Examining the northern spatial extent of estuarine bottlenose dolphins sighted in Roanoke Sound, NC

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Introduction

Bottlenose dolphins (*Tursiops truncatus*) are distributed worldwide within temperate waters (Leatherwood and Reeves 1983). Along the Northwestern Atlantic coast, two distinctive ecotypes have been found, coastal and pelagic, with variation in genetics, foraging techniques, and social structures (Louis et al. 2014). Specifically, coastal bottlenose dolphins are found up to 3 km from shore, with eighteen coastal and estuarine stocks or management units along the coastline (Hayes et al. 2017; Waring et al. 2015). The National Marine Fisheries Service (NMFS) defines a stock of marine mammals as a group within an area that interbreeds and are functioning elements of their ecosystem (Wade and Angliss 1997). Stocks of bottlenose dolphins can serve as indicators of the health of surrounding marine ecosystems and food chains (Wade and Angliss 1997). While overlap among stocks may occur, stocks are treated as separate groups to better understand the health of individual stocks.

Many of the bottlenose dolphins found in the Roanoke Sound, NC compromise the Northern North Carolina Estuarine System Stock (NNCESS) (Hayes et al. 2017). Since 2008, the Outer Banks Center for Dolphin Research (OBXCDR) has studied these dolphins using photo-identification, finding both seasonally resident and transient individuals within Roanoke Sound (Taylor et al. 2014; Taylor et al. 2017). To further understand site fidelity and movements, it is common to compare and contrast stocks along the coastline in order to find overlap or patterns across sites. The Mid-Atlantic Bottlenose Dolphins Catalog (MABDC) is the master catalog along this coast that compiles multiple photo-identification catalogues, with the primary purpose to examine stock structure (Urian et al. 1999).

Using the MABDC, the NNCESS dolphins have been found to range as far south as Beaufort, North Carolina, marking their southern range (Mason and Taylor 2016; Shervanick and Taylor 2016; Yanes and Taylor 2016; Fuentes and Taylor 2015; McKeowan and Taylor 2015). However, the northern range of the NNCESS has been identified as far north as the Chesapeake Bay into southern Virginia and northern Maryland (Young and Taylor 2017). Since matches have been found at these sites, updates for both the OBX catalogue and the Maryland catalogue (MD-PCDP) have been incorporated into the MABDC.

Fluctuations in some population parameters from climactic variances can also be dependent on latitude. For example, Florida manatees have been found further north in the periods of heat waves during the summertime (Craig and Reynolds 2006; Deutsch et al. 2003). Pinnipeds in the Arctic have seen an overall decrease in population size, in occurrence with melting sea ice, causing an increase in predation and decrease in habitat (Kelly 2001). Declining biodiversity with latitude has been an alarming side effect of climate change (Hillebrand 2004). This decline is quantifiably greater in marine environments than in terrestrial environments (Hillebrand 2004), emphasizing the importance of studying the northern range of the NNCESS dolphins.

The purpose of this study is to provide an updated examination of the NNCESS dolphins' northern range by comparing updates from the OBX catalogue to the MD-PCDP catalogue. This assessment can be used to better guide conservation and management efforts for the NNCESS dolphins. Assessing these changes in the NNCESS stock is important, as there have been observed shifts in ranging patterns of many marine mammals in response to climate change, further contributing to the decline in biodiversity along latitudinal gradients.

Methods

Data Collection

The OBXCDR regularly conducts both dedicated and opportunistic photo-identification surveys within the Roanoke Sound (Figure 1). The Roanoke Sound separates Nags Head from Roanoke Island. The average depth in the sound is approximately 3.5 ft, with a man-made channel ranging from 8-12 ft deep. The sound is mostly compromised of seagrass beds, which provide a habitat for soniferious fish—the primary diet of coastal bottlenose dolphins (Gannon and Waples 2004).

Dedicated boat-based surveys were conducted in Roanoke Sound along a standardized transect route. Surveys were conducted from 2008 through 2013—with the majority of surveys taking place from May through October—aboard a 16' or 17' outboard vessel. Dolphins were slowly approached, as to not interfere with their natural behavior. For every sighting, group size estimates, GPS coordinates, observed behaviors, and environmental conditions (salinity, visibility, sightability, cloud coverage, water and air temperatures, and wind speed) were recorded. Photographs of each individual dorsal fin were taken using standard photo identification techniques (Würsig and Würsig 1977). All dedicated transect surveys were

conducted under a NMFS General Authorization Permits LOC-13416 and LOC-17988 awarded to J. Taylor.

Opportunistic data was collected on board the Nags Head Dolphin Watch, on two pontoon boats approximately 30 and 36 ft in length. Photo-id and data collection were taken when dolphins were sighted, however routes did not follow predetermined transect lines.

Analysis

FinBase was used to process photos and sighting data (Adams et al. 2006). Photos were first cropped, sorted, and then graded for quality. Finally dorsal fins were matched to a preexisting individuals in the OBXCDR catalog or entered as a new fin into the database. All matches were verified by a second individual to minimize errors. The updated catalog was sent to the MABDC.

Poor quality fins and fins with low distinctiveness were eliminated from analysis. Dolphins previously matched to the southern Virginia catalog (VA-HDR; n=5) and new dolphins added to OBXCDR since 2013, with more than three sightings, were selected for analysis. The OBXCDR fins (n=31) were then matched to highly distinct (D1 and D2) and high quality (Q1 and Q2) fins in the MD-PCDP catalog (n=193) (Table 1).

