Monitoring Endangered Right Whales in Coastal Waters of Northeast Florida by a Volunteer-Based Citizens Network

2019-20 Season

## A Report by the Marineland Right Whale Project to Volunteers, Collaborators, and Sponsors

James Hain, P.I. Associated Scientists at Woods Hole Woods Hole, MA 02543 (508) 540-5050 jhain@earthlink.net www.aswh.org





28 July 2020

# **Table of Contents**

Summary	3
<ul> <li>1.0 Background and Overview</li></ul>	5 5 5 5 5
2.0 Methods         2.1 Overview         2.2 Study Area and Sectors         2.3 Sighting Protocols         2.4 Shore-Based Lookouts         2.5 Response Teams         2.6 Unmanned Aerial System (UAS) and Observations         2.7 Monitoring for Human-impacted Individuals         2.8 Phone Notification System         2.9 Sea-Surface Temperature (SST)         2.10 Outreach and Education         2.11 Data and Photo Analysis and Submission	6 6 7 7 7 8 9 9 9 9 10
<ul> <li>3.0 Results</li> <li>3.1 Sighting Effort</li> <li>3.2 Right Whale Sightings 2019-2020</li> <li>3.3 Quantification of Sighting Effort and Conditions</li> <li>3.4 Sea-Surface Temperature</li> <li>3.5 Collaboration with the FWCC Team</li> <li>3.6 Volunteer Training and Public Outreach</li> <li>3.7 Contributions to Scientific, Management, and Conservation Forums</li> <li>3.8 Disposition of Data</li> </ul>	10 10 11 11 12 12 12 12 14 14
<ul> <li>4.0 Discussion</li> <li>4.1 Twenty Years of the Marineland Right Whale Project</li> <li>4.2 Technological Advances</li> <li>4.3 Sea Surface Temperature</li> <li>4.4 An Imperfect Sighting Effort</li> <li>4.5 Population Status and the Future</li> <li>4.6 Human Impacts and the Numbers</li> <li>4.7 Thoughts While Looking Forward</li> </ul>	14 14 15 15 15 15 16 16
Acknowledgments	17
Tables Figures	18 21

## Monitoring Endangered Right Whales in Coastal Waters of Northeast Florida by a Volunteer-Based Citizens Network

2019-20 Season

## Summary

The Marineland Right Whale Project completed the 20<sup>th</sup> year of the program in the near shore waters of northeastern Florida, generally between St. Augustine Inlet (29°54') and Canaveral Seashore (28°56'). The project is one of several research and monitoring efforts along the east coast of the U.S. and Canada.

During the 2019-20 season, the Marineland Right Whale Project had 15 right whale sightings. The first of these sightings came on New Year's Day, 1 January 2020—an auspicious start to the season. Our most frequently sighted whales were female Catalog #3560 and her first calf, sighted on nine occasions. Female #3546, *Halo*, and her second calf were sighted on five occasions. A yearling, the 2019 calf of #1294 was sighted only once in our area. There were two confirmed sightings of humpback whales. The 2019-20 season was our best in four years.

Drones (unmanned aerial systems or UASs) were employed on nine occasions. This considerably increased the efficacy of the shore-based volunteer program. Still images enhanced photo-identifications, and videos are being analyzed for behaviors. There is a strong synergy between the sighting reports by the volunteer network and the photo IDs by the drone.

Collaborations with other research teams in the area continued. We communicated and interacted with the Florida Fish & Wildlife Team and the Marine Resources Council on a near-daily basis. Sightings were reported in real time to the Whale Alert system (alerts mariners as to the presence of right whales). Data and photos were submitted on 23 April to the central photographic catalog and database maintained by the New England Aquarium in Boston, Massachusetts.

Outreach and education continued—two presentations to volunteers and six presentations for public education and engagement were given. Both within and external to our program, public awareness and citizen science is gaining in visibility and importance. Our volunteers were interviewed by News4JAX on 10 February, and a documentary film crew from Hitplay productions/Canadian Broadcasting Company worked with us on 22, 23, and 26 February. By the end of the season, we had posted seven videos to our YouTube channel. We partnered with

the Blue Ocean Society, Portsmouth, New Hampshire, and used their educational "Year of the Right Whale: Booth in a Box" on several occasions.

At the population level, the status of the right whale population was reported to the annual meeting of the North Atlantic Right Whale Consortium, Portland, Maine, on 14 November 2019. The current best estimate for the period ending December 2018 was 409 individuals. Since about 2010, there has been a downward trend in the population size and a decreasing number of calves born. However, at the close of the 2020 southeastern U.S. season, there was cautious optimism. Ten calves were born into the population and the demographics of individuals migrating to the SEUS were more diverse than in several previous years—hinting at a possible return to the situation of the previous decade.

Right whales are a keystone species—for the ocean habitat, for the health of our natural resources, and ultimately, for human health and well-being. Our program contributes to the stewardship of the species, the oceans, and broader environmental issues.

