Seasonality and site-fidelity of humpback whales off the mid-Atlantic region of the U.S.

Sarah D. Mallette[1], Gwen G. Lockhart[2], Jooke Robbins[3], Alexis Rabon[1], Kristin Rayfield[4], Noelle Mathies[1], Peter Stevick[5], Tom Fernald[5], Judy Allen[5], Jessica Aschettino[6], Mark Swingle[1], Jacqueline Bort Thornton[2], Monica Pepe[7], Amy Engelhaupt[8], Susan Barco[1]

[1]Virginia Aquarium & Marine Science Center, [2]Navy Facilities Engineering Command Atlantic, [3]Center for Coastal Studies, [4] Rudee Flipper, [5]College of the Atlantic, Allied Whale, [6]HDR, Inc., [7]Whale and Dolphin Conservation, [8]Amy Engelhaupt Consulting

Introduction

The Virginia Aquarium & Marine Science Center curates the mid-Atlantic Humpback Whale Photo-ID Catalog (MAHWC), a collaborative collection of 318 individually identified whales documented from 1989 through 2017. The catalog primarily includes whales documented during research and whale watch cruises or opportunistic sightings off the coast of Virginia (VA) while some sightings (mostly pre-2012) from North Carolina have been included (Figure 1). Although humpback whale photo-identification efforts have been inconsistent across years and locations, over two decades of data provide insight into humpback whale seasonal occurrence, site fidelity, and behavior in the mid-Atlantic region of the U.S.

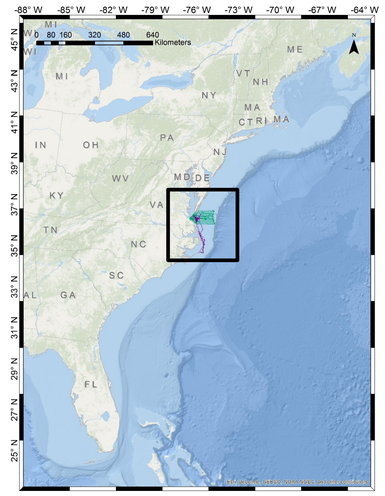


Figure 1. Humpback whales documented off of the mid-Atlantic coast are integrated into the mid-Atlantic Humpback Whale Photo-ID Catalog (MAHWC). Results reported here are focused on whales sighted off the coast of VA.

Objective

- Establish baseline data on humpback whale movement patterns, site fidelity and seasonal behavior off the coast of Virginia and within the mid-Atlantic region of the U.S

Methods

- Photo-ID conducted from vessel cruises (dedicated research and whale watch), aerial surveys and opportunistic contributions between 1989-2017
- Beginning in 2012, VA vessels collected:
  - Tracks and waypoints
  - Photographs, environmental data, group size, species identification, and animal behavior for all encounters
- Whale watch vessels operated Nov –Mar; 2 trips a day in nearshore waters (weather permitting)
- Research vessels (VAQ, HDR, Inc. and Duke University) also operated intermittently in the Atlantic Ocean and lower Chesapeake Bay
- Effort has been relatively consistent since 2012, therefore results of analyses include data collected between 2012-2017 seasons
- Images of unique whales are cataloged based on flukes and/or dorsal fin
- Humpback whale season in VA refers to sightings spanning from July – June
  - Ex: 2016 season = July 2016 through June 2017
- *Resighting intervals* were calculated by subtracting the date of last identification from the date of first identification within a given season

Results

Seasonal Occurrence:

- 1,794 whales sighted between 2012-2017
- 319 uniquely identified
- Seasonal presence in VA waters is primarily winter, although may extend into fall and spring months, with few sporadic sightings in summer **(Figure 2)**
- The peak period of humpback whale presence is between Dec – Feb

Results Continued

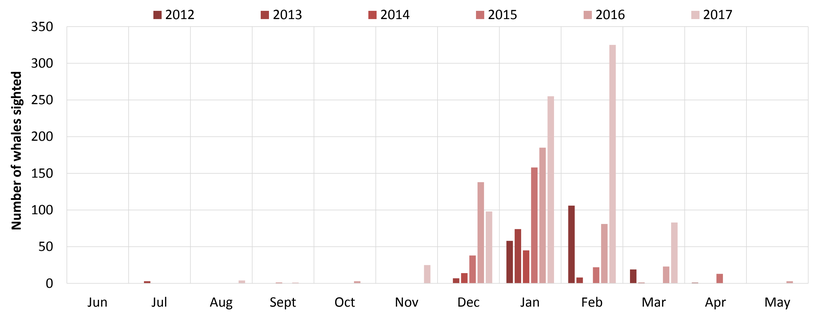
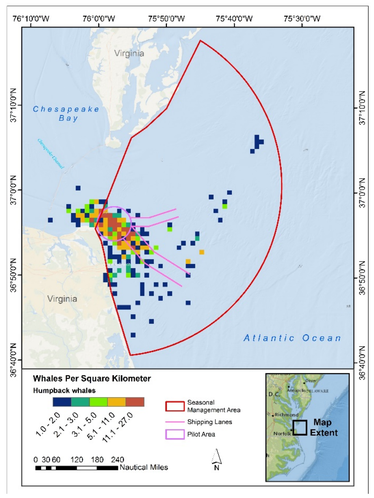


Figure 2. All humpback whale sightings in each month whales were documented. Sighting numbers include research (VAQ, HDR, Inc.) and whale watches



- Highest whales/km^2 documented in the shipping lanes at the entrance to Chesapeake Bay compared to coastal ocean **(Figure 3)**

Observed Behavior

- Juvenile whales previously documented feeding off of Virginia beach, VA[8]
- Bubble net and/or lunge feeding behavior documented across all years **(Figure 4)**
- Atlantic menhaden (*Brevoortia tyrannus)* and bay anchovy (*Anchoa mitchilli)* have been photo-documented or found in the stomach of stranded specimens

Figure 3. Point count grid of humpback whales (per square kilometer) at first observation. Data includes research (VAQ and HDR, Inc.) and whale watch operation sightings from 2012-2017.

Figure 4. Images of humpback whales bubble net feeding (series of images on left) and lunge feeding off the coast of Virginia (right).

Documented Matches:

***A* systematic matching effort across sites is now underway but isn't completed, thus the matches below represent a minimum number of confirmed resightings

- Of the 14 known-aged whales, all were <12 years old and only one individual was known to be sexually mature at time of Virginia sighting[6]
- Of the whales sighted in Virginia that were also matched to high latitude feeding areas, 5% were confirmed matches to eastern Canada, and 21% matched to whales sighted in the Gulf of Maine. A majority of the whales in the MAHWC (73%) have not currently been matched to a feeding ground although matching is ongoing[6,7]
- At least four whales sighted in Virginia were also sighted in Dominican Republic during the breeding season and one sighting was documented at the migratory stopover in Bermuda[7] **(Table 1).**

Table 1. Number of whales matched to the northern latitude feeding grounds, mid-Atlantic and southeast, U.S. states, Bermuda and Dominican Republic. Matching efforts are ongoing and represent minimum confirmed matches.[6,7]Note-not all areas match on dorsal fins therefore numbers may represent an underestimaete of resightings to other locations that exclusively use fluke-based matching**

Location	Minimum # of whales matched
Eastern Canada	17
Gulf of Maine	68
New York	5
Mid-Atlantic and Southeast U.S.	25
Bermuda	1
Dominican Republic	4

Results Continued

Residency and site fidelity

Within-season resighting intervals **(Figure 6)**

- Ranged from 0 to 79 days
- Of those identified more than once, the mean interval was 20.7 ±18.2 SD days (median=16.5)
- Most whales (73.6%) had resighting interval of < 28 days
- Some individuals may remain in the area for extended periods

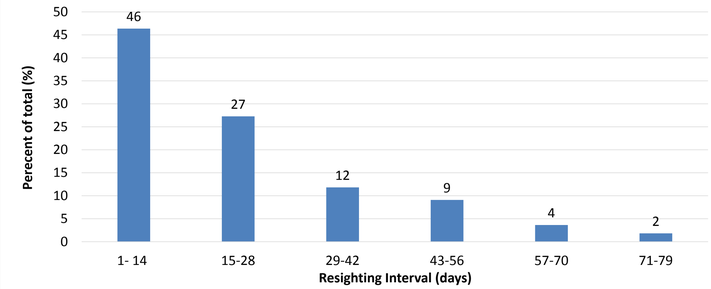


Figure 6. Resighting intervals (between first and last identifications within the same season) of all whales seen on more than day off Virginia Beach, Virginia

Between-season resightings **(Figure 7)**

- 21% of all individuals were repeat visitors between years
- We documented 29 individuals as being resighted over multiple seasons with five individuals sighted each year from 2012-2017