Results

Three confirmed matches were found between the catalogs (Table 1). Most of these matches were sighted more frequently within the OBXCDR catalog, with the exception of individual 771 (Table 2). All three of these matches were only found at these two sites, with no other site matches in the MABDC for these individuals.

Discussion

These results aid in further delineation of the northern range of the Northern North Carolina Estuarine System Stock. The low number of matches across the two catalogs could have resulted from several variables such as different study periods across sites. The MD-PCDP catalog has only been active for 5 years with data in the MABDC uploaded for only 2 seasons. As this catalog continues to grow and include more individuals over time, it is likely an increase in matches will be seen between these two study sites. Additionally the higher number of sightings within the matches found can also be attributed to the OBXCDR catalog being active for a longer period of time.

The presence of three individual Roanoke Sound dolphins in the MD-PCDP study area could indicate the beginning of a change in spatial trends for either the Northern Migratory Stock or the Northern North Carolina Estuarine System Stock. The MD-PCP dolphins likely belong to the Northern Migratory Stock, which may be expanding into Roanoke Sound. The other, more likely, scenario could be that the NNCESS is moving further north, potentially due to climate change. To further assess which of these two scenarios is happening, longer studies for both catalogs would have to be assessed.

A higher number of OBX dolphins were found in the VA-HDR catalog (n=13; Young and Taylor 2017) and Virginia Beach area (n=1; Urian et al. 2019), suggesting that this area is more significant to the NNCESS' range, rather than the Potomac study area. However this comparison should be updated frequently, as the MD-PCDP catalog study period increases, as more matches are found between the VA-HDR and OBXCDR catalog or as coastal waters begin to warm. For example, NOAA suggests that reports for non-strategic stocks of marine mammals, such as bottlenose dolphins, should be updated every 3 years or in light of new scientific findings (NOAA Populations Assessments 2019).

In response to climate change, marine mammals have been observed to change their typical ranges. For example, West Indian manatees (*Trichechus manatus*) found along the Atlantic coast of Florida have a small seasonal migration route. However, in recent years, they have been seen as far north as Virginia and Massachusetts (Craig and Reynolds 2006; Deutsch et al. 2003). This in part is due to the narrow metabolic temperature at ~24℃ needed for manatee metabolism (Irvine 1983). The rise in water temperatures could be a plausible explanation for manatees being seen further north during the summer months.

Similarly with bottlenose dolphins, the NNCESS could see a seasonal migration change as well; however historical data is needed to confirm this trend. Therefore the northern range of the NNCESS should be reevaluated and updated frequently and compared to more northern catalogs in the MABDC.

Figures

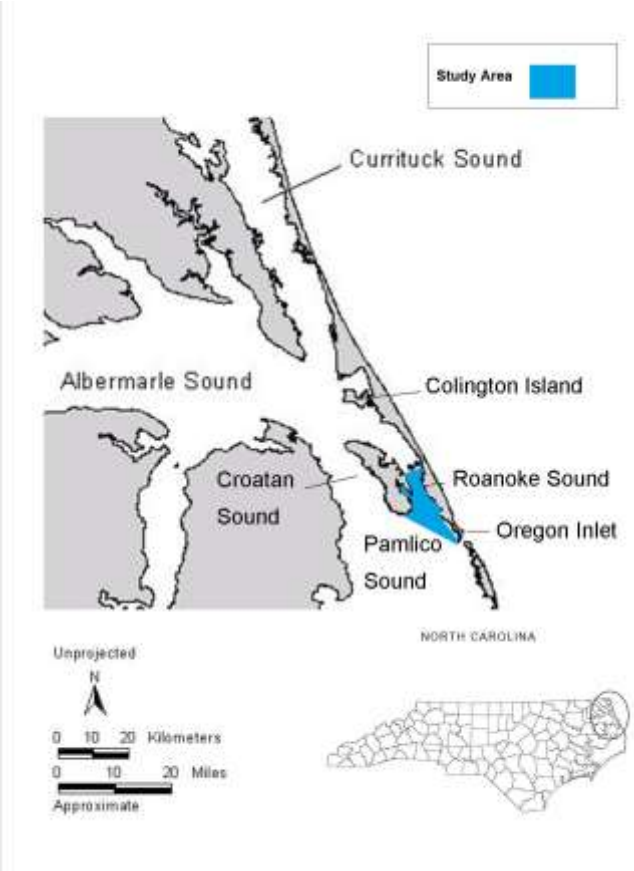

Figure 1. The Outer Bans Center for Dolphin Research study area.

Table 1. Comparison of MABDC catalogs.

Catalog	Contact	Study Area	Study Period	Catalog Size	Number of Fins Matched	Number of Matches
NC-OBXCDR	Jessica Taylor, *OBXCDR*	Roanoke Sound, NC	2008-2018	1044	31	N/A
MD-PCDP	Anni Jacoby, *PCDP*	Potomac/Chesapeake, MD	2014-2015	193	193	3

Table 2. Matched individuals from OBXCDR and PCDP catalogs.

Match ID	OBXCDR ID	PCDP ID	Number of Sightings (NC)	Number of Sightings (MD)
449	157	MAS	4	1
653	504	HDG	2	1
771	1140	WIT	2	2

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