#### 1.0 Background and Overview

## 1.1 The Marineland Right Whale Project

Two organizations, Associated Scientists at Woods Hole and the Marine Resources Council, collaborate to provide monitoring and stewardship of the endangered North Atlantic right whale, *Eubalaena glacialis*, and its nearshore habitat in coastal waters of northeastern Florida. At the core of this effort is the Volunteer Sighting Network. The network is composed of citizen scientists who are provided training and resources and work alongside experienced staff. The Marineland component, "The Marineland Right Whale Project," was initiated in 2001, and the 2019–20 season was its 20<sup>th</sup>.

## 1.2 Right Whale Calving and Wintering Grounds

The coastal waters of the southeastern United States—principally Florida and Georgia—are the principal calving and nursing ground for the North Atlantic right whale. The small population currently numbers about 409, with a small number of calves born each year (the average over the past 10 years has been 11).

Florida's coastline includes 175 nautical miles (nmi) of right whale critical habitat. In the 2019-20 season, as in most preceding seasons, the great majority of aerial survey effort by the states of Georgia and Florida took place in the northern section—the Mandatory Ship Reporting/Early Warning Survey area. South of St. Augustine (about 125 nmi or 70% of the Florida critical habitat), most sighting effort was provided by the Volunteer Sighting Network.

## **1.3 Monitoring Priorities**

Our monitoring priorities include documenting calf production, health of mother-calf pairs, and human impacts (vessel strikes, fishing gear entanglements, boater harassment, and habitat issues).

## **1.4 Collaborations**

Throughout each survey season, we are in near-daily contact with the group to our south, the Marine Resources Council, and the group to our north, the Florida Fish and Wildlife Conservation Commission (FWC) Team. More broadly, we collaborate/communicate with the Georgia DNR/Clearwater Aquarium Team, the New England Aquarium right whale group, the

Navy, and the National Oceanic and Atmospheric Administration/National Marine Fisheries Service.

## 2.0 Methods

## 2.1 Overview

During the course of 20 seasons, the Volunteer Sighting Network has evolved, and refinements and innovation have been incorporated. In its present form, a number of interrelated components have proven essential to success:

- Dedicated teams
  - \* Mobile
  - \* Community/Condo
- Opportunistic sightings
- Right Whale Hotline
- Response teams
- Land-based photos
- Aerial photos and videos via drones
- Timely and effective communication with volunteers and collaborators
- Education and outreach
- Collaboration
- Data processing, analyses, synthesis, and presentation

The volunteer handbook, which provides essential information on right whale biology, is posted on our website: <u>www.aswh.org</u>.

## 2.2 Study Area and Sectors

The study area, monitored with a combination of a shore-based sighting network and complementary drone flights, is in the near-shore waters of northeastern Florida between St. Augustine Inlet (29°54) and Canaveral Seashore (28°56'), within 5 nmi of the coast (Figure 1). This ~60nmi section is subdivided into six sectors, each ~10 nmi in latitudinal extent (Figure 2). The shore-based monitoring extends south to Ponce Inlet (29°04'), while some opportunistic monitoring extends farther south to Canaveral Seashore.

## 2.3 Sighting Protocols

Sightings, photo documentation, and data collection are based on interrelated sources and responses. The initial sightings are made almost exclusively from shore. The response, extended observations, and photographs may include shore, air (drone), and/or a combination thereof. Throughout, there are standardized search effort and data collection protocols. This includes photo documentation and photo-identification, which is essential to monitoring and data collection. The results are optimized through communication and collaboration, and by utilizing multiple platforms.

## 2.4 Shore-Based Lookouts

As described, the study area is divided into six sectors. A shore-based volunteer sighting network works with experienced scientists. The volunteer sighting network includes two components: 1) scheduled observers, and 2) opportunistic observers. The scheduled observers, typically teams of two to four volunteers, are of two types: a) mobile and b) stationary. The mobile teams meet at 0800 hr at a designated point and travel by vehicle to a series of lookout stations where a 15 min search is conducted at each station. At the end of the series (typically five stations per team), they reverse the search and end back at the starting point.

The stationary teams (typically based in shore-front condos or housing communities) maintain lookouts from the balconies of shorefront buildings or dune walkovers. In both cases, most watches are concluded by 1200 hr.

The opportunistic observers are residents and/or workers who have been provided information and the sighting-report hotline number, and report sightings made during the course of normal recreation or work. Opportunistic observers include, for example, the Volusia County Beach Patrol.

The 200+ member volunteer sighting network and its several components (Figure 3) provides effective coverage of our ~ 60 nmi section of coastal habitat.

## 2.5 Response Teams

A central location (the office in Marineland) is manned during daylight hours (Figure 4). This is linked to the central call-in hotline maintained by the Marine Resources Council. When a sighting is reported, a response team that includes experienced scientists and volunteers is deployed. The response team carries portable GPS units (Garmin 12XL or similar) and digital cameras with long lenses (*e.g.*, Canon EOS 60D with a Canon EF 600-mm image-stabilized f 4.0

telephoto lens fitted with either a 1.5x or 2.0x Canon extender). On many occasions, the response includes a drone and drone operator.

Standardized protocols are followed for data collection. Bearings are measured using binoculars with built-in compasses (*e.g.*, Nikon OceanPro 7X50 Model #7441). Ranges are estimated visually by experienced observers based on calibration and training trials. Data and sighting sheets are standardized and reviewed for quality control.

### 2.6 Unmanned Aerial Systems (UASs)

In the 2016 season, we began using drones (unmanned aerial systems or UASs). These replaced the airplane that we flew from 2007 through 2017. The program currently has three drones, two DJI Phantom 3 Pros, and one DJI Phantom Pro 4 v.2. In addition, a volunteer operates a DJI Phantom Pro 4 v.2. With a total of four drones and five operators, the plan is that for any given sighting event, at least two will be available. All drones are registered with the Federal Aviation Administration (FAA). As we are considered to be a commercial operation (which includes scientific research) under CFR 14, Part 107, two of our operators have an FAA Remote Pilot Certificate. Four of our operators are listed in our NOAA/NMFS research permit, #20626. An operator with authorization in each category is on site whenever the drone is deployed.

Because of the proximity of several coastal airports to our study area, we have applied for, and received, FAA airspace waivers for Northeast Florida Regional (SGJ), Flagler (FIN), and Ormond (OMN) airports. (This waiver provides for operations within five nautical miles of the airport). In addition, we have the AirMap app on our mobile phones to utilize the Low Altitude Authorization Capability (LAANC) and provide for operation within five nmi of Daytona Beach International (DAB). In the future, we will apply for authorization for New Smyrna Beach (EVB). The Canaveral Seashore National Park is closed to drone operations, making this section of the coast unavailable.

The protocol for drone use is as follows: When a sighting is reported, a response team is deployed. This will typically include one or more drone operators. An assessment on a drone launch will be made as to weather and sea state conditions, and the distance from shore to the whale(s)—*i.e.*, is it reasonably within range? A drone will be deployed to first obtain high-quality identification photos and secondly, to obtain video that will contribute to behavioral studies. As detailed in our NOAA/NMFS permit, operators and assistants wear vests identifying them to the public as researchers (Figure 5). In many cases, images will be sent to members of the Florida Fish and Wildlife Commission (FWC) Team to inform their decisions about darting and boat/aircraft deployment. Likewise, if conditions or distance preclude a drone launch, this information will be relayed so that FWC has the option of deploying their aircraft for photo-ID.

## 2.7 Monitoring for Human-impacted Individuals

In the field and during photo archiving and analysis, particular attention is paid to noting and documenting human-impacted individuals. Impacts or potential impacts include ship/boat collisions, fishing gear entanglement, and harassment by boaters, paddle boarders, or surfers.

Data and photo documentation are submitted to NOAA law enforcement, the Whale-Vessel-Interaction database maintained by FWC, as well as the database and photo catalog maintained by the New England Aquarium (NEAQ), Boston, Massachusetts.

#### 2.8 Phone Notification System

The phone notification system has proven to be a success and is continuing. To facilitate faster, efficient, and complete notification of survey team members during whale sightings, we contract with One Call Now, an automated telephone messaging service. After importing the team members' names and contact numbers, One Call Now allows us to create a voice message and deliver it to certain sectors, or, to the entire list, within 20 minutes. Volunteers either answer the call live and hear the message, or, the service leaves a voice mail. Giving the volunteers an opportunity to see right whales is a high-priority goal, both as a reward for the volunteers' assistance, and, to help new volunteers establish their right-whale sight image for better detection/species identification during surveys and follows. An additional function of the phone network is to advise volunteers on inclement weather conditions and changes to the survey schedule.

### 2.9 Sea-Surface-Temperature (SST)

Sea-surface temperature (SST) satellite images are received daily from the Naval Oceanographic Office, Stennis Space Center, Mississippi. The images are based on AVHRR reflective measurements interpolated, averaged, and analyzed within a 10 km (~5 nmi) grid. The SST value is ground-truthed with drifting buoys. The error estimate for the images with reference to the buoys is described as  $\pm$  0.5 degrees. In parallel, for a nearshore fine-grain measurement, we use the SAUF1 National Data Buoy Station at the end of the St. Augustine Pier. Data are posted on the National Data Buoy Center website (Station SAUF1-St. Augustine, FL), and are available for download.

## 2.10 Outreach and Education

Engaging citizens and community is an important part of our core mission. Training and orientation sessions are given to volunteers and potential volunteers prior to and at the beginning of the season. As the season progresses, updates with information and results are scheduled. Updates are posted online at <u>marinelandrightwhale.blogspot.com</u>, and videos are posted on YouTube. We also give public talks, and respond to media requests, print and television. We also partner with other organizations, *e.g.*, the Blue Ocean Society, Portsmouth, New Hampshire.

#### 2.11 Data and Photo Analysis, and Submission

As is the custom, the right whale data and photos are submitted to the database and photo catalog maintained by the NEAQ, Boston, Massachusetts. The humpback whale data and photos are submitted to FWC, and subsequently to the Center for Coastal Studies, Provincetown, Massachusetts.

