Humpback whale affinity for shipping channels near the mouth of the Chesapeake Bay can be lethal

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Abstract

The waters at the mouth of the Chesapeake Bay along the mid-Atlantic east coast of the U.S. are heavily utilized by the U.S. Navy and commercial vessels, providing opportunities for interactions between ships and humpback whales (*Megaptera novaeangliae*) that frequent the area in winter months. In 2015, the U.S. Navy initiated a multi-year satellite-monitored tagging study as a means to better understand how humpback whales utilize these waters, with a focus on the U.S. Navy training area, "W-50," and commercial shipping channels. From December 2015 to February 2017 thirty-two Wildlife Computers LIMPET-configured SPOT6 location-only tags and three LIMPET-F depth-recording FastLoc GPS tags were deployed on humpback whales near the mouth of the Chesapeake Bay. Tags transmitted 2.7—43.8 days (mean=13.9). Whale locations were overlaid onto shipping channels and W-50 area to determine presence/absence within. Results indicate that nearly all whales were located within or in close proximity to the shipping channels at some point during tag deployment. Approximately 25% of all filtered locations occurred within shipping channels and 8% of filtered locations were located within the W-50. In addition, nine of 107 humpback whales catalogued during this study (8.4%) had evidence of propeller strikes, one of which was a deceased whale previously tagged with locations within and near the shipping channels. In April 2017 NOAA declared an unusual mortality event (UME) for humpback whales along the Atlantic east coast from Maine to North Carolina due to a larger-than-normal number of deaths that occurred in this area (n=42) from 2016-2017. Ten of the twenty whales examined had evidence of injuries sustained from vessel strikes. Findings to date from this study suggest a substantial number of humpback whales frequent high-traffic areas near the mouth of the Chesapeake Bay and these interactions may be a contributing factor to an increase in fatalities in this region.

Acknowledgements

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Introduction

- Humpback whales of the West Indies distinct population segment (Bettridge et al. 2015) migrate from six northern feeding grounds in the Gulf of Maine, the Gulf of St. Lawrence, Newfoundland/Labrador, western Greenland, Iceland, and Norway to Caribbean Sea waters during the winter months (Katona and Beard 1990, Palsbøll et al. 1997).
- Some whales do not take part in this migration and use the Mid-Atlantic region to over-winter (Barco et al. 2002).
- Norfolk, Virginia, is home to the world's largest U.S. Navy base, and is also ranked the 6th busiest container port in the U.S (**Figure 1**).
- Above factors, combined with the presence of recreational and fishing vessels, result in a constant and often heavy flow of vessel traffic through the mouth of the Chesapeake Bay and adjacent areas.
- The North Atlantic Right Whale (*Eubalaena glacialis*) (NARW) Seasonal Management Area (SMA) encompasses a section of the habitat surrounding the mouth of the Chesapeake Bay (**Figure 2**). The NARW SMA imposes a 10 knot speed restriction from November – April, however speed restrictions are not enforced outside of this area.
- **Understanding the occurrence and behavior of humpback whales in this region is important in mitigating potentially harmful impacts on the species.**

Figure 1. Satellite-tagged humpback whale surfaces alongside a container ship in shipping channels outside the mouth of the Chesapeake Bay, in Virginia Beach, Virginia (United States).

Primary objectives include the following:

- *Collect baseline **occurrence data** (location, group size, behavior) of humpback whales (and other species of baleen whales opportunistically) in the nearshore waters of Virginia Beach.*
- *Obtain **identification photographs** of humpback whales for inclusion in local and regional catalogs.*
- *Collect **biopsy samples** of humpback whales for sex determination, mitochondrial control region sequencing and microsatellite genotyping of tissue samples, and stable isotope analysis to assess foraging related to prey consumption.*
- *Conduct **satellite tagging** to document seasonal humpback whale movement patterns in the nearshore waters off Virginia Beach, specifically whether the whales spend significant time in areas of high shipping traffic and/or areas of U.S. Navy training exercises.*

Figure 3. Nearshore survey vessel, *Whale Research*. Photo © Brian Lockwood.

Figure 4. Wildlife Computers SPOT-6 satellite tag deployed on humpback whale.

Methods

- Small vessel (8.2-meter [**Figure 3**]) surveys were completed during three field seasons from 2015-2017.
- Surveys focused on photo-identification, biopsy sampling, focal-follows, and satellite tagging.
- Survey area: Nearshore (less than 20 nm) waters off Virginia Beach, Virginia including the Mine Neutralization Exercise (MINEX) training range (W-50) and shipping channels (shown in **Figure 2**).

