Seasonal Variation of Occurrence, Distribution, and Density of Bottlenose Dolphins in the Southern Chesapeake Bay and Virginia Coastline

A. Engelhaupt[1], J.M. Aschettino[2], T.A. Jefferson[3], D. Engelhaupt[2], J.T. Bell[4], and A. Kumar[5]

1-Amy Engelhaupt Consulting | 2-HDR Inc. | 3-Clymene Enterprises | 4-Naval Facilities Engineering Command, Atlantic | 5-Naval Facilities Engineering and Expeditionary Warfare Center

Abstract

A combination of visual line-transect survey and photo-identification methods is being used to gather baseline information on the occurrence, distribution, and density of marine mammals near areas of substantial U.S. Navy activity in Virginia. Sixty-one line-transect surveys were completed in two zones (INSHORE and MINEX) between August 2012 and August 2015, with 5,106 km and 276.5 hours completed on-effort. The majority of sightings were of common bottlenose dolphins (*Tursiops truncatus*), although humpback whales (*Megaptera novaeangliae*), short-beaked common dolphins (*Delphinus delphis*), and harbor porpoises (*Phocoena phocoena*) were also sighted. Conventional line-transect analysis of bottlenose dolphin sightings showed both spatial and seasonal variation in density (D) and abundance (N), with greatest abundance in the MINEX zone during fall months, followed closely by the INSHORE zone during fall months. Densities in the INSHORE zone were calculated as 3.88 individuals per km^2 (abundance [*N*] =1,203) in fall, 0.63 (*N*=195) in winter, 1.00 (*N*=311) in spring, and 3.55 (*N*=1,101) in summer. Densities in the MINEX zone were calculated as 2.14 individuals per km^2 (*N*=1,277) in fall, 0.06 (*N*=37) in winter, 1.53 (N=913) in spring, and 1.39 (*N*=829) in summer. Twenty-seven photo-ID surveys were completed, and a catalog was created using photos taken during both dedicated photo-ID and line-transect surveys. Approximately 500 unique individuals were added to the catalog from the first year of survey efforts. Re-sighting rates across surveys were low, indicating an open population, with short-term visits to the area. Most re-sightings were less than 3 months and 23 km apart, and between-year re-sightings showed seasonal occurrence in the study area–with animals not sighted for the majority of the year then returning the following year in the same season. Further analyses are needed to better define the distribution patterns of the dolphins utilizing the area, and the extent of overlap with bottlenose dolphin stocks along the coast.

Introduction

Bottlenose dolphins (*Tursiops truncatus*) are common in Chesapeake Bay and in waters off the Virginia coastline. These individuals are part of both the Western North Atlantic Southern Migratory Coastal Stock of bottlenose dolphins, which ranges in distribution in summer from Cape Lookout, North Carolina, to central Virginia; and the Western North Atlantic Northern Migratory Coastal Stock, which ranges from the Chesapeake Bay mouth to Long Island, New York, in the summer (Waring et al. 2014).

Previous work has investigated metrics to estimate bottlenose dolphin abundance in this region, however, the seasonal fluctuation in abundance estimated in parts of this area of overlap between stocks is not thoroughly understood.

In addition to extensive commercial shipping traffic, the waters off the Virginia coast are heavily utilized by the U.S. Navy due to the proximity of the world's largest naval base (Naval Station Norfolk [NSN]), as well as Joint Expeditionary Base Little Creek-Fort Story (JEB-LC-FS), all located adjacent to Chesapeake Bay, and the Virginia Capes operating area Mine Neutralization Exercise (MINEX) training range (W-50).

Methods

Visual surveys were completed from August 2012 to August 2015. The main objective was to provide quantitative data and information on the seasonal occurrence, distribution, and density of marine mammals. Two survey techniques were employed:

1. Monthly systematic line-transect surveys to determine distribution and density/abundance of marine mammals in the vicinity of NSN, JEB-LC, JEB-FS, and the MINEX W-50 area.
2. Monthly photo-identification (photo-ID) surveys to determine the site fidelity and distributional patterns of marine mammals utilizing the areas listed above.

