Reducing Conflicts Between Fisheries & Protected Species in North Carolina - Year 2

Final Report

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In this report we describe the results of two research projects funded under this program. Each is described separately below.

A. Documenting interactions between pilot whales and the pelagic longline fishery in the Cape Hatteras Special Research Area

Project Background

Attempts to reduce the frequency of conflicts between pilot whales and longline fishing gear have been hampered by a lack of information regarding the nature and timing of these interactions. In this project, we are using an integrated series of techniques to characterize interactions between pilot whales and the pelagic longline fishery, including observations made directly by fishermen. The Pelagic Longline Take Reduction Team (PLTRT), convened by the National Marine Fisheries Service to address these interactions, identified a series of information needs to better understand this conflict (see http://www.nmfs.noaa.gov/pr/interactions/trt/pl-trt.htm). Our work directly addresses the research priorities identified by the PLTRT.

At the present time we do not understand these interactions sufficiently to formulate effective mitigation strategies. For example, we do not know how pilot whales detect longline gear, exactly how they interact with the gear, or when interactions occur during fishing operations (*e.g.* while the gear is fishing or during setting or haul-back). Therefore, our initial efforts have focused on investigating when interactions occur during the fishing process, so that we will be able to make a preliminary assessment of the efficacy of potential mitigation measures.

Objectives

The primary objective of this project was to characterize the nature and timing of pilot whale interactions with pelagic longline fishing gear by: (1) conducting visual and acoustic monitoring of pilot whales from an independent research vessel in the Cape Hatteras Special Research Area (CHSRA); (2) working directly with longline fishermen to examine interactions using acoustic recording equipment; and (3) facilitating direct data collection by fishermen regarding the timing and frequency of interactions. In addition, we wanted to determine which of the two species of pilot whales (long-finned or short-finned) present in this area interacts with longline gear and to test the applicability of photo-identification techniques to pilot whales, so that we could assess their patterns of residency within the CHSRA and to investigate whether particular individuals consistently interact with pelagic longline gear.

Methods

To prepare for our first phase of field work, we attended a meeting of longline fishermen, NMFS scientists, and managers in Wanchese, NC during June 2006 to learn about pelagic longline fishing operations and to present our research plan. We also received the locations of pilot whale sightings and interactions with longline gear from the NOAA/NMFS/SEFSC Laboratory in Miami so that we could identify areas of pilot whale concentrations within the CHSRA.

In our first phase of field work we contracted the R/V *Stellwagen*, a 70' research vessel operated by Ocean Works Group, Inc., to locate groups of pilot whales within the CHSRA, make acoustic recordings of pilot whales and other species, and collect skin samples and photo-identification images for species identification.

We operated out of Wanchese, NC from September 2 – 7, 2006, conducting visual surveys for marine mammals at a speed of approximately 8 knots. We focused most of our survey efforts inside the CHSRA. During surveys, three observers used Fujinon binoculars and searched the port, starboard and center quadrants from the flying bridge of *Stellwagen*, at an eye height of approximately 23 feet. The center observer also served as data recorder. Six observers worked in 30 minute shifts, rotating through these three positions. We recorded time on effort, any change in sea state or environmental conditions, and the start and ends of survey transect lines. When we observed marine mammals, we broke from the transect line and approached the group for species identification. At each sighting, we recorded the position of the vessel, water depth, group size and activity, and the distance and bearing of the group to our vessel.

When we identified pilot whales (and when sea state conditions allowed) we deployed a 17' Whaler with a Honda 50 hp four-stroke outboard engine to: (1) record the vocalizations of pilot whales; and (2) obtain biopsy samples and photographs of their dorsal fins. We followed the "Photographic and biopsy protocols for pilot whale species identification" developed by Brenda Rone from UMass-Boston and Richard Pace, of NOAA/NMFS/NEFSC and the NOAA/NMFS/SEFSC protocol for biopsy sampling and handling. The acoustics team was deployed first to make recordings and, when an adequate sample of recordings was made, they returned to the *Stellwagen*, to be replaced by the biopsy team. Observers aboard the *Stellwagen* helped direct the Whaler to the pilot whales.

While at dock in Wanchese awaiting good weather conditions, we met with pelagic longline fishermen to discuss deploying acoustic recorders (T-PODs) on their gear. T-PODs detect and record the occurrence of echolocation clicks, but the units must be programmed to record species-specific vocalizations (so that we are detecting only pilot whales and not other odontocetes).
In essence, the T-PODs report the occurrence of sounds exceeding a threshold amplitude within specified frequency ranges. Peak frequency is a critical parameter that allows the T-PODs to correctly identify the target species. To determine the peak frequency of pilot whale echolocation clicks, we recorded pilot whales during our research cruise with a high-frequency digital recorder (see above). From these recordings, we found that the peak frequency of pilot whale echolocation usually occurred between 30-45 kHz. We also evaluated different settings by deploying two T-PODs while we made our high-frequency recordings around pilot whales.

We used the T-PODs to determine when during the fishing process pilot whales interact with longline gear. We provided the units to fishermen who deployed and retrieved them during each set. Fishermen typically deployed a single T-POD at one end of the mainline, although this configuration varied from fishermen to fishermen and from set to set. The longline fishermen in Wanchese make trips that last for several days in which they make multiple sets. We retrieved the T-PODs at the end of each trip and brought them back to the Duke Marine Laboratory in Beaufort to download the data. The longline fishermen also agreed to record information on the deployment of the T-PODs and on the occurrence of pilot whale interactions on data sheets that we provided.

Results

We departed Wanchese on September 3rd, at 08:43, and began observations at 11:55 AM. We returned to Wanchese on September 4th at 19:15, due to deteriorating weather conditions. We waited at port for conditions to improve on September 5 - 6th, but Hurricane Florence passed offshore creating large swells. These conditions would have prevented deployment of the Whaler from the *Stellwagen*, so we decided to postpone our remaining survey effort until the spring.

During our two days of survey effort, we made three sightings of pilot whales within the CHSRA, all in water depths greater than 200m. We also encountered several other species of cetaceans, as well as a number of loggerhead and leatherback turtles (see Appendix 1 and Figures 1 and 2). We were able to approach, record, photograph, and collect skin samples from pilot whales in each of the three encounters. There were no longline vessels working in proximity to us during these two days, so we were not able observe or record whales in association with fishing gear.

Analysis of the acoustic recordings collected from the Whaler allowed us to choose the best settings to detect pilot whale echolocation in the CHSRA. The peak frequency of pilot whale echolocation clicks was 36 kHz. We were also able to double-check our initial T-POD settings and determine how well they worked by comparing the recordings we made with the digital recorder to the T-POD data. We compared the recordings in which we heard echolocation clicks with the record from the same time in the T-PODs to determine whether or not the T-PODs correctly detected the clicks.

We collected six biopsy samples during this initial phase of field work: two samples on September 3rd and four samples on September 4th. Individual pilot whales exhibited a low response to the biopsy sampling. We obtained photographs of all individuals sampled; all six had distinctive dorsal fins. We provided the skin samples to Dr. Patricia Rosel (NMFS/SEFSC) for genetic analysis. All samples were confirmed to be from short-finned pilot whales; five of the whales sampled were males and one was a female (pers. comm., Dr. Patricia Rosel, NMFS/SEFSC Marine Mammal Genetics Laboratory). We took approximately 590 dorsal fin images for photo-identification and identified 15 distinctive pilot whales from excellent and good quality dorsal fin images (see Appendix 2). We submitted these images to Dr. Richard Pace (NMFS/NEFSC) and Dr. Lance Garrison (NMFS/SEFSC) for comparison to photographs of pilot whales taken on NOAA surveys in this area.

Several commercial longline fishermen from Wanchese, NC agreed to deploy T-PODs on their gear. In total, T-PODs were deployed on 25 sets from 7 September through 28 December 2006. Fishermen deployed a single T-POD on most (21) sets, two T-PODs on three sets and three T-PODs on a single set. Table 1 provides a summary of the data collected by the recorders in these sets.

The data from the T-PODs consisted of the time and duration of all echolocation clicks detected, as well as the angle of the unit itself. Thus, we were not only able to tell when pilot whale clicks were detected but also when the recorders were deployed in the water (from their angle). The T-PODs were attached to one of the end buoy drops of the mainline, so we could calculate an approximate soak time for each set by subtracting the time the T-POD was retrieved from the time it was deployed. As most sets were monitored by a single T-POD, these estimates of soak time are negatively biased (a more accurate estimate requires a T-POD on both ends of the mainline). Soak times estimated by this method varied widely from four hours and 20 minutes to almost 24 hours.

There was also considerable variation in the time of day in which sets occurred. Eighteen sets began in the late afternoon and seven were started just before dawn. Total fishing effort varied with time of day (Figure 3). Most gear was in the water from 20:00 in the evening until about 09:00 in the morning and there was little fishing effort from 12:00 to 17:00 (Figure 3). Pilot whales were detected around the gear in the evening, night and early morning. No pilot whales were detected near longline gear from 12:00 until 17:00 (Figure 4).

In total, pilot whale echolocation was detected on all but one set (Table 1). There was considerable variation in the timing of first detection of pilot whale clicks, but whales were often detected very soon after the gear was set. For example, during six sets pilot whales were detected within 10 minutes of the gear being set and in seven sets pilot whales were detected within one hour of deployment.

Depredation was confirmed by fishermen on three of the sets in which we detected pilot whales with T-PODs. During the first set the captain notified us that he had observed pilot whales around his gear and provided us with the heads of two tuna that had been taken by the whales (Figures 5a and 5b). The depredation of the tuna was consistent with that documented by fisheries observers from the NMFS Pacific Islands Fisheries Science Center in Honolulu (D. Johnston, NOAA/NMFS/PIFSC, personal communication). Depredation was also documented in the set with the greatest occurrence of pilot whale echolocation (Set 20). However, during the set with second highest occurrence of echolocation (Set 14) no depredation was documented. Depredation can only be confirmed by the presence of fish remains (such as the head) on the hook. This is a conservative estimate of the frequency of interactions, as incidences of depredation would not be reported if the entire fish was removed.

Preliminary Conclusions

Although the duration of our field work was limited by weather, we successfully tested protocols for sampling pilot whales within the CHSRA, calibrated the T-POD recorders and deployed them on pelagic longline gear. To our knowledge , this is the first time that such acoustic recorders have been deployed on pelagic longline gear to document interactions with odontocete cetaceans. We believe that this very powerful technique will yield significant insight into the timing and nature of interactions between pilot whales and pelagic longlines (and perhaps interactions with other species elsewhere).

From our work to date, we can draw the following preliminary conclusions:

1. Short-finned pilot whales are present in the CHSRA during fall. All six of the animals we sampled were short-finned pilot whales and we assume that this species was interacting with pelagic longline gear within the CHSRA. We will obtain biopsy samples from additional animals during our next cruise to confirm this species identification. We have determined that photo-identification techniques work well with these animals, opening the possibility that we will be able to examine patterns of individual residency and perhaps the frequency with which such animals interact with longline gear.

2. Pilot whales occur frequently in the vicinity of longline gear. Pilot whale echolocation was detected in all but one of the 25 sets that we monitored. At the present time, we do not know at what distance pilot whale echolocation clicks can be detected by the T-PODs, but these high-frequency vocalizations are unlikely to be detectable at any distance. We will estimate this detection distance in our next cruise. It is clear from these preliminary results that pilot whales interact frequently with pelagic longline gear in the CHSRA.

3. Pilot whales frequently depredate big-eye and yellowfin tuna. This behavior leads to significant economic losses to the fishery and to the entanglement, serious injury and mortality of pilot whales. This depredation occurs frequently, although the true rate of occurrence is difficult to estimate. We hope to institute a better system of monitoring the rate of depredation in our future work (see below).

4. Pilot whales interact with pelagic longline gear most frequently in the evening, night-time and early morning. We documented very little pilot whale echolocation in the vicinity of pelagic longlines during the daytime. If pilot whale depredation occurs primarily during the night-time, it may be possible to modify the time in which fishing occurs to reduce the occurrence of this behavior.

Future work

As fishing activity resumes this spring in the CHSRA, we will monitor interactions between pilot whales and pelagic longlines with T-PODs. We will also ask vessel captains to place a second type of acoustic recorder (LARS-HF units) on their longline gear to collect more detailed acoustic data. We plan to provide digital cameras to fishermen deploying the recorders, so that they can document depredation and the identity of pilot whales that interact with their gear.

We are currently planning a ten-day research cruise aboard the R/V *Stellwagen* during the spring of 2007. We will communicate with fishermen so that we can locate pilot whales near active fishing vessels (several captains have agreed to communicate with us in the CHSRA via VHF radio). During this cruise, we will: (1) record the vocalizations of pilot whales in the vicinity of longline gear; (2) conduct standardized behavioral observations of pilot whale groups around longline gear, using focal follow techniques to document their response to the sounds of vessels setting and hauling gear; (3) obtain acoustic recordings of pelagic longline vessels during setting and haul-back for future playback experiments; (4) test the detection range of the T-PODs; and (5) obtain a larger sample of biopsy samples of pilot whales to determine species identity. We will also continue to obtain images of pilot whales within the CHSRA to add to our existing catalog of individual whales.

Publications, reports, and presentations that were supported by this grant:

Read, A. Interactions between pilot whales in the western North Atlantic pelagic longline fishery. Marine Mammal Advisory Committee for the Western Pacific Fishery Management Council, Honolulu, HI. January 2007.

Read, A. Interactions between marine mammals and commercial fisheries. Invited Seminar. Institute of Marine Sciences, University of North Carolina, Morehead City, NC. February 2007.

Waples, D., A Read, K. Urian, L. Williams, and D. Swanner. Depredation by small cetaceans in North Carolina. Symposium on Fisheries Depredation by Killer and Sperm Whales, Pender Island, B.C. October 2-5, 2006.

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Table 1. Summary of pilot whale echolocation occurrence on pelagic longline sets in the Cape Hatteras Special Research Area equipped with T-POD recorders.

Set #	Date Deployed	Moon Phase	Set Time	Soak Time (H:m)	Whales Detected	First Click Detection After T-Pod Deployed (H:m)	Total # of Minutes Clicks Detected (H:m)	Depredation Observed
1	7-Sep-06	Full Moon	Night	5:56	Yes	0:06	0:35	Yes
2	8-Sep-06	Full Moon	Night	4:23	Yes	0:34	0:41	No
3	28-Sep-06	Waxing	Night	8:35	Yes	0:19	4:15	No report
4	29-Sep-06	Waxing	Day	6:20	Yes	0:03	0:31	No report
5	29-Sep-06	Waxing	Night	8:35	Yes	1:57	0:23	No report
6	30-Sep-06	Waxing	Day	5:10	Yes	1:15	1:28	No report
7	1-Oct-06	Waxing	Night	4:42	Yes	1:05	0:08	No report
8	16-Oct-06	Waning	Day	7:24	Yes	0:11	0:02	No report
9	17-Oct-06	Waning	Day	7:55	No	NA	NA	No report
10	19-Oct-06	Waning	Day	6:41	Yes	0:22	0:01	No report
11	20-Oct-06	Waning	Day	6:12	Yes	1:51	0:01	No report
12	26-Nov-06	Waxing	Night	23:48	Yes	3:23	3:38	No
13	27-Nov-06	Waxing	Night	14:28	Yes	0:04	1:52	No
14	28-Nov-06	Waxing	Night	13:21	Yes	0:38	4:16	No
15	30-Nov-06	Waxing	Night	19:58	Yes	19:56	0:02	No
16	2-Dec-06	Waxing	Night	15:54	Yes	8:08	0:26	No
17	3-Dec-06	Waxing	Night	15:51	Yes	0:46	1:52	No
18	5-Dec-06	Full Moon	Night	14:42	Yes	0:42	3:52	No
19	5-Dec-06	Full Moon	Night	16:53	Yes	6:31	0:27	Yes
20	9-Dec-06	Waning	Night	18:55	Yes	2:50	4:44	Yes
21	12-Dec-06	Waning	Day	4:20	Yes	2:00	0:38	No
22	12-Dec-06	Waning	Night	8:31	Yes	5:05	1:01	No
23	16-Dec-06	Waning	Night	15:17	Yes	0:10	0:47	No
24	17-Dec-06	Waning	Night	14:37	Yes	0:02	2:18	No
25	28-Dec-06	Waxing	Night	9:17	Yes	0:10	0:16	No

Figure 1. Tracklines for R/V *Stellwagen* and sighting locations of animals observed on September 3, 2006, during pilot whale surveys in the Cape Hatteras Special Research Area.

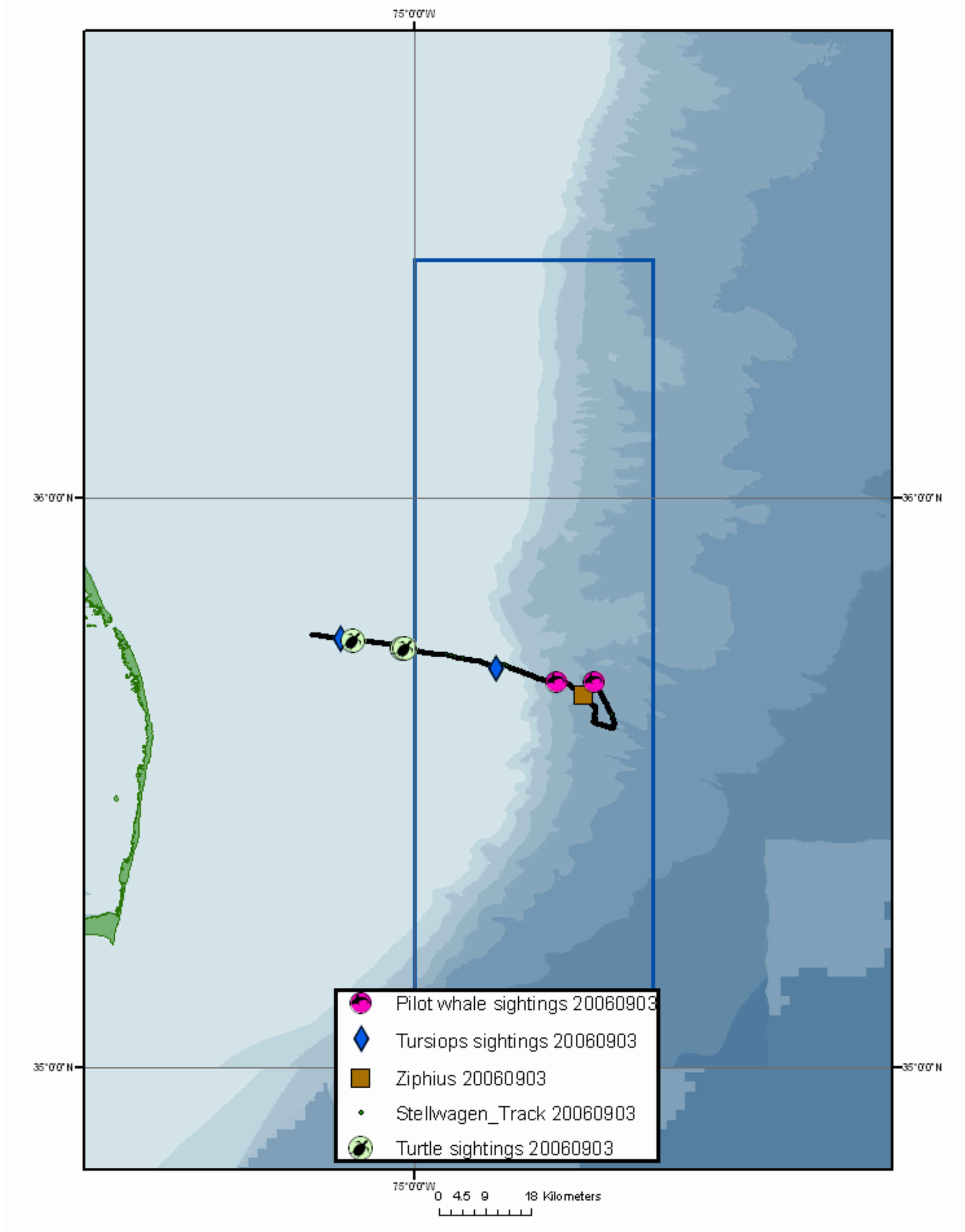


Figure 2. Tracklines for R/V *Stellwagen* and sighting locations of animals observed on September 4, 2006, during pilot whale surveys in the Cape Hatteras Special Research Area.

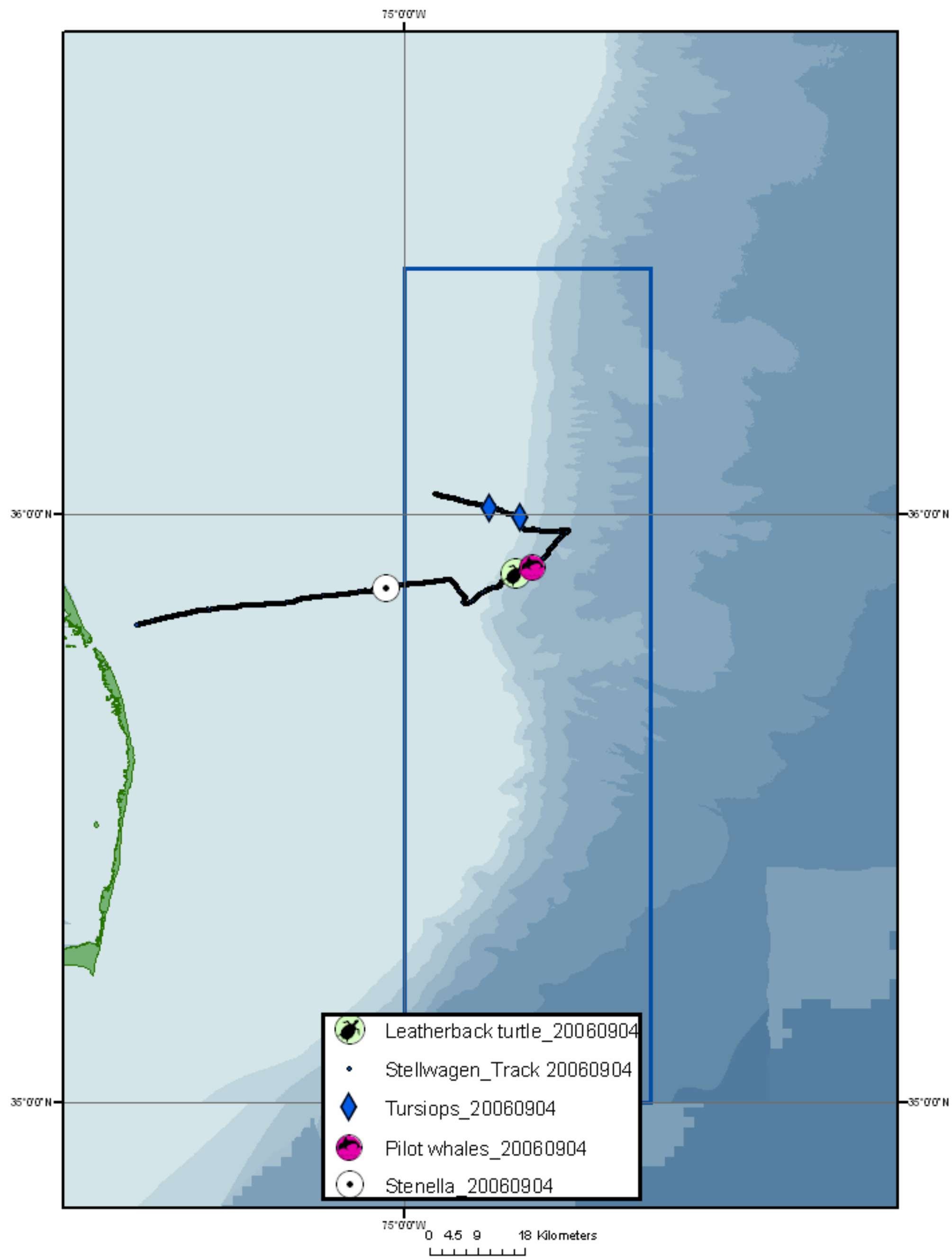


Figure 3. Number of T-POD recorders by hour of day that either detected or did not detect pilot whale echolocation clicks.

