May population of dolphins appears to use larger habitats, travel farther for food, and may be interacting with one another.

However, a study of bottlenose dolphins, short-beaked common dolphins (*Delphnius delphis)*, and long-beaked common dolphins (*D. capensis)* in Santa Monica Bay, California, documented mixing between inshore and offshore habitats (Bearzi 2005). Bearzi (2005) predicted this mixing occurred due to these three different dolphin species sharing the same habitat, causing resource partioning among the three species, rather than supporting any potential gene flow. Although the study does not specifically say how often the bottlenose dolphins were observed in offshore waters, it does state that they were mostly found in inshore waters, but occassionally observed in deeper waters (Bearzi 2005). In a study observing bottlenose dolphins in Ireland (Oudejands et al. 2015), evidence was found for one distinct inshore community and one or more multiple offshore communities (within 3 km and between 4.5-41 km, respectively). However, in that study they did not find the individuals mixing between habitats.

Only 11 small groups were observed in same sighting occurrences more than once. These were mostly made up of paired dolphins who were not seen together more than two times (Table 2). This does not support any type of consistent intraspecific communities as found in other bottlenose dolphin populations (Wells 1986, Rossbach et al. 1999, Gubbins 2002, Urian et al. 2009). However, two pairs of dolphins that were seen twice together were only sighted those two times, which gives them a 100% sighting rate of being together. There were also three pairs that had a 50% sighting rate. This may indicate that these groups travel together often, and can lead to potential intraspecific community formations. In addition, six out of the 11 groups of dolphins were also seen in both 2013 and 2014. This means there has been long term interactions documented between pairs of dolphins. This could implicate that they migrate down south together, as well as back up north together. With the help of more picture analysis, additional sighting effort, and a dedicated research vessel, community structure could be better assessed for these and other groups.

Analyzing home range areas also provides information on the social structure and mating selection of bottlenose dolphins, as well as valuable information on their habitats (food availability etc.). Wells et al. (1987) stated that having at least 15 sightings of an individual dolphin provides a reliable home range area. The present study, which included bottlenose dolphin sightings between 2 and 12 times, was limited because the data were collected over a relatively short period of time and off a public whale watching boat, reducing the chances of capturing all the necessary photographs. Not all dolphins were identified every time they were sighted, and not all of the dolphins GPS locations were able to be recorded. Further research is needed to complete this analysis. Perhaps high-speed video with enabled image grabs could allow for greater identification of individuals, which would resolve home range sizes, group development, and intraspecific communities.

Despite this, the home range areas that were calculated for the dolphins seen utilizing both the inshore and offshore habitats, as well as dolphins sighted more than six times, align with others reported in the literature. The home range areas calculated did overlap between individuals, as found in the South Carolina bottlenose dolphin population (Gubbins 2002). Gubbins (2002) found that residential bottlenose dolphin home range numbers were between $38.5km^2$ and $98.9km^2$. These are close to the average numbers found in this study for dolphins sighted more than 6 times ($59.8km^2$). Wells (1991) found home range averages ranging from $50km^2$ to $100km^2$ in Florida, which is still within the average that I found for dolphins sighted more often than six times. Dolphins sighted only four times had an average home range area of $93.05km^2$, which also is similar to numbers found in the previous literature. Only two dolphins, Tt0137 and Tt0110 were found offshore during the same sighting. However, it is important to note that the home range averages found in this study were of dolphins utilizing both inshore and offshore habitats, and the numbers they were comparable to in other studies were only for coastal dolphins.

When analyzing only coastal dolphin home range average, the area was $4.09km^2$. This is much smaller than home ranges identified from Florida ($59.8km^2$) and South Carolina ($51.1\ km^2$ ). It is certainly possible that the sampling effort, which was specifically geared toward public education and not dedicated to home range detection, restricted home range detection. However, it is also possible that the small home range indicates a more abundant food source that is consistently distributed, and this may be the case in the coastal Cape May area.This region supports high levels of productivity and dolphin home range is usually dependent on habitat and food and reproductive resources (Scott et al. 1990, Gubbins 2002).

With regard to linear distance measurements of home ranges (dolphins only sighted twice), the mixing dolphins average home range was 36.65 km, which falls in the range found by Mazzoil et al. (2008) who had an average between 22 to 54 km for dolphins from Florida. For the linear home range calculations, the linear distance over the island of Cape May was left out for consistency with the area graphs, but this does lead to underestimates. The home range data that this study obtained and analyzed may be an artifact of limited data rather than an accurate reflection of home range patterns of this population. Further research is needed that includes a full two to three years worth of data where there are up to fifteen sightings of individual dolphins. This will give a much more accurate representation of these dolphin's home ranges.

Home range analysis showed that there is clearly an area where the dolphins that were sighted both inshore and offshore tended to congretate (Figs. 12, 13). Ten different dolphins (out of 17) were seen in that one area, southeast off the shoreline of Cape May. It is possible that there is a reason that multiple sightings occurred in this region, but I was unable to identify any. There does not appear to be any geologic feature which would account for this observation such as the edge of the continental margin. There were 9 separate sightings (only two dolphins seen seen at this location were sighted during the same sighting) and 7 of these sightings were in August 2013 and 2 sightings were in July 2013. There were no consistent behaviors observed during these observations, but it is possible that food may have driven these observations. The ship had no pre-determined course, and went where there were either dolphin sightings or went to an area by chance.

However, further research is needed to explore this particular area to find out why these dolphins tend to go there rather than anywhere else. This will require a more detailed effort analysis to ensure that similar aggregations elsewhere in the region are not being missed.

The most prominent behaviors observed during sightings were feeding and mating. Comparing behaviors between years, in 2013 traveling was most often seen during the month of September, which is when the dolphins start to migrate south (Toth et al. 2012). The large error bar in Fig. 15 for the month of August may be due to dates towards the end of August looking more like September because the dolphins are preparing to start traveling down south. Observations did increase in late August compared to early August. In 2014, traveling was seen more often during July and August, but had comparable numbers to those in 2013.This could potentially be because the dolphins were moving towards higher food concentrations. Although there were not enough sampling dates in September 2014 to be included in the statistical analysis, traveling in August 2014 was similar to traveling in August 2013, which may indicate that traveling patterns were similar in both years. Therefore, the dolphins were most likely preparing to travel down south in September 2014 as well.

In 2013, feeding was seen much more often during the morning hours during each month (Fig. 16), especially in June and July, and is comparable to the results found by Saayman et al. (1973). August and September may have less feeding being observed because the dolphins are preparing to travel down south. However, in 2014 feeding was observed similarily between morning and evening, and there was not as much of a drop in August (Fig. 21). Further research is needed to understand why behaviors changed so drastically between the two years. Lack of food could potentially be the cause. In 2013, mating was observed most often during the month of July and mating was usually observed in the morning (Fig. 17). However, during 2014, mating was observed both during the morning and evening trips, and in June, the most mating was seen during the evening. In both years, mating observations seemed to drop in late August and September. Since most, if not all, of the calves are seen during May and June, mating decreasing later in the season makes sense. This is most likely due to a decrease in food, and preparations to begin traveling down south. The dolphins are not going to want to calve when there will be less food and the water will start to become colder. Therefore, in September mating observations may be more recreational rather than procreational. Again, more research is needed to understand why these behaviors changed between years. In 2013 there was no variation for surfing and breaching behaviors, but in 2014, breaching was seen more often during the evening (Fig. 23).

In summary, the bottlenose dolphin population off of Cape May, NJ is very social and dynamic. This study has found a large population in the area. It has also shown that these bottlenose dolphins seem to be less habitat-limited than others reported in the literature (Wells 1991, Wursig and Lynn 1996, Gubbins 2002), with indications that individuals are using both inshore and offshore habitats. Accordingly, Cape May's coastal population may be interacting with the offshore population. Such interactions may include mating, but potentially also behavioral and cultural transfer, which may indicate that the area is particularly important to the regional bottlenose dolphin meta-population. This study has also provided insights into the home range and habitat use of the animals in the area, which is relatively consistent with published literature. Key compnents from this study indicate significant differences in behavior activities over the course of a day (although the specific pattern varied from 2013 to 2014) as well as seasonally. Specifically, observations of traveling were significantly greater during the month of September in 2013, with rates comparable across 2013 and 2014 for July and August. Further research efforts are needed in order to answer the many remaning questions obtained from this study. Identifying the rest of the dolphins from 2014 will provide a more reliable population estimate. Knowing how many more dolphins are utilizing both inshore and offshore habitats will provide knowledge on population structure and gene flow in this population. Primarily studying the one area offshore that the inshore/offshore dolphins continue to travel to may show hot spot areas for food. Behaviors changing from 2013 to 2014 may be due to a multidue of reasons, including changing in their food resoruces, temperature of the water, and population numbers. A dedicated research vessel, rather than a public whale watching vessel, would be very helpful in attempts to answer these comments and questions.

