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

2016-17 SEUS Season

**A Report to:** Volunteers, Collaborators, and Sponsors

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

2016-17 SEUS Season

#### Summary

The Marineland Right Whale Project completed the 17<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. Our work merges into the bigger picture. The bigger picture is worrisome.

At the 16<sup>th</sup> annual meeting of the North Atlantic Right Whale Consortium, 22 October 2017, Halifax, Nova Scotia, the concerns for the species were elevated. Reports at the meeting described a reduced calving rate, an increased calving interval, the absence of first-time mothers, an increase in mortalities, and a declining population. As reported in the November 2017 issue of *Right Whale News* (see <u>www.narwc.org</u>), as of 1 September 2017, the catalogued population through the end of 2016 was estimated at 529 individuals (previous estimates were 524 for 2015 and 526 for 2014). However, in comparison, Richard Pace, Northeast Fisheries Science Center, based on modeling results, estimated the population through 2016 as 451 individuals.

The numbers of births and mortalities contribute to the concern. In 2017, there were five calves born (the 10-year average is 20), with an average calving interval of 10 years (the 10-year average is 4 years). There were no first-time mothers in 2017, another unusual and worrisome element. Heather Pettis, New England Aquarium, reported that, of the reproductive females available to calve in 2017, only 7% actually did calve. Again, a worrisome finding. For mortalities, 16 mortalities have been reported thus far in 2017, 4 in U.S. waters and 12 in Canadian waters.

Perhaps a premonition of these concerns came in the 2016-17 season in the southeastern U.S. We, the Marineland Right Whale Project, for the first time in our 17-year history, had no right whale sightings. (Recall that in 2012, we only had two sightings, both of the same individual.) For the combined efforts of all research and monitoring teams, there were only three

mother-calf pairs reported and a single adult male—a total of seven individuals for the entire southeastern U.S.

Challenges this season included poor weather, and previous lookout points (*e.g.*, walkovers and viewing platforms) damaged or inaccessible due to hurricane Matthew in October.

The only right whale sightings south of St. Augustine this season were far to the south—a mother-calf pair (Catalog #1711 and her 3<sup>rd</sup> known calf) reported off Satellite Beach on 14 January, and in the Sebastian Inlet (latitude 27°53') the following day (15 January) by our collaborators, the Marine Resources Council. (Recall the Sebastian inlet incursion by mother-calf pair, Catalog #3450, *Clipper*, and her 1<sup>st</sup> calf on 8-9 February 2016.) Aside from a puzzling curiosity, these "data outliers" provide valuable information.

Humpback whales were sighted in the area south of St. Augustine on 10 occasions.

All in all, this was the lowest number of right whale sightings since the program began in 2001. Considering the overall concern for the status/condition of the North Atlantic right whale, there is an increased need for the best efforts of the programs like the Marineland Right Whale Project.

Due to the lack of sightings, the surveys were ended two weeks early, on 26 February. We made a similar decision back in 2012.

Outreach and education continued—five presentations to volunteers and 12 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.

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

A collaboration of two organizations, Associated Scientists at Woods Hole and the Marine Resources Council, have joined in providing 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 a volunteer network—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 2016-17 season was its 17<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 endangered North Atlantic right whale, *Eubalaena glacialis*. The small population numbers about 451, with a small number of calves born each year (the average in the recent 10 years has been 17).

Florida's coastline includes 175 nautical miles (nmi) of right whale critical habitat. (Note that a revised and enlarged right whale critical habitat was designated on 27 January 2016.) In the 2016-17 season, as in several 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— a collaboration between Associated Scientists at Woods Hole and the Marine Resources Council.

#### **1.3 Monitoring Priorities**

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

### **1.4 Collaborations**

Throughout, 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 Commission Team. More broadly, we collaborate/communicate with the Georgia DNR/Sea to Shore Alliance 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 17 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
- Aircraft surveys and response
- 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 the 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 the complementary aerial surveys, 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. The shore-based monitoring extends south to Ponce Inlet (29°04'), while the aerial survey monitoring extends further 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 from the shore, the air, and occasionally from a vessel. Likewise, the response, extended observations, and photographs may include shore, air, vessel, and/or a combination. 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, 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. 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 dune walkovers, or the balconies of shorefront buildings. In both cases, most watches are concluded by 1230 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 2) provides effective coverage of our ~ 60 nmi section of coastal habitat.

