

# **BROWARD COUNTY SEA TURTLE CONSERVATION PROGRAM**

## **2020 Technical Report**



Submitted by:

Dr. Derