

Seasonal Exchange of Bottlenose Dolphins (*Tursiops truncatus*) Transient to the Outer Banks of North Carolina

Ana Yanes and Jessica Taylor
Outer Banks Center for Dolphin Research

Introduction:

Bottlenose dolphins (*Tursiops truncatus*) are found in both temperate and tropical waters around the world (NOAA 2015). There are coastal populations that migrate into bays, estuaries, and river mouths as well as offshore populations that inhabit pelagic waters along the continental shelf. The Northwest Atlantic populations of bottlenose dolphins are split into two distinct ecotypes: coastal and pelagic (NOAA 2015). These ecotypes can include individuals that display short-term seasonal residency, year-round residency, and transience (Toth et al. 2011). The type of residency displayed by each population is dependent on factors such as: availability of food, presence of predators, suitability of habitat, and environmental conditions like water quality, salinity and temperature (Campbell et al. 2002).

The National Marine Fisheries Service (NMFS) manages the bottlenose dolphins as stocks, with the mandate that these stocks are maintained as functioning elements in their ecosystem which can produce viable offspring. The dolphins found in the Roanoke Sound are considered to be part of the Northern North Carolina Estuarine System Stock (NNCESS), which is estimated to have up to 900 inhabitants that will range as far south as Beaufort, NC and can be as far as 1 km offshore during the warmer summer months (Gorgone et al. 2014; Waring et al. 2012). In the colder winter months, it is believed that the dolphins move out of the estuarine waters and can be found up to 3 km offshore and can be found between Cape Hatteras and the New River (Waring et al. 2012). When the dolphins are in Beaufort during the winter months, there is a possible overlap of the NNCESS and the Northern and Southern Migratory Stocks (Waring et al. 2012). Because of the overlap of these stocks and the seasonal movements between Beaufort and the Roanoke Sound, understanding the extent of the mixing is important for the appropriate management of the stocks.

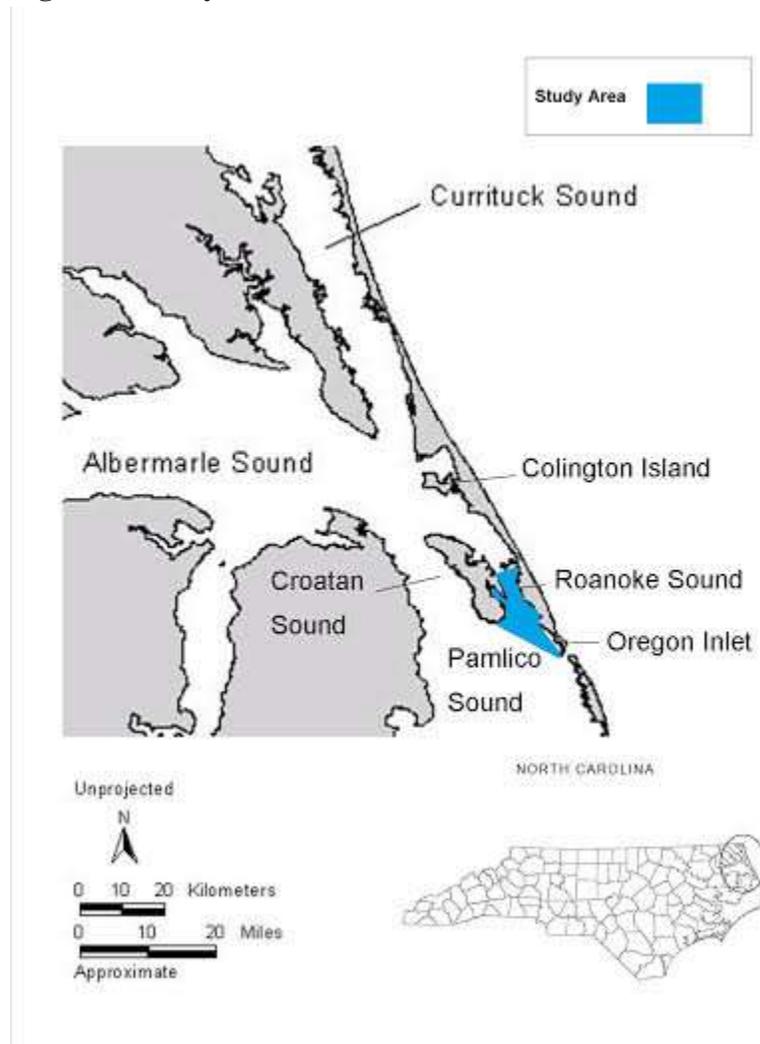
Since 2008, the Outer Banks Center for Dolphins Research (OBXCDR) has been conducting a long-term monitoring study of bottlenose dolphins in the Roanoke Sound. Over 650 individual dolphins have been identified in the area. Dolphins are typically found in the sound during the months of April through November and exhibit seasonal migratory and transient patterns of site fidelity (Taylor et al. 2014). Through photo-identification and the use of the Mid-Atlantic Bottlenose Dolphin Catalog (MABDC), the OBXCDR is able to document individuals that are found as residents of both Beaufort and the Roanoke Sound study sites. Photo-identification is a type of mark and recapture study; it is the most economical and extensively used method to monitor bottlenose dolphin populations (Weir et al 2008). The identification process is dependent on clear images of natural markings on the dorsal fins of the cetaceans. The