#### 2.5 Aerial Surveys and the AirCam

To complement the shore-based network, aid in obtaining high-quality identification photos, and provide additional search effort (including in the area beyond ~2 nmi from the shore), we utilize a small, quiet, open-cockpit aircraft designed specifically for wildlife surveys and photography (an AirCam). The aircraft is hangered in Hastings, Florida, about 15 nmi west of the Matanzas Inlet. Survey flights are weather-dependent (clear skies, winds  $\leq 12$  kt, and sea states  $\leq$  Beaufort 3). Based on these criteria, we typically fly two to three times a week. The plane functions in two modes—flying a standard survey pattern (Figure 3), and responding to reported sightings. During flights, a Garmin GPS Map 296 automatically records the GPS positions every 30 sec, as well as on demand at waypoints, conditions changes, and sighting locations. As in previous seasons, we monitor the aircraft's flights in real time through the use of a SPOT Gen3 satellite messenger. The SPOT Gen3 transmits the aircraft position every 10

minutes, which can be viewed on a computer, tablet, or smart phone. The SPOT unit is also capable of emergency notification, and sending GPS location-based messages, such as when the aircraft is preparing for takeoff or has landed at the conclusion of a flight. Our protocols include a feature offered by Lockheed Martin Flight Services where the AirCam's SPOT positions are relayed to the Lockheed Martin system for automated flight monitoring. This adds an additional layer of aircraft tracking and safety.

#### 2.6 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 1.5 or 2.0 Canon telextender).

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.

### 2.7 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 and paddleboarders/surfers.

Data and photo documentation are submitted to NOAA law enforcement, the Whale-Vessel-Interaction database maintained by the Florida Fish and Wildlife Conservation Commission (FWCC), 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 any combination of the sectors we designate 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. Having the 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 during surveys and follows.

#### 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. After a gap in 2014 and 2015, the SAUF1 station was fully operational in the 2016-17 season.

#### 2.10 Quantification of Aerial Survey Effort

In the 2011-12 season we sought to quantify the aerial survey effort incorporating consideration of survey conditions. In this way, a sightings-per-unit (SPUE) value could be prepared, and compared across seasons. We also sought to evaluate the merits of comparing SPUE with the other aerial survey teams. Working with Dr. Robert Kenney, Graduate School of Oceanography, University of Rhode Island, we established protocols and created datasets aimed at quantifying the aerial effort data for our area. This proved to be more complicated than anticipated. Secondly, in our case, calculation of SPUE is confounded by the interplay of shorebased and aerial sightings. As a result, in the 2016-17 season, we continued to record and tabulate data in a more streamlined fashion.

#### 2.11 Unmanned Aerial System (UAS) and Observations

On 13 October 2015 we purchased a DJI Phantom 3 Pro multi-rotor drone or UAS. On 10 February 2016, we received the Section 333 Exemption from the FAA to authorize our operation for research purposes. On 29 August 2016, the FAA implemented the new Part 107 small UAS rule, which facilitates our operation. A remaining hurdle for our particular operation was obtaining authorizations to operate within state and national park boundaries (when we are

beach-launching), and a waiver to operate within 5 nmi of an airport. Applications were submitted, and authorizations are in place for the coming season.

#### 2.12 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 New England Aquarium, Boston, Massachusetts. The humpback whale data and photos are submitted to the Florida Fish and Wildlife team, 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 Figure 1). Included in these points were 28 points in the six sectors, 3 condo/community teams, as well as the lookout points provided by the Volusia County Beach Patrol. The 20 points and 3 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.

Dedicated surveys began on Monday, 2 January 2017 (3 locations were affected by Hurricane Matthew: Matanzas, Washington Oaks, and Malacompra). Due to lack of sightings, we ended the surveys early this season, on Sunday, 26 February 2017. During this eight-week period, the dedicated mobile and community teams logged 1,302 hours of survey time, totaling 3,580 hrs of volunteer time), generally beginning at 0800 hr and ending around 1200 hr. This combined effort was supplemented by opportunistic lookouts along the coast.

#### Aerial Surveys and Photo-Documentation

From 28 December 2016 to 12 February 2017, the Associated Scientists/Marineland group made 10 flights in the SEUS with the AirCam on 10 separate days (Table 1). In the course of these flights, there were no right whale sightings. There was a humpback whale sighting on 25

January. Due to poor conditions, there were no flights during the six-week period from mid-February to late March.

### 3.2 Right Whale Sightings 2016-17

### **Overall Sighting Summary**

In the 2016-17 season, there were no right whale sightings in the Marineland area (St. Augustine inlet to Canaveral Seashore).

The only right whale sightings south of St. Augustine this season were far to the south—a mother-calf pair (Catalog #1711 and her 3<sup>rd</sup> known calf) reported off Satellite Beach on 14 January and in the Sebastian Inlet (latitude 27°53') the following day (15 January) by our collaborators, the Marine Resources Council.

Humpback whales were sighted in the area south of St. Augustine on 10 occasions (Table 2).

### Aircraft Sightings

From 28 December 2016 to 12 February 2017, the Associated Scientists/Marineland group made 10 flights in the SEUS with the AirCam on 10 separate days (Table 1). In the course of these flights, there were no right whale sightings. There was a humpback whale sighting on 25 January. Due to poor conditions, there were no flights during the six-week period from mid-February to late March.

### Human Impacts

We had no entangled, injured, or dead whales this season in the Marineland area.

# 3.3 Quantification of Aerial Survey Effort

As described, we developed a streamlined collection and tabulation of effort data in the 2012-13 season. The survey effort and sightings-per-unit-effort values are also shown in Table 1.

#### 3.4 Unmanned Aerial System (UAS) Observations

Due to the absence of whales in our area, the UAS was not employed for right whale observations in the 2017 season.

#### 3.5 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 cold-water feature progressing southward along the coast was relatively undeveloped (Figure 5). The finer-grain SST as measured at the NOAA SAUF1 station at the St. Augustine pier showed the customary mid-season dip A comparison to other seasons indicated this was neither a "warm" nor a "cool" season, but rather a "middling" one (Figure 6). Lastly, in a cross-season analysis, using 1 February as a reference point, in 2017 the SST was slightly warmer than the 16° C temperature we use as a reference point—just above average (Figure 7).

#### **3.6 Weather and Survey Conditions**

As described, continued emphasis and training were placed on the dedicated surveyors' documentation of environmental conditions, providing better quality data to analyze surveys and weather conditions. Of the 56 total survey days, full surveys were conducted in good weather conditions on 34 days (55%)—an increase over last season (Figure 8). On 23 days (41%), full or partial surveys took place under moderate or poor weather conditions. On 2 survey days (4%), no surveys took place, or, less than 25% of the survey area was covered due to high winds, fog, or extreme cold. Windy conditions that produced increased Beaufort sea states were the principal causal factor in approximately 80% of the survey days that had moderate or poor weather conditions. Fog and rain were secondary factors at 16 and 4% respectively.

#### 3.7 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 the Florida Fish and Wildlife Conservation Commission 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.

#### 3.8 Volunteer Training and Public Outreach

The participation of local citizens is central to the program. This season, we had about 220+ 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 3). 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. In addition, sightings and results were posted for both volunteers and the public in a timely manner at <u>marinelandrightwhale.blogspot.com</u>.

The "Marineland Right Whale Survey Project" brochure was on hand, 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.

#### 3.9 Disposition of Data

Due to the absence of right whale sightings, the usual submission of data and photographs to the Right Whale Catalog at the New England Aquarium, Boston, Massachusetts, did not occur this year. The data and photographs of humpback whales were provided to the Florida Fish and Wildlife team, and subsequently to the Center for Coastal Studies, Provincetown, Massachusetts.

### **4.0 DISCUSSION**

### 4.1 Perspective

Until about 2011, we believed that we were monitoring and encouraging slow and steady progress for conserving and recovering the small population of endangered North Atlantic right whales. This has changed. We are now working to understand a downturn. This involves asking and answering questions, and addressing the unknowns. This mission goes beyond right whales. It extends to overall environmental awareness and stewardship.

### 4.2 Overview

Effective conservation and management depends on good information. After 17 years, that information is telling us that right whale distribution and abundance in our area is fluid and dynamic. There is uncertainty with the population size and distribution, variable environmental conditions, variable right whale biology, and changing demographics on the SEUS calving and wintering ground (and elsewhere). While we often search for means, patterns, and predictions; recording, analyzing, and understanding the variability of the many environmental and biological parameters is key to our improved conservation and stewardship of the ocean and its inhabitants. The longer we study the species, the less predictability we find.

