

Mid-Atlantic & Southeast Humpback Whale Photo-ID Catalog:

2018 Annual Progress Report

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Cover Photo Credit:

Humpback whale (*Megaptera novaeangliae*) fluke images being compared using upgraded tools in the OBIS-SEAMAP hosted MAHWC. A map of the sighting locations of individual whales is shown below the fluke images.

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Acronyms and Abbreviations

AW	Allied Whale
CCS	Center for Coastal Studies
GOMDIS	Gulf of Mexico Dolphin Identification System
GOMHWC	Gulf of Maine Humpback Whale Catalog
MABDC	Mid-Atlantic Bottlenose Dolphin Catalog
MAHWC	Mid-Atlantic Humpback Whale (Photo-ID) Catalog
NAHWC	North Atlantic Humpback Whale Catalog
OBIS-SEAMAP	Ocean Biogeographic Information System-Spatial Ecological Analysis of Megavertebrate Populations
Photo-ID	Photo-Identification
Photo-ID App	Photo-Identification Application
VAQF	Virginia Aquarium & Marine Science Center Foundation, Inc.
UNCW	University of North Carolina Wilmington
U.S.	United States
WDC	Whale & Dolphin Conservation

1. Introduction and Background

Naval Station Norfolk is the world's largest naval station, with a high concentration of military vessel traffic and training exercises occurring in the nearshore and offshore waters of Virginia. The United States (U.S.) Navy (Navy) has supported research on the identity, residency, site fidelity, and habitat use of humpback whales sighted in the mid-Atlantic region through the funding of tagging and biopsy efforts (Aschettino et al. [2016](#), [2017](#), [2018](#), [2019](#)), and aerial surveys (Malette et al. [2016](#), [2017a](#), [2018](#)). The Navy also provided funding to the Virginia Aquarium & Marine Science Center Foundation, Inc. (VAQF) and key collaborators to support the development of a web-based Mid-Atlantic and Southeast Humpback Whale Photo-Identification (Photo-ID) Catalog (MAHWC).

Longitudinal mark-recapture data (e.g., photo-ID) can serve as a non-invasive mechanism to investigate and develop patterns of humpback whale occurrence, inter-annual site fidelity, and changes in distribution and phenology over time. Since 1989, VAQF has conducted photo-ID of humpback whales off the coasts of Virginia and North Carolina. VAQF currently curates the MAHWC, an expanding collection of photographs and sighting histories of live and stranded (dead) individual whales. The objectives of these long-term efforts are to establish baseline data on humpback whale movement patterns, population demographics, site fidelity, and seasonal habitat-use in the mid-Atlantic, while supporting multi-decadal photo-ID efforts and research in the broader western North Atlantic. This collaborative work continues to provide insight into the feeding ground origin of humpback whales sighted in the mid-Atlantic and provides a means to detect changes in what we currently understand about distribution and seasonal occurrence. Human impacts (e.g., injuries from entanglement or watercraft), body condition, and behavior (e.g., foraging) can also be assessed through image analysis.

Humpback whales have been increasingly observed in the mid-Atlantic, particularly during winter (CETAP 1982, Swingle et al. 1993, Barco et al. 2002, Tetra Tech and Smultea Sciences 2018, Waring et al. 2017). Both survey effort and opportunistic sightings in the mid-Atlantic and southeastern United States have increased in the last few years compared with the late 1990s and early 2000s (Wiley et al. 1995). To more effectively integrate current and historic data from multiple sources, a streamlined process for data/image submissions, management, and access has become necessary. In 2016, the Navy began funding the development of an online version of the MAHWC, an integrative web-based repository that facilitates collaboration. This project contributes to broader-scale monitoring of the West Indies Distinct Population Segment and complements existing Navy marine species monitoring efforts ([Mid-Atlantic Humpback Whale Monitoring](#), [Mid-Atlantic Continental Shelf Break Cetacean Study](#), and [Aerial Survey Baseline Monitoring](#)).

The MAHWC is currently a limited access site hosted on the Ocean Biogeographic Information System-Spatial Ecological Analysis of Megavertebate Populations ([OBIS-SEAMAP](#); Halpin et al. 2009) platform, a web-based biogeographic database of sighting data for marine megafauna. It provides tools for mapping and visualizing species sighting data and serves as an accessible repository for researchers to submit data and images. Currently, OBIS-SEAMAP hosts multiple other photo-ID catalogs (e.g., Mid-Atlantic Bottlenose Dolphin Catalog [MABDC], Pacific Islands

Photo ID Network) and provides a user-friendly interface and efficient tools for comparison of collections.

The web-based MAHWC is intended to be a high-quality scientific product that will inform users of the identity, residency, site fidelity, and habitat use of humpback whales in the waters off the mid-Atlantic and southeastern United States. Simplifying and standardizing submissions from the mid-Atlantic to the broader regional and North Atlantic catalogs also will permit a more efficient exchange of information between regions. This tool will benefit researchers, managers, and educators by supporting informed management and environmental planning.

This report describes the progress for development of the web-based MAHWC for 2018.

2. Methods

Existing examples of photo-ID catalogs with a web-based interface (e.g., MABDC, Gulf of Mexico Dolphin Identification System [GOMDIS], Pacific Islands Photo-Identification Network Catalog for Spinner Dolphins, the North Atlantic Right Whale Catalog, and Antarctic Humpback Whale Catalogue) have served as models for identifying the key components needed to develop an online catalog accessible by multiple researchers and tailored specifically to collaborative humpback whale photo-ID efforts. To facilitate the exchange of information between contributors, data-access protocols were developed by the stakeholders with the goal of sharing data agreed upon by the stakeholders and with the approval of the respective contributors. The core stakeholder group, including individuals involved in curating large photo-ID catalogs, and Duke University's programmer (Ei Fujikoa), have provided invaluable guidance throughout the development of the catalog (e.g., data-sharing agreement and data/image submission, quality assurance, and matching protocols). The draft Photo-ID Application (Photo-ID App: web interface/database) of the MAHWC was developed by Ei Fujioka in consultation with Kim Urian, curator of the MABDC.

Unique variations in the ventral fluke pattern; fluke trailing edge shape; shape, size, and scarring of the dorsal fin; and other body scars, marks, and features are used to catalog individual humpback whales (Katona and Whitehead 1981). To maintain as much consistency as possible among images, the MAHWC curator assigns feature codes to images that are included in the catalog. These unique codes permit efficient filtering through the catalog.

Sighting data and images are submitted to the curator in one of two standard templates—MAHWC Permitted or MAHWC Basic Template. Because some photo-ID efforts (e.g., whale-watch vessels or opportunistic sightings) collect only basic sighting data, while other groups collect more detailed information associated with on-going research efforts, contributor feedback suggested separate versions of the template for different users. Sighting data are populated into either of the standard templates by following image- and data-accession protocols in the MAHWC Submission Package, allowing efficient processing/management and quality control of the database. In the submission protocol, we request that each sighting location have a corresponding image of sufficient quality to identify an individual whale. Each sighting location is checked to ensure there was a corresponding image. If no image existed, that data point is deleted.

Feature codes used to score images for identification (e.g., fluke pigmentation patterns, dorsal fin shape, peduncle knuckle prominence, and body scarring) were developed and adapted from codes used by the Gulf of Maine Humpback Whale Catalog (GOMHWC) and North Atlantic Humpback Whale Catalog (NAHWC) (See [Malette et al. 2017](#) for MAHWC). Additionally, each image was scored for quality to reduce the potential for false negatives when matching. A protocol for systematically scoring humpback whale images was being tested in late 2018 and will be integrated into the curator package that will be completed in year three of the project. A collection of reference images for each category of fluke and dorsal fins also will be included in these protocols and available on OBIS-SEAMAP for users to review. This includes “Type” feature codes with text descriptions and an example image for contributors for reference when selecting a category for filtering images to make matches between whales.

Following feature and quality code assignment by the catalog curator, the quality-controlled data and associated images are submitted to be uploaded to the OBIS-SEAMAP platform. The web-based interface permits searches by study site, specific whale ID, and/or by fluke or dorsal fin features. It also provides mapping features of sightings locations of matched whales. When images are marked as a match, image contributors are prompted automatically by email to review the potential match. Each contributor of the proposed match independently endorses or rejects the match. If both parties agree, and the curator verifies the match, and it is placed into a ‘Verified’ state. At the time of consent or rejection, the database will be updated with a unique match identifier for the two matched IDs. An email prompt is then sent to the matching team and the contributors. The curator oversees this process.

3. Progress Summary

The MAHWC is currently in its final year of development. Year 1 focused on engaging key stakeholders involved in humpback whale research, management, and outreach, as well as potential contributors to the MAHWC. This was achieved through the MAHWC Stakeholder Workshop, during which data-access protocols were developed; standardized draft protocols for data/image submission and quality assurance for the MAHWC were developed; and the workflow for submission of images/sighting data between the MAHWC, larger regional catalogs, and contributors was agreed upon. A draft web interface/database design modeled after that of the MABDC was developed for stakeholders to review and offer their feedback. A Final Stakeholder Workshop Report ([Malette et al. 2017b](#)) was produced, which summarized the outcomes of the workshop.

