

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

**2014-15 SEUS Season**

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

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26 October 2015

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## **Summary**

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

*“For it is in these waters that the history of the endangered right whale will be written”*

The Marineland Right Whale Project completed the 15<sup>th</sup> year of the program in the near shore waters of northeastern Florida, generally between St. Augustine Inlet ( $29^{\circ}54'$ ) and Canaveral Seashore ( $28^{\circ}56'$ ). The central theme this year, as in past years, is recognizing and describing the variability that exists in most factors, supported by our truism that, “every day, every season, and every whale is different.”

Environmental factors were monitored closely. The sea-surface-temperature (SST) this year was middling or average—and we had neither a “warm” nor a “cool” season. Based on 15 years of sampling, SST in the Marineland area is warming. Is this variability, a cyclical event, or evidence for climate change? Whatever the cause, the 2015 seasonal weather was windier, cooler, and rainier than usual. This was reflected in the sighting effort. Likely due to a combination of factors, no right whale sightings were recorded in the Marineland area from 9 February to 12 March.

Compared to the two previous seasons, the number of verified right whale sightings (11) decreased again after two years of a modest upward trend. Of these sightings, 5 were mother-calf pairs—with 3 different mother-calf pairs sighted. Female #1604 and her fifth known calf were sighted on three different occasions. There were six sightings in the singles-pairs category, and no sightings of groups of  $\geq 3$ . Noteworthy were several instances of offshore sightings by aircraft, beyond the sighting range of the shore spotters.

In collaboration with the Marine Resources Council, a number of sightings were recorded south of Cape Canaveral, seemingly in contradiction to what might have been predicted based on the warm SSTs in this area. Likewise, the southern excursion of female #3420 and her first calf adds to our curiosity about habitat use of first-time mothers. These “data outliers” provide valuable information.

In an example of good collaboration, the volunteer network and our coastal survey aircraft contributed to the limpet tagging of individual S078 off New Smyrna Beach on 20 January.

Human impacts were recorded on a single occasion. Mother-calf pair #1604 was approached by a paddleboarder and a surfer off Flagler Beach on 9 February. While the 500-yard approach rule was violated, the event was recorded as generally benign. Humpback whales were sighted on four occasions—a relatively small number for our area. The right whale data and photos for the season were submitted to the New England Aquarium’s collaborative catalog and database on 15 June 2015. The humpback records and photos were submitted to the Center for Coastal Studies, Provincetown, Massachusetts.

Trendlines of two types were applied to the analyses graphics. Despite several low calving years, annual calving rates from 1992 through 2015 continue to show a gradual increase in calf production. At the same time, SST in the Marineland area is gradually increasing while the total number of sightings as well as the number of mother-calf pairs sighted is decreasing.

A consistent sighting effort was maintained. Similar to previous years, 37 lookout points were monitored within the 60 nmi section of coast between the St. Augustine Inlet and New Smyrna Beach. Dedicated shore-based surveys began on 4 January and ended on 14 March 2015. During this ten-week period, the dedicated mobile and community teams logged 1,345 hours of survey time (a decrease from last season due to weather). The complementary and synergistic aerial survey effort took place from 13 December 2014 through 31 March 2015—20 flights on 20 days. The aerial surveys were likewise impacted by weather (*e.g.*, there was a 12-day period in mid-February with no flights).

Outreach and education continued—nine presentations to volunteers and 19 presentations for public education and engagement were given, including participation in the Right Whale Festival on 14 November 2014. Both within and external to our program, public awareness and citizen science is gaining in visibility and importance.

Monitoring and conservation of the whales and their ocean habitat continues. However, resources are decreasing. The overall SEUS aerial survey effort for the 2014-15 season was reduced. The overall calf production in recent seasons was less than what might be expected. Distribution and abundance are changing. Is climate change in evidence?

There is interest in modeling. Yet, there is uncertainty in the ability to predict either whales or weather in a changing and dynamic environment. We submit that a carefully considered observational program will remain at the core. 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. In more than a decade, there has been learning. Yet, the learning is incomplete. Continuing monitoring and diligence are warranted.

*And finally, why do this? Why should we care? It is not a pocketbook issue. It cannot be justified as an economy issue. It is a quality-of-life issue—for this generation and the next. Whales, sunsets, rainbows, mountains, birds, trees, rivers, flowers, and sandy beaches. We are all involved. We are all stewards. Special events and places don't stay special by accident!*

## 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 2014-15 season was its 15th year.

## **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 510, with a small number of calves born each year (the average in the recent 10 years has been 20).

Florida's coastline includes 175 nautical miles (nmi) of right whale critical habitat. In the 2014-15 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.

This more southerly coverage is important for several reasons, including: a) right whale sightings-per-unit effort (SPUE) values for the area south of St. Augustine are often comparable to those for the more heavily surveyed area to the north, b) characterizing the biology and addressing the mitigation in the more northerly EWS area necessarily includes data from throughout the right whale habitat, c) several channel entrances, with their associated vessel activity, lie in this more southerly area, and d) this area is experiencing rapid coastal development and an increase in population and warrants careful monitoring. Lastly, observations at the edge (the “outliers”) of a population’s distribution can be useful to measuring variability and change (e.g., climate cycles or change) for a population and its environmental correlates (Greene *et al.* 2009).

Recovery and protection of right whales continues to be a priority and sometimes contentious topic. The National Oceanic and Atmospheric Administration (NOAA) has regulations that affect routing and speed of some vessels. (The five-year “sunset clause” expired in December 2013—an important deadline—the rule is now permanent but does allow for a review of efficacy.) The Navy has issued Environmental Impact Statements for bringing additional vessels to Mayport, and for establishing an Undersea Warfare Testing Range (USWTR) east of Jacksonville (construction has begun, and operation is expected for the 2018-20 timeframe; R. Kalin, 6 October 2015). The commercial and cruise ship operators are proposing increases in vessel size and/or number in several parts of the region. Channel dredging and beach re-replenishment projects are ongoing. The Bureau of Ocean Management (BOEM) has proposed seismic testing along the U.S. east coast. Development of marinas may bring additional boating traffic. If the right whale population is increasing, as seems to be the case, interactions between humans and whales may increase, and successful co-existence may become more challenging. Particularly in light of the changeable numbers and distribution during past seasons, continued monitoring and best efforts are warranted.

### **1.3 Program Scope and Objectives**

Building on the previous 14 seasons of experience, objectives for 2014-15 included:  
a) asking and addressing the important scientific questions, b) maintaining the number and quality of volunteers, c) increasing the sighting effort and geographic coverage, d) continuing to develop collaborations with other investigators and groups, e) continuing to increase data quality and percentage of right whales that are photo-identified, f) continuing to describe both patterns and variability, and g) synthesize and publish results.

## **2.0 Methods**

### **2.1 Overview**

During the course of 15 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: [www.aswh.org](http://www.aswh.org).

### **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 ( $29^{\circ}54'$ ) and Canaveral Seashore ( $28^{\circ}56'$ ), within 5 nmi of the coast (Figure 1). This ~60nmi section is subdivided into six sectors, each ~10 nmi in latitudinal extent.

## **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 above, 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.

## **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 2**), 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 (**Figure 3**). 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.

For this season, to reduce cold and wind buffeting in the rear seat, a partial enclosure was installed on an experimental basis. Constructed and installed by Lockwood Aviation, Inc., Sebring, Florida, it consisted of Lexan panels with an access door on the right, a camera port on the left, and a leatherette panel behind the pilot's seat. We experimented with refinements during the season. The desired outcome was to improve conditions in the rear seat for the observer/photographer.

## **2.6 Response Teams**

A central location (the office in Marineland) is manned during daylight hours. 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 teleextender).

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 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 have in the past used the SAUF1 National Data Buoy Station at the end of the St. Augustine Pier. Unfortunately, the SST at the pier was not operational again for most of this season. This led to an interruption in a long-term data set from this source. As a substitute, we (for a second year) used water-temperature data as measured from the intake system at the Marineland dolphinarium. This was judged to be a reasonable measure of temperature, particularly relative temperature, in nearshore waters in our area.

On 11 March 2015, the SST sensor at the NOAA SAUF1 station on the end of the St. Augustine pier was repaired, after a gap of nearly two years in the data record from this source.

## **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 shore-based and aerial sightings. As a result, in the 2014-15 season, we continued to record and tabulate data in a more streamlined fashion.

## **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 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 five mornings a week by two teams.

Dedicated surveys began on Sunday, 4 January 2015, and ended ten weeks later on Saturday, 14 March 2015, as planned. During this ten-week period, the dedicated mobile and community teams logged 1,345 hours of survey time, generally beginning at 0800 hr and ending around 1200 hr. Volunteers from the Georgia Aquarium contributed an additional 23 hours between 1200 and 1600 hr, the 7<sup>th</sup> through the 13<sup>th</sup> of February, during a week-long field trip to assist with right whale surveys. This combined effort was supplemented by opportunistic lookouts along the coast.

#### *Aerial Surveys and Photo-Documentation*

From 13 December 2014 to 31 March 2015, the Associated Scientists/Marineland group made 20 flights in the SEUS with the AirCam on 20 separate days. Nineteen flights surveyed parallel track lines at 0.5 nmi and 1.5 nmi from the shoreline (Figure 2)—a dual-purpose mode that benefits multi-species search objectives, facilitating the detection of manta rays (*Manta sp.*) that may be present in the study area in early winter and those arriving during their spring migration. Eleven of the nineteen flights completed both parallel track lines within an area defined from 29° 55' N to 28° 56' N, with the track lines about 65 nmi in length. Several flights were incomplete or partial surveys due to weather and other factors (Table 2). On one of the 20 flights, the parallel track lines extended farther south to False Cape, 28° 35', about 77 nmi in length from the start at Matanzas Inlet.

The exact track line surveyed during each flight varied somewhat due to weather conditions, coordination with the FWC survey aircraft, and reports of sightings by the Volunteer Sighting Network and others. An overall total of 2,375 nmi were flown during 59.9 flight hours. Weather variables and sighting data were recorded according to standard protocols.

The test of the rear enclosure met with mixed results. It significantly reduced the buffeting in the rear seat, increasing cooler temperature tolerance and ease of data collection. However, it introduced new buffeting onto the back of the pilot and reduced observer visibility with some introduction of inside glare on the Lexan panels. Further refinements and design modifications will need to be explored.

## 3.2 Right Whale Sightings 2014-15

### *Overall Sighting Summary*

In the 2014-15 season, there were 11 sightings in the Marineland area (St. Augustine inlet to Canaveral Seashore) ([Table 1](#), [Figure 4](#)). This was about half of the sightings for the 2013-14 season, and similar to the 2012-13 season. (Recall that during the 2011-12 season, there were only two sightings in our area—both of the same individual.) For the recent four years, the average number of total sightings has been 12. For the preceding ten years, the average has been 20.

There were five sightings of mother-calf pairs, with three different mothers: Catalog #1604, #2223, and #3693. Female #1604 is more than 29 years of age; and gave birth to her 5<sup>th</sup> known calf in 2015. Female #2223, *Calvin*, is 23 years of age; and gave birth to her 3<sup>rd</sup> calf. Female #3693 was greater than 9 years of age, and gave birth to her 1<sup>st</sup> known calf. Mother-calf pair #1604 was the most sighted, three times, first in Ormond Beach on 13 January, then off North Peninsula State Park on 8 February, and finally off north Flagler Beach on 9 February. The other two pairs were only seen on a single occasion.

Of the six sightings of single-pairs, there were five different individuals. In this season, we did not record any groups ( $\geq 3$  individuals).

Our partners to the south, the Marine Resources Council, reported 10 sightings in the area south of Cape Canaveral, with 7 of mother-calf pairs, and 2 of single individuals ([Figure 5](#)). Female #3693 and her 1<sup>st</sup> calf were sighted on 30 January, and female #3420, *Platypus*, and her 1<sup>st</sup> calf were sighted on several occasions from 3 March through 15 March.

Noteworthy is that our combined efforts resulted in three reports of new calves for the season—adding to the overall calf count. These were #1604 on 13 January, #3693 on 8 February, and #3420 on 10 March. Likewise, we had initial reports of two individuals: #4092 on 4 January, and S078 on 18 January.

Also noteworthy is that, of the three satellite-tagged individuals this season (see [www.alaskasealife.org](http://www.alaskasealife.org)), all were sighted by our groups. First was #4092, a six-year old female, sighted on 4 January off Daytona Beach and subsequently tagged on 6 January to the north off Fernandina Beach. Next, S078 was sighted on 19 January just south of Marineland, and re-sighted the next day, 20 January, to the south off New Smyrna Beach. The report was passed on, and this individual was tagged later that day ([Figure 6](#)). The final sighting was of MC pair #3420 on 10 March. The female (without calf at the time) was tagged on 21 January to the north off Cumberland Island, Georgia. The 10 March sighting by an MRC volunteer south of Cape Canaveral was the first to report the calf.

Also of note is that a number of the sightings in the area south of St. Augustine were at some distance from the shore. A single adult, #3360, on 18 January was 5 nmi off, mother-calf pair #3693 on 8 February was about 2 ½ nmi off, and a single individual (humpback), reported by an offshore birding trip off Ponce Inlet on 26 January, was about 3 nmi off.

Based on a compilation by the Florida Fish & Wildlife team, no individual right whales were uniquely sighted in our area this season. That is, all whales recorded by our groups south of St. Augustine were also recorded by one or more of the other survey teams.

Humpback whales were sighted on four occasions in our area (refer back to Figure 4)—a relatively small number compared to the previous season. In addition, a minke whale was sighted and photographed on 26 March off Port Canaveral.

#### *Aircraft Sightings*

From 13 December 2014 to 31 March 2015, the Associated Scientists/Marineland group made 20 flights in the SEUS with the AirCam on 20 separate days.

On four days there were right whale sightings. On all of the days, sightings were relayed from other sources. However, on one day, 8 February, the aircraft team recorded a unique sighting—female #3693 and calf. The sighting was about 1 nmi beyond the 1.5 nmi survey line (about 2 ½ miles off), and was the second sighting this season of whales beyond practical sighting distances from the shore (the other was a single individual, #3360, on 18 January, about 5 nmi off).

The AirCam team photographed humpback whales on two occasions. The Florida Fish and Wildlife team reported that the photographs provided individual identifications.

#### *Opportunistic and Contributed Sightings*

Sightings and photographs contributed by citizens are an occasional but important component. Citizens reported a number of sightings directly, or, through the MRC hotline. Photos and videos were likewise contributed (e.g., images of MC #1604 by Carlos Dias on 13 January—established the presence of a new calf for the season; and the report and photographs by Elizabeth Zeigert aboard the *Sea Mist III* on 15 March, was one of two southernmost records for the season). Noteworthy also was the report of MC #3420 on 10 March off Satellite Beach by MRC volunteers Karen & John Brusca (a new calf for the season, and a previously tagged individual). Lastly, as has been true in previous years, the trainers and staff at the Marineland Dolphin Adventure facility also reported several sightings this season.

#### *Human Impacts*

We had no entangled, injured, or dead whales this season. We did have one event of a close approach and possible harassment. On Sunday, 9 February, Female #1604 and calf were swimming slowly northward off North Flagler Beach. At shortly after 9:00 a.m., at 22nd St. N, a paddleboarder and a surfer paddled out. They were respectful and cautious and did not get too close, but rather stopped short and sat still as the whale pair approached. Even before the whales got up to them they withdrew and paddled back in. We recorded the event as benign in nature. Both the paddleboarder and the surfer were provided the information on the 500 yd approach rule, as well as the possible danger to humans should they get too close, or, get between the

mother and calf. This information was provided by the police (who had been called), as well as one of our volunteers who was nearby and went down to the beach (Figure 7). Data and photo documentation were submitted to NOAA fisheries law enforcement officer Richard Chesler on 23 February.

### **3.3 Quantification of Aerial Survey Effort**

As described, we developed a streamlined collection and tabulation of effort data in the 2012-13 season. We continued to track basic sightings-per-unit effort values (Table 2). Analysis and further refinement are underway.

### **3.4 Sea Surface Temperature**

Based on the sea-surface-temperature (SST) as measured at Marineland on 1 February 2015, the SST was slightly less than the 16° C temperature we use as a reference point—almost average (Figures 8 and 9). However the courser-grain SST as shown by satellite imagery suggested a generally warmer season (Figure 10). For comparison, Figure 11 shows the progression of the cool nearshore “finger”, the southward extension of the 22° C isotherm to well below Cape Canaveral, and the 13° C temperature off Marineland on 1 February in 2005—a “cold” year. On 11 March 2015 the SST sensor at the NOAA SAUF1 station on the end of the St. Augustine pier was repaired, after a gap of nearly two years in the data record from this source. From Figure 8, it appears that the NOAA SST data are about a degree cooler than the Marineland values.

### **3.5 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 70 total survey days, full surveys were conducted in good weather conditions on 19 days (27%). On 44 days (63%), full or partial surveys took place under moderate or poor weather conditions. On seven survey days (10%), no surveys took place, or, less than 25% of the survey area was covered due to high winds, fog, or extreme cold. In general, weather and wind conditions were poorer than in the two previous years, with the fewest number of full or partial surveys conducted in either good or moderate conditions (Figures 12 and 13).

### **3.6 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.

### **3.7 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 ([Figure 14](#)). On 14 November 2014, we participated in the Right Whale Festival in Jacksonville Beach.

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 ([www.aswh.org](http://www.aswh.org)) 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 [marinelandrightwhale.blogspot.com](http://marinelandrightwhale.blogspot.com).

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, [www.aswh.org](http://www.aswh.org).) At the end of the season, as a gift and souvenir for the volunteers, the “Marineland Right Whale Project” calendar (providing a summary of the season’s sightings and events) was assembled, printed, and distributed to volunteers, business partners, and collaborators.

### **3.8 Disposition of Data**

As in previous years, images and corresponding data were submitted to the Right Whale Catalog at the New England Aquarium, Boston, Massachusetts. The complete packet was mailed to the New England Aquarium on 15 June 2015. 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 Overview**

Effective conservation and management depends on good information. After 15 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). We have begun to characterize both patterns and variability, and have established a valuable baseline. However, the most important finding from our 15

seasons is that 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.

## 4.2 The Big Picture

The current best estimate is that there are 510 individual right whales in the population (NARWC Annual Report Card 2014, at [www.narwc.org](http://www.narwc.org)). There may be ~100 reproductive females. If one subscribes to the general wisdom that the calving interval for female right whales is ~3.5 years, then an average of 29 calves might be born each year. In 2011, there were 21; and in 2012, there were 7; in 2013, there were 21; in 2014 there were 11, and in 2015, there were 17—a five-year average of 15—and below expected. However, more than two decades of records compiled by the New England Aquarium, show that, despite great variability, there has been a gradual increase in overall calf production ([Figure 15](#)).

Another curious happening is the change in the number of juveniles migrating to the SEUS. For much of the most recent decade, more than 100 juveniles/young adults made the migration to the SEUS wintering grounds. In the 2010 season, there may have been nearly 200 (Zani and Jackson, 2010). In the 2015 season, as happened previously in 2013 and 2014, there may have been fewer than 20 juveniles. This too is a change. Hamilton (*Right Whale News*, February 2013) describes that juveniles were never a large component of the SEUS whales until the early 2000's. There seems to be an ebb-and-flow in the demographics.

For the Marineland Right Whale Project, from 2001 through 2011, the total number of sightings per year showed a general upward trend ([Figure 16](#)). Then, in 2012, there was nearly a complete absence of right whales in our area (this has happened previously—in 2000). In 2013, there was a modest rebound. In 2014, the rebound was maintained. But, in 2015, there was a decrease. This decrease was similarly reflected in the number of mother-calf pairs sighted in our area ([Figure 17](#)). There are likely several contributing factors—of which we have a poor understanding (see below). We await the 2016 season.

## 4.3 Habitat Use and Movements

As described previously, there were a number of more offshore sightings this season. This more offshore area south of St. Augustine is perhaps under-sampled. We note that the compilation by Kraus and Kenney (1991) show a number of offshore sightings south of St. Augustine. To some unknown degree, the offshore sightings may be a function of survey effort. While the indications are that the distribution is generally more nearshore in this area, in view of current changes, our curiosity is aroused.