## **3.0 Results**

## **3.1 Sighting Effort**

## Shore-Based

Similar to previous years, 37 lookout points were monitored within the 60 nmi section of coast between the St. Augustine Inlet and the Canaveral Seashore (refer back to Figures 1 and 2). Included in these points were 28 points in the five sectors, two condo/community teams, as well as the lookout points provided by the Volusia County Beach Patrol. The 20 points and two condo/communities in Sectors 1 through 4, St. Augustine Beach to Ormond Beach, were surveyed seven mornings a week. The eight points in Sectors 5N and 5S, Ormond Beach to Daytona Beach South, were surveyed up to four mornings a week by two teams (partial coverage).

Dedicated surveys began on Sunday, 5 January 2020, and ended on Sunday, 15 March 2020. During this 10-week period, the dedicated mobile and community teams logged more than 1,080 hours of survey time, totaling 3,240 hrs of volunteer time. The lookouts generally began at 0800 hr and ended around 1200 hr. This combined effort was supplemented by opportunistic lookouts along the coast.

### 3.2 Right Whale Sightings 2019-20

## **Overall Sighting Summary**

During the 2019-20 season, the Marineland Right Whale Project had 15 right whale sightings (Table 1, Figure 6). The first of these sightings came on New Year's Day, 1 January 2020—an auspicious start to the season. Our most frequently sighted whales were female Catalog #3560 and her first calf, sighted on nine occasions. Female #3546, *Halo*, and her second calf were sighted on five occasions. A yearling, the 2019 calf of #1294 was sighted only once in our area. There were two conformed sightings of humpback whales.

The travels of mother #3560 and calf pair were unusual—after our last sighting on 12 February off Gamble Rogers State Park, they passed south of Cape Canaveral, passed by Miami, and were sighted off Key Largo on 20 February. On 15 March, they were off the Florida Panhandle. On 27 March, they were back south of the Florida Keys, and on 6 April were off Cape Lookout, North Carolina (Figure 7).

### UAS assisted Sightings

To aid in obtaining the aerial views of the dorsal head and body valuable to individual identification, and for entry into the right whale catalog, a drone (unmanned aerial system or UAS) was employed on nine occasions (see also Table 1). On several occasions, an image was relayed to the FWC Team to aid decisions about boat deployment. The complete set of aerial images was included with our data/photo submission to the database/catalog on 23 April.

#### Human Impacts

We did not observe any entangled, injured, or dead whales this season in the Marineland area. (However, see further information in the Discussion section.)

## 3.3 Quantification of Sighting Effort and Conditions

Sighting conditions and the likelihood of sighting whales are variable over space and time. On a finer scale, on a given day, the conditions may vary during the four-hour lookout shift, and over the geographic range covered by the five teams. To quantify and evaluate the daily sighting conditions over the 10-week survey period and across the areas covered by the five teams (approximately 60 nmi in latitudinal extent), daily records were summarized and evaluated. Three contributing components, sea state, sun, and visibility were rated over the 71 dedicated survey days. This resulted in an index value for each day (Figures 8 and 9). Of the 71 days, surveys were cancelled due to unsatisfactory conditions on 13 (18%), and on another 18 days (25%) survey conditions were rated as fair or poor. This left 40 days (56%) with good or excellent conditions.

## 3.4 Sea Surface Temperature

The large-scale sea-surface-temperature (SST) was monitored from the NAVOCEANO daily plots. Relative to at least some other seasons, the cool-water feature progressing southward along the coast was relatively undeveloped (Figure 10). While the 16° C isotherm extended south to Marineland, and the 20° C isotherm extended south of Cape Canaveral, the coldest "finger" (the purple color on the plot) stayed to the north. Likewise, the finer-grain SST as measured at the NOAA SAUF1 station at the St. Augustine pier showed a customary mid-season dip, but remained around 17°C. A comparison with other seasons indicated this was neither a "warm" nor a "cool" season, but rather a "middling" one (Figure 11). Lastly, in an across-season analysis, using 1 February as a reference point, in 2020 the SST was slightly cooler than the 16° C temperature we use as a reference point—just below average (Figure 12). There is variability in these index values, and the overall trend line suggests a slight cooling over time (likely not statistically significant).

## 3.5 Collaboration with the Florida Fish and Wildlife Conservation Commission Team

As in past seasons, an active and successful collaboration with other researchers is an essential component of this project. Collaboration on skills and resources increases the options available and the results obtained. In particular, the Marineland Right Whale Project and FWC shared resources and exchanged information before, during, and after the season. This was the case for flight planning, relay of sighting reports, and compilation of summary data and reports.

On two occasions (both on 25 January) we worked with FWC to aid their boat to the sighting location to obtain a biopsy sample. On three occasions we communicated the sighting location to the FWC survey plane. As an example, on 16 January, we had a single individual off Highbridge, in North Peninsula State Park. However, the distance was such that identification photos by us were unlikely. The FWC plane was diverted to our location and obtained the needed photos.

## 3.6 Volunteer Training and Public Outreach

The participation of local citizens is central to the program. This season, we had about

200+ dedicated participants (most of whom were returnees and had one or more years of prior experience), and many more when the opportunistic spotters are included. The training, education, and outreach are achieved through numerous meetings, seminars, and community presentations (Table 2). During sighting events, scientists and volunteers interact with the public and pass along information. This includes distribution of wallet cards that include the whale hotline phone number. This helps to increase the pool of opportunistic spotters.

As shown, we were involved with school, church, Elderhostel, environmental, community, and recreational groups.

We have learned that feedback and communication is essential to the success of a volunteer network. This includes regular gatherings, periodic newsletters, and e-mail updates. In this season, e-mail updates and reports were sent on a regular basis. The website (<u>www.aswh.org</u>) was updated at the beginning of the season. Sightings and results were posted for both volunteers and the public throughout the season at <u>marinelandrightwhale.blogspot.com</u>.

Copies of the "Marineland Right Whale Survey Project" were passed out, and the Team Handbook was updated and reprinted. (The Team Handbook was also posted on the website, <u>www.aswh.org</u>.

Our program information and results were provided to local news outlets, resulting in a number of newspaper articles.

Our volunteers were interviewed by News4/JAX on 10 February, and a documentary film crew, HitPlay Productions/Canadian Broadcasting Company, worked with us on 22, 23, and 26 February.

We invested in new video editing software to create short videos highlighting operations, whale behavior, and volunteer participation. By the end of the season, we had posted seven videos to our YouTube channel.

We partnered with the Blue Ocean Society, Portsmouth, New Hampshire, and used their educational "Year of the Right Whale Booth-in-a-Box" at presentations and a public talk at Gamble Rogers State Park on 11 January, the Flagler County Audubon Society on 13 February, and on other occasions.

We also participated in the Year of the Right Whale, Information and Planning, Zoom meeting, on 17 June 2020.

We worked with the Flagler Beach Historical Museum to install an educational exhibit on right whales in the Flagler Beach area. The materials provided included a cross section of photos and information. We also arranged for an illuminated entangled right whale sculpture by Kristian Brevik, Burlington, Vermont. This sculpture vividly displays an entangled whale, and engages the public on this important human impact. The April opening was cancelled due to the CoVid-19 pandemic. The opening will be rescheduled.

After the season was over, outreach continued. Research associate Sara Ellis contributed an article, *Whales and Scientists: Travelers*, to the Gulf of Maine Marine Educators Association Newsletter, April 2020. Program leader Jim Hain participated in an interview with First Coast News Jacksonville, on 13 July 2020.

#### 3.7 Contributions to Scientific, Management, and Conservation Forums

Marineland Right Whale Project season-summary materials were contributed to the North Atlantic Right Whale Southeast Implementation Team Meeting, 20 May 2020—held via webinar.

## 3.8 Disposition of Data

The submission of data and photographs to the Right Whale Catalog at the New England Aquarium, Boston, Massachusetts, took place on 23 April 2020. The data and photographs of humpback whales were provided to the FWC team, and subsequently to the Center for Coastal Studies, Provincetown, Massachusetts.

## **4.0 DISCUSSION**

### 4.1 Twenty years of the Marineland Right Whale Project

During the period 2001 through 2020, the Marineland Right Whale Project recorded 454 right whale sightings. From these, 79 mother-calf pairs, 33 non-reproductive females, 60 males, and 61 calves have been entered into the North Atlantic right whale catalog. The number of sightings by the project during the 20-year period has been highly variable, ranging from 63 in 2010 to zero in both 2017 and 2018 (Figure 13).

The shore-based Volunteer Sighting Network continues to be the core of the program. This has been augmented by vessels and aerial platforms, including airships, fixed-wing aircraft, and currently, multi-rotor drones.

Community outreach and engagement is a program component. We have given presentations to Flagler Audubon, Georgia Aquarium volunteers, University of Florida, Flagler Women's Club, Sierra Club, school groups, and diverse public groups.

Our scientists and volunteers make a point to interact with the curious public during sighting events. When we first began the program, a common response from folks we met was, "I didn't know there were any whales down here." Since then, this has changed. Now, a common reaction from folks we encounter, "Have you seen any whales today?"

Likewise, on the scientific side, we have participated in meetings of the Southeastern U.S. right whale implementation team, the annual meetings of the North Atlantic Right Whale Consortium, the Atlantic Large Whale Take Reduction Teams, annual meetings of the Marine Mammal Commission, and the Recovery Program Review of April 2016.

#### 4.2 Technological Advances

The availability of moderately priced and high capability multi-rotor drones has considerably enhanced the capability of the shore-based network. Now, when a sighting is made from shore, a drone can often be deployed to obtain the desirable overhead identification photos (Figure 14).

## 4.3 Sea Surface Temperature

Sea surface temperature is likely one of many factors that influences the distribution of right whales in Florida. A preliminary inspection of Figures 12 and 13 suggests that "cold" years result in a more southerly distribution of the whales into the Marineland area. However, the correlation is incomplete. In 2018, for example, the temperature was cold but the whales were absent.

## 4.4 An Imperfect Sighting Effort

While the volunteer network provides "eyes on the water," periods of windy and stormy weather (sometimes over several days) compromise the sighting effort. In 2019-20, this left perhaps 30% of days with poor or no sighting effort. This introduced further uncertainty into our sighting data.

#### 4.5 Population Status and the Future

As of 4 September 2019, the best estimate for the North Atlantic right whale population size at the end of 2018 is 409 (www.narwc.org). This is a decrease from an estimate of 522 at the close of the 2013 year, and a downward trend since that time. The estimates are influenced by uncertainty, assumptions, and caveats. The actual number is unknown. However, as Richard Pace (NMFS Northeast Fisheries Science Center) has pointed out, the numbers are less important than the trend. It is likely that the downward trend is real, and a cause for concern.

### 4.6 Human Impacts and the Numbers

In the 2019-20 season, 10 calves were born. The calf of Female #2360, *Derecha*, was seriously injured and probably mortally wounded in early January. The calf of female #3560 was killed by a vessel strike in June (Figure 15).

In the past five years, 33 calves have been born (average=7 per year). During the same period, 36 mortalities were reported. Taking into account the unreported mortalities, the cause of the downward trend is clear.

## 4.7 Thoughts while Looking Forward

In recent years, mathematical modeling used to generate estimates of right whale population size and corresponding parameters has increased in visibility. At the same time, field biology and basic natural history studies—"on-the-ground biology"—are somewhat less favored. However, these remain important, both in their own right, and because they provide essential information to plug into the models.

The volunteer network of citizen scientists fills two important gaps. The first is geographic—monitoring and providing stewardship for an area of critical habitat to the south of the "core area." The second is engagement—actively engaging a diverse and broad part of the public beyond what more typical scientific efforts might reach.

Lastly, two decades of study have revealed both a generalized regularity and a particular unpredictability for right whales occurring in Florida waters.

Will we be able to learn enough, and soon enough, to help ensure the successful coexistence of whales and humans?

## Acknowledgments

First and foremost, we are grateful for the good efforts and strong commitment of our research associates, Sara Ellis and Joy Hampp. Ralph Bundy, Terry Clark, Sara Ellis, and Joy Hampp are our capable drone operators. Program support is, or has been, provided by the U.S. Army Corps of Engineers, Jacksonville District; the Batchelor Foundation, the Elizabeth Ordway Dunn Foundation, Victoria Principal Foundationl, the Deerbrook Trust, the Lastinger Family Foundation, and private donors. In-kind services are provided by the University of Florida's Whitney Laboratory, the Guana-Tolomato-Matanzas National Estuarine Research Reserve, Jacoby Development, Inc., the Marineland Dolphin Adventure, the Volusia County Beach Patrol, and many others. Collaboration and assistance with research and analysis was provided by the Marine Resources Council, the Florida Fish and Wildlife Conservation Commission, and the New England Aquarium. Research was authorized by NOAA/NMFS research permit #20626.

Date	Day	Time <sup>1</sup>	Location	Lat <sup>2</sup>	Long <sup>2</sup>	Species/ Class <sup>3</sup>	Hdg	Pager #	Notes (Who sighted, etc.)	Verified?/ Photos?
23 Dec	Mon	16:22	Cardinal Dr., Ormond Beach			RW ?	S		Beach patrol, relay MRC, no MLD response, late in day	N/N
1 Jan	Wed	14:02	Ormond-by-the- Sea	29 21.2	81 03.7	RW	S	FWS004	Ralph drone, Martha beach, FWC plane	Y/Y #3560 & calf
5 Jan	Sun	12:58	Varn Park	29 32.0	81 08.5	RW	VAR		Distant, Martha photos from beach; Jim photos FBTS	Y/Y #3560 & calf
6 Jan	Mon	09:59	Flagler Beach	29 27.6	81 06.8	RW		VSN001	Jim, big camera, photos from beach Danny Meyer, drone	Y/Y #3560 & calf
10 Jan	Fri		Ormond-by-the- Sea			RW ?		VSN002	Puzzle about sighting	Y/N
13 Jan	Mon	13:50	Ormond	29 18.0	81 02.0	RW	S	VSN003	Ralph, drone	Y/Y #3560 & calf
14 Jan	Tue		Highbridge							Scoter ducks
16 Jan	Thur	11:54	North Peninsula State ParkP	29 24.6	81 05.0	RW	S	FWS021	Vols called, land photos, Jim & Martha., Single, Highbridge	Y/Y FWC posit & photo 2019 c of 1204, a yearling
25 Jan	Sat	09:32	Flagler Beach	29 28.2	81 07.1	RW	S	VSN004, FWS026	Julie MRC relays call, Sara photos from beach	Y/Y, #3560 & calf FWC plane & boat dart
25 Jan	Sat	11:50	Crescent Beach	29 44.7	81 14.3	RW	VAR	FWS025	FWC relays call to vols, Team 1 verifies, Martha photos from beach.	Y/Y, #3546 Halo & calf FWC boat dart
26 Jan	Sun	09:25	Malacompra to Jungle Hut	29 37.0	81 10.9	RW	S	Not paged out ?	Julie MRC relays call, Sara big camera from beach, Starbuck FAU	Y/Y, #3546 Halo & calf

Table 1. Sighting summary 2019-20 season. Collaborative reports of the Marineland Right Whale Project and the Marine Resources Council.