### 4.3 The Big Picture

At the 16<sup>th</sup> annual meeting of the North Atlantic Right Whale Consortium, 22 October 2017, Halifax, Nova Scotia, the concerns for the species were elevated. Reports at the meeting described a reduced calving rate, an increased calving interval, the absence of first-time mothers, an increase in mortalities, and a declining population. As reported in the November 2017 issue of *Right Whale News* (see <u>www.narwc.org</u>), as of 1 September 2017, the catalogued population through the end of 2016 was estimated at 529 individuals (previous estimates were 524 for 2015 and 526 for 2014). However, in comparison, Richard Pace, Northeast Fisheries Science Center, based on modeling results, estimated the population through 2016 as 451 individuals.

The numbers of births and mortalities contribute to the concern. In 2017, there were five calves born (the 10-year average is 20), with an average calving interval of 10 years (the 10-year average is 4 years). There were no first-time mothers in 2017, another unusual and worrisome element. Heather Pettis, New England Aquarium, reported that, of the reproductive females available to calve in 2017, only 7% actually did calve. Again, a worrisome finding. For

mortalities, 16 mortalities have been reported thus far in 2017, 4 in U.S. waters and 12 in Canadian waters.

Perhaps a premonition of these concerns came in the 2016-17 season in the southeastern U.S. We, the Marineland Right Whale Project, for the first time in our 17-year history, had no right whale sightings. (Recall that in 2012, we only had two sightings, both of the same individual.) For the combined efforts of all research and monitoring teams, there were only three mother-calf pairs reported and a single adult male—a total of seven individuals for the entire southeastern U.S.

On all counts, large changes are occurring in region and in the SEUS.

### 4.4 Surveys and Sightings

For the Marineland Right Whale Project, from 2001 through 2011, the total number of sightings per year showed a general upward trend (Figure 9). However, for the recent 5-year period, 2012 through 2017, the number of sightings were at a lower level. This decrease was similarly reflected in the number of mother-calf pairs sighted in the SEUS (Figure 10). There are likely several contributing factors—of which we have a poor understanding.

The "outliers" to the general distribution are of interest. What do they tell us? In two seasons, a mother-calf pair was reported to the south and with an incursion into the Sebastian Inlet. On 15 January 2017, Female #1711 (30 years old) and her 3<sup>rd</sup> known calf made the incursion. Previously, on 8-9 February 2016, Female #3450, *Clipper* (age unknown but at least 12 years old), and her 1<sup>st</sup> calf made the incursion. In addition to these reports, one or more right whales are reported from south of Cape Canaveral in some or many years.

#### 4.5 Human Impacts

While no human-impacted individuals were sighted in the Marineland area this season, there was one noteworthy event. The June 2017 *Right Whale News* reported that on 5 January 2017, a Florida Fish and Wildlife Conservation Commission (FWC) survey aircraft sighted a 13-year-old male right whale, #3530, *Ruffin*, entangled, about 20 miles east of Little Cumberland Island, Georgia. Heavy rope passed through the whale's mouth, passed over the back, and trailed behind. Early on the morning of the 6<sup>th</sup>, a disentanglement response by Georgia Department of Natural Resources (GDNR) and FWC was initiated. By noon, the whale was gear-free. This whale was subsequently re-sighted post disentanglement, 17 nmi east of Fernandina Beach, Florida, on 14 January 2017, and in Cape Cod Bay, Massachusetts, by the Center for Coastal Studies on 19 February 2017. Subsequent examination of the gear revealed that this whale had

dragged Canadian snow-crab gear down from the Gulf of St. Lawrence (Figure 11)—reminding us of the scope of these entanglements.

# 4.6 Sea-Surface Temperature

SST continues to be examined as a correlate to right whale distribution and abundance. The 11 March 2015 repair of the NDBC sensor at the end of the St. Augustine pier was welcome, and continues to contribute to continuing analyses of this factor. As seen back in Figure 7, the SST in the Marineland area appears to be warming. Does this constitute a cyclical event or a trend, or, a combination of both? As a further confounding factor, inspection of this figure reveals no conspicuous correlation between "cold" and "warm" seasons and abundance of right whales.