MABDC was created in 1997 in order to help catalog and organize dorsal fin images from various researchers along the Eastern Coast of the United States in order to help with photo-identification. The MABDC currently is made up of 19 catalogs, 20 contributors and over 11,000 dorsal fin images (Urian 2014).

Methods:

The study area is located in the Roanoke Sound of the Outer Banks in North Carolina and covers approximately 41 square miles from the northern tip of Roanoke Island to south of the Oregon Inlet (Figure 1). The Roanoke Sound separates Nags Head from Roanoke Island. The average depth of the sound is three and a half feet, excluding the dredged channel of the Intracoastal Waterway. Additionally, the Roanoke Sound is important for both recreational and commercial fishing, as well as watersports.

Figure 1. Study Area



The Outer Banks Center for Dolphin Research regularly conducts both dedicated and opportunistic photo-identification surveys of bottlenose dolphins (*Tursiops truncatus*) within the study area outlined above. Exploratory surveys were conducted in the southernmost area of the study site during October 2007. Dedicated photo-identification surveys took place from June-August 2008, February 2009, May-October 2009, May-October 2010, and May-October 2011 at least once per month. A standardized transect route to cover the entire area of interest was created in November of 2011 with MapSource and uploaded to a GPS unit. Dedicated surveys were conducted along the transect route in the study area from a 16' or 17' outboard vessel during November 2011, April – November 2012, and April – November 2013, with the exception of May and July of 2013. Once a group of dolphins was sighted along the transect route, the group's location was marked on the GPS and the dolphins were slowly approached in order to not change their natural behavior. Photographs of the dorsal fin of each dolphin were obtained using standard photo-identification techniques (Wursig and Wursig 1977). In addition to the GPS location of the group of dolphins, date, time, activity state, observed behaviors, and environmental conditions such as salinity, water temperature, and wind speed were obtained and recorded for each individual sighting. The sighting ended if any of the three following events happened: 1) the dolphins exhibited avoidance behaviors or were lost, 2) the maximum allotment of one hour for the sighting was reached according to the General Authorization permit under which the surveys were conducted, or 3) every dorsal fin had been photographed in the group. After the sighting was concluded the research vessel returned to the transect line and continued the transect route until completion or until another group of dolphins were spotted.

The opportunistic data was collected from May 2008-October 2013 aboard the Nags Head Dolphin Watch. The collection of data and survey methods were similar to the dedicated survey methods, but differed in the route taken to locate dolphins, approaching the group, and maximum sighting time. The tours occurred within the study area but did not follow a set transect line. After locating a group of dolphins the captain followed the NMFS Recommended Viewing Guidelines for bottlenose dolphins. These guidelines limited the maximum viewing time to half an hour.

The program FinBase (Adams et al. 2006) was used in the processing of the field data and photo-identification images. The images collected from every dedicated survey and random opportunistic surveys were sorted, graded for photo quality, and then matched to the NC-OBXCDR photo-identification catalog. The NC-OBXCDR catalog includes dorsal fins from October 2007 – October 2013, and consists of both dedicated and opportunistic surveys in the Roanoke Sound. After a researcher believed they found a match in the catalog, a second researcher verified the match. The sighting data collected from that survey was linked to the images of that dolphin. The data was then sent to Kim Urian, Duke University Marine Lab (DUML), in order for it to be added to the MABDC. Images that were considered poor quality or fins without any markings or distinguishing characteristics were not included in this analysis. A Bayesian mark-recapture approach (Durban et al. 2010) was used to identify clusters of dolphins

with different levels and patterns of capture probability over time (Gardner et al. 2010, Fearnbach et al. 2012). Cluster 1 had low site fidelity, Cluster 2 had intermediate site fidelity, and Cluster 3 had high site fidelity (Taylor et al. 2016).

The goal of this study was to match the highly distinct dolphins from cluster 1 (N=26/69), to the North Carolina Maritime Museum (NC-NCMM 2015) catalog using the MABDC. The reason the NC-NCMM catalog has been chosen is because that study area is located in Beaufort, NC, where a large group of the Roanoke Sound dolphins spend the winter months. If there was believed to be a match made by the OBXCDR researcher, the match must be verified by Kim Urian, a second OBXCDR researcher, and the NCMM catalog contributor. A table was created for every individual that had been matched (Table 1). This table included sex (if determined), the first sighting date of that animal and the total number of sightings in the Outer Banks. The gender of the animal was considered a female if she was sighted three or more times consistently with a dependent calf, the individual was considered a male if it was seen surfacing beside another adult dolphin three times consistently and was believed to be part of a male pair. The percentage of dolphins matched to the NC-NCMM 2015 catalog of the total sample (N=14) was calculated (Table 2).

Results

Of the 25 dolphins with high distinctiveness in Cluster 1, only 14 were able to be compared to the NC-NCMM 2015 catalog. Six of those 14 dolphins were matched to the NC-NCMM 2015 catalog, and 8 were not able to be matched. As seen in Table 1, sex was able to be determined for only two of the dolphins. The total number of sightings for the Cluster 1 dolphins was low.

Table 1. Results of Cluster 1 matching to NC-NCMM 2015 catalog.

OBXCDR ID/Alias	MABDC ID	NCMM ID	Sex	First Sighting Date	Total Sightings
34/FB415	8731	15532	F	10/13/2007	4
118	8779	16808		6/12/2008	3
150	8809	19069		6/20/2008	1
155	8813	18845		6/20/2008	1
252/Wicked	8898	18260		7/1/2008	3
831/Virginia	11441	0863a	F	8/21/2011	2

Table 2. Results of Cluster 1 Matching.

Number of dolphins compared to NC-NCMM catalog	14
Total matched	6
Percentage matched	42.8%

Discussion

The dolphins in Cluster 1 had very low site fidelity to the Roanoke Sound, so it is not surprising that only 6 of the 14 dolphins compared to the NC-NCMM 2015 catalog were able to be

matched. Additionally, 5 of the 6 dolphins were also matched to several other catalogs besides the NC-NCMM 2015 catalog, implying that perhaps they have low site fidelity in other sites (Table 3). Dolphin 150 is the only one of the six dolphins that has only been matched to the NC-NCMM 2015 catalog.

Table 3. Additional Catalog Matches

MABDC Catalog	Study Area	Date Range	Individual Matched
NC-DUML-UNCW	Nags Head, NC south to Oak Island, NC	1995-2011	34/FB415, 155, 252/Wicked, 831/Virginia
NC-RMD	Nags Head, NC	1997-1998	34/FB415, 118, 831/Virginia
VA-SB	Virginia Beach, VA	1989-1998	118, 155, 831/Virginia

Future Directions

Future studies of the NC-OBXCDR catalog and Roanoke Sound dolphins should continue the matching of the NC-NCMM 2015 catalog to the NC-OBXCDR catalog to find more matches between the sites. This would help to further examine the site fidelity of the individuals in North Carolina to determine if they show seasonal home range preferences, or if they use full extent of their home range year around. Additionally, later years should be included in the comparisons because many of the dolphins in Cluster 1 have been sighted in the Roanoke Sound multiple times after 2013. The remainder of cluster 1 dolphins should also be matched to the NCMM catalog, not just the highly distinctive dolphins. Lastly, the dolphins in all 3 clusters should be matched to other catalogs along the east coast to see where else they might be traveling or migrating during the year and throughout their lives.

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