27 Jan	Mon	10:47	South Flagler Beach	29 27.0	81 06.3	RW	S	VSN006	Martha photos from beach	Y/Y, #3546 Halo & calf, Terry drone, Sara drone flight #1
27 Jan	Mon	11:58	Sunsplash Park, Daytona Beach	29 13.1	80 59.7	RW	VAR	VSN007		Y/Y, #3560 & calf Ralph drone
31 Jan	Fri	09:40	Canaveral, Cocoa Beach	28 20.3	80 35.9	RW	STA	VSN008, RSRCH007	MRC, Blue Water Research Institute	Y/Y, #3546, Halo & calf, D. Colmenares photos
4 Feb	Tues	14:31	Daytona Beach	29 09.9	80 57.8	RW	N	VSN009		Y/Y, #3546, Halo & calf, Ralph drone
4 Feb	Tues	15:29	Sebastian Inlet	27 55.2	80 28.4	RW, SING	STA	VSN011	MRC	
5 Feb	Wed	08:07	N Flagler Beach to 16th Rd	29 31.6	81 08.5	RW	N	VSN012	Tony C, Dave Gustafson	Y/Y, #3546 Halo & calf, Sara drone
7 Feb	Fri		Jungle Hut							Not verified
8 Feb	Sat	13:34	Ocean Hammock Park	29 49.9	81 15.4	RW	VAR	VSN013, FWS041	Kim, Team 1 Sat calls	Y/Y, #3560 & calf, Sara drone
10 Feb	Mon		SunGlow Pier to Ponce Inlet						RW or HU, UNK	N/N
11 Feb	Tues	12:27	Marineland	29 39.9	81 12.1	RW	S	VSN did not get paged out,FWS042	Terran relay from Marineland Dolphin Adventure	#3560, Sara drone, FWC plane
12 Feb	Wed	12:12	Gamble Rogers	29 26.4	81 06.0	RW	S	VSN014	fog, brief window, drone	Y/Y, #3560 & calf, Sara drone
16 Feb	Sun	11:54	Sebastian Inlet.	27 50.1	80 25.8	RW	S	VSN016	MRC , BWRI, FB	Y/Y, #3560 & calf
19 Feb	Wed	10:14	N Flagler	29 31.2	81 08.3	HUWH	Ν		Martha got pics	Y/Y, SEUS2005
20 Feb	Thur	15:05	Ponce Inlet	28 51.6	80 46.4	RW, SING	Ν	VSN019	Canaveral staff to MRC, Species ID only	Y/N
24 Feb	Mon	Ĩ	Ormond Beach			UNK			Not verified, HUWH ?	N/N
25 Feb	Tues		S Flagler Beach			HUWH			Team 3, not resighted	Y/N

Table notes:

>> all positions are whale positions rather than observer positions
 <sup>1</sup> Time = time of initial report or species verification
 <sup>2</sup> Lat and Long = position when verified and photographed
 3 RW=right whale, HUWH=humpback whale, SING=single individual

Table 2. Presentations to groups and organizations, 2019-20 season

Date	Presenter	Detail					
4 January	Jim Hain	Training class held for new and returning Project surveyors at Whitney Center for Marine Studies, U. of Florida Whitney Laboratory, Marineland; 180 attended					
8 February	Jim Hain, Sara Ellis	Mid-Season update for Project surveyors at Whitney Center for Marine Studies, U. of Florida Whitney Laboratory, Marineland; ~ 150 attended					
21 March		Season-end event, Whitney lab, cancelled due to COVID-19.					

A: Volunteer Recruitment/Training

B: Public Education/Outreach

Date	Presenter	Detail
3 Dec	Joy Hampp	Flagler County Public Library, 8 attended
6 Dec	Joy Hampp	St. Johns County Public Library, 32 attended
14 Dec	Frank Gromling	Ormond Beach Environmental Discovery Center, 28 attended
11 Jan	Jim Hain & Sara Ellis	Gamble Rogers State Park, 54 attended
13 Feb	Frank Gromling, Jim Hain	Flagler Audubon Society, Palm Coast Community Center, 40 attended
18 Feb	Mike Adams, Sara Ellis, Joy Hampp,	Embassy Suites Hotel, Public, 54 attended



Figure 1. The 37 lookout points used by shore-based spotters in the Marineland Project during the 2019-20 season. Although there have been small adjustments to locations, and some points may be added or removed, the overall sighting effort has remained fairly constant for the past several years. The boundary of the 2016 SEUS right whale critical habitat (blue line) and three near-shore depth contours (labeled) are shown.



Figure 2. The study area is divided into five sectors. Each sector is monitored by a mobile team, with the exception of Sector 5. The larger sector 5 is divided into north and south, each with a team.



Figure 3. A core of 200+ dedicated and capable volunteers provide "eyes on the water." Many eyes are the antidote to few and widely scattered whales. The volunteers include fishermen, beach walkers, condo dwellers, town and county employees, and the teams that conduct surveys from January through mid-March. In this example, a team called in a sighting and a response team with a drone was deployed to obtain images and video.



Figure 4. The central call-in and dispatch office at the Guana-Tolomato-Matanzas National Estuarine Research Reserve facility in Marineland is manned during daylight hours. This is also the repository for equipment, data, and images.



Figure 5. Our program is evolving as technology and tools evolve. Beginning in 2016, we have employed a quadrotor drone. When used within our protocols, this provides unobtrusive photo and video capability. And, it is a highly cost-effective method for aerial data collection. (Top) The DJI Phantom III Pro quadrotor drone, controller, sunshade, filters, spare batteries and backpack.

(Bottom) An example of a beach-launch setup. As we are often in view of the public, the drone operator and spotter wear identification vests. A third person is on-scene to interact with public and answer questions.



Figure 6. Verified right whale sightings by the Marineland Right Whale Project, 2019–20 season, n=15. The plot projection is Mercator. The solid blue line indicates the boundary of the right whale critical habitat as revised in 2016.



Figure 7. Sightings of female #3560 from 27 November 2019 to 6 April 2020. Female #3560, age 15, was a first-time mother, with calf #1. The initial sighting for the season was off Sapelo I., Georgia (prior to calving) on 27 November. She was seen with a calf for the first time on 16 December. There was a series of near shore sightings of the mother-calf pair up through 12 February. Shortly thereafter, they were sighted south of Cape Canaveral, off Miami, off the Keys, off the Panhandle, back south to the Keys, and finally off Cape Lookout, North Carolina, on 6 April. The critical habitat boundary of February 2016 is shown. Assistance with sightings compilation by the FWC Team.



Figure 8. Effective surveys and the ability to reliably sight whales should they be present depends on the interplay of wind and weather—depicted here as consisting of three components. The fourth panel (lower right) summarizes the results of the components. A full survey consists of four hours (approximately). A partial survey suggests that a survey effort was begun but subsequently terminated due to poor or deteriorating conditions. A determination for a cancelled survey would have been made the evening prior or the morning of.

Rating	Sea State	Sun	Visibility	Survey Level
Excellent	0, 1, or 2	Full, or mostly sunny	Clear	Full
Good	0, 1, or 2	Partial to none	Clear	Full
Fair	3	Full, partial, none	Any (inc fog or haze)	Full
Poor	4	Full, partial, none	Any (inc fog or haze)	Full or partial
Cancelled	NA	NA	NA	Cancelled

Table 3a. Coding of the survey conditions.

Table 3b. The number of survey days for each category.

Code	Index Value	Count
А	Excellent	19
В	Good	21
С	Fair	6
D	Poor	12
Е	Cancelled	13

The four component factors (previous page and Table 3a) were coded or ranked and then assigned to a summary table with index values for survey or sighting effort quality (Table 3b and figure below.



Figure 9. The 71 dedicated survey days in the 2020 season were rated according to survey or sighting quality. Of the total days, 57% were excellent or good, 25% were fair or poor, and 18% of the days had cancelled lookouts.



Figure 10. The Sea-Surface-Temperature (SST) as interpolated from satellite-based AVHRR measurements provide the big-picture view of ocean temperature features—the warm Gulf Stream is shown just to the left of bottom center (brown), and the cool-water feature developing southward along the Georgia-Florida coast is shown in the upper left (blue). The red symbol indicates the location of Marineland as a reference point. In this image from mid-season, on 1 February 2020, the cool water feature extends well southward, and the SST in the Marineland area is about 16° C.



Figure 11. The SST in C° as measured at the National Data Buoy Center station on the end of the St. Augustine pier during the 2019-20 season (red symbols). The 2020 average SST suggests neither a "warm" nor a "cold" year. For comparison, 2005, 2010, and 2018 had periods of cold temperatures. (See also Figure 12.)



Figure 12. An index of SST, measured in °C in the Marineland area from 2000 through 2020. The values are assigned based on the degree that the average SST on 1 February was above (red) or below (blue) the 16° C reference level (a value based on Garrison (2007) and adapted for the Marineland area). The index is imperfect, as the NOAA data station on the end of the St. Augustine pier was inoperative in 2014 and 2015, and the intake water temperatures from the Marineland facility were used instead. A trend line suggests a slight (~0.5 ° C) cooling trend during the 21-year period.

*Garrison, L.P. 2007. Defining the North Atlantic Right Whale Calving Habitat in the Southeastern United States: An Application of a Habitat Model. NOAA Technical Memorandum NOAA NMFS-SEFSC-553: 66 p.* 



Figure 13. Total number of right whale sightings in the Marineland area, 2001 through 2020. Note the variability, with a low year in 2012 with two sightings, both of the same single individual, and the absence of sightings in 2017 and 2018.



Figure 14. Female Catalog #3560 and her first calf off Gamble Rogers State Park on 12 February 2020. The distance from the observers to the sighting was 0.6 nmi. The drone was deployed, flown to the sighting location, and this top-down shot was obtained. These vertical shots are preferred for the North Atlantic Right Whale Catalog. The shore-based observers with binoculars and the drone are synergistic. Photo taken under NOAA/NMFS research permit #20626.



Figure 15. After a season with frequent sightings of #3560 and her calf, the reality of human impacts that impede the growth of the right whale population set in. On 25 June 2020, a dead floating carcass was reported off New Jersey. It was the calf of #3560, seen in the previous photo. The cause of death was attributed to one or more collisions with vessels (note the propeller marks on the anterior left dorso-lateral surface). Image: Center for Coastal Studies under NOAA/NMFS research permit #18786-04.