Likewise, we continue to be curious about movements. In reports from past years, we suggested that first-time mothers may share the characteristic of being frequently sighted, having a nearshore occurrence, a repetitive longshore movement, and a southerly occurrence. The

extended southerly excursion of mother-calf #3420, March 10 through 15, contributes to these data.

#### **4.4 Human Impacts**

While the approach to a mother-calf pair off Flagler Beach on 9 February was generally benign, the issue of nearshore whales in good weather attracting attention and subsequent approaches remains. Education and outreach efforts continue. We favor an educational and collaborative, rather than a cattle-prod reaction, so as to engage rather than alienate local citizens. No other human-impacted right whales were documented in our area this season.

#### **4.5 Sea-Surface Temperature**

SST continues to be examined as a correlate to right whale distribution and abundance. The repair of the NDBC sensor at the end of the St. Augustine pier was welcome, and will be valuable to continuing analyses of this factor.

#### **4.6 Weather**

As seen back in [Figure 9](#), the SST in the Marineland area appears to be warming. At the same time ([Figures 12 & 13](#)) the weather appears to be worsening. Both of these are generally taken as evidence for climate change and global warming. At the same time, we note that cycles and variability are present. In the period extending from the 16<sup>th</sup> to 19<sup>th</sup> centuries, what has been termed the “Little Ice Age,” took place in Europe and the Northern Hemisphere. There were some glacial advances. In the winter of 1780, New York Harbor froze, allowing people to walk from Manhattan to Staten Island. Possible causes have been given as orbital cycles, decreased solar activity, increased volcanic activity, altered ocean current flows, the inherent variability of global climate, and reforestation following decreases in human population. This was a period of cooling that occurred after the “Medieval Warm Period,” about 1000 to 1300 (Wikipedia). Current global warming is sometimes disputed. Researchers in England (*Washington Post*, 14 July 2015) predict that a decrease in solar activity and global cooling will take place in the 2030s. This research states that changes in solar radiation are likely to have a bigger influence than anthropogenic changes on the Earth’s temperature. In February 2015, Boston experienced the snowiest and coldest weather in recent history. All the foregoing results in a lively and ongoing discussion. Weather and whales—a perfect pairing.

#### **4.7 Inspection of Trendlines**

Variables and factors. The trendlines shown in several figures are of interest. The first is in the overall calf production (refer back to [Figure 15](#)). While there appears to be a gradual upward trend, in two of the last three seasons, the total number of calves born has been about half of what might be expected. Then there is the relationship between the increasing SST at

Marineland (Figure 9) and the decreasing number of total right whale sightings as well as those of mother-calf pairs (Figures 16 and 17). Do these trendlines indicate natural variability, cyclical changes, or long-term climate change and global warming?

## 4.8 Observations and Models

There is continuing interest in the predictive capabilities of modeling (*e.g.*, Gowen and Ortega-Ortiz 2014). Models, as do many tools, may provide useful information. We submit, however, that a carefully considered observational program should appropriately be conducted in parallel with a carefully considered modeling effort.

## 4.9 Conservation and Management

The Marineland Right Whale Project has completed its 15<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 (Figure 18), and we continue to refine the approaches and methods that optimize their contribution.

Science and knowledge both evolve. The early reports of right whales in coastal waters of northeast Florida date back to sighting reports collected at Marineland in the 1950s (Kraus and Kenney, 1991; Winn, 1984), and established the presence of right whales and the importance of this habitat, as well as the need for protection (Neuhauer, 1986). In the years since, we collectively have learned a great deal. The Marineland Right Whale Project has contributed, and for more than a decade has been one of six teams effectively monitoring the SEUS habitat.

Awareness and engagement of a diverse local citizenry is a major product of the program. Citizen science continues to gain in visibility and value (Tweddle *et al.* 2012, Frontiers in Ecology and Environment 2012; *National Geographic* 2013). Education and outreach, including local law enforcement, surfers, paddleboarders, and boaters is ongoing. As described, the number of 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. Constraints resulting from funding and resources are escalating. Biological variability, uncertainty, and unknowns are perhaps likewise escalating. Human impacts continue to have an effect on the population. There are questions about natural variability and cycles, and/or long-term climate

change. Right whales are a symbolic and keystone species—for the ocean habitat, for the health of our natural resources, and ultimately, for human health and well-being. In more than a decade, there has been learning. Yet, the learning is incomplete. Whales and weather! 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.

And finally, why should we care? Why is this important? In discussing the economics of public issues, Miller *et al.*, 2014, describe whales as a “charismatic” species—that is, people get satisfaction from simply knowing that they are out there swimming in the ocean. Thus, whales are said to have “existence value”—some people get satisfaction just from knowing that they exist, satisfaction that would be lost if the co-existence of humans and whales would cease. There is a value that is difficult to quantify. Aside from any scientific and economic studies, healthy whales relate to healthy humans and enhance the quality of life.

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### Acknowledgments

First and foremost, we are grateful for the good efforts and strong commitment of our volunteers. Joy Hampp and Becki Smith are both program coordinators and 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; 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.

Table 1. Sighting summary 2014-2015. This summary includes sightings by both the Marineland Project and the Marine Resources Council.

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?	
4 Jan	Sun	10:23	S Daytona	29 10.1	80 58.0	1 AD	S	MRC001	MRC, BP, Team 5, Jim&Sheila, FWC	FWC	4092
4 Jan	Sun	13:13		29 09.2	80 56.0			FWS003	FWC follow up		4092
13 Jan	Tues	09:10	Ormond	29 17.5	81 02.0	MC		MRC002	MRC, Carlos Dias, Becki, Tm 5, Joy&Jim Respond, don't see	Becki, Carlos submit later	1604
18 Jan	Sun	10:57	Off Ormond	29 16.7	80 52.6	1 AD	NE	FWS006	5 mi off	Y/Y	3360 "Horton"
19 Jan	Mon	11:53	Wash Oaks	29 36.8	81 11.0	1 AD	S	MLDA001	Team 2	Y/Y	S078
20 Jan	Tues	12:56	NSB	28 58.8	80 51.3	1 AD	Sta	MLDA002	MRC, limpet tagged	Y/Y	S078
20 Jan	Tue	14:59		28 55.6	80 49.2	1 AD		FWS010			SO78
20 Jan	Tue	17:25	Sebastian	27 48.5	80 24.8	1 JUV			B. & J. Barnes	Y/Y	UNK
21 Jan	Wed		Melbourne Bch	27 56.4	80 29.4	HUWH			Cory Langel	Y/Y	
22 Jan	Thur	15:14	Melbourne	28 04.1	80 33.2	MC		MRC003	Arnold Dubin	Y/Y	3693 ?
22 Jan	Thur					HUWH			MRC, Julie	N/N	
24 Jan	Sat	18:05	Pt. Canaveral	28 24.2	80 32.5	MC ??		MRC004	Harbor pilot	No photos	Not verified
26 Jan	Mon	07:50	Ponce Inlet	29 06.2	80 51.9	HUWH			Mike Brothers	Y/Y	Pics fr Mike
30 Jan	Fri	14:46	Villano Beach	29 56.5	81 17.9	MC	N	MRC005	FWC responds		1701 Aphrodite
30 Jan	Fri	16:54	Bethune Beach	28 57.3	80 50.3	2 AD	STA	MRC006			Ruffian 3530 + 3942
8 Feb	Sun	11:50	N Penn St Park	29 24.2	81 05.3	MC	STA	MLDA003	Larry Bell, Team 4, GAAQ vols	Y/Y	1604
8 Feb	Sun	12:20	Ormond	29 19.1	80 59.7	MC	STA	MLDA004	AirCam	Y/Y	3693
9 Feb	Sun	07:00	Flagler	29 29.2	81 07.4	MC	N	ASL	Fisherman at Pier, via MRC, Terri Clark, others, paddleboarder	Y/Y	1604
9 Feb	Mon	09:56	Flagler	29 31.0	81 08.4	MC	N	FWS022	Missed, called back		1604
9 Feb	Mon	11:20	Flagler	29 31.7	81 08.5	MC	N		AC		1604
20 Feb	Fri	16:18	Flagler	29 29.8	81 07.5	HUWH	N&S		Tony Caruso via M.	Y/Y	

								Gustafson via Julie, Becki, Joy, Jim		
03 Mar	Tues	10:00	Canaveral	28 36.1	80 35.1	RW, SING ?	Other030	KSC, NOAA, FWC	Y/Y	
9 Mar	Mon	10:51	Flagler	29 28.9	81 07.6	Kogia		AC and stranding	Y	
10 Mar	Tues	11:57	Satellite Beach	28 10.9	80 35.3	MC	S	MRC007	Julie, MRC	Y/Y 3420 w c 1 New, MC #17
10 Mar	Tues	17:26	Melbourne Bch	28 03.5	80 33.0	MC	S	MRC008		3420 still
12 Mar	Thur	12:39	Crescent Bch	29 46.7	81 14.7	MC	Sta	MRC009	Citizen via lifeguard via Julie, MLD, FWC	Y/Y 2223 Calvin
12 Mar	Thur	14:19	Crescent Bch	29 46.7	81 14.7	MC	Sta	FWS033	Follow-up	2223 Calvin
12 Mar	Thur		S. Hutchinson I	27 13.7	80 10.8	MC			Not verified	No photos 3420 Platypus
13 Mar	Fri	17:28	Lake Worth I, Riviera Beach	26 46.6	80 01.6	MC	Sta	Public	Other 034, via FWC, Amber Howell, FWC Tequesta	Y/Y Distant photos
14 Mar	Sat		Lantana Beach	26 35.2	80 01.8	MC			Prob Platypus	No photos
15 Mar	Sun	16:00	Boynton Bch	26 39.0	80 01.2				Definite Platypus <i>Fr Sea Mist III</i> , Elizabeth Ziegert	Y/Y 3420 Platypus
15 Mar	Sun	19:13	Lake Worth pier	26 36.8	80 01.8	MC			Photos sent to MRC, Shamyleika Vega	Y 3420 prob
16 Mar	Mon	11:17	Ormond	29 24.0	81 02.6	HUWH			AirCam	Y/Y Good pics
17 Mar	Tues	12:23	Ormond	29 27.6	81 06.2	HUWH			AirCam	Y/? Fair pics
26 Mar	Thur	12:40	Pt. Canaveral	28 23.2	80 32.1	MIWH			F'man via Steve Burton	Y/Y
28 Mar	Sat	13:12	MLD	29 39.3	81 12.0	1 AD	S	D. Sejda	MLD001	Y/N No pics