In Year 2, the data-access and data-sharing protocols were finalized. Images and sighting data were collected from local contributors and standardized for integration into a template that was then uploaded to the OBIS-SEAMAP platform. Almost, 2,000 sighting records were added and at least 800 “best of” images were processed, scored, and incorporated into the Photo-ID App. These sighting data and images from four different sites have been used to beta test the App while additional seasons and contributor’s data were processed offline. Standard templates for image and sighting-data submissions for both permitted and basic submission types were developed and modified to accommodate supplemental data agreed upon by contributors—including tagging, biopsy, and survey effort data. A draft Contributor Submission Package was developed to guide contributors through completing the template. These templates and the

reference documents in the submission package continue to be tested with additional contributors as they populate templates and submit images, to ensure that protocols are clearly explained and the submission process is streamlined. For each submission from a contributor, the curator performed a complete quality control review of submissions offline and then submitted images and data in batches to the Duke programmer for upload to the Photo-ID App and to test the submission workflow. Beta-testing and bug-fixing occurred continuously throughout the process to improve the user interface, tools for matching, and queries available to the user. Modifications to the Photo-ID App are continuing to be made, based upon feedback from the contributors and discussions among active collaborators with OBIS-SEAMAP hosted catalogs (e.g., Kim Urian [MABDC], and Carolyn Cush [GOMDIS]). Currently, the MAHWC Photo-ID App is being upgraded simultaneously with the MABDC and GOMDIS catalogs. These upgrades are projected to be completed mid-February 2019. Once these upgrades are finalized, the beta version of the OBIS-based MAHWC will be launched for use by and feedback from collaborators.

Examples of upgrades are listed below:

- The view of the existing matches was greatly improved so that it provided a more flexible and intuitive list of matches.
- A new action "Revoke" on matches was added. This action cancels an existing match in case new evidences and/or better-quality images have revealed that the animals are not the same.
- The filtering functionality was expanded for more options to query animals and images.
- Filtering by match state was added: Verified, In review, Rejected, or No (animals with no match).
- Criteria by fin/dorsal features can now be combined by "NOT" or "ONLY" conditions in addition to "OR" and "AND." "NOT" will pick up animals that do not have specified features. "ONLY" will pick up animals that have exactly same features selected (not more or less).
- "Strict" option was added to the query on the date range. This option is useful to find the animals that were dead (i.e., no sightings since date of death/stranding).

Images are simultaneously being systematically compared between collections offline while the Photo-ID App development is being completed. Data/images are being processed and quality-controlled to identify matches and to assign new individuals to the catalog when no match is made. Images of new whales are also submitted to the two existing regional catalogs—GOMHWC and NAHWC—at the end of each season. VAQF is working with Duke to develop the workflow for submissions of annual sighting data/images from the OBIS-based MAHWC to the NAHWC and GOMHWC. Updates on matches to the different locations are described below.

Virginia

Submissions from local contributors (e.g., VAQF; HDR, Inc.; Rudee Flipper; VAQS Whale Watch) and those contributed from other organizations including North Carolina Maritime Museum and Gotham Whale were scored. Local contributor images and sighting data collected

between 1989 and the 2017 seasons submitted by VAQF; HDR, Inc.; and Rudee Flipper Whale Watch were standardized in the contributor template, and images scored based on feature codes (of the dorsal fins and flukes) and image quality. Historic sightings collected by VAQF (1989–2000) were in slide format, and these were digitized for integration into the MAHWC. All images of whales submitted between the 1989 and 2017 seasons from Virginia contributors have been compared and new whales integrated into the catalog. As of December 2018, the catalog included 332 unique whales. Image and sighting data are currently being processed from the 2017–2018 and 2018–2019 seasons. As stranded whales were not the priority data points to integrate into the MAHWC, stranded whales have been opportunistically added from Virginia records.

To date, humpback whales in the MAHWC documented from 1989 through 2016 have been compared to the NAHWC and GOMHWC. Images from Virginia contributors from 2017 and 2018 are at various stages of comparison with both the NAHWC and GOMHWC. Of those that have been matched, at least 104 individuals have a NAHWC ID, although most sighting histories were short and many were assigned IDs based on the Virginia sightings. To determine the feasibility of incorporating aerial images into the MAHWC, images collected from aerial surveys between 2012 and 2017 were reviewed. We were able to uniquely identify 38 whales, 19 of which were matched to MAHWC images taken from vessels. Whales with MAHWC IDs continue to be compared to collections from contributors in New York, New Jersey, North Carolina, Georgia, and Florida offline. These sighting and stranding data have not yet been formally integrated into Photo-ID App, and matching is at different stages for each contributor.

Gulf of Maine

Matching efforts are ongoing, although at least 74 whales have been matched to the Gulf of Maine to date. Of those matches that have been made, 19 whales had Gulf of Maine histories that began when the whales were calves. These known-age whales were seen in the mid-Atlantic between 1996 and 2017 and ranged in age from 1 to 11 years old at the time of their first MAHWC sighting (mean=4.5 years). Two whales were known to be sexually mature at the time of sighting off Virginia's coast (Jooke Robbins, Center for Coastal Studies, *pers. comm.*).

New York/New Jersey

Whale & Dolphin Conservation (WDC) is leading efforts to gauge interest of whale-watch and research groups to contribute to the MAHWC and collate data from those interested. In Year 3, WDC will host a meeting with groups from both states to review progress on the MAHWC and facilitate the establishment of data-sharing agreements with potential contributors. Interest in contributing to the MAHWC has been expressed by both whale-watch and research groups in New York. Images from New York are being compared to those in the MAHWC, and at least 16 whales have been matched to whales sighted in Virginia between 2005 and 2017.

Thus far, the two major whale-watch operators in Cape May, New Jersey—Whale Watch & Research Center and Princess Anne Cruises—have expressed interested in contributing to the MAHWC, and one has provided data and images which are currently being integrated into the MAHWC. Of the NJ images collected in 2017 and suitable for ID comparison, 23 distinct individuals were recognized. Of those 23, five were seen off Cape May in previous years (i.e., 2015 and 2016). One was seen off Cape May in consecutive years between 2015 and 2017,

and was also documented off the coast of Virginia in 2017 (MAHWC0301). One was matched to an individual in the Gulf of Maine catalog, who was seen as early as 2004 in the Gulf of Maine but had no prior known sightings off the coast of Cape May, New Jersey. Three were matched to whales seen earlier in 2017 off the coast of Virginia (MAHWC0266, MAHWC0303, and MAHWC0313) and one to a whale sighted in December 2016 in Virginia (MAHWC0300). None of these individuals had prior known sightings off Cape May. Additionally, one dead-stranded whale found in Virginia in early 2018 matched to a whale sighted off the coast of Cape May (WDC ID: NJ1707). One whale seen off the coasts of Virginia in 2015 and New Jersey in 2016 was found dead in the Gulf of Maine in the spring of 2017 (MAHWC0151).

There were six whales with intra-annual re-sightings. Of those, three had residency times of three, four, and five days, respectively. One had three sightings spanning 17 days between April and May. The longest gap between these sightings was 14 days. Another whale had two sightings 46 days apart between August and October, although there were regular trips in between with no sightings, not suggestive of residency. A different whale was seen six days apart in April and then had a final sighting in November.

Southeast

Contributions from other mid-Atlantic and southeastern groups (Florida Fish and Wildlife Conservation Commission, Georgia Department of Natural Resources, Duke University Marine Lab), have been solicited and are being collated by these groups for submission to the MAHWC. At least two matches have been made between Georgia/Florida and Virginia. The University of North Carolina Wilmington has also expressed interest in submitting images for whales stranded in North Carolina to the MAHWC.

Other Contributors

VAQF will continue to solicit for other contributions (e.g., Maryland Department of Natural Resources, verified opportunistic sightings) after the larger core-group datasets have been integrated into the MAHWC.

4. Future Work

Year 3: September 2018–December 2019

- Conduct a final bug-fixing for the OBIS-based catalog and formally launch the web-based MAHWC Photo-ID App.
- Develop website content for MAHWC as a central location for communication among contributors, including sharing information on the workshop, curating pertinent publications, providing relevant links to other websites such as the Navy Marine Species Monitoring website, highlighting current photo-ID techniques, and providing guides to exemplar images.
- Develop a training guide for coding images based on cross-training with Allied Whale (AW) and the Center for Coastal Studies (CCS) for the curator training.
- Finalize curator protocols and plan curator training for future sustainability of the catalog.
- Prepare and submit manuscript(s) from the project.
- Work with northeastern and southeastern stranding networks to collate and integrate photo-ID data from stranded whales into the OBIS-based catalog.

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