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Heather Estep
Coastal Carolina University

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**Population Structure of *Tursiops truncatus* in North Inlet,
South Carolina and use of Inlet as a nursery ground**

Heather Estep

Marine Science

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Abstract

Abundance, distribution and movement patterns of bottlenose dolphin populations are becoming more frequently studied along the Atlantic Coast from Virginia to Florida. One aspect of dolphin populations that has not been a focus of study is the use of nursery grounds by females with calves. Nursery grounds for bottlenose dolphin populations have been identified in Sarasota Bay, Florida and near Beaufort, North Carolina. This study analyzed data collected from September 1997 to June 2006 on focal follows and photo identification to determine if females were utilizing North Inlet, South Carolina as a nursery ground. There was no significant difference in the number of calves + young –of-year (YOY) sighted between seasons, indicating that females did not use the Inlet more during any one season to rear their young. Two resident females gave birth from mid-May to early June and two from the end of June to the beginning of July. We could not conclude an accurate time of birth for the fifth mom in the study.

Introduction

Bottlenose dolphins are distributed along the Atlantic coast from New York to Florida (Zolman 2002) and in the Gulf of Mexico (Balmer *et al.*, 2008). Due to dolphins being taken as bycatch in excess amounts (Read *et al.*, 2003; Torres *et al.*, 2005) and large scale mortality events (Balmer *et al.*, 2008; McFee *et al.*, 2006), the number of studies conducted on the population structure, abundance and distribution of bottlenose dolphins (*Tursiops truncatus*) has increased over the past 15 years.

Populations can be identified as offshore or coastal, and migratory or resident dolphins. Torres *et al.* (2005) defined dolphins located in water up to 7.5km from shore as coastal dolphins, 34km or more from shore as offshore, and those between 7.4 and 34km as an overlap in both types. Coastal dolphins can be seasonal migrants, staying south during winter months and moving north during summer months (Barco *et al.*, 1999; Zolman *et al.*, 2002; Sloan 2006) or resident dolphins. Resident

dolphins are those seen in the same area during all four seasons (Zolman 2002) and move little over the course of the year (Gubbins *et al.*, 2003). The area that resident dolphins utilize for finding prey, mating and nursing young can be defined as their home range (Gubbins 2002a). Migratory and resident dolphins can be found further offshore along the continental shelf or inshore in estuaries, bays and by barrier islands (Read *et al.*, 2003).

Photo identification is one technique used to determine area distribution, movement patterns, abundance and inter-individual behaviors (Würsig *et al.*, 1990) of cetaceans. Dorsal fins acquire distinctive markings over the years due to encounters with other animals, boats and fishing gear. Markings, which can include the shape of the fin, shading, scraps, scars and wounds, allow for 50% of bottlenose dolphin populations to be identified (Würsig *et al.*, 1990). Pictures of dorsal fins help to identify individual dolphins as resident or migratory, and in this study helped to determine which females were observed with calves.

According to Moller *et al.* (2004), bottlenose dolphins can form associations including long-term associations or alliances between several males and moderate association of females with other females. This study also suggests that calves remain in the same area as adults, supporting evidence of residential populations. Sarasota Bay, Florida is known to have individual dolphins that have used the same area for the last 25 years and this resident population is the largest one studied (Gubbins 2002b).

There is not much data published on the bottlenose dolphin stock between Murrells Inlet, SC and Cape Romain National Wildlife Refuge near McClellanville, SC (Sloan 2006). The data collected during this 10 year survey period could help to identify resident and seasonal dolphins, and mom-calf pairs in North Inlet. The objectives of this study were to determine 1) if known moms are more frequently sighted in North Inlet when they are with calves than without, 2) how many calves each

known mom gave birth to, the timing of these births, and how long the calf stayed with the mom, and 3) if there is a difference in the number of sightings of calves between the four seasons.

Methods

Study Site

The study was conducted in North Inlet, south of Georgetown, South Carolina. North Inlet is part of the North Inlet- Winyah Bay National Estuarine Research Reserve and is bordered on the east by the Atlantic Ocean and on the west by Mud Bay and Winyah Bay (Fig. 1). The 32 km² area has one opening to the Atlantic Ocean and consists of salt marsh, oyster reefs, mudflats and tidal creeks (Young and Phillips 2002). There are approximately 25 smaller tidal creeks, 3 major creeks – Debidue, Town and Jones, and three bays – Oyster, Bass Hole and Sea Creek . North Inlet is a vertically well mixed system driven by tides. The average tidal range is 1.7m and the average tidal depth is 2.5m for the major creeks. Water temperatures range from 9°C to 31°C and salinities from 30‰ to 34‰. The Inlet is home to a diverse range of animals including bottlenose dolphins, small sharks, small fish (mummichogs and silversides), spot, pinfish, mullet and red drum. Crabs (blue, fiddler, hermit and mud), snails (periwinkle and mud), oysters, birds (heron, osprey, pelican and white ibis), shrimp, *Spartina* and zooplankton also inhabit the estuary.

Survey Procedures

Surveys were conducted year round from September 1997 to June 2006. An 18 foot aluminum skiff was used to survey the study area and cruised at a speed of 3-4 kt during surveys. The number of people on board averaged 3-4 and included a photographer, data recorder and driver. Survey methods for finding dolphins consisted of focal follows. Creeks were searched haphazardly until a dolphin or group of dolphins was spotted. Recent history sightings were mainly used to determine what area should be searched for a group of dolphins. Once a group of dolphins was sighted, a focal group follow

commenced until the sighting was lost. Dorsal fin photographs were taken of all dolphins in each event, as possible. An 80mm video camera was used to take photographs from 1997-2001 and in 2002 a Canon Digital SLR 300mm zoom lens was used.

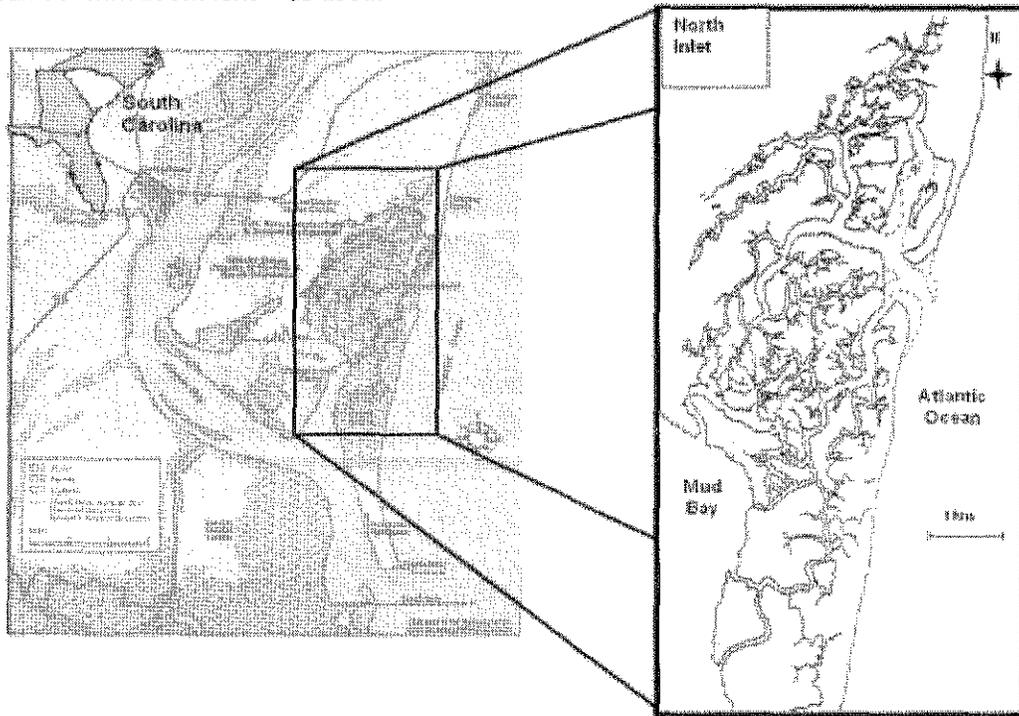


Figure 1. Study site consisting of 32km² of salt marsh and tidal creeks near Georgetown, SC.