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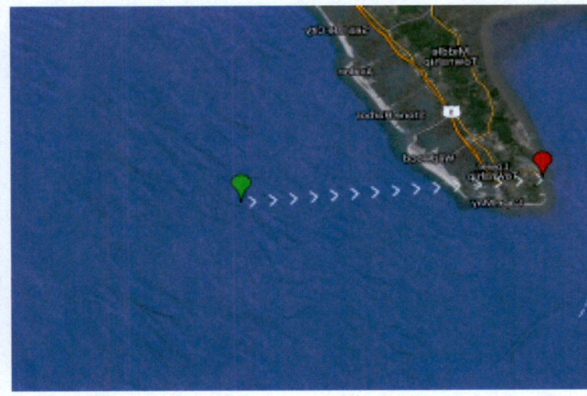
Appendix A- Identified dolphins sighted multiple times (bolded IDs are dolphins seen both inshore and offshore).

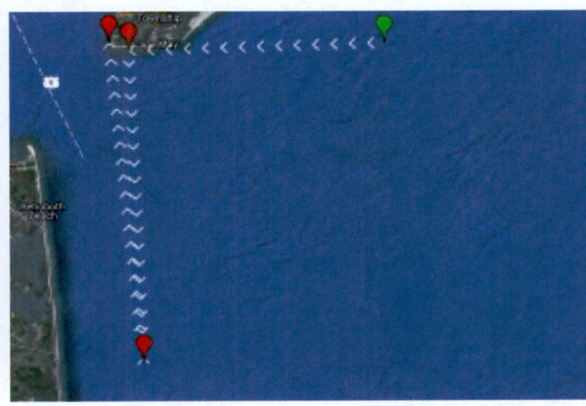
| ID (Tt#) | Number of Sightings | ID (Tt#) | Number of Sightings |
|---|---|---|---|
| 0008 | 6 | 0560 | 2 |
| **0041** | **2** | **0577** | **4** |
| **0044** | **4** | **0583** | **2** |
| 0052 | 2 | **0591** | **2** |
| 0068 | 2 | 0597 | 2 |
| 0069 | 5 | 0601 | 2 |
| 0074 | 2 | 0603 | 3 |
| 0075 | 4 | 0605 | 2 |
| 0076 | 2 | 0619 | 2 |
| **0083** | **2** | 0624 | 2 |
| **0085** | **2** | 0648 | 2 |
| 0090 | 4 | 0651 | 2 |
| **0110** | **3** | 0653 | 2 |
| 0125 | 2 | 0656 | 2 |
| 0129 | 2 | 0676 | 4 |
| 0131 | 2 | 0691 | 2 |
| **0137** | **12** | 0696 | 2 |
| 0153 | 2 | 0699 | 5 |
| 0172 | 2 | 0703 | 2 |
| **0205** | **2** | 0707 | 3 |
| 0213 | 2 | 0723 | 3 |
| **0231** | **4** | 0724 | 6 |
| 0253 | 4 | 0732 | 2 |
| 0254 | 2 | **0757** | **2** |
| 0268 | 3 | 0768 | 2 |
| 0270 | 3 | 0779 | 2 |
| 0274 | 3 | 0793 | 2 |
| 0293 | 2 | 0794 | 2 |
| 0305 | 2 | **0802** | **6** |
| 0307 | 6 | **0804** | **2** |
| 0317 | 3 | 0823 | 2 |
| 0331 | 2 | 0847 | 2 |
| 0333 | 5 | 0851 | 3 |
| 0338 | 2 | 0852 | 2 |
| 0348 | 2 | 0854 | 2 |
| 0350 | 4 | 0900 | 2 |
| 0371 | 3 | 0908 | 4 |
| 0372 | 2 | 0952 | 2 |
| 0378 | 2 | 0964 | 2 |
| 0396 | 2 | 0970 | 2 |

| | | | |
|---|---|---|---|
| 0400 | 4 | 0984 | 3 |
| 0441 | 2 | 1027 | 2 |
| 0451 | 7 | 1029 | 2 |
| 0462 | 2 | 1076 | 2 |
| **0480** | **2** | 1091 | 2 |
| 0495 | 2 | **1095** | **2** |
| **0496** | **2** | 1096 | 2 |
| 0522 | 3 | 1097 | 2 |
| 0523 | 2 | | |