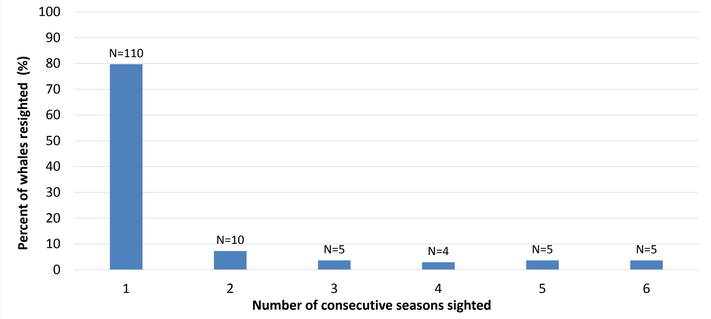


Figure 7. Percent of whales resighted in consecutive seasons between 2012 and 2017 off Virginia Beach, Virginia

Summary

- Humpback whales have been consistently sighted and identified in Virginia since 2012, primarily in the cooler months
- Residency intervals, within-season resightings, and documentation of feeding behaviors suggest that Virginia and perhaps much of the mid-Atlantic region provides important seasonal foraging habitat for at least some, primarily juvenile, humpback whales
- Between year resightings suggest that approximately 20% of whales identified occur in a relatively small study area in consecutive years
- There continues to be evidence of whales from multiple feeding areas in the region
- Additional investigation is necessary to determine the implications for long-term recruitment of humpback whales in Virginia and the mid-Atlantic region.

References

[1] Barco, S.G., W.A. McLellan, J.M. Allen, R.A. Asmutis-Silvia, R. Mallon-Day, E.M. Meagher, D.A. Pabst, J. Robbins, R.E. Seton, W.M. Swingle, M.T. Weinrich, and P.J. Clapham. 2002. Population identity of humpback whales (*Megaptera novaeangliae*) in the waters of the U.S. Mid-Atlantic States. *Journal of Cetacean Research and Management*, 4(2), 135–141.

[2]Mallette S.D., Lockhart G G., McAlarney R.J., Cummings E.W., Pabst D. A., McLellan W.A., Barco S.G. 2016. Offshore energy planning for Marine Protected Species off of Virginia's coast: A synthesis of aerial surveys in the proximity of the Virginia wind energy area, 2012-2015. VAQF Scientific Report 2016-04.

[3]Bettridge, S., C.S. Baker, J. Barlow, P.J. Clapham, M. Ford, D. Gouveia, D. Mattila, R.M. Pace III, P.E. Rosel, G.K. Silber, and P.R. Wade. 2015. *Status Review of the Humpback Whale (*Megaptera novaeangliae*) Under the Endangered Species Act.* NOAA Technical Memorandum NMFS-SWFSC-540. National Marine Fisheries Service, La Jolla, California. 263 pp.

[4]NOAA (National Oceanographic and Atmospheric Administration) 2017. 2016-2017 Humpback Whale Unusual Mortality Event along the Atlantic Coast. Website updated August 1, 2017. http://www.nmfs.noaa.gov/pr/health/mmume/2017humpbackatlanticume.html

[5]Swingle, W.M., S.G. Barco, T.D. Pitchford, W.A. McLellan, D.A. Pabst. 1993. Appearance of juvenile humpback whales feeding in the nearshore waters of Virginia. *Marine Mammal Science* 9(3):309-315.

[6]Center for Coastal Studies. Gulf of Maine Humpback Whale Catalog.

[7]Allied Whale. North Atlantic Humpback Whale Catalog.

Acknowledgements

We would like to acknowledge the following funding sources: US Fleet Forces Command under the US Navy's Marine Species Monitoring Program, and the Virginia Aquarium Foundation Batten Collaborative Research Endowment, and the Kellam Family Foundation. We also want to thank VAQ Research & Conservation staff and volunteers, Winter Wildlife Cruise and Rudee Flipper interpreters, captains and data collectors, HDR Inc., NAVFAC Atlantic, NC Maritime Museum, University of North Carolina Wilmington, Gotham Whale and all of the contributors of images and sighting data to the Mid-Atlantic Humpback Whale Catalog (MAHWC). We would like to acknowledge the NAHWC and GOM humpback whale photo-ID catalog long-term efforts. All work was conducted under the following permits: NMFS GA #1735 PI: Barco at Virginia Aquarium; NMFS ESA permit #16325 PI: Jooke Robbins at Center for Coastal Studies for large whale photo-ID; NMFS ESA permit #16473 PI: Ann Pabst at UNC Wilmington for aerial survey of endangered whales.