Data Analysis

For each group sighted, date, event number, start and end time, general and sub-location, latitude and longitude, and physical variables (weather conditions, Beaufort sea state, and air and water temperature) were recorded. An event is defined as the time of the first sighting of a group of dolphins until the last sighting of the group and can range from minutes until hours depending on how long the dolphins stayed in sight. The minimum, maximum and total number of dolphins was recorded as well as the minimum, maximum and total number of calves and young-or-year (YOY) respectively. The best estimate was determined from a consensus of all observers on the boat. Calves were identified based on 1) presence with known mom and 2) presence of smaller dolphin consistently associated with unknown

adult female in calf position. Young –of-y ear (YOY) were defined as neonates that displayed fetal folds and /or floppy fins. Dorsal fins were compared to CCU Photo ID catalog photos for positive identification.

The percentage of calves that made up each event was calculated as well as percentage of YOY, calves + YOY, and moms + calves + YOY. Each event was then sorted into fall, winter, spring and summer, and the average percentage of calves per event was taken for each season. The last step was repeated for YOY, calves + YOY, and mom + calves + YOY. An ANOVA was run to determine if there was statistical difference between the percentage of calves + YOY between seasons.

The timing of birth of each calf was determined by looking at the date of the last sighting of the mom by herself before she was sighted for the first time with her calf. From these two dates, a birth range was determined for each calf.

Results

From September 1997 to June 2006, a total of 360 survey days were conducted and data were collected on 722 events. There were 162 fall (Sept-Nov), 135 winter (Dec-Feb), 199 spring (Mar-May) and 226 summer (June-Aug) events. Calves and YOY were present in 53% (n=86) of fall events, 52 % (n=70) of winter events, 51% (n=101) of spring events, and 55 % (n=125) of summer events (Fig. 2). There was no significant difference in the number of calves + YOY between seasons ($p = 0.347$). On average, the total number of dolphins per event was comprised of 17.8% of calves in fall, 17.9% in winter, 17% in spring and 20.3% in summer (Fig. 3).

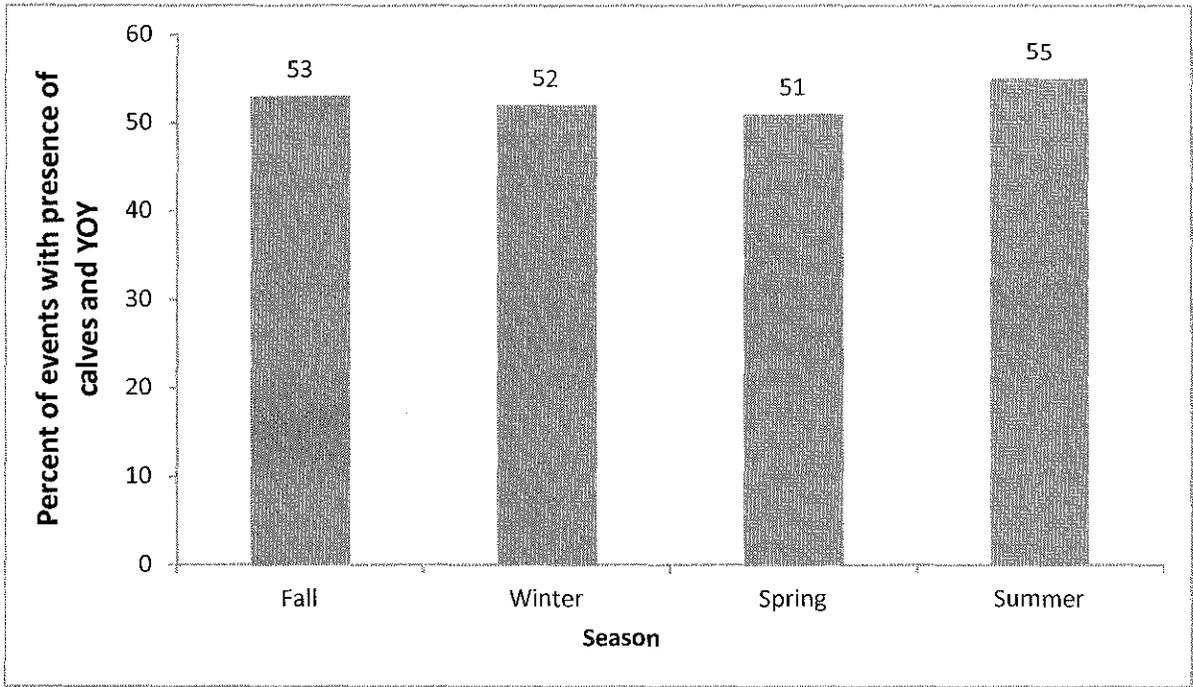


Figure 2. The percent of events that calves and YOY were present for each season.

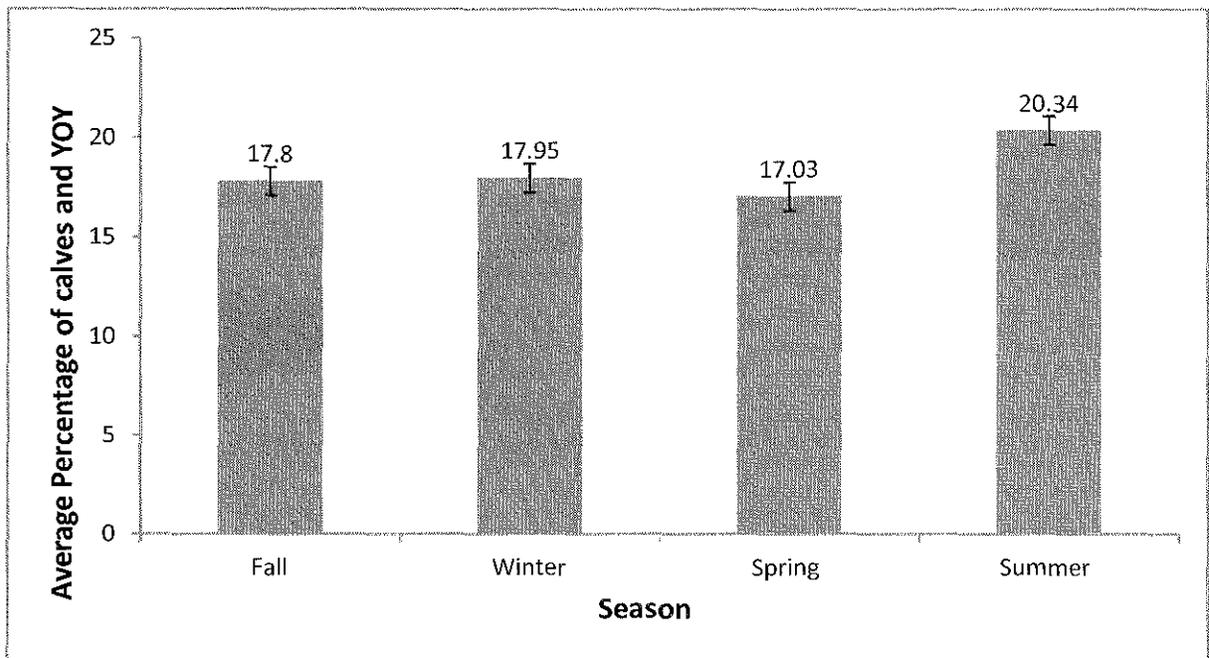


Figure 3. The average number of calves and YOY that made up the total number of dolphins per event in the Inlet for each season. There is no significant difference between the number of calves + YOY per season.