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 2: AirCam Survey Effort Summary 2014-15. 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	CATEGORY	HOBBS HRS	TRACKLINE (NM)	POOR COND (NM)	TOTAL GOOD TRACKLINE (NM)	EFFORT (KM)	SIGHTINGS	RIGHT WHALES	SPUE (per KM)	NOTES
13-Dec-2014	Sat	Complete	3.0	134	17.5	117	215.53	0			BSS=4 to 5 south of Daytona
17-Dec	Wed	Partial	1.1	52	28	24	44.40	0			BSS=4 from Matanzas Inlet to Ormond Bch; Survey enroute to Sebring
6-Jan-2015	Tue	Complete	3.2	134	54	80	148.00	0			BSS=4 from Ormond to New Smyrna Bch
17-Jan	Sat	Complete	3.0	134	87	47	86.95	0			BSS=4 from Ormond to St. Aug. Inlet
19-Jan	Mon	Partial	3.6	111	0	111	204.43	1	1	0.00489	Response and search covered some trackline sections twice and time/fuel consumption prevented full survey.
20-Jan	Tues	Partial	4.0	125	0	125	231.25	1	1	0.00432	Circled sighting ~1 hr. & cut trackline short for fuel

21-Jan	Wed	Complete	3.0	134	0	134	247.90	0			
25-Jan	Sun	Complete	3.4	157	0	157	290.45	0			Matanzas Inlet to False Cape
29-Jan	Thurs	Partial	2.6	120	43	77	142.45	0			Began from St. Aug Apt. SS shortened to 15 nm south of Flagler Pier
8-Feb	Sun	Partial	3.9	125	0	125	231.25	2	4	0.01730	Shortened trackline for time spent circling
9-Feb	Mon	Partial	2.3	41	0	41	75.85	1	2	0.02637	Rain shortened survey
22-Feb	Sun	Complete	3.1	134	0	134	247.90	0			
2-Mar	Mon	Partial	1.7	57	0	57	105.45	0			Fog covered tracklines
8-Mar	Sun	Complete	3.1	134	0	134	247.90	0			
9-Mar	Mon	Partial	3.2	133	0	133	246.05	0			End St. Aug Pier, FWC in area
15-Mar	Sun	Complete	3.1	134	0	134	247.90	0			
16-Mar	Mon	Complete	3.1	134	0	134	247.90	0			1 HUWH
17-Mar	Tue	Complete	3.1	134	0	134	247.90	0			1 HUWH
30-Mar	Mon	Partial	3.3	115	0	115	211.83	0			Smoke & gusty winds
31-Mar	Tue	Complete	3.1	134	0	134	247.90	0			
TOTALS			59.9	2375	229.5	2146	3969.18	5	8	0.00202	

Table 3. Presentations to groups and organizations

A: Volunteer Recruitment/Training

Date	Presenter	Detail
4 Dec 2014	Joy Hampp, Becki Smith, Sheila McKenney	Introductory talk held at Flagler County Public Library, Palm Coast, Fl; 63 attended
6 Dec	Joy Hampp, Becki Smith	Introductory talk held at Ormond Beach Public Library; Ormond Beach, FL; 30 attended
6 Dec	Joy Hampp, Sheila McKenney	Introductory talk held at Anastasia Branch, St. Johns County Public Library, St. Augustine Bch, FL; 21 attended
9 Dec	Joy Hampp, Becki Smith, Sheila McKenney	Pre-season coordination meeting for Project Team Leaders, Beverly Beach Town Hall, Beverly Bch, FL; 15 attended
3 Jan 2015	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; 149 attended
7 Feb	Jim Hain, Joy Hampp	Mid-Season update for Project survey teams at Whitney Center for Marine Studies, U. of Florida Whitney Laboratory, Marineland; 110 attended
7 Feb	Becki Smith	Review of data collection procedures for Georgia Aquarium Volunteers, Marineland Dolphin Adventure, Marineland, FL; 16 attended
8 Feb	Becki Smith	Right whale orientation for first-time Georgia Aquarium Volunteers, Flagler Beach, FL; 4 attended
28 Mar	Joy Hampp, Jim Hain	Year-end review for Project survey teams at U. of Florida's Whitney Center for Marine Studies, Marineland, FL; 94 attended

B: Public Education/Outreach

Date	Presenter	Detail
9 Nov 2014	Becki Smith	Right whale presentation for Jewish War Veterans, Aberdeen Clubhouse, Ormond Beach, FL; 15 attended
12 Nov	Paul Eckstein	Right whale presentation for Road Scholar program, Hilton Garden Inn, St. Augustine Beach, FL; 27 attended
14 Nov	Joy Hampp, Sheila McKenney, Assorted Vols	Right whale information table, Right Whale Festival; Jacksonville Beach, FL; Est. 2500 <sup>1</sup> attended.
10 Dec	Paul Eckstein	Right whale presentation for Road Scholar program, Hilton Garden Inn, St. Augustine Beach, FL; 38 attended
7 Jan 2015	Paul Eckstein	Right whale presentation for Road Scholar program, Hilton Garden Inn, St. Augustine Beach, FL; 34 attended
10 Jan	Frank Gromling	Right whale presentation for Gamble Rogers Memorial State Park, Flagler Beach, FL; 65 attended.
15 Jan	Frank Gromling	Right Whale presentation, Ocean Art Gallery, Flagler Beach, FL; 19 attended.
23 Jan	Penny Bellas, Arliss Ryan, Diane Hazel, Terran McGinnis, Darrel Austin	Right whale/Bottlenose Dolphin presentation for kindergarten class, Osceola Elementary School, St. Augustine, FL; 134 attended.
21 Jan	Paul Eckstein	Right whale presentation for Road Scholar program, Hilton Garden Inn, St. Augustine Beach, FL; 33 attended
31 Jan	Frank Gromling	Right whale presentation for Gamble Rogers Memorial State Park, Flagler Beach, FL; 34 attended.
4 Feb	Paul Eckstein	Right whale presentation for Road Scholar program, Hilton Garden Inn, St. Augustine Beach, FL; 35 attended
11 Feb	Paul Eckstein	Right Whale talk for Presbyterian Women's Association, Trinity Presbyterian Church, Palm Coast, FL; 39 attended.
18 Feb	Paul Eckstein	Right whale presentation for Road Scholar program, Hilton Garden Inn, St. Augustine Beach, FL; 35 attended
4 Mar	Paul Eckstein	Right whale presentation for Road Scholar program, Hilton Garden Inn, St. Augustine Beach, FL; 35 attended
18 Mar	Paul Eckstein	Right whale presentation for Road Scholar program, Hilton Garden Inn, St. Augustine Beach, FL; 33 attended
3 April	Paul Eckstein	Right whale presentation for Road Scholar program, Hilton Garden Inn, St. Augustine Beach, FL; 24 attended
9 April	Joy Hampp	Right Whale presentation for Exploring Our Environment, GTM NERR Science Center, Marineland, FL; 20 attended
30 Apr	Paul Eckstein	Right whale presentation for Road Scholar program, Hilton Garden Inn, St. Augustine Beach, FL; 26 attended
20 July	Arliss Ryan	Right whale presentation for Environmental Camp, The Casements, Ormond Beach, FL; 31 attended

<sup>1</sup> From personal communication with Cheryl Bonnes, Co-Chair, NOAA Fisheries

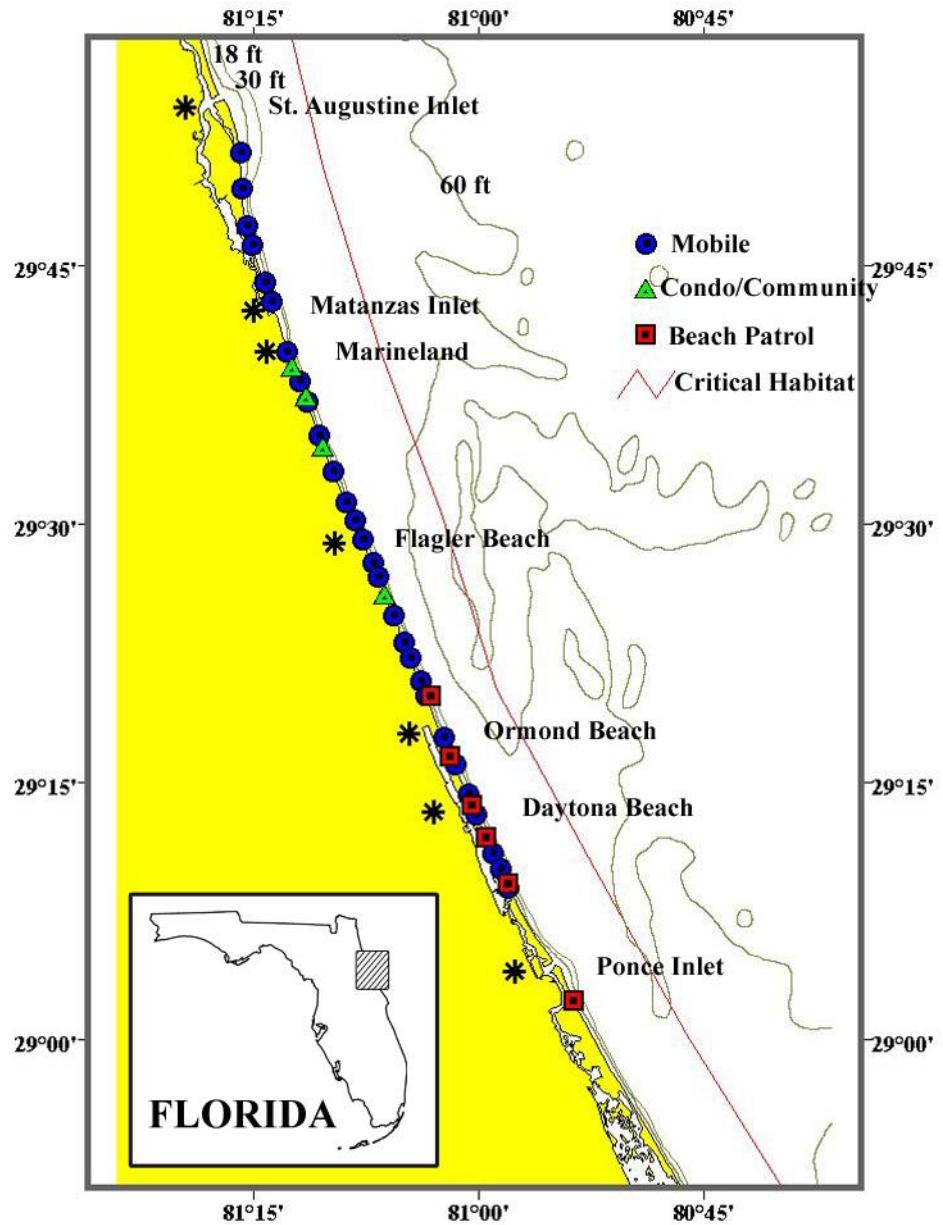


Figure 1. The 37 lookout points used by shore-based spotters in the Marineland Project during the 2014-15 season. Although there may be small adjustments to locations, and points may be added and subtracted, the overall sighting effort has remained fairly constant for the past several years. The 5 nmi boundary of the SEUS right whale critical habitat (red line) and three near-shore depth contours (labeled) are shown.