Survey Area - Prior to initial surveys in 2012, two primary survey zones based on areas of naval activity were established (Engelhaupt et al. 2015). Following supplementary information including results from this study, the offshore zone was adjusted in March 2014 to optimize coverage. The amended zones are shown in **Figure 1**:

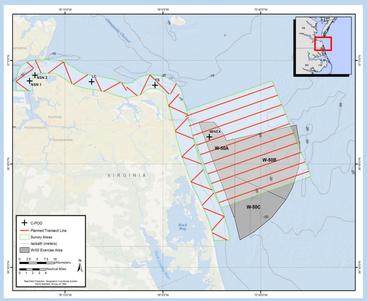

Figure 1. Study area showing transect lines for COASTAL/INSHORE and OFFSHORE/MINEX zones.

COASTAL/INSHORE – a 310.4 km^2 area covering a strip extending from shore out to 3.7 km. The zone includes the Chesapeake Bay waters near NSN, extends past JEB-LC and JEB-FS, and extends down the Atlantic coast towards the Virginia/North Carolina border.

OFFSHORE/MINEX – a 596.6 km^2 area covering Atlantic waters from 3.7 km to 25.7 from shore. The zone includes nearly the entire VACAPES MINEX W-50a and W-50b training areas.

Line-Transect Surveys – Monthly line transect surveys were conducted aboard charter vessels with an elevated platform and unobstructed view. Standard line-transect protocol was followed by a three-observer team using hand held 7x50 binoculars. Effort and sighting data were collected using specialized software. Priority was given to complete the transect lines for either the INSHORE or MINEX zone on-effort, and breaking off the lines to collect photos when time and conditions allowed.

Conventional line-transect methods (also known as Conventional Distance Sampling or CDS) were used to analyze the survey data (Buckland et al. 2001). Due to sample size limitations, data were pooled from all strata to produce a single detection function, f(0). The seasons were defined as spring (March–May), summer (June–August), fall (September–November), and winter (December–February).

Photo-ID surveys – Monthly photo-ID surveys were conducted from a small center-console charter vessel, covering areas with high likelihood of dolphin sightings. Photographs were taken during all sightings when possible using a Canon 7D digital camera with 100 to 400-mm zoom lens. Observers adjusted the amount of time spent with each group as necessary to obtain photographs of as many individuals within the group as possible, while allowing additional survey time to encounter other groups.

Line-Transect Results

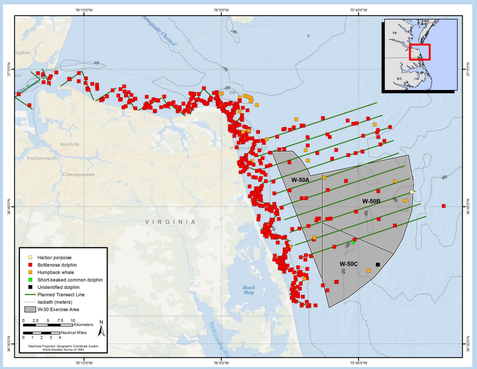

Figure 2. Marine mammal sighting locations for all line-transect surveys.

A total of 33 INSHORE and 28 MINEX surveys were completed between August 2012 and August 2015.

Total on-effort distance was 5,876 km and time was 18,894 minutes.
- INSHORE zone - 3,530 km/11,253 min
- MINEX zone - 2,146 km/7,641 min

482 groups of bottlenose dolphins were sighted.
- INSHORE zone – 417 groups
- MINEX zone – 65 groups

Estimated group size ranged from 1-290.

Seasonal Density Estimate Results

The detection function was modeled using the hazard rate key function, with a cosine adjustment. The calculated value of f(0) was 6.4689 (CV=11.2%), and the effective strip width (1/f(0)) was 155 meters. **Table 1** shows the values used for calculations following truncation. The season with the highest density for each zone is highlighted in white.

Table 1. Line-transect parameters and estimates of density and abundance for bottlenose dolphins in different zones and seasons.

Zone	Season	No. Stgs.*	Effort (km)	Avg. Grp. Size	Stg. Rate§	Density#	Abundance	% CV†
INSHORE	Fall	142	989	8.3	0.144	3.88	1,203	25
INSHORE	Winter	15	792	10.3	0.019	0.63	195	63
INSHORE	Spring	48	1001	6.4	0.048	1.00	311	32
INSHORE	Summer	97	748	8.5	0.130	3.55	1,101	22
MINEX	Fall	12	658	17.7	0.018	2.14	1,277	91
MINEX	Winter	1	471	9.0	0.002	0.06	37	124
MINEX	Spring	22	507	10.9	0.043	1.53	913	38
MINEX	Summer	13	842	13.3	0.015	1.39	829	69

*After truncation; § Individuals per linear km; # Individuals per km^2; † Coefficient of Variation

Photo-ID Results

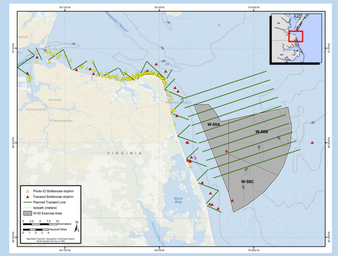

Figure 3. Bottlenose dolphin group sighting locations used in photo-ID catalog.