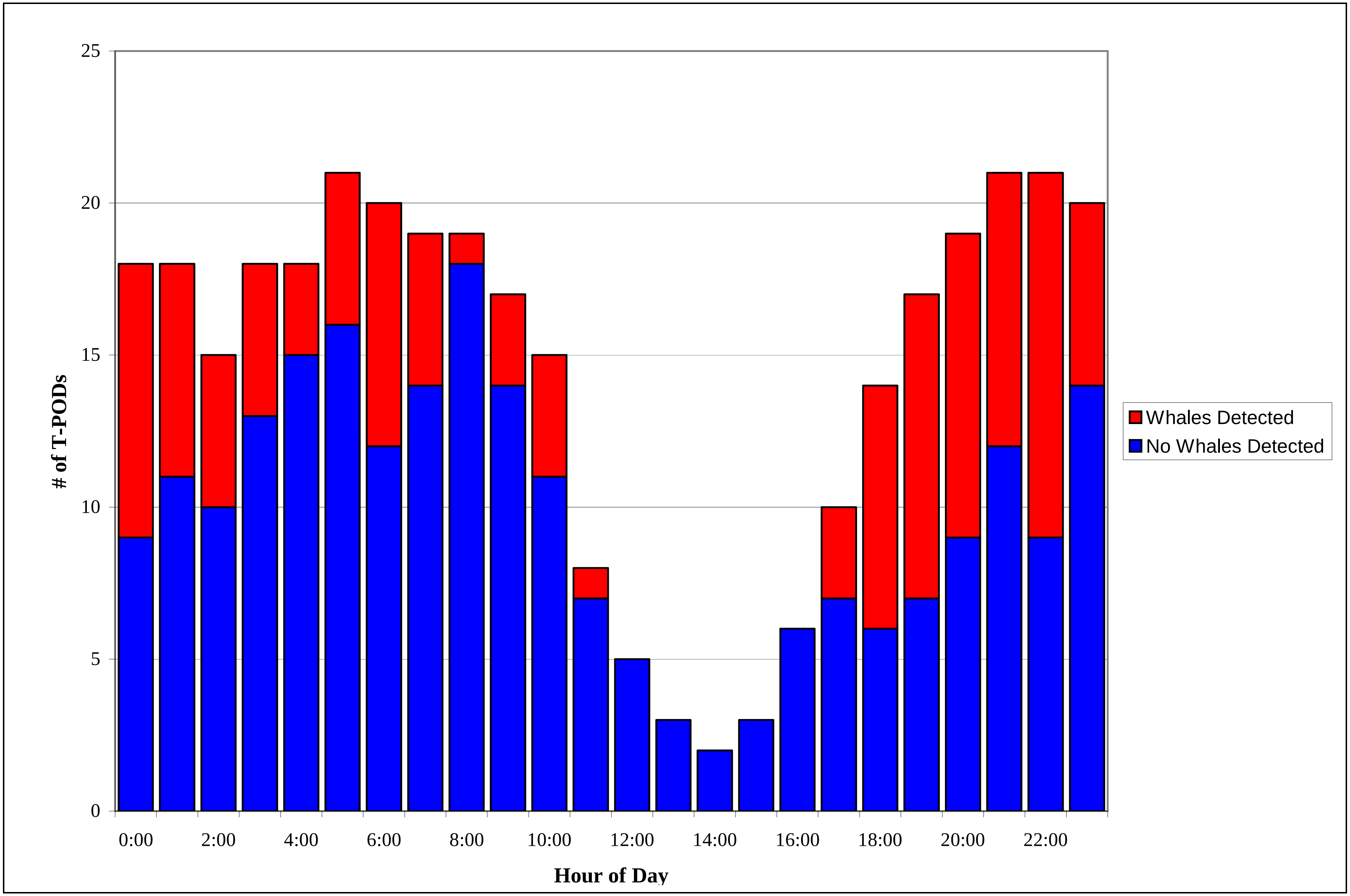
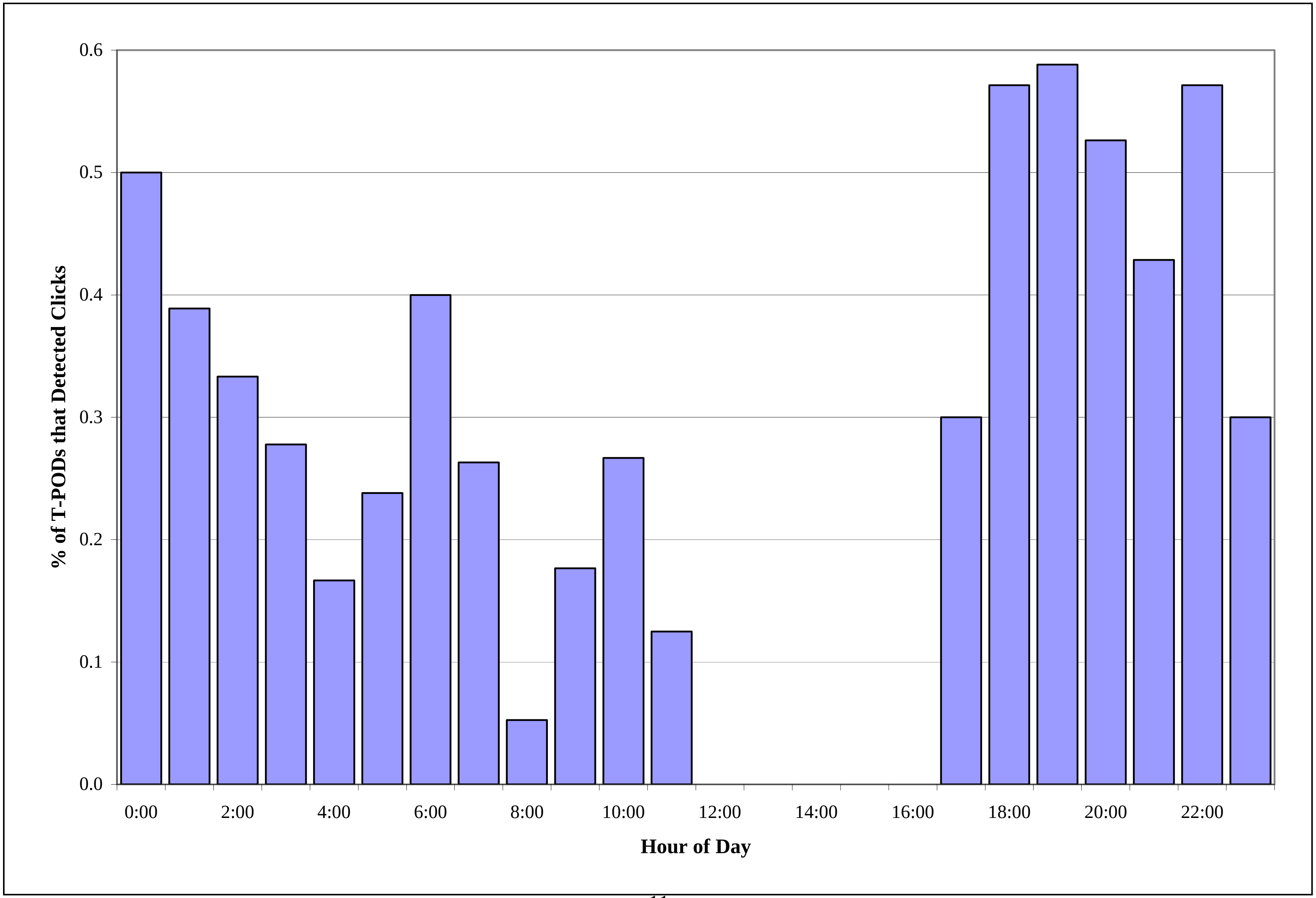


Figure 4. Percent of T-POD recorders by hour of day that detected pilot whale echolocation clicks.



Figures 5a and b. Photographs of tuna heads showing evidence of depredation by pilot whales.

Appendix 1. Sightings of marine mammals and sea turtles during surveys of the Cape Hatteras Special Research Area made during September, 2006.

Date	Species	Group size
9/3/2006	*Tursiops truncatus* (Bottlenose dolphin)	10
9/3/2006	*Caretta caretta* (Loggerhead turtle)	1
9/3/2006	*Caretta caretta* (Loggerhead turtle)	1
9/3/2006	*Caretta caretta* (Loggerhead turtle)	1
9/3/2006	*Caretta caretta* (Loggerhead turtle)	1
9/3/2006	*Tursiops truncatus* (Bottlenose dolphin)	25
9/3/2006	*Globicephala spp* (Pilot whale)	15
9/3/2006	*Ziphius cavirostris* (Cuvier's beaked whale)	2
9/3/2006	*Globicephala spp* (Pilot whale)	15-20
9/3/2006	Unidentified rorqual whale	1
9/4/2006	*Tursiops truncatus* (Bottlenose dolphin)	20
9/4/2006	*Tursiops truncatus* (Bottlenose dolphin)	25
9/4/2006	*Globicephala spp* (Pilot whale)	6
9/4/2006	*Dermochelys coriacea* (Leatherback turtle)	1
9/4/2006	*Stenella frontalis* (Spotted dolphin)	150
9/4/2006	*Caretta caretta* (Loggerhead turtle)	1

Appendix 2. Pilot whale Photo-ID Catalog.

3-001_2006-09-04-LGT_086

6-001_2006-09-04-LGT_046

6-002_2006-09-04-KU_245

7-001_2006-09-04-LGT_108

7-002_2006-09-04-KU_219

7-003_2006-09-04-KU_240

Appendix 2. Pilot whale Photo-ID Catalog.

7-004_2006-09-04-KU_295

7-005_2006-09-04-KU_215

7-006_2006-09-04-KU_194

7-007_2006-09-03_091

8-001_2006-09-03-KU_019

9-001_2006-09-03_091

Appendix 2. Pilot whale Photo-ID Catalog.

9-002_2006-09-04-LGT_004

9-003_2006-09-04-LGT_115

9-004_2006-09-04-LGT_093

B. Identification of stranded bottlenose dolphins in North Carolina

Project Background

Along the Mid-Atlantic States, strandings of bottlenose dolphins are used to monitor fisheries-related mortality, in addition to traditional at-sea observer programs (Waring *et al.* 2007). Stranded dolphins are assessed for evidence of fisheries-based mortality and samples collected from these individuals can yield significant information on the life history and stock identity of individual animals prior to death. However, the origin of an individual dolphin prior to the standing event is rarely known, limiting the inferences that can be drawn from post-mortem examination. Nevertheless, it is possible to compare images of the dorsal fins of stranded dolphins to existing photo-ID images to determine the identity of these individuals (see, for example, Enhanced evaluation of human interactions with bottlenose dolphins (*Tursiops truncatus*) in North Carolina and Virginia: Identification of stranded bottlenose dolphins in North Carolina and Virginia. Report to the John H. Prescott Marine Mammal Rescue Assistance Grant Program, 30 April 2005). We were interested, therefore, in determining the identity of stranded dolphins in North Carolina, particularly those individuals killed as a result of entanglement in coastal gill net fisheries, and assessing their ranging patterns prior to stranding to determine where and when they may have interacted with fishing gear.

Objectives

The objective of this project was to improve our understanding of interactions between bottlenose dolphins (*Tursiops truncatus*) and fisheries in North Carolina. As noted above, information on ranging patterns and reproductive histories of individual dolphins with extensive photo-ID histories greatly enhances our interpretation of life history and genetic data collected post-mortem. Knowledge of the movement patterns of dolphins with known sighting histories, in combination with genetics data, can be used to identify boundaries and stock units. Genetic analyses of samples from stranded dolphins with sighting histories are much more powerful than those of samples taken from dolphins of unknown origin (currently the typical situation). Such 'matched samples' are particularly useful in identifying exposure to anthropogenic causes of death. The identification of stranded dolphins with evidence of fishery interactions, and for which a sighting history is available, may provide important information on the areas in which entanglement is likely to occur. This information could assist in directing observer coverage to particular areas and in monitoring the efficacy of the Bottlenose Dolphin Take Reduction Plan.

Methods

We compared images of the dorsal fins of stranded dolphins from stranding response efforts in North Carolina with the Mid-Atlantic Bottlenose Dolphin Catalog (MABDC). This catalog is a cooperative program, comprised of images and data contributed by researchers conducting independent photo-ID studies from New Jersey to Florida. The catalog includes approximately 4,000 dolphins with images dating back to 1979. We obtained images of the dorsal fins of stranded bottlenose dolphins from the University of North Carolina Wilmington and the NOAA/NMFS/SEFSC Beaufort Laboratory.

The University of North Carolina Wilmington Marine Mammal Stranding Program (UNCW) responds to strandings from the NC/SC border to the New River, NC. The NMFS Beaufort Lab Marine Mammal Stranding Network responds to strandings from the New River north to the Virginia border. Both institutions submitted images of stranded dolphins to Kim Urian, curator of the MABDC, although because of logistical difficulties, the NMFS Laboratory did not begin to submit images until August 2006.

Each dorsal fin image was evaluated for quality and dorsal fin distinctiveness (Urian *et al.* 1999). The image quality score was based on a weighted scale that incorporated the following characteristics: focus and clarity, contrast, angle of the fin to the photographer and visibility of the fin. Any image at an oblique angle or that did not show the entire trailing edge of the dorsal fin from the tip to the posterior insertion was excluded from further analysis. Excellent quality images received an overall score of 1; good quality images were scored 2; and poor quality images scored 3. The distinctiveness of marks on each dolphin's dorsal fin was evaluated using the patterns of nicks and notches on the fin. Dolphins with the most distinctive features (evident in even a poor quality photograph) were scored 1; those with intermediate features (at least 2 distinguishing features or 1 major feature) were scored 2; and animals with few or no distinctive characteristics were considered unmarked and received a score of 3.

In some cases, the distinctiveness of the dorsal fin could not be evaluated, because of severe decomposition, or because it was difficult to determine if the trauma to the dorsal fin occurred post-mortem. Only excellent and good quality images that received dorsal fin distinctiveness scores of D-1 and D-2 were used for our analysis. We then established a database with associated information for each stranded dolphin for which a usable image was available. The database included the following Level A data (Hoffman 1991):

1. Field number
2. Contributor
3. Date of recovery
4. Location (Latitude and Longitude) of the stranding event
5. Sex
6. Total length
7. Smithsonian Institution's condition code
8. Human interaction/Fishery interaction
9. Quality of the dorsal fin image
10. Distinctiveness of the dorsal fin
11. Submission date
12. MABDC Match number

We then compared each dorsal fin image that met our image quality and distinctiveness criteria with the MABDC. The digital images of dorsal fins in the MABDC are organized in separate catalogs for each field site. All images in the MABDC have been processed for use with Finscan© (Hillman *et al.* 2003), a computer-assisted matching system. To facilitate matching, each image of a stranded dolphin was processed in this manner. For this study, comparisons were made only to the regional catalogs that range from Cape May, NJ to Charleston, SC (Table 1).

The curator of the MABDC conducted all preliminary matching to ensure quality control and consistency. Potential matches made by the curator were then circulated to the relevant contributors for verification. To confirm a match, consensus among the contributors and the curator was required. When a potential match was verified, the curator requested the photo-ID sighting history (dates and locations) for that dolphin from each contributor.

Results

We received a total of 13 dorsal fin images of stranded dolphins from NC from April 2006-March 2007 (see Table 2). One dorsal fin image could not be evaluated for distinctiveness because of decomposition of the carcass or because it was not possible to determine whether trauma to the dorsal fin had occurred post-mortem. We did not receive images from a large number of other strandings because the stranded dolphins were unmarked neonates (total body length less than or equal to 124cm, Thayer *et al.* 2003).

Images of seven of the 13 stranded dolphins met our criteria for quality and distinctiveness and were compared to the MABDC. To systematically compare each of the stranded dolphins to the subset of images from the MABDC, we made 34,860 pair-wise comparisons.

Many images submitted for evaluation and comparison to the MABDC were of fresh carcasses (condition codes 1 and 2), and of larger, and presumably older, dolphins (see Table 3). Mature dolphins have had longer periods to acquire the nicks and notches used for identification.

One of the seven dolphins was matched to the MABDC (Table 3). BRF 061 was a confirmed matched to NJ-KR_7-001, a dolphin photographed by Keith Rittmaster (NC Maritime Museum) in the coastal waters off of Wildwood, NJ on 8 September 2002, during a health assessment and tagging project conducted by the NMFS Beaufort Lab. BRF 061 stranded near Nags Head, NC on 5 April 2006 (see Figure 1); this mature male had no signs of fishery interaction.

Conclusions

Matching the dorsal fins of stranded dolphins to regional catalogs is time and labor-intensive. Nevertheless, this approach can yield a significant amount of information about stock boundaries, life history, and exposure to anthropogenic causes of death, particularly in areas where there is uncertainty about ranging patterns and stock structure (McLellan *et al.* 2002). Examination of ranging patterns of stranded dolphins prior to death can yield significant insight into exposure to potential threats. An examination of these ranges, overlaid with potential sources of mortality, such as the distribution of fishing effort or environmental contaminants, would be a useful application of these data.

Unfortunately, none of the dolphins that we identified from stranding records exhibited evidence of human interaction that contributed to the animal's death, so we were not able to assess 'hot spots' of entanglement in this report. There has been a significant decline in coastal gillnet fisheries in North Carolina during the last few years, and the total number of stranded bottlenose dolphins has also declined. The Bottlenose Dolphin Take Reduction Plan was implemented in 2005. This Plan, together with the closing of the spiny dogfish gill net fishery, has significantly reduced the number of dolphins killed in coastal fisheries over the past few years.