There were a total of five known moms that utilized the Inlet; Marge, Eve, Kaiser, Flattip and Sweeper. Marge was first sighted in North Inlet in October 1997 and was sighted with her first calf Hadji in June 1999. The timing of Hadji's birth was narrowed down to a period of 20 days and stayed with Marge for four months. The last sighting of Hadji in October 1999 was also the last sighting of Marge for 8 months. Marge reappeared in the Inlet in June 2000 and was sighted during surveys for the next 2 years. Marge reared her second calf, Larsen, in May 2002. The birth of Larsen can be narrowed down to a time frame of 8 days and stayed with Marge for 3 years. In June 2005, Marge had her third calf that stayed with her for at least 3 months when the surveys ended.

The first sighting of Eve was in September 1997 and the first sighting of her first calf Slappy was in June 1999. Slappy stayed with Eve for 16 months until September 2000 and then both disappeared from the Inlet. Eve was not seen again until both she and her second calf Dodger were sighted in May 2001. Dodger stayed with Eve for 2 years before he was spotted in the Inlet without Eve. This date is when Dodger was considered independent of Eve, but he was still observed with Eve many times after this day. In May 2003, Eve and her third calf were spotted and this calf stayed with Eve for 2 years. Eve's fourth calf was first spotted in June 2005 and during this event, Eve, Dodger, and calves 3 and 4 were spotted together.

Kaiser was first observed in June 1998 and did not give birth until June 2003. This calf was present with Kaiser until the surveys ended in June 2005. Dusty, Sweeper's first calf, was present in Sweeper's first sighting on July 2001 and therefore the DOB is unknown. Sweeper's second calf was first sighted in July 2005 and therefore after until the surveys ended. Dusty stayed with Sweeper from 2001-2006. The first sighting of Flattip was in September 1997 with the second sighting a month later. Flattip was not sighted after this until October 2001 when she was sighted three times over the next four

months. She then disappeared for 6 months and upon her return, her first calf was sighted in August 2002 (Table 1).

Table 1. First sighting of calf with mom, birth range and duration of calf with mom. Birth range is the possible number of days prior to first sighting of calf with mom that the calf could have been born. The time frame under birth range is the number of days between the last sighting of the mom alone and the first sighting of the mom and calf. Duration is the number of years that the calf was sighted with the mom. A * denotes calves that still use the Inlet after dependence from mom and **denotes calf still with mom after surveys ended.

Mom and Calf	First sighting of calf with mom	Birth Range	Duration of calf with mom
Eve			
Slappy	June 9, 1999	18 days	1.4 years
Dodger	May 17, 2001	8 months	2 years*
Calf #3	May 20, 2003	11 days	2 years
Calf #4	June 7, 2005	12 days	1 year*
Marge			
Hadji	June 1, 1999	19 days	4 months
Larsen	May 15, 2002	8 days	3 years*
Calf #3	May 24, 2005	11 days	1 year**
Flattip			
Calf #1	August 22, 2002	6 months	1 year*
Kaiser			
Calf #1	June 28, 2003	2 days	3 years**
Sweeper			
Dusty	July 31, 2001	Unknown	4 years*
Calf #2	July 7, 2005	7 days	1 year**

Discussion

The study conducted by Scott et al. (1990) in Sarasota Bay, Florida determined that females with calves prefer certain geographic areas, most likely because these areas are protected, shallow and offer abundance of prey. Barros and Wells (1998) reached similar conclusions regarding nursery grounds in Sarasota Bay. The shallow seagrass beds in the bay provide pinfish as a food source and protection from predators. Barco et al. (1999) found that female bottlenose dolphins with neonates were sighted more in the Chesapeake Bay than the Atlantic Ocean, indicating that the females showed preference for the

bay. Most neonate sightings occurred near Cape Henry which provides the most protection from waves. A third known nursery ground is located near Beaufort, North Carolina (Barco *et al.*, 1999).

The shallow, tidal creeks and abundance of fish in North Inlet provide adequate habitat and resources for calf rearing. The tidal creeks offer protection from waves and large boats, and the estuary provides an abundance of fish. These characteristics are those present in the nursery grounds of previous studies, and demonstrate that North Inlet has the ideal habitat to act as a nursery ground for bottlenose dolphins. Dolphin populations tend to display greater site and association fidelity when found inshore in waters that are shallow and protected (Gubbins 2002a), similar to the characteristics of a nursery ground. Further investigation could show that greater site fidelity of females and calves found in inshore waters is due to females favoring the area to raise their young.

It is not possible to conclude that moms are sighted with their calves more in any one season or that the percentage of calves that make up the total number of dolphins per event increases between seasons. To further investigate the theory that females use the Inlet as a nursery ground, surveys should be conducted further offshore. Offshore surveys should be conducted in the same time period as those in the Inlet. The number of offshore mom-calf sightings can be compared to the mom-calf sightings in the Inlet. These results can determine if moms utilize both areas and if preference is shown for a certain area. If sightings are higher in the Inlet, this could provide solid evidence that moms use the Inlet to rear calves. If sightings are higher in the Inlet in certain seasons, it could be said that the Inlet is only a nursery ground part of the year. Survey effort should be consistent between all four seasons. This consistency will provide support that number of sightings is different due to movement of mom-calf pairs and not due to survey effort.

Allen *et al.* (2001) described dolphins entering North Carolina estuaries in the spring and leaving when water temperatures got colder in late fall. Mom-calf pairs did not show this pattern in North Inlet.

Consistent survey effort would be needed for supporting evidence, but this finding could demonstrate that moms stay in the Inlet year round because the area is a nursery ground.

Scott et al. (1990) observed more calves in Palma Sola Bay during spring and summer with calving peaking in spring and early summer. This finding is similar to the calving pattern of the females in our study. Marge and Eve gave birth to their calves at the end of May to the beginning of June. Scott et al. (1990) also concluded that there was a secondary calving peak in late summer to early fall. None of the moms in North Inlet gave birth this late, but Kaiser and Sweeper gave birth between these two peaks at the end of June and beginning of July respectively. Flattip, the fifth mom, had a birthing time frame of six months, and therefore, we could not determine what peak her calf was born. Flattip first appeared with her calf at the end of August 2002 which would follow the second calving peak.

The tidal creeks that make up North Inlet provide many bends for dolphins to hide, making it difficult for the group to be spotted by observers. It is possible that females and calves were not observed on certain survey days due to focal follows being used. For future studies, transects could be used to increase the consistency of survey effort per day. However, focal follows allow a group of dolphins to be observed for as long as the group stays in sight. An advantage to this is that information can be collected on how dolphins utilize the inlet; what creeks are most popular, times of day that groups appear in certain locations, and main feeding spots.

Solid conclusions cannot be made without further study, but North Inlet shows evidence of being a nursery ground for bottlenose dolphins. The area is comprised of the same habitat as known nursery grounds in Florida, and females are present year round with their calf. Further studies should focus on 1) mom-calf pairs in offshore surveys and in Winyah Bay and 2) sightings of non-moms in the Inlet. If mom-calf pairs are not sighted offshore or in Winyah Bay, then the moms are showing

preference for the Inlet. If the number of non-moms using the Inlet is approximately the same as the number of mom-calf pairs, it could be a popular residence area for all dolphins.

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