# 4.7 Conservation and Management

The Marineland Right Whale Project has completed its 17<sup>th</sup> year of right whale monitoring in a 60 nmi section of the SEUS right whale critical habitat. The program is a successful combination of public engagement and careful science. The volunteers are an invaluable resource, and we continue to refine the approaches and methods that optimize their contribution.

A major product of the program is the awareness and engagement of a diverse local citizenry. As described, sightings reported from both dedicated and opportunistic sources is a direct result of heightened awareness and interest.

Collaboration with other investigators and programs continues to yield results. Information, sightings, and photographs from multiple sources (shore, boat, plane), multiple investigators (FWCC, MLD, MRC, NEAQ), and multiple seasons, are producing an accurate description of the SEUS biology of right whales and their habitat. Information and perspective gained from our program is regularly provided to the SEUS Right Whale Forum and SE US Right Whale Recovery Plan Implementation Team.

Monitoring and conservation of the whales and their ocean habitat continues. Continuing monitoring and diligence is warranted. Our efforts continue to be aimed at the successful co-existence of right whales and humans—for this generation and the next.

The cornerstones of our program continue to be careful science, thoughtful analyses, good people, and contribution to conservation and management—all held over the long term.

#### 4.8 Concluding Thoughts

In the 2016-17 season, there were only three calves born in the SEUS. And, there were no right whale sightings in the Marineland area. What has been learned? What is the value of the work?

Simply this: there are two sides to the equation ... mortalities and births. The known mortalities in 2017 were high. The calf production in 2017 was low. The mission of our program, as well as that of others, is to study and understand the input side of the equation: the calf production, as well as the corresponding habitat and human-impact factors.

The work can be daunting, discouraging, and perplexing; but also sometimes rewarding. With our continuing good efforts, and a bit of resolve, perseverance, and stamina, future generations of whales and humans can (hopefully) and successfully co-exist. We can address this and other environmental problems. We can collectively be part of a solution. We have a 17year dataset to draw on. Throughout, there is the demonstrated value in citizen awareness and engagement.

#### Acknowledgments

First and foremost, we are grateful for the good efforts and strong commitment of our volunteers. Joy Hampp, Terry Clark, and Becki Smith are program coordinators and also the very capable aerial survey team. 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 Foundation; 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, the Volusia County Beach Patrol, Jacoby Development, Inc., the Marineland Dolphin Adventure, 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 authorized by NMFS permit #13927.

Table 1: AirCam Survey Effort Summary 2016-17. Flown as a dual-purpose survey (right whales and manta rays) on parallel 0.5 and 1.5 nmi tracklines. The standard survey area extends from the St. Augustine Inlet south to the Canaveral National Seashore. This pattern is a total of 134 nmi. "Good" trackline is defined as clear visibility of at least 2 nmi and Beaufort sea state  $\leq 3$ .

DATE	DAY	CAT	PERS	HRS	TOTTRACK	TOTPOOR	TOTGOOD	EFFORT	SPUE	SIGHTS	NOTES
					(nmi)			(km)	(per km)		
12/28/16	Wed	Partial	Hampp & Clark	2.3	89	0	89	164.7	0.00	0	Shortened survey due to a.m. fog
1/05/17	Thur	Complete	Hampp & Hain	3.1	134	0	134	247.9	0.00	0	
1/11/17	Wed	Partial	Hampp & Hain	3.6	161	0	161	297.9	0.00	0	Included False Cape, ended Crescent Bch, fuel limited
1/13/17	Fri	Partial	Hampp & Clark	2.6	102	0	102	188.7	0.00	0	Ended southbound track early, at Sunglow Pier, due to rain
1/17/17	Tues	Complete	Hampp & Smith	3.2	134	0	134	247.9	0.00	0	
1/20/17	Fri	Partial	Hampp & Clark	1.3	29	0	29	53.7	0.00	0	Ended early due to gusty winds aloft
1/25/17	Wed	Partial	Hampp & Clark	3.3	83	0	83	153.6	0.00	1 HUWH	Inc. St. Augustine for transponder certification
2/01/17	Wed	Complete	Hampp & Smith	3.1	137	0	137	253.5	0.00	0	3 nmi track in place of std 1.5 line
2/06/17	Mon	Complete	Hampp & Clark	3.2	134	7	127	234.6	0.00	0	BSS=4
2/12/17	Sun	Partial	Hampp & Smith	2.8	107	0	107	198.0	0.00	0	End Matanzas, due to gusty winds
TOTALS				28.5	1,110	7	1103	2,040.2	0.00	0	

Date	Day	Time <sup>1</sup>	Location	Lat <sup>2</sup>	Long <sup>2</sup>	Species/ Class	Hdg	Pager #	Notes (Who sighted, etc.)	Verified?/ Photos?	
25 Oct	Tues	11:04	Ormond			??			Becki responded	Ν	
29 Dec	Wed	11:49	Ponce Inlet			??			AirCam searched	Ν	
4 Jan	Wed		Ponce, NSB			??			HUWHs-NOAA	Ν	
4 Jan	Wed		Canav NSS								mantas
10 Jan	Tues	17:00	NSB	29 01.9	80 53.2	MC	S	VSN001	Ken McNair	Y/Y	UNK
14 Jan	Sat	12:42	Satellite Beach	28 10.9	80 35.3	MC	S	VSN002	Julie, MRC	Y/Y	#1711
15 Jan	Sun	09:40	Sebastian Inlet	27 52.6	80 27.2	MC	S	VSN003	Julie, MRC	Y	#1711
20 Jan	Fri					HUWH			Waitress, Reef R Samantha Knowles	video	
21 Jan	Sat	12:15	St. Aug pier			HUWH	S		Team 1	Y	
21 Jan	Sat	15:20	Butler Beach, Crescent Beach			HUWH	S		Andris & Jim	Y/N	
23 Jan	Mon	16:05	Ormond			??			Becki responds		
24 Jan	Tues	09:56	Gamble Rogers, Flagler Pier			HUWH prob			Glenn Wood 2 <sup>nd</sup> hand	?	
24 Jan	Tues	11:30	N Flagler, 23 N			HUWH			Tony Caruso photos	Y/Y	
25Jan	Wed	10:48	Ormond by the Sea			HUWH			Team 4	Y/N	
25 Jan	Wed	13:18		29 29.2	81 05.9	HUWH			AirCam	Y/Y	
3 Feb.	Fri					HUWH			Fisherman rpt	Y/Y	20 mi off Canaveral at Pelican Flats
8 Feb.	Wed		Varne Park	29 33.1	81 09.1	HUWH		2 ?	Matlocks	N/N	Didn't call
8 Feb.	Wed.		Villano Bch			HUWH			Unk name	N/N	
9 Feb.			Off Kennedy Space Center			HUWH			Greg Rapp Sea Leveler Charter	Y/Y	Saw video on Facebook
9 Feb.	Thur	~ 10:54	Hammock Dunes			HUWH	S		Greg	Prob N/N	

Table 2. Sighting summary 2016-2017. This summary includes sightings by both the Marineland Project and the Marine Resources Council.

14 Feb	Sat	14 nmi S of Ft. Pierce Inlet	27°14.2'	80°10.4'	HUWH		Fisherman rpt to FWC, HBOI assist, Jensen Bch nxt day		Sickly E. Howells, HBOI
9 May	Tue				SPWH		Julie, boater	Good video	
13 May					??		Joe Chavera	photo	

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

Table 3. Presentations to groups and organizations

Date	Presenter	Detail
15 Nov 2016	Joy Hampp	Introductory talk held for GTM NERR at Marineland Dolphin Adventure, Marineland, FL; 27 attended
3 Dec 2016	Joy Hampp	Introductory talk held at SE Branch, St. Johns County Public Library, St. Augustine, FL; 30 attended
6 Dec 2016	Joy Hampp	Introductory talk held at Flagler County Public Library, Palm Coast, Fl; 11 attended
8 Dec 2016	Joy Hampp, Becki Smith	Introductory talk held at Ocean Art Gallery, Flagler Beach, FL; 13 attended
10 Dec 2016	Joy Hampp	Introductory talk held at Ormond Beach Public Library; Ormond Beach, FL; 24 attended
13 Dec 2016	Joy Hampp	Pre-season coordination meeting for Project Team Leaders, Beverly Beach Town Hall, Beverly Bch, FL; 12 attended
30 Dec 2016	Joy Hampp, Jim Hain	Training class held for new and returning Project surveyors at Whitney Center for Marine Studies, U. of Florida Whitney Laboratory, Marineland; 102 attended
4 Feb 2017	Jim Hain, Joy Hampp	Mid-Season update for Project survey teams at Whitney Center for Marine Studies, U. of Florida Whitney Laboratory, Marineland; 91 attended
25 Mar 2017	Joy Hampp, Jim Hain	Year-end review for Project survey teams at U. of Florida's Whitney Center for Marine Studies, Marineland, FL; 76 attended