Satellite tagging:

- Wildlife Computers (Redmond, Washington) Smart Position and Temperature (SPOT-6) Argos satellite-linked tags in the Low Impact Minimally Percutaneous External-electronics Transmitter (LIMPET) configuration (Andrews et al. 2008) (**Figure 4**) utilized.
- LIMPET-F Fastloc® GPS tags were also tested in 2017.
- The tags were remotely deployed using a DAN-INJECT JM25 pneumatic projector (www.dan-inject.com).
- Two 6.8-centimeter surgical-grade titanium darts with six backwards-facing petals were used to attach tags to the dorsal fin or just below the dorsal fin.
- Given the existing information on attachment durations of LIMPET tags on humpback whales, maximum tag attachment duration was expected to be less than 30 days; therefore, tags were programmed to maximize the number of transmissions and locations received during attachment rather than to extend battery life.
- Based on satellite availability in the area, tags were programmed to transmit for 22 hours per day with an unlimited number of transmissions.
- Locations of tagged individuals were approximated by the Argos system using the Kalman filtering location algorithm (Argos Users Manual © 2007-2015 CLS), and unrealistic locations (i.e., those on land) were manually removed using tools provided within Movebank (www.movebank.org).

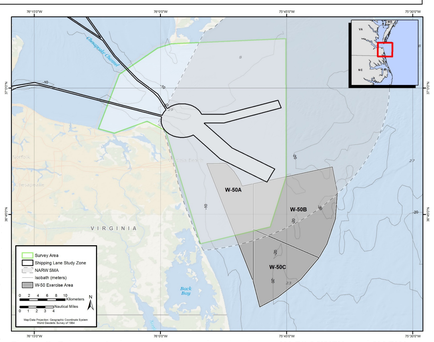

Figure 2. Primary study area showing shipping lanes, W-50 MINEX, and NARW SMA.

Results

- 72 nearshore surveys completed between January 2015 and March 2017 (**Figure 5**)
- 322 baleen whales sighted (**Figure 5**)
  - 310 humpback whales (107 unique individuals)
  - 8 fin whales (6 unique individuals)
  - 3 minke whales (2 unique individuals)
  - 1 unidentified large whale
- 35 satellite tags deployed on humpback whales
  - 32 SPOT-6 and 3 LIMPET-F (**Figures 6-8**)
- 53 biopsy samples collected (33 from tagged whales); genetics analyzed on 29 (14 ♀ /15 ♂)
- 71% (76/107) of humpback whales estimated to be juveniles
- Photo-ID results indicate humpback whales spend an average of 33 days in the area

Table 1. Summary of results from satellite tag data, including number of days tag transmitted, number of locations post-filtering, percent of locations in shipping lanes, percent of locations in W-50, and distance from initial tag location (max and mean).

Animal ID	Day Transmitted	Number of Locations Post-Filtering	Within Shipping Lane (%)	Within W-50 (%)	Max Distance from Initial Location (Km)	Mean Distance from Initial Location (Km)
157915	10.4	163	25.8	9.2	82.6	22.7
157916	13.2	212	12.3	0.0	41.7	11.7
157917	11.3	149	14.8	0.0	506.2	104.3
157918	5.1	76	5.3	0.0	20.7	8.5
157919	11.1	163	29.4	0.0	12.7	5.1
157920	16.5	210	9.0	4.3	241.5	81.1
157921	21.3	231	45.0	4.3	343.6	40.0
157922	3.0	10	60.0	0.0	114.8	33.7
157923	20.6	305	32.5	3.9	189.1	22.0
158674	12.9	163	0.0	0.0	83.3	54.6
158675	3.5	78	9.0	9.0	158.0	62.0
158676	2.7	62	6.5	30.6	31.9	14.9
158677	6.7	163	12.3	4.3	211.8	55.5
158678	6.0	144	4.9	9.0	136.4	34.3
158679	8.4	211	11.4	4.7	204.8	70.8
158680	8.4	215	6.0	6.5	120.0	50.8
158681*	9.3	253	45.5	9.1	20.0	8.2
158682	8.3	206	27.2	4.9	28.8	11.6
158683	12.8	292	31.8	1.0	20.7	9.3
163792	20.6	127	0.0	0.0	26.1	4.6
166671	19.6	498	35.5	13.9	49.3	13.0
166672	7.2	160	35.6	1.9	23.8	8.3
166673	38.7	724	18.6	17.5	94.2	25.7
166674	18.9	319	15.0	23.5	157.7	41.3
166675	10.0	84	27.4	0.0	52.9	19.7
166676	9.2	254	33.9	5.1	103.8	19.1
166677	11.5	265	6.0	54.0	110.6	41.4
166678	18.4	487	51.5	11.3	40.4	13.3
166679	17.2	471	51.4	0.6	26.0	7.8
166680	24.6	705	1.3	1.0	178.8	96.5
166681	11.5	303	46.9	3.6	52.6	8.3
166682	21.8	547	48.4	14.8	40.9	11.7
166683	19.1	512	42.2	10.2	38.5	8.9
166684	10.6	100	0.0	0.0	76.1	28.6
166685	43.8	862	8.2	1.5	237.9	127.8
168231	26.6	217	0.0	0.0	905.3	288.9
168232	10.8	93	0.0	0.0	111.3	34.5
168686	8.2	184	9.8	0.0	66.0	27.3
168687	10.9	200	26.0	1.0	40.3	11.0
168688	5.1	99	53.5	2.0	23.6	13.1
Mean	13.9	262.9	22.5	6.6	125.6	38.8