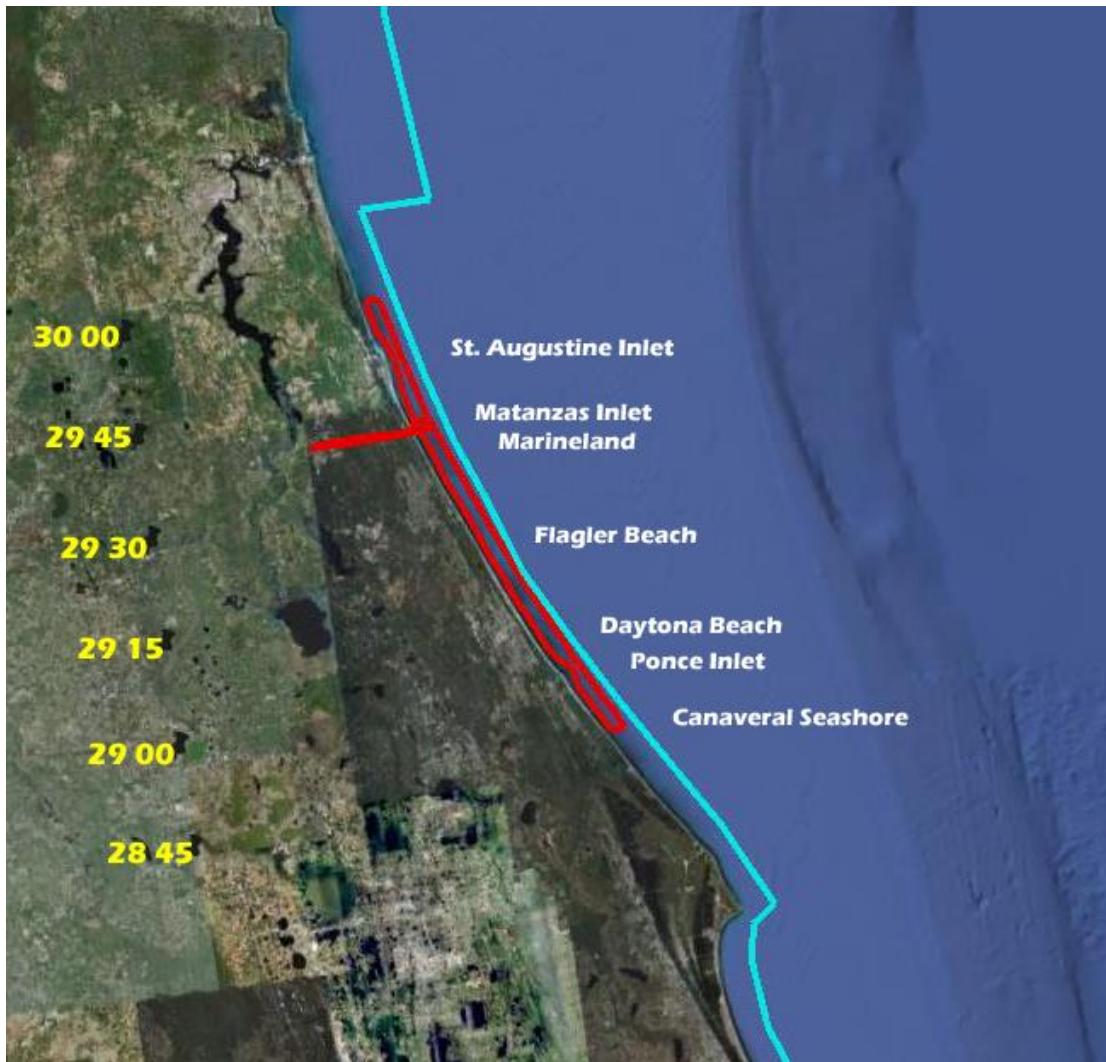


Figure 2. The shore-based sighting network and the aircraft surveys and responses are both complementary and synergistic. Shown are the standard aircraft survey tracks (red line) and the boundary of the SEUS right whale critical habitat (aqua line). The aircraft also responds to sighting reports originated by shore spotters, and aids in obtaining high-quality photographs essential to photo-identification and documentation.

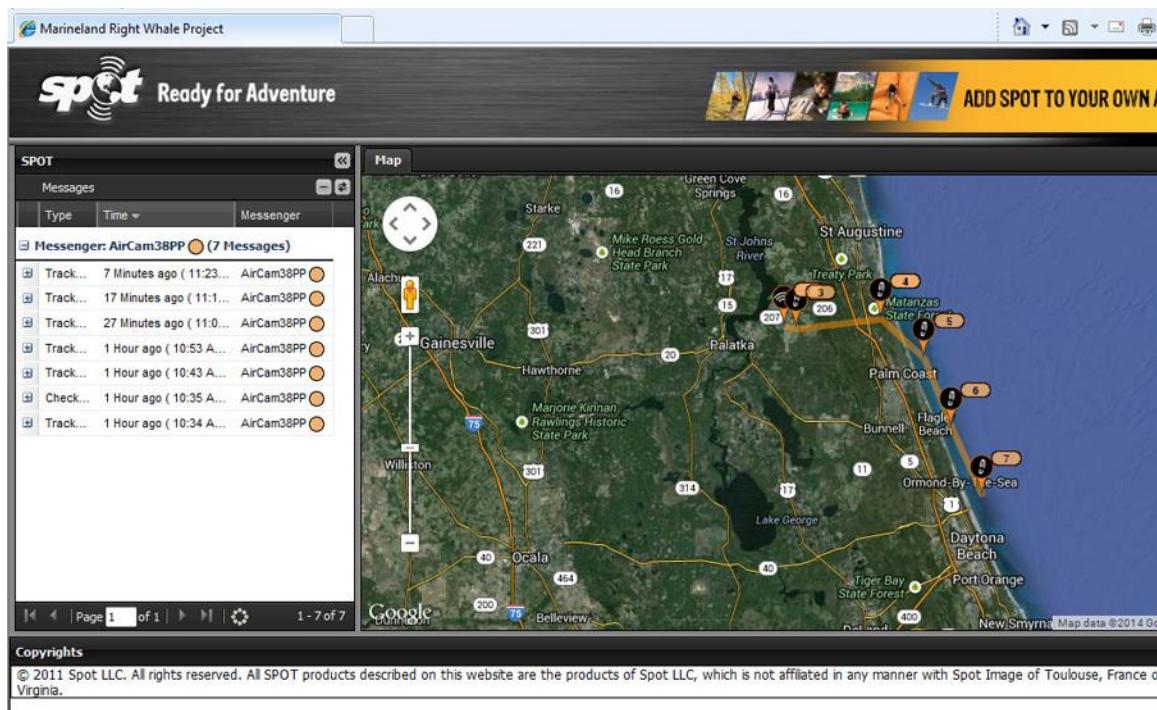


Figure 3. The satellite-based SPOT tracker provides an additional level of aircraft position and safety reporting as well as location information that aids in responding to reported sightings. Positions are reported to the ground contact at Marineland every 10 minutes. Take-off and landing status reports are also provided. In the event of an emergency, a position report is sent to designated contacts, so that a response can be initiated.

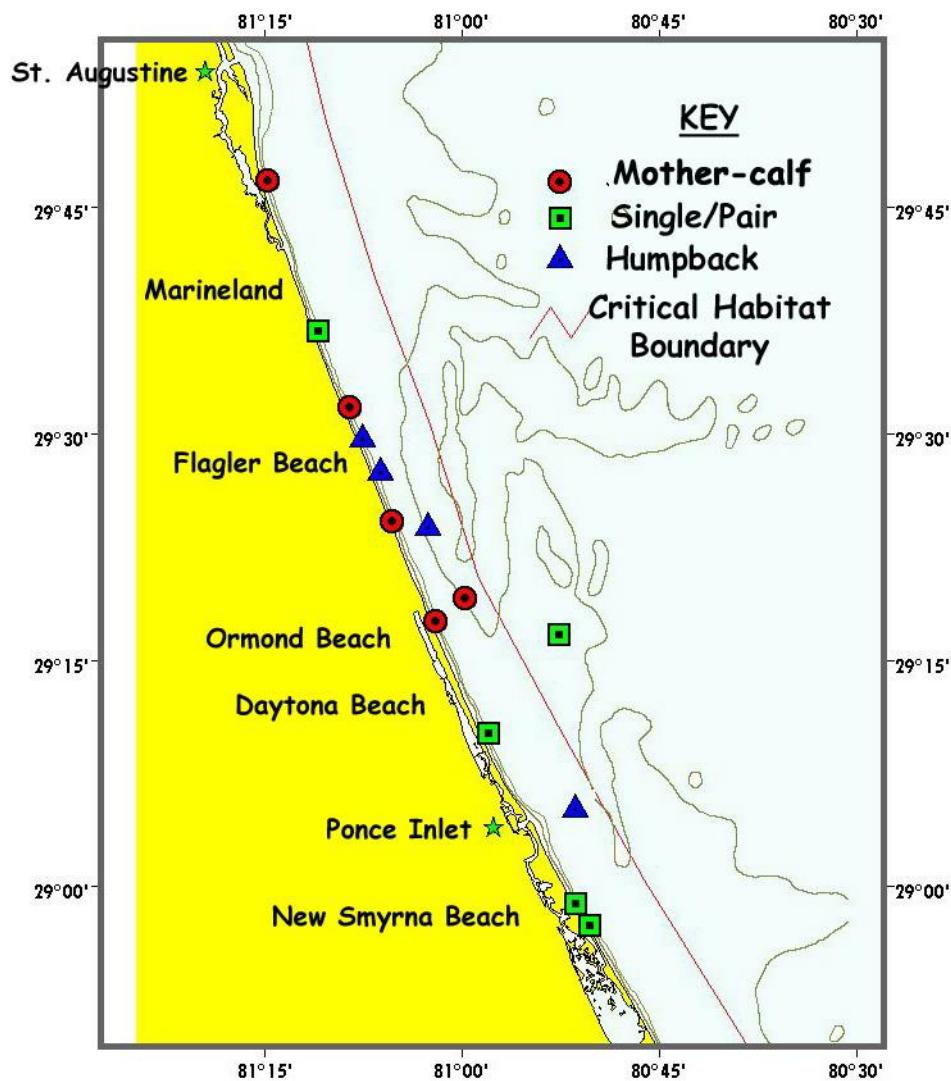


Figure 4. Verified whale sightings by the Marineland Right Whale Project and the Marine Resources Council during the 2014-15 southeastern U.S. (SEUS) season.

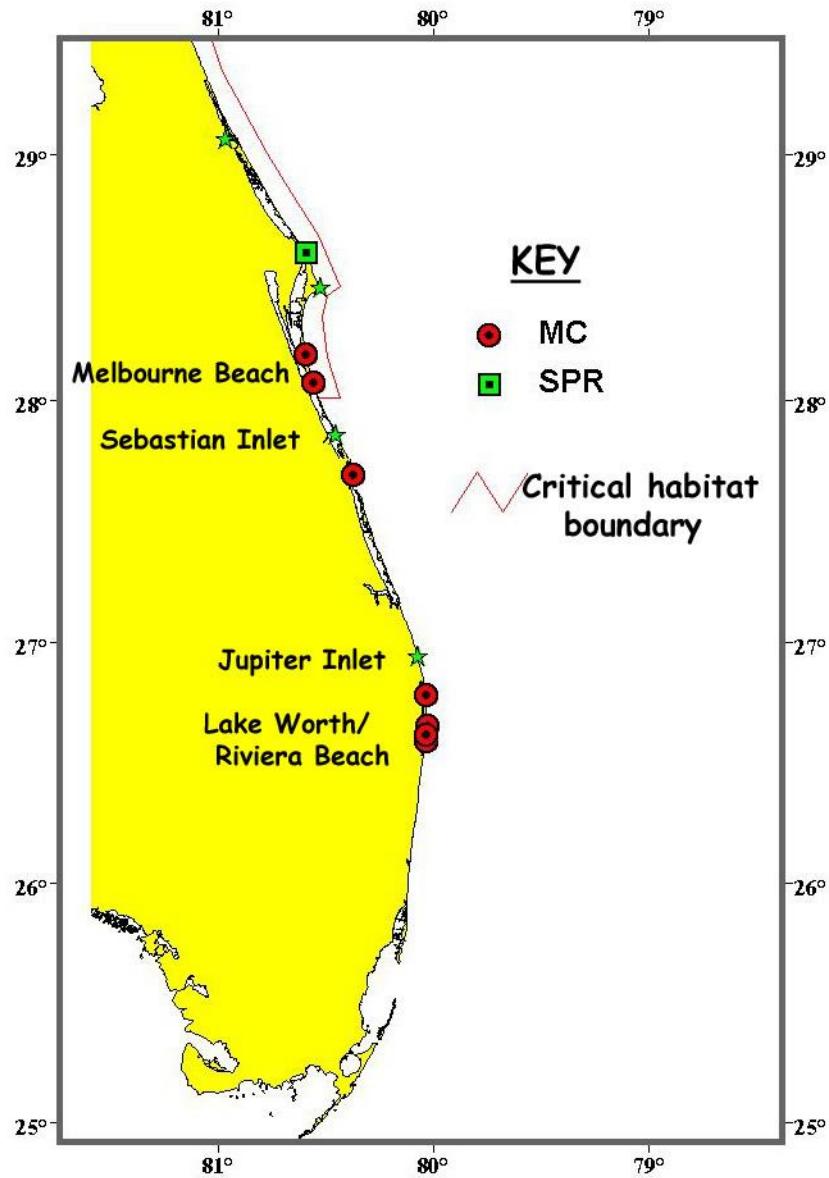


Figure 5. The Volunteer Sighting Network south of Cape Canaveral contributed valuable sightings, most notably of mother #3420, *Platypus*, and her first calf. Key: MC=mother-calf pair, SPR=single or pair. No groups of  $\geq 3$  were reported.



Figure 6. A new initiative this season, a collaborative effort of NOAA, Alaska Sealife Center, Florida Fish & Wildlife Conservation Commission, Georgia DNR, and the Sea to Shore Alliance, was satellite tagging. Three limpet tags were placed. The volunteer sighting network and the coastal aerial surveys directly or indirectly contributed to all three events. In this example, a single individual was sighted by a volunteer team on 19 January 2015 just south of Marineland, and by a volunteer the next day off New Smyrna Beach. The sighting was relayed to the tagging teams and our aircraft remained on site until the first tagging boat arrived. The tag transmitted for 15 days, allowing this individual to be tracked up the coast of the Carolinas as far as Cape Hatteras. This was good collaboration and good science. (Images: J. Hain and Alaska Sealife Center)



Figure 7. On 9 February 2015, a Sunday with good weather, mother #1604 with her calf swam northward off Flagler Beach. At shortly after 9:00 a.m., a paddleboarder and, shortly thereafter, a surfer paddled out. Both were respectful and did not approach too closely (although they were in violation of the 500-yard approach rule). After a short period, they withdrew and paddled back to shore. We recorded the event as benign in nature. Subsequently, both were provided information on the 500-yard approach rule as well as the possible danger should humans get too close, or, get between the mother and calf. The information was provided by the police (who had been called), as well as one of our volunteers who was on site. (Images: J. Hain)

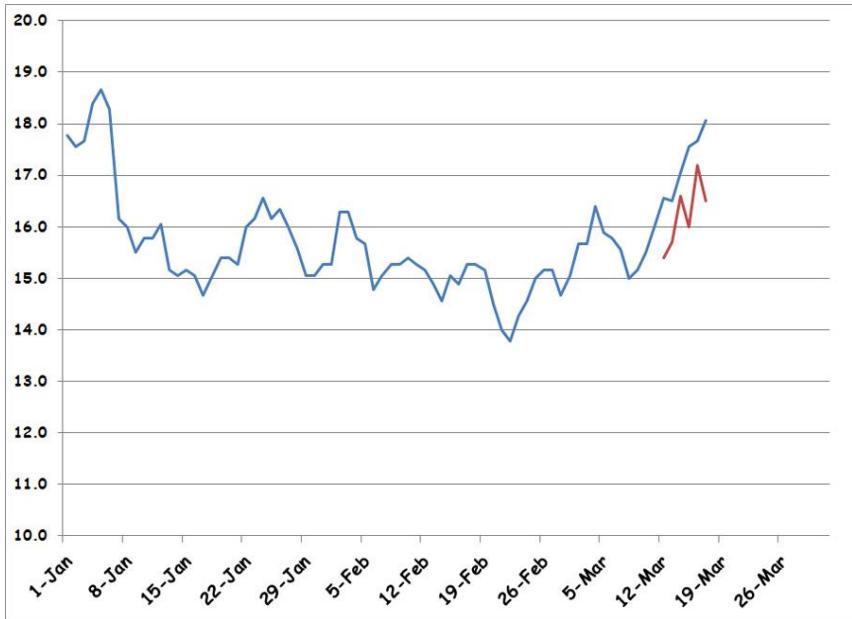


Figure 8. SST as measured from the intake system at the Marineland Dolphin Adventure facility during January through March 2015. When the St. Augustine NOAA SST sensor came back on line in March 2015 (red line) it suggested that the Marineland SST was warmer by about  $1^{\circ}\text{ C}$ .

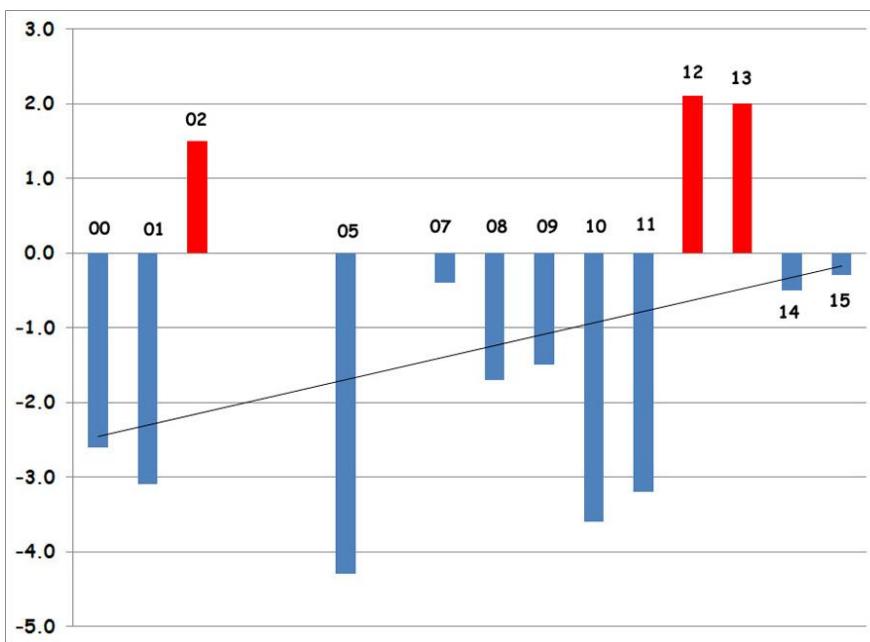


Figure 9. An index of SST in the Marineland area from 2000 through 2015. The values are assigned based on the degree that the average SST on 1 February was above (red) or below (blue) the  $16^{\circ}\text{ C}$  reference level (a value based on Garrison (2007) and adapted for the Marineland area). The 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. As seen in the above, the Marineland temperatures varied from the NOAA data by about 1 degree C. The trendline suggests a warming trend during the 16-year period.

