

Seasonal Movements of Bottlenose Dolphins in the Outer Banks

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Introduction

Atlantic Bottlenose (*Tursiops truncatus*) populations are distributed world-wide and can be found on most continental coastlines (Hammond et al. 2012). Patterns of distribution are driven by seasonal short-term residency, permanent year-round residency, and transience (Toth et al. 2011). Factors such as temperature, salinity and prey availability can affect the degree of site fidelity in each area (Toth et al. 2011).

Atlantic Bottlenose dolphins are common along the U.S. Atlantic coast. Individuals observed in the northeastern North Carolina region are a part of the Northern North Carolina Estuarine System Stock (NNCESS). For management purposes, the NNCESS is defined as a group of animals that occupy the coastal waters of North Carolina through Chesapeake, Virginia from July through August (Waring et al. 2015). During the cold water months, the NNCESS is thought to occupy the coastal waters (< 3km from shore) between the New River and Cape Hatteras (Waring et al. 2015). The movements and distribution of this stock have been tracked through the use of photo-identification of the dorsal fin. Marine mammals can be tracked and identified through natural or acquired markings such as blemishes, scars, notches, and nicks (Wells et al. 1994).

The Outer Banks Center for Dolphin Research (OBXCDR) was incorporated in 2008 with the mission to promote the conservation of bottlenose dolphins in the Outer Banks through research and education. Promoting research through conservation and education is accomplished by monitoring population size, movement patterns, health, and behaviors of bottlenose dolphins that inhabit the Roanoke Sound. Since 2008, over 700 individual dolphins have been identified in this area. The OBXCDR catalog is managed by Jessica Taylor, founder of the OBXCDR. It is believed that the number of individuals vary seasonally in sounds of North Carolina. Through all of the photo-identification work, the OBXCDR has gained knowledge of the site fidelity and seasonal movements of the dolphins in the Roanoke Sound display.

Although individuals belonging to the NNCESS are known to range as far north as southern Virginia, there is a speculation as to how far north they may travel. It is possible that they may range as far north as New

Jersey. Researchers in the New Jersey area use photo-identification techniques to build the New Jersey-Cape May Whale Watch Research Center (NJ-CMWWRC) Catalog. The Cape May Whale Watch was created in 2011 with the primary mission to use photo identification to enhance their knowledge in seasonal migration, distribution, and abundance of bottlenose dolphins. Since 2011, the Cape May Whale Watch has documented over 300 individuals in their catalog. The Cape May Whale Watch Research Center catalog is managed by the CMWWRC contributor, Melissa Laurino. The bottlenose dolphins in New Jersey belong to the Northern Migratory Coastal Stock (NMCS) (Waring et al. 2015). The NMCS has a possible range of New York to Cape Hatteras (Waring et al. 2015), yet New Jersey is the northernmost site with photo-identification effort (Toth et al. 2011). The migratory patterns of bottlenose dolphins are not well known due to the extreme changes in water temperature in New Jersey (Toth et al. 2011). Along the coast of New Jersey, the water temperature can have a difference of 25°C between cold and warm water months (Toth et al. 2011).

The OBXCDR and CMWWRC contribute photo-identification data to the Mid-Atlantic Bottlenose Dolphin Catalog (MABDC). In 1997, the MABDC was created to help better understand bottlenose dolphin stock structure (Urian 2014). The MABDC is a resource that contains photo-identification research from different locations along the Atlantic Coast. The research is submitted by contributors that allow the information to be organized and streamlined into one general area.

Objectives

Our main goal of this study was to use the MABDC to identify seasonal movement patterns of bottlenose dolphins between the Outer Banks of North Carolina to bottlenose dolphins in Cape May, New Jersey.

Methods and Materials

The OBXCDR study area takes place in the Roanoke Sound, which is approximately 41 square miles from the northern tip of Roanoke Island to south of the Oregon Inlet (Figure 1). The Roanoke Sound separates

Roanoke Island from Nags Head, and is typically used for recreational and commercial fishing (Figure 2). The average depth of the Roanoke Sound is 3.5 feet, with the exception of the channel, and is mostly comprised of shallow seagrasses, sandbars, and channels that have been dredged out. The Cape May Whale Watch research vessel uses the study area of the Cape May Inlet along the shoreline of the beachfront of Cape May (Figure 3). CMWWRC uses photo-identification efforts during the months of April-October (Table 2). Table 2 describes the number of dolphins that were sighted during their surveys with the month and year.

The Outer Banks Center for Dolphin Research conducts both dedicated and opportunistic surveys of bottlenose dolphins from April through October. A standardized transect route was created in November of 2011 to cover the entire study area. The dedicated transect surveys take place on a 17' outboard vessel that goes out in the Roanoke Sound. The transect lines were created in the program MapSource and was then uploaded to a GPS unit. Dedicated surveys followed predetermined track lines. When a group of dolphins had been sighted, the GPS location was recorded. The research vessel would then slowly approach the group of dolphins in a way to avoid disturbing any natural behavior. Photo-identification images of the dorsal fins of dolphins sighted were taken.. The goal of the transect survey was to obtain a photograph of each individual's dorsal fin in that particular group so that each individual could be identified. Additional information such as wind speed, water temperature, water salinity, date, time, and observed behaviors were also recorded during each individual sighting. After the sighting, the research vessel would return back to its transect line and transect route until another sighting was observed. Opportunistic data was collected from May 2008 through October 2013 with the Nags Head Dolphin Watch. The collection of data is very similar to the dedicated surveys, with the exception of the transect survey route. The Nags Head Dolphin Watch does not follow a specific survey route, but GPS coordinates are collected and recorded at the beginning and the end of each dolphin sighting.

In order to process the sighting data and photo-identification images, the software program FinBase was used (Adams et. al 2006). The images that were obtained from the dedicated and opportunistic surveys were sorted, graded for photo-quality, and identified as a match or a new dorsal fin in the OBXCDR catalog. Lastly,

every dorsal fin that was matched or entered into the catalog was verified by another researcher to ensure accuracy. The data was then sent to Kim Urian, MABDC curator, who added the data into the MABDC.

In order to examine the different levels of sighting probabilities, a Bayesian mark-recapture approach was applied using 413 distinctive dolphins that were identified from high quality photos (Taylor et al. 2016). This was done to identify population clusters that were based upon individual capture probabilities (Taylor et al. 2016). From this study, three major clusters were identified, with Cluster 2 and Cluster 3 having the highest site fidelity to the Roanoke Sound (Taylor et al. 2016). Approximately 43 individuals were assigned to Clusters 2 and 3. The Cluster 2 and Cluster 3 dolphins (N=43) were then compared to the dolphins in the CMWWRC-NJ (N=333) catalog using the MABDC (Table 1).

Figure 1: Roanoke Sound study area

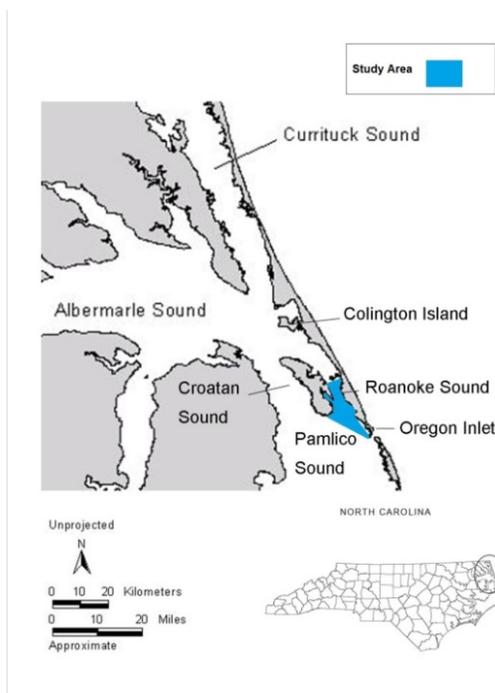


Table 1: MABDC catalog comparisons

Field Site	Catalog Size	Period	Organization
Roanoke Sound, NC	330	2007-2013	OBXCDR
Cape May, NJ	333	2011-2016	CMWWRC

Figure 2: Roanoke Sound sightings

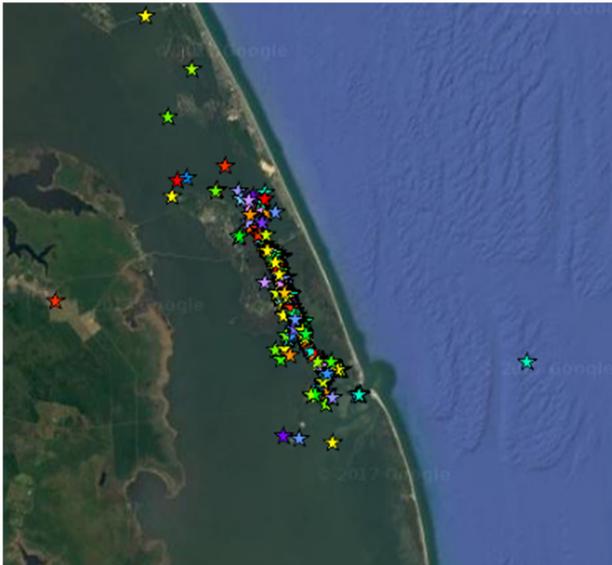


Figure 3: Cape May Whale Watch study area



Table 2: Cape May Bottlenose Dolphins Identified between 2011 and 2016

Year/Month	1	2	3	4	5	6	7	8	9	10	11	12	Sub-Total
2011										2			2
2012					2	44	4	8	7	1			66
2013				1	4	13	40	58	1	8	1		126
2014				2	22	18	4	15	3				64
2015				20	5	8	18	3	6		2		62
2016					5	8							13
Total	0	0	0	23	38	91	66	84	17	11	3	0	333

Results

Of the dolphins in the OBXCDR Catalog in Cluster 2 and 3 (N=43), no matches were made to the CMWWRC Catalog (N=333). These results suggest that the bottlenose dolphins in Cluster 2 and 3 do not travel as far north as New Jersey.

Discussion

Although no matches were made between the CMWWRC and OBXCDR catalogs, it is likely that bottlenose dolphins photographed in New Jersey may travel to Maryland and Virginia. It has already been confirmed that Cluster 2 and 3 travel to south eastern Virginia with the potential to travel to Maryland (Young and Taylor 2017). Young and Taylor identified 5 confirmed matches of Cluster 2 and 3 dolphins between the OBXCDR and VA-HDR catalogs. There have not been any matches made to the CMWWRC catalog in the MABDC. For future studies, the CMWWRC catalog should be compared to the catalog in Maryland (MD-

PCDP) and Virginia (VA-HDR). A majority of the Cluster 2 and 3 dolphins had previously been identified in other catalogs and locations such as NC-DUML, NC-NMFS, NC-NCMM, and NC-RMD (Taylor 2016). The OBXCDR could also attempt to match individuals sighted in Roanoke Sound during the spring and fall to the NJ-CMWWRC catalog to see if there is any overlap in migratory behavior.

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