*tag battery failed prematurely

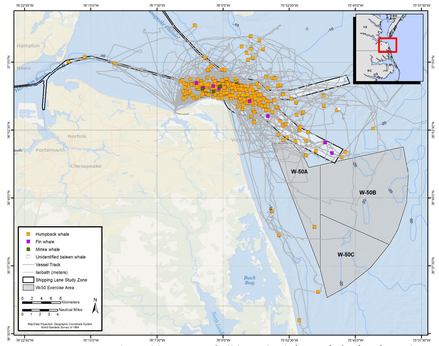

Figure 5. Survey tracks and locations of all humpback (n=310), fin (n=8), minke (n=3), and unidentified large baleen whale (n=1) sightings: January 2015–March 2017.

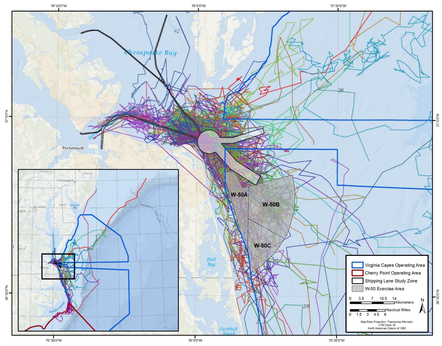

Figure 6. Tracklines of all satellite tagged humpback whales (n=35).

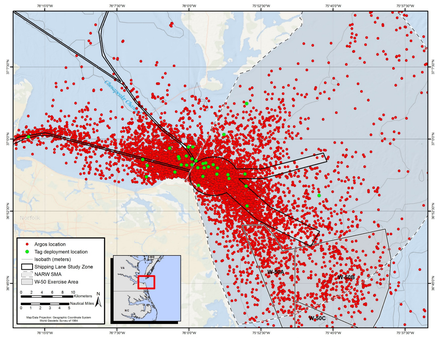

Figure 7. Tag deployment locations (green dots) and all filtered Argos locations (red dots) of humpback whales, showing high concentration in and around the shipping channels – 2,570 of 10,517 (24.4%) of all filtered tag locations were inside shipping channels.

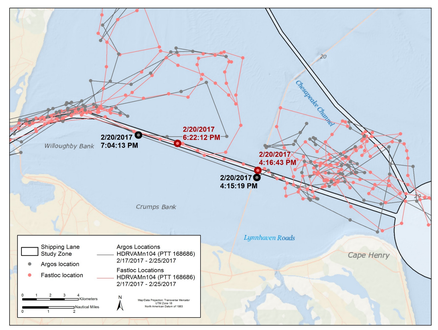

Figure 8. Comparison of Fastloc © locations and Argos locations for a satellite tagged whale in and around shipping lanes at the mouth of the Chesapeake Bay.

- Satellite tags transmitted 2.7-43.8 days (mean=13.9 days) (**Table 1**).
- Area near mouth of Chesapeake Bay was heavily utilized; 24.4% of all filtered tag locations were inside shipping channels and 7.7% were within the W-50 MINEX range (**Figure 7**).
- Nine (9/107 = 8.4%) humpbacks in HDR catalog have propeller scars or apparent vessel-related injuries.
- During 2015/2016 field season four whales were encountered with fresh injuries likely from vessel strikes (**Figure 9**).
- During 2016/2017 field season three whales died of vessel-related injuries over an 8-day period; at least one whale had a serious propeller wound (**Figure 10**).
- 87% of all dives recorded from LIMPET-F tags were in less than 15 meters and 78% of dives were 2 minutes or less.

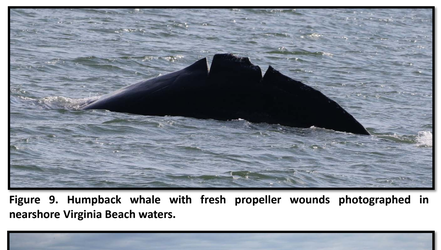

Figure 9. Humpback whale with fresh propeller wounds photographed in nearshore Virginia Beach waters.

Figure 10. Dead humpback whale that washed ashore on Virginia Beach with large propeller wound, February 2017.

Conclusions

- **Humpback, fin, and minke whales utilize the waters around Virginia Beach seasonally.**
- **Satellite tags confirm movements around U.S. Navy training areas and west of Chesapeake Bay Bridge Tunnel.**
- **Habitat preference directly overlaps with high-traffic shipping lanes and can have deadly consequences.**
- **Speed restrictions from NARW SMA do not protect all areas heavily utilized by humpbacks.**
- **UME declared for humpback whales between New York and North Carolina demonstrates need for continued effort.**
- **Future work to look at switching state space models and overlapping Automatic Identification System data with Fastloc© tracks.**

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