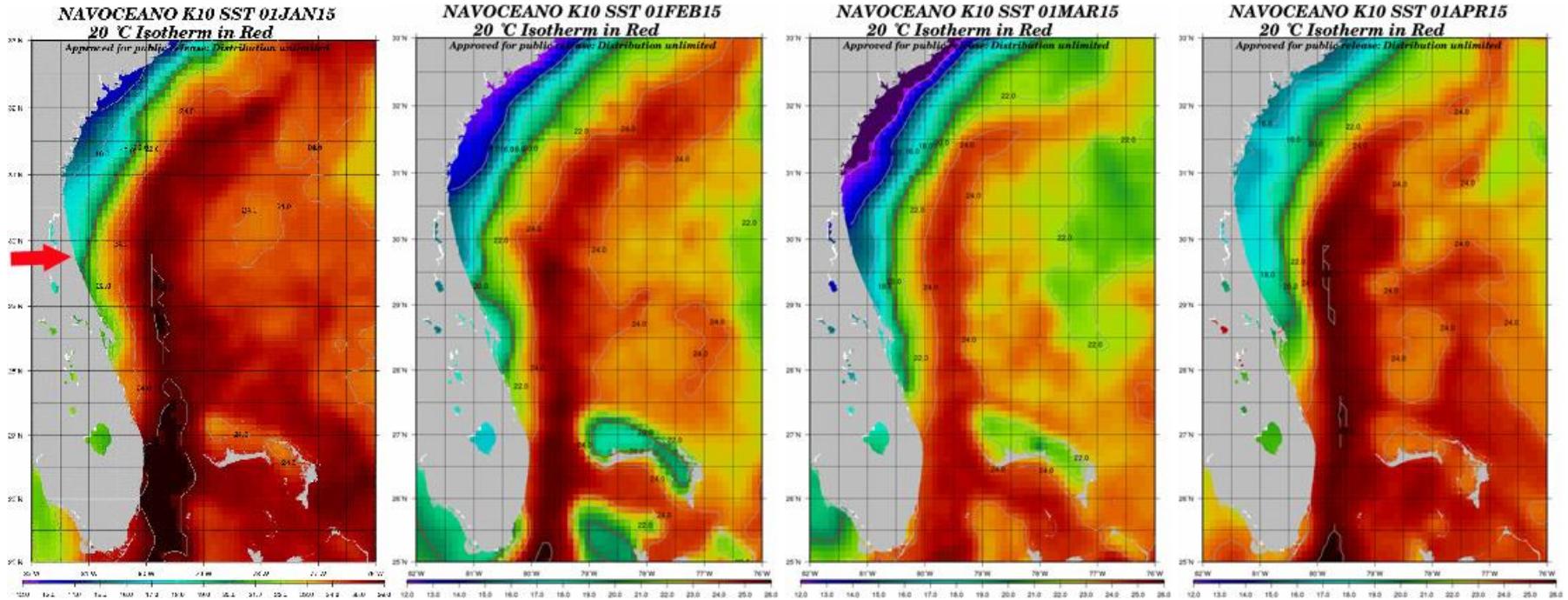


Figure 10. The Sea-Surface-Temperature (SST), as interpolated from satellite-based AVHRR measurements of radiance provide the big-picture view of major SST features—the lens of cool water extending southward along the coast and the warm water of the Gulf Stream flowing northward offshore. The images show the general appearance of the nearshore cool water “finger” and general cooling as the season progresses, followed by the retreat of the cool finger and general warming as the SEUS right whale season comes to an end. The SST at Marineland was ~18.2° C on 1 January, ~15.7° C on 1 February, and ~15° C on 1 March. The red arrow indicates the location of Marineland. (Imagery: Naval Oceanographic Office, Stennis Space Center, Mississippi)

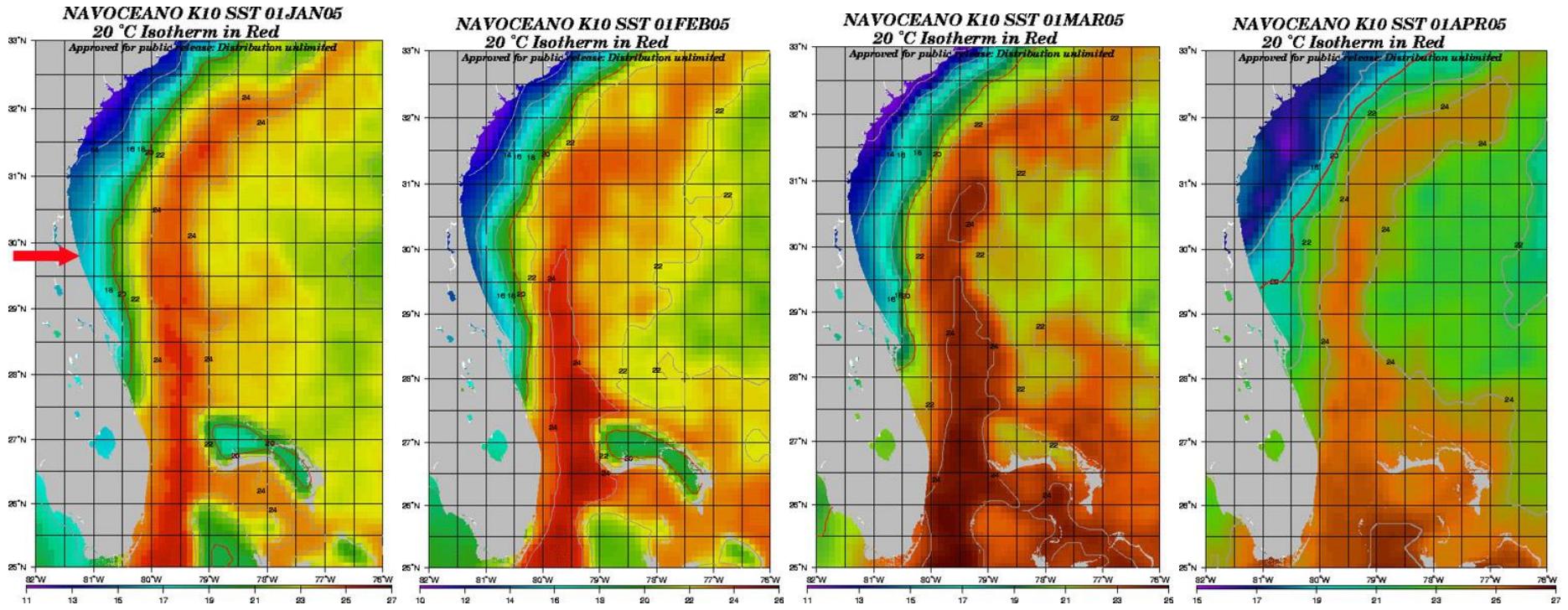


Figure 11. The 2005 season in the SEUS was a “cold” year. The 20° C isotherm was well south of Cape Canaveral for most of the season, and SST at Marineland was ~16° C on 1 January, ~13° C on 1 February, and ~14.5° C on 1 March—the coolest water temperatures in 15 years.

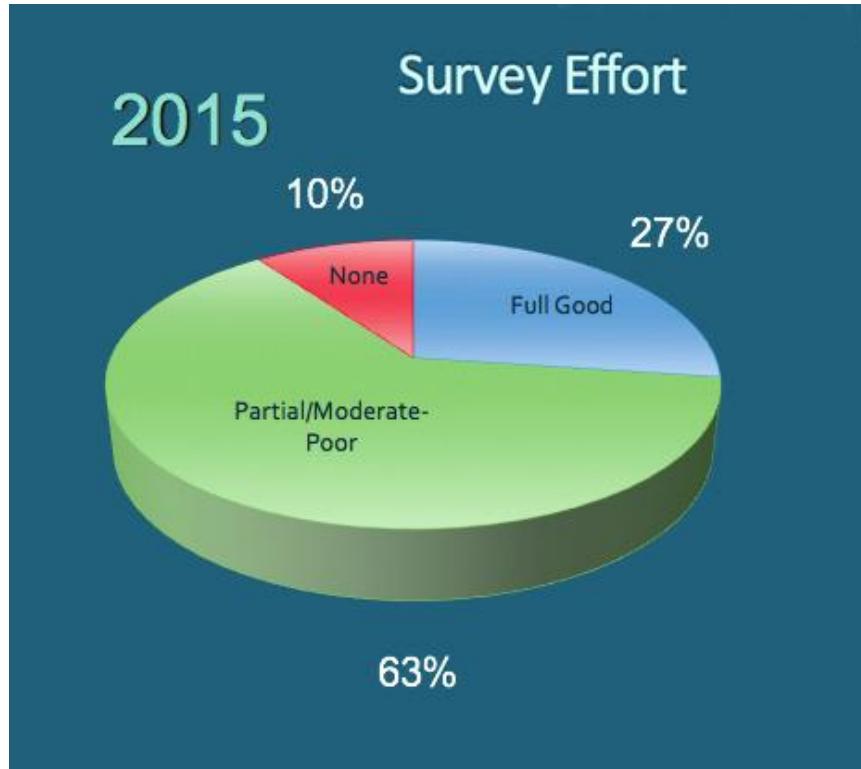


Figure 12. Of the 70 total available survey days in the 2015 season, full surveys were conducted in good weather conditions on 19 days (27%). On 44 days (63%) survey quality was compromised by moderate to poor weather. On 7 survey days (10%), no surveys took place, or, less than 25% of the survey area was covered.