Many regional stranding networks still do not systematically submit dorsal fin images to the MABDC for comparison, or simply do not take dorsal fin images of stranded animals. Prior to this study, we instituted a protocol to standardize methods among stranding programs for taking images of the dorsal fins of stranded bottlenose dolphins and for circulating these images and relevant data to the MABDC curator (see Appendix 1). We believe that further standardization and training within the regional Stranding Program will increase the number of images available for analysis and, thus, the information available from these animals. This approach requires an exchange of information between the stranding networks and photo-ID researchers. Providing information on the date and location of the 'terminal sighting' is invaluable to photo-ID researchers. The information feedback loop moves in both directions, however, and life history information, such as size and reproductive history, collected from stranded dolphins at post-mortem can be extraordinarily useful to the researchers who studied them in the field.

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Table 1. Photographic components of the Mid-Atlantic Bottlenose Dolphin Catalog compared to dorsal fin images of stranded bottlenose dolphins recovered by the UNCW and VAqSP Stranding Programs.

Field site	Catalog size	Period	Contributor	Affiliation
Cape May, NJ	32	1991-1996	R. Mallon-Day (NJ-RMD)	Cape May Dolphin Survey
Cape May, NJ	38	Sep-2002	K. Rittmaster (NJ-KR)	NC Maritime Museum
Wallops Island, VA	21	1997-1998	D. Schofield (VA-MSC)	Marine Science Consortium
Virginia Beach, VA	303	1989-1998	S. Barco (VA-SB)	Virginia Aquarium and Marine Science Center
Roanoke Sound, NC	138	1997-1998	R. Mallon-Day (NC-RMD)	Nags Head Dolphin Watch
Hatteras, Pamlico Sound, & Beaufort, NC	856	1998-2003	A. Read (NC-DUML)	Duke University Marine Laboratory
Beaufort, NC	1788	1985-2002	K. Rittmaster (NC-NCMM)	NC Maritime Museum
Wilmington, NC	502	1991-2002	L. Sayigh/G. Rountree (NC-UNCW)	UNC-Wilmington
Murrell's Inlet, SC	85	1997-1999	R. Young (SC-RY)	Coastal Carolina University
Charleston, SC	767	1994-2003	E. Zolman/ T.Speakman (SC-NOS)	NOS-Charleston Lab

Table 2. Summary of stranding records evaluated to compare to the MABDC.

	UNCW	NMFS
Dorsal fin images	**6**	**7**
Q-3: Poor quality images	0	0
D-Unknown	0	1
D-3: Not distinctive (Neonates)	1	4
D=1+2	**5**	**2**
Number of matches to MABDC	**1**	**0**

Table 3. Summary of stranding records with dorsal fin images and matches made to the MABDC.

Field Number	Stranding date	Stranding location	Sex	Code	Length (cm)	HI	Contributor	Matched to:
BRF 061	05-Apr-06	Nags Head, NC	M	2	275.0	No	UNCW/NMFS	NJ-KR_7-001;08-Sep-02
CALO 0606	13-Apr-06	Cape Lookout Bight	F	3	286.0	CBD	NCMM	No match
BRF 090	26-Aug-06	Bodie Island, NC	M	3	182.0	No	UNCW/NMFS	No match
PBC 001	26-Aug-06	Oak Island, NC	CBD	3	252.0	No	UNCW	No match
WAM 627	05-Oct-06	Cape Fear, NC	F	2	194.0	Yes	UNCW	No match
BRF 095	05-Oct-06	Buxton, NC	M	4	206.0	CBD	NMFS	No match
BRF 098	11-Oct-06	Sanderling, NC	F	1	245.0	No	NMFS	No match
WAM 628	13-Oct-06	Oak Island, NC	F	1	246.0	No	UNCW	No match
WAM 629	17-Oct-06	Topsail Beach, NC	F	2	258.0	No	UNCW	No match
BRF 099	24-Oct-06	Salvo, NC	M	3	223.0	Yes	NMFS	No match
BRF 100	29-Oct-06	Ocracoke, NC	F	3	196.0	CBD	NMFS	No match
AMG 009	31-Oct-06	Sandy Point, NC	M	3	205.5	No	NMFS	No match
ESG 001	31-Oct-06	Atlantic Beach, NC	M	2	203.0	Yes	NMFS	No match

Figure 1. Sighting and stranding locations of BRF 061, photographed near Wildwood, NJ in September 2002 and stranded in April 2006 near Nags Head, NC. Dorsal fin image of BRF 061 courtesy of the UNCW Marine Mammal Stranding Program.

Appendix 1.

PROTOCOL
Circulating images of the dorsal fins of stranded dolphins

At the stranding event:

- Take full-frame images of the left and right side of the dorsal fin, with a board as a background.
- Avoid shadows that could obscure features, particularly on the trailing edge of the fin (it may help to hold the board flush to the fin).
- The **entire** leading and trailing edges should be clearly visible, from the anterior to posterior insertions.
- The **Field #** and **Date** should be written legibly on a dry erase board or placard and displayed in the image, preferably below the fin. Be careful not to obscure the leading or trailing edges of the fin.
- Review digital images before leaving the stranding site.

In the lab:

- Download digital images and file them in a folder for that Field #. Individual image files can be renamed using the "Batch Rename" feature to include the Field # and Date. Images can then be labeled by feature, e.g. dorsal fin, lung, etc.

- Back up images for each stranding event to a CD.

- Once the images are downloaded and labeled, *immediately* send an e-mail message to Kim Urian (kurian@ec.rr.com) that includes:
  Field #
  Stranding date
  Gender
  Length
  Location and Lat/Long
  Condition code
  Dorsal fin images as attachments

  (*regardless of distinctiveness*), for comparison with the Central Catalog. Kim will assign an Image Quality and Distinctiveness score to each fin. Fins with Distinctiveness scores of 1 or 2 (very distinctive or average markings) will be processed in Finscan and compared to the Central Catalog.

- If a match is found, the catalog contributors and stranding program will be notified immediately, and a sighting history and map of sighting locations will be circulated to the stranding program and catalog contributors. The catalog contributors may request additional information on the stranding from the stranding program.

- If no match is found to the catalog, then the dorsal fin image will be circulated to the regional contributors for them to search for potential matches to their recent field dorsal fin images.

Dorsal fin photo – "Do's"

Dorsal fin photo – "Don'ts"