A: Volunteer Recruitment/Training

# B: Public Education/Outreach

Date	Presenter	Detail
9 Nov 2016	Paul Eckstein	Right whale presentation for Road Scholar program, Hilton Garden Inn, St. Augustine Beach, FL; 17 attended
19 Nov 2016	Joy Hampp	Right whale presentation for University Women of Flagler, Hilton Garden Inn, Palm Coast, FL; 54 attended.
7 Dec 2016	Paul Eckstein	Right whale presentation for Road Scholar program, Hilton Garden Inn, St. Augustine Beach, FL; 33 attended
22 Jan 2017	Frank Gromling	Right whale presentation for Gamble Rogers Memorial State Park, Flagler Beach, FL; 37 attended.
25 Jan 2017	Paul Eckstein	Right whale presentation for Road Scholar program, Hilton Garden Inn, St. Augustine Beach, FL; 18 attended
22 Feb 2017	Paul Eckstein	Right whale presentation for Road Scholar program, Hilton Garden Inn, St. Augustine Beach, FL; 35 attended
8 Mar 2017	Paul Eckstein	Right whale presentation for Road Scholar program, Hilton Garden Inn, St. Augustine Beach, FL; 31 attended
8 April 2017	Frank Gromling	Right whale presentation for Gamble Rodgers State Park, Ocean Art Gallery, Flagler Beach, FL; 9 attended.
6 May 2017	Joy Hampp	Right whale presentation for Florida Marine Science Educators Association, St. Johns River State College, St. Augustine, FL; 11 attended



Figure 1. The 37 lookout points used by shore-based spotters in the Marineland Project during the 2016-17 season. Although there may be small adjustments to locations, and points may be added and subtracted, the overall sighting effort has remained fairly constant for the past several years. The 5 nmi boundary of the 1994 SEUS right whale critical habitat (red line) and three near-shore depth contours (labeled) are shown.



Figure 2. 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, beachwalkers, condo dwellers, town and county employees, and the teams that conduct surveys from January through mid-March.



Figure 3. The shore-based sighting network and the aircraft surveys and responses are both complementary and synergistic. Shown are the standard aircraft survey tracks (red line) and the boundary of the 1994 SEUS right whale critical habitat (aqua line). The aircraft also responds to sighting reports originated by shore spotters, and aids in obtaining high-quality photographs essential to photo-identification and documentation.



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. 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 center, and the cool-water feature developing southward along the coast is shown in the upper left. The red arrow indicates the location of Marineland as a reference point. At mid-season on 2 February 2017, the cool water feature is relatively undeveloped and the SST in the Marineland area is about  $17^{\circ}$  C.



Figure 6. The SST as measured at the NDBC station on the end of the St. Augustine pier during the 2016-17 season (red symbols). The 2017 SST suggests neither a "warm" nor a "cold" year.



Figure 7. An index of SST in the Marineland area from 2000 through 2017. The values are assigned based on the degree that the average SST on 1 February was above (red) or below (blue) the  $16^{\circ}$  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 trendline (not shown) suggests a slight (~0.5 ° C) warming trend during the 17-year period. The numbers over the bars are examples of total number of calves born in a given year for the SEUS region. Are warm and cold seasons somehow correlated to the numbers of calves born?



Figure 8. A represention of survey quality during the 2017 season, and in comparison to two previous seasons. Of the 56 total survey days this season, full surveys were conducted in good weather conditions on 55% of the days—an increase over the two previous seasons.



Figure 9. Total number of right whale sightings in the Marineland area, 2001 through 2017. Note a low year in 2012 with two sightings, both of the same single individual, and the absence of sightings in 2017.



Figure 10. The number of different mother-calf pairs sighted in southeastern U.S. (records compiled by the New England Aquarium).



Figure 11. A 13-year-old male right whale, # 3530, became entangled in Canadian snow crab gear in the Gulf of St. Lawrence and subsequently dragged the gear for five months and 1,400 nmi until being disentangled on 6 January 2017. With this example, we are reminded of the scope of these entanglements. (Images courtesy Julia van der Hoop)