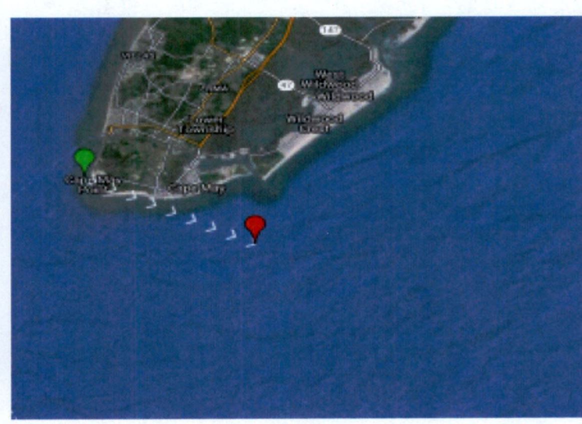
Appendix B: Dorsal fin photographs and traveling ranges of the mixing inshore and offshore dolphins. The green marker indicates the first location the dolphin was sighted.



A) Tt0041

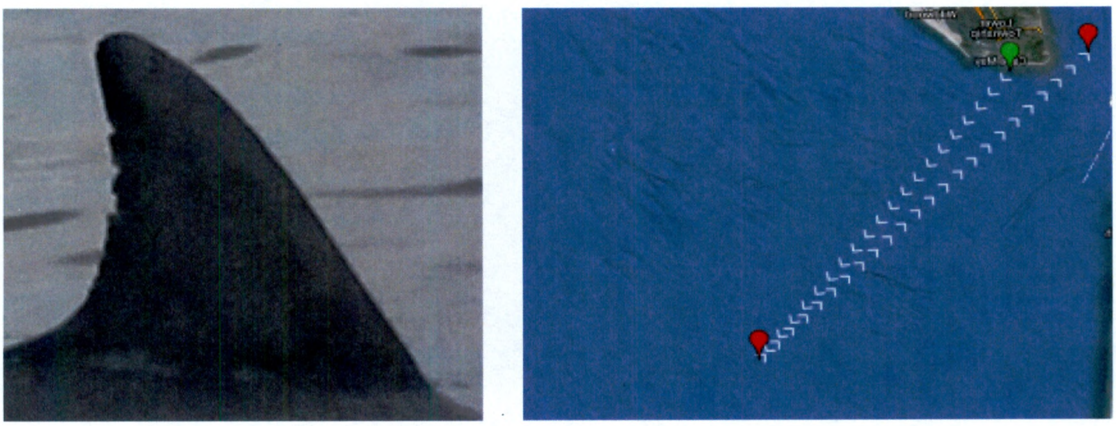


B) Tt0044

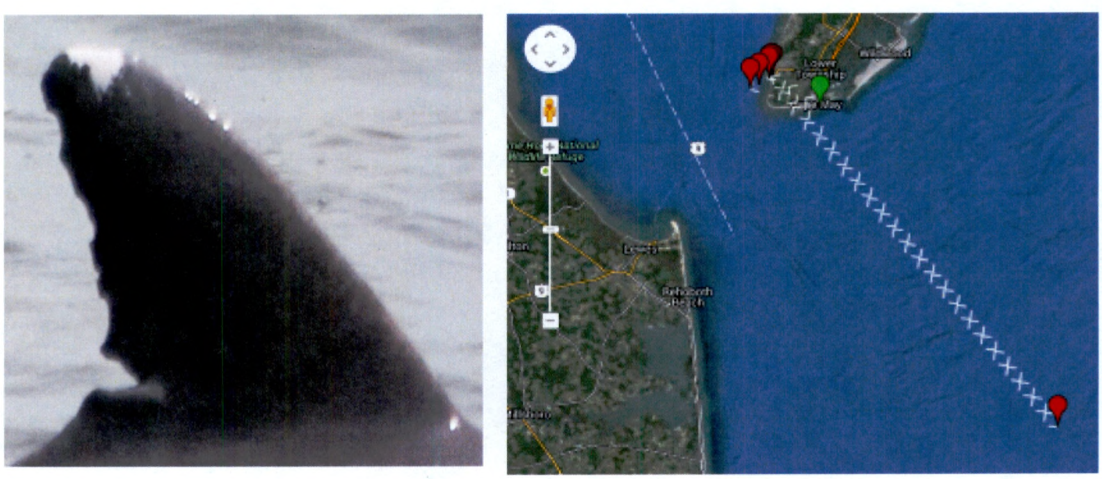


C) Tt0083

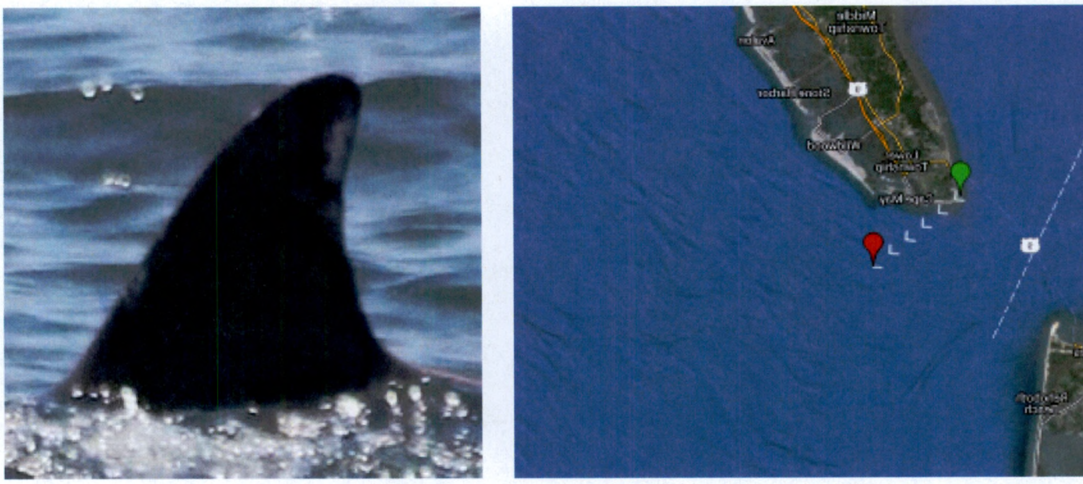

D) Tt0085



E) Tt011

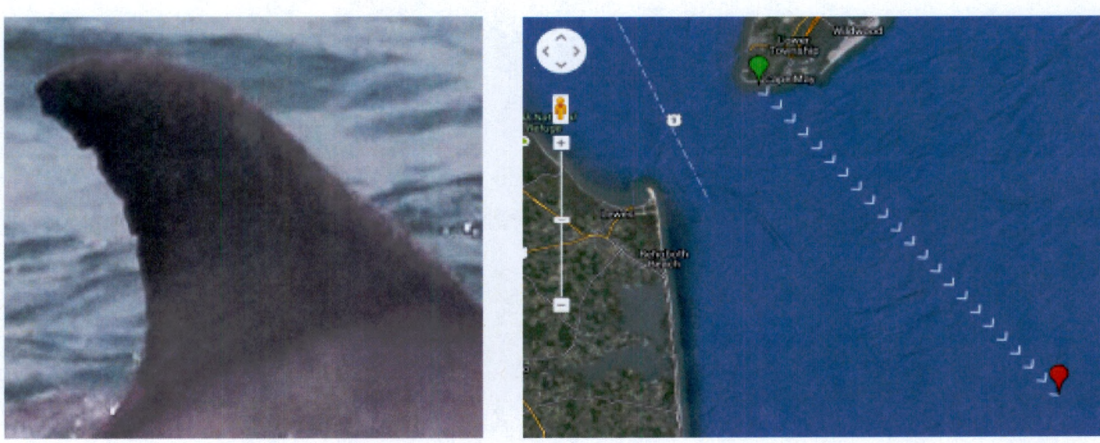



F) Tt0137

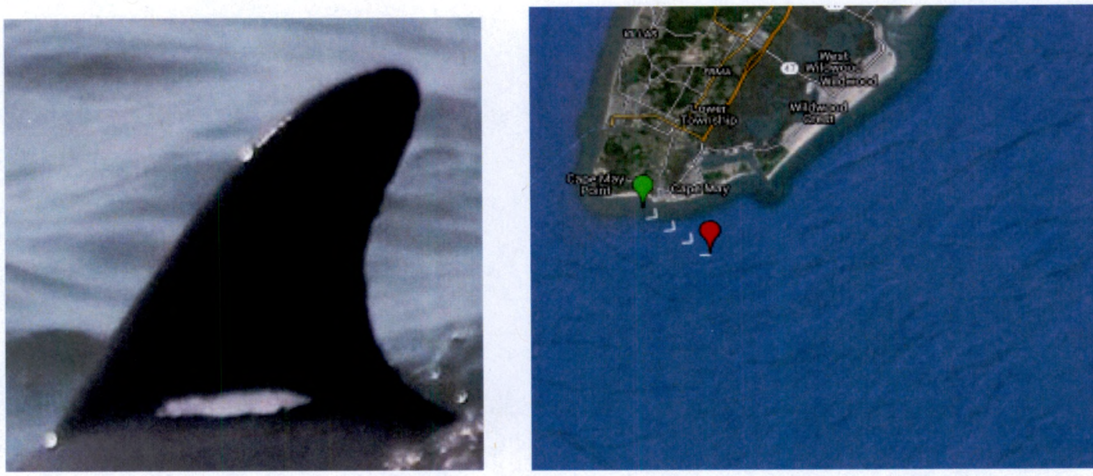


G) Tt0205

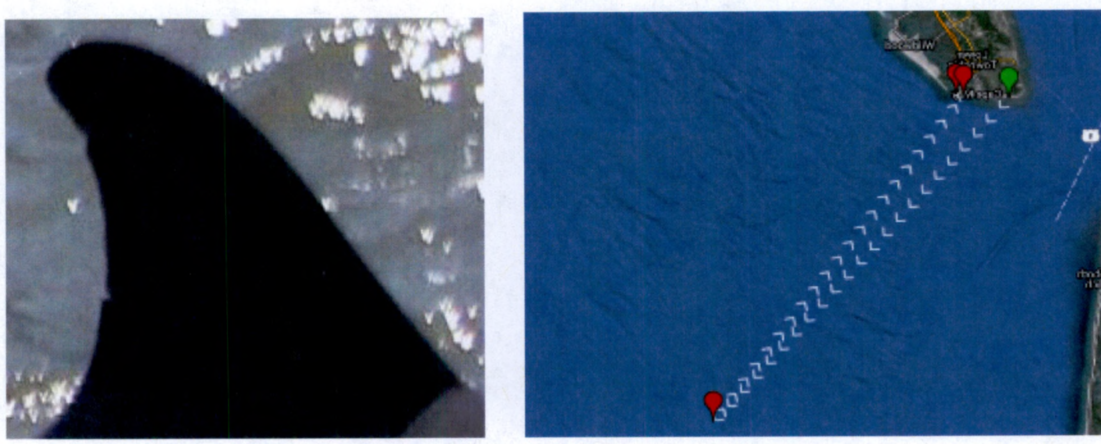