27 Surveys completed August 2012 – August 2015.

190 groups of bottlenose dolphins sighted.

ID photos collected from 180 groups.

Catalog contains 606 individuals to date (August 2012 – October 2013).

86 matches
- 18 same day re-sightings
- 57 within-year re-sightings
- 11 between-year re-sightings
  - maximum distance between group locations 22.6km (shown in **Figure 4**)

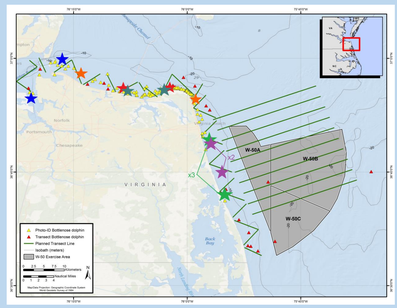

Figure 4. Sighting locations for between-year re-sighted individuals. Each color of star represents an individual dolphin

Discussion

Bottlenose dolphins are common in the study area, with densities fluctuating seasonally. The highest densities are found in the coastal waters in summer and fall. All dolphins, however, do not completely move out of these waters in other seasons, with individuals still present in winter and spring months. Densities in offshore waters of the MINEX zone are generally lower than in the coastal strip, although in some seasons small sample sizes precluded obtaining highly precise estimates. Current indications suggest that density in the MINEX area in fall is reasonably high (D = 2.14 individuals per km^2), and that over 2,400 bottlenose dolphins likely inhabit the entire study area in fall months.

Though photo-ID cataloging efforts are not yet complete, early results indicate a very open population, with short-term visits to specific areas (as shown in **figure 4**). Dolphins that were re-sighted were in close proximity (within 23 km) to their original sighting locations, and in most cases these re-sights occurred within a couple months of each other. Between-year re-sightings show emerging support of a pattern of seasonal fidelity of dolphins migrating through the area. Further analysis will search for support of the described movement of individuals from south to north in the spring and north to south in the fall (Waring et al. 2014). Collaboration, channeled through the Mid-Atlantic Bottlenose Dolphin Catalog (MABDC), will also further this effort. To date, four individuals from the Virginia catalog have been matched to known individuals in North Carolina and further comparisons are planned.

Acknowledgements

We would like to thank NAVFAC Atlantic and HDR for technical support, project management, and contractual support as well as U.S. Fleet Forces Command for funding this project under the U.S. Navy's Marine Species Monitoring Program. We also want to thank observers from HDR, the Virginia Aquarium Stranding Response Team, REMSA, Inc., East Coast Observers, and Todd Pusser for being a part of our observing team. Thanks also to Kim Urian of Duke University and MABDC contributors. These data were obtained under NMFS Permits No. 14451 issued to Joseph R. Mobley, Jr. and No. 16239 issued to Dan Engelhaupt.

Literature Cited

Buckland, S.T., Anderson, D.R., Burnham K.P., Laake, J.L., Borchers, D.L. and Thomas, L. (2001) Introduction to Distance Sampling. Oxford University Press, Oxford, U.K. 432 pp.

Engelhaupt, A., J. Aschettino, T.A. Jefferson, M. Richlen, and D. Engelhaupt. 2015. *Occurrence, Distribution, and Density of Marine Mammals Near Naval Station Norfolk & Virginia Beach, VA: Annual Progress Report. Final Report.* Prepared for U.S. Fleet Forces Command. Submitted to Naval Facilities Engineering Command Atlantic, Norfolk, Virginia, under Contract No. N62470-10-3011, Task Orders 031 and 043, issued to HDR Inc., Virginia Beach, Virginia. 07 August 2015.

Waring, G.T., Josephson, E., Maze-Foley, K., and Rosel, P.E., eds. (2014) U.S. Atlantic and Gulf of Mexico marine mammal stock assessments -- 2013. In: NOAA Technical Memorandum NMFS-NE-228. 471 pp.

Corresponding Author: amyengelhaupt@gmail.com