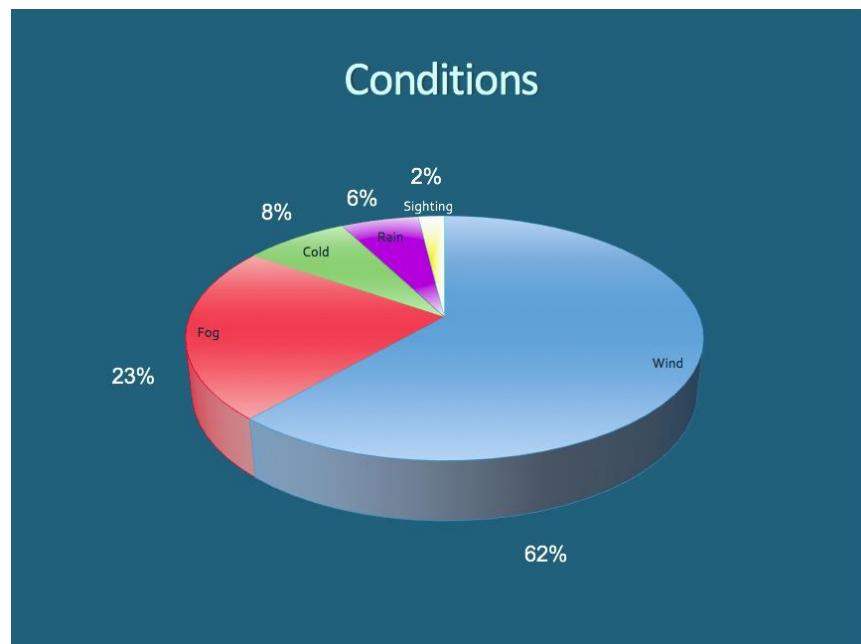


Figure 13. High winds that in turn resulted in high sea states was the major factor in compromised survey conditions. Compared to previous season, weather was poorer and effective survey days were decreased.



Figure 14. An essential component of the program is outreach and education. In this example, presentations were given to classes at Osceola Elementary School on 23 January 2015 by volunteer Arliss Ryan (rear, center) and others. We seek to inform the citizens of this generation and the next.

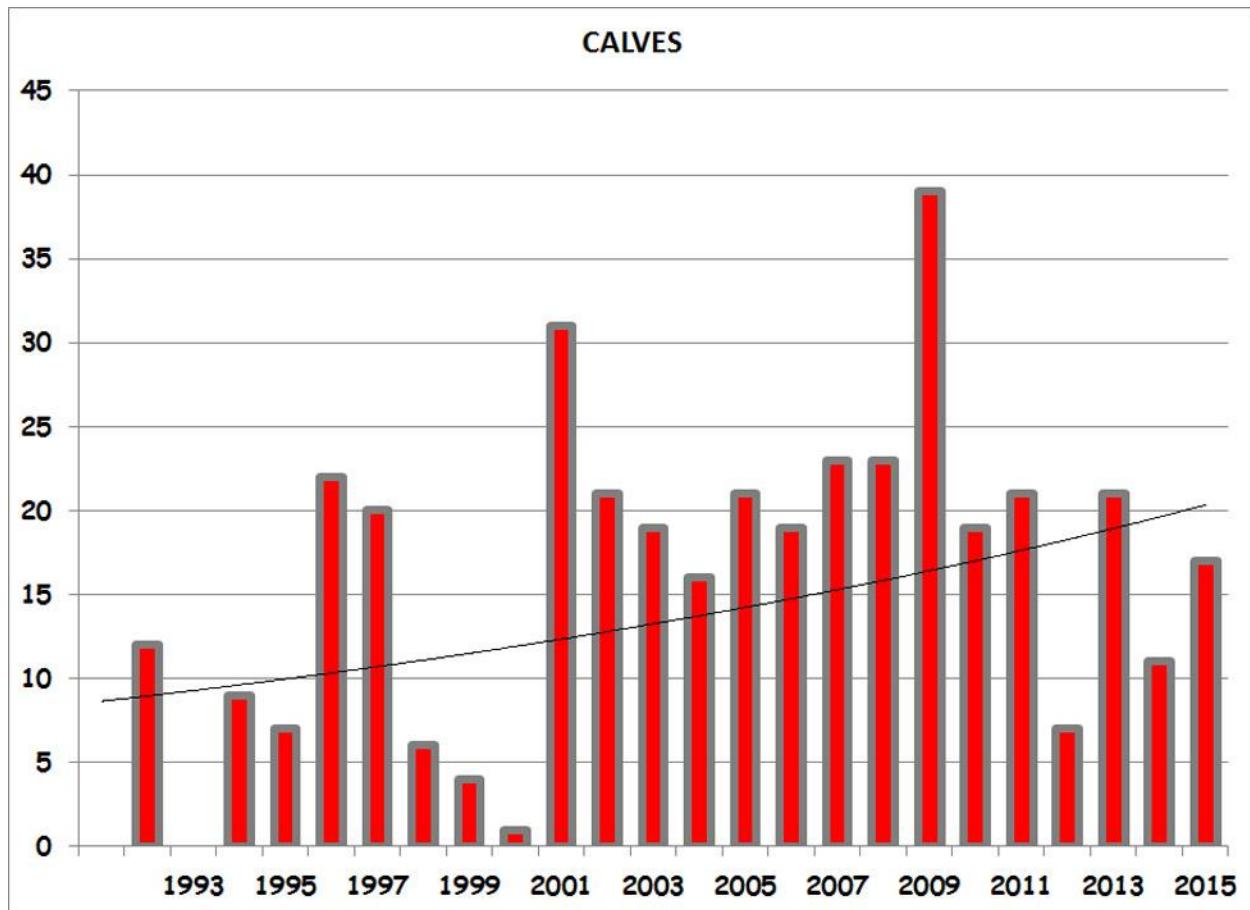


Figure 15. Records compiled by the New England Aquarium show great variability in annual calf production. Despite the variability, the trend (black line) indicates a gradual increase.

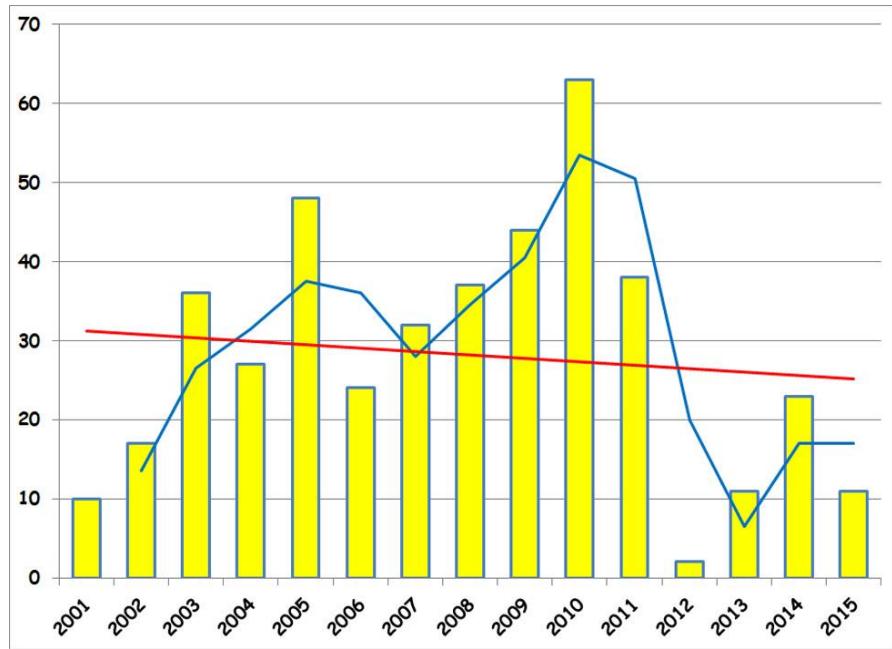


Figure 16. Total number of right whale sightings in the Marineland area, 2001 through 2015. The blue line is the two-year moving average, and the red line is the overall trend.

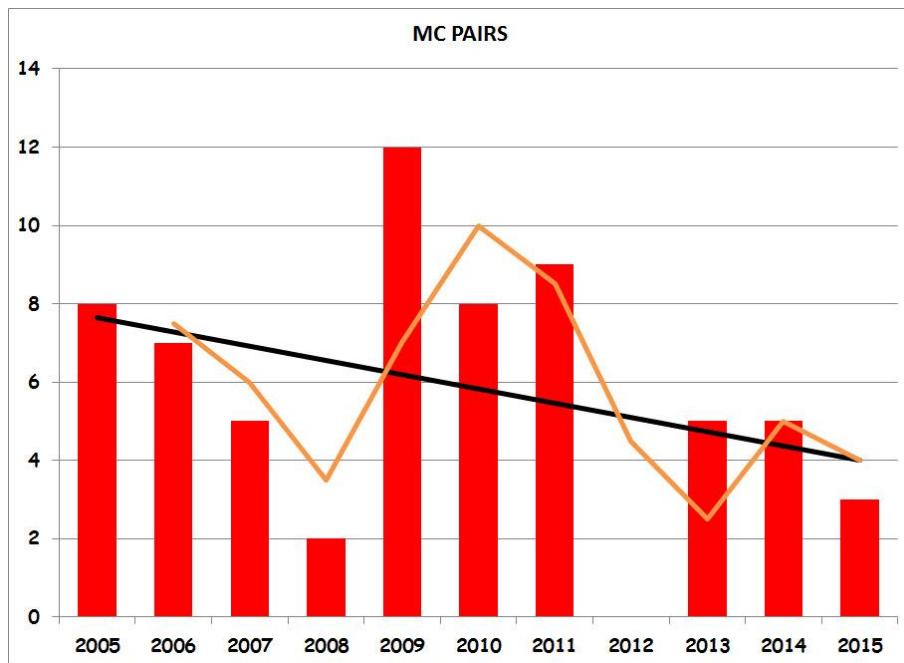


Figure 17. The number of different mother-calf pairs sighted in the Marineland area. The black line is the overall trend, the orange line is the two-year moving average.



Figure 18. A core of 200+ dedicated and capable volunteers provide “eyes on the water.” As the program grows, and outreach continues to improve, the volunteers include fishermen, beachwalkers, condo dwellers, town and county employees, and the teams that conduct protocol surveys for ~ 10 weeks from January through March.