H) Tt0231



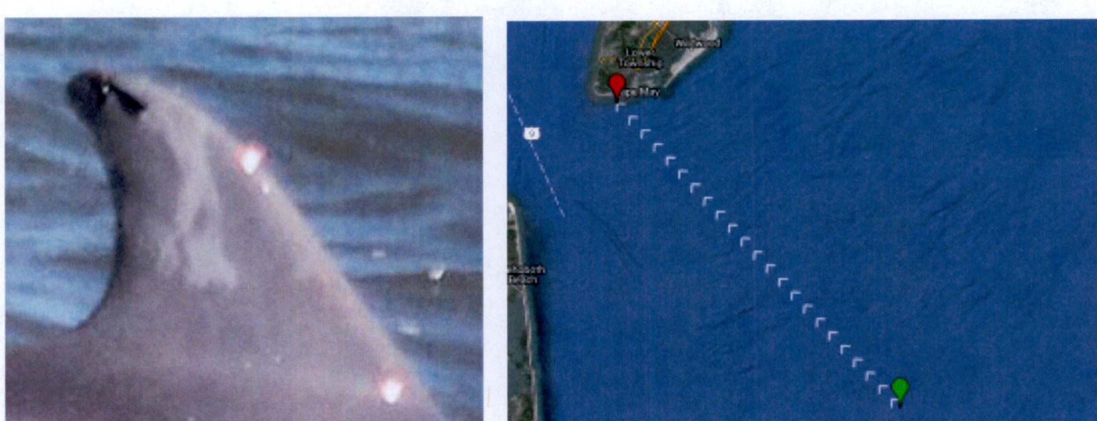
I) Tt0480



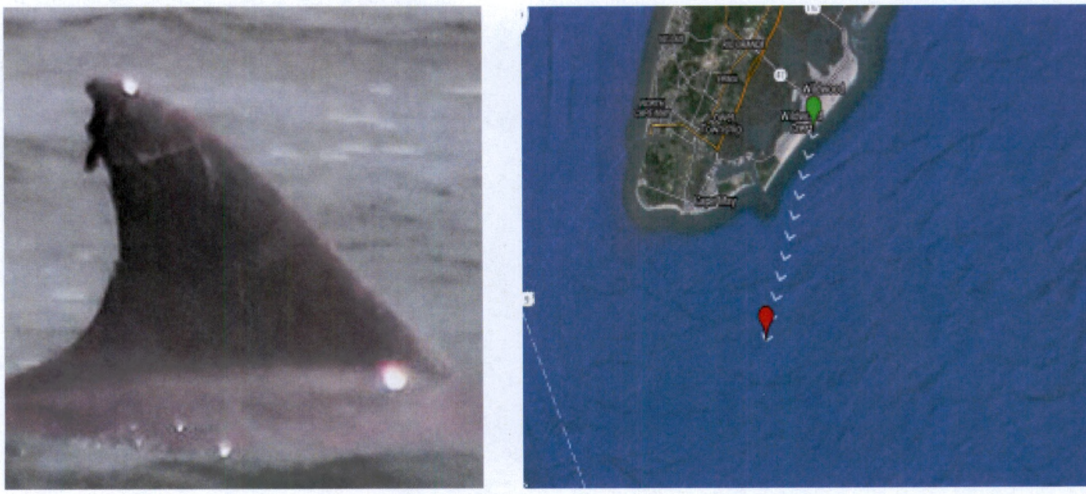
J) Tt0496



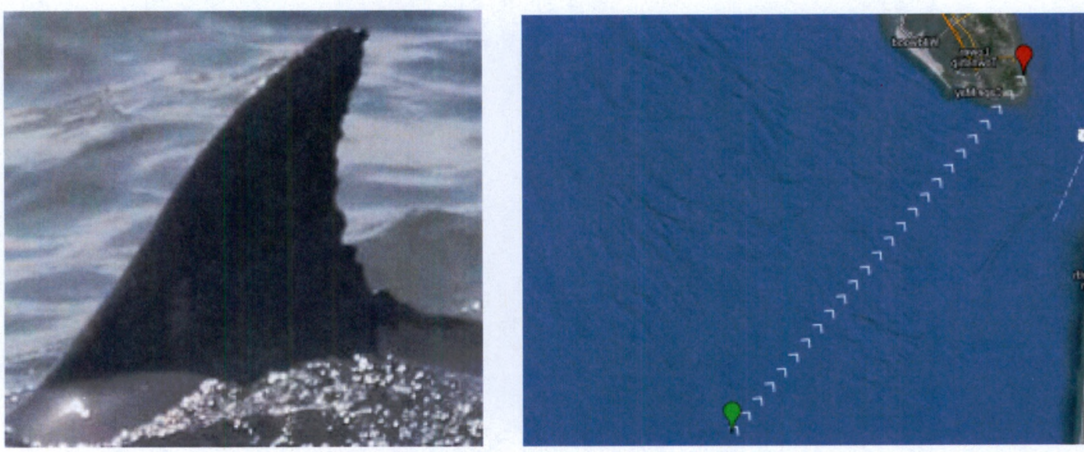
K) Tt0577



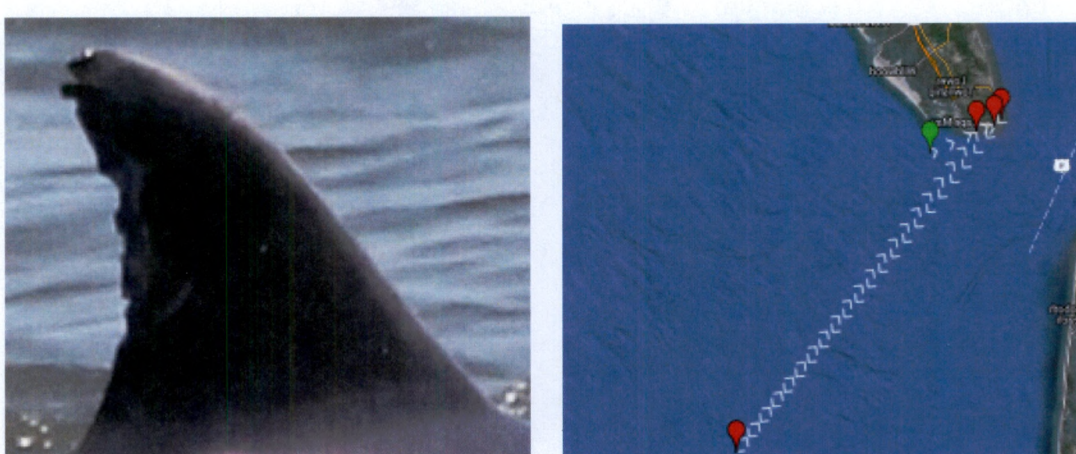
L) Tt0583



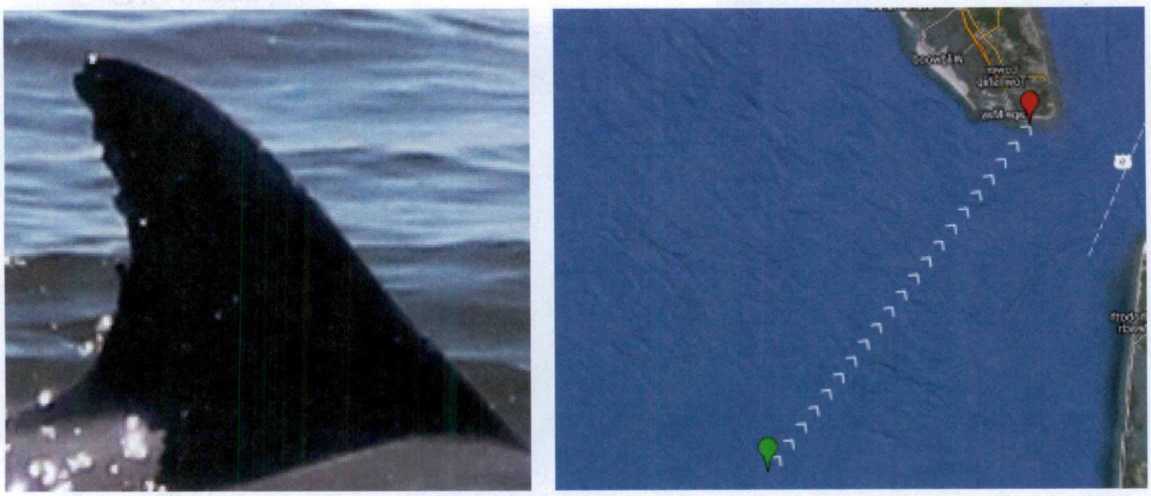
M) Tt0591



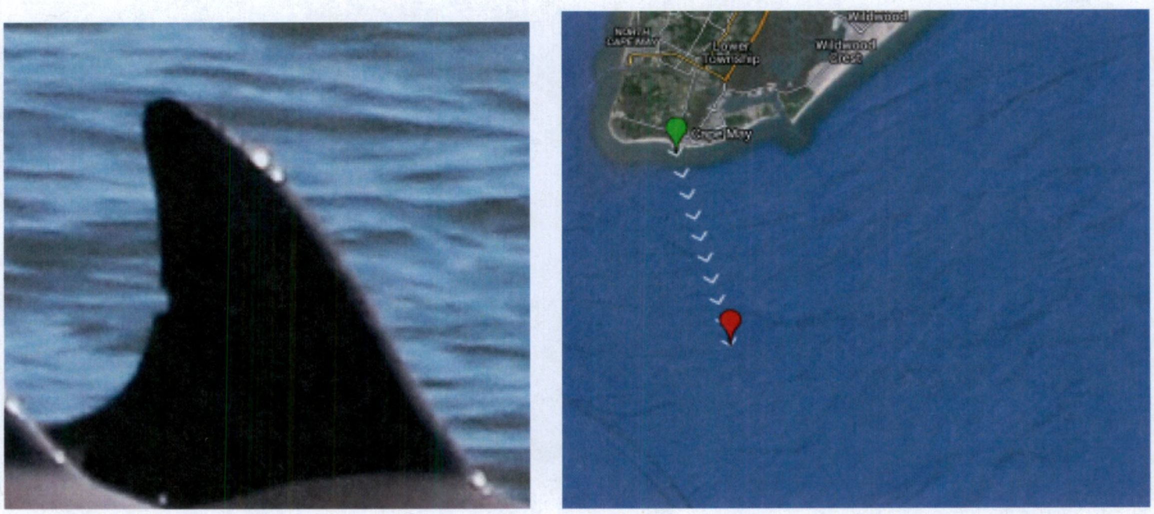
N) Tt0757



O) Tt0802



P) Tt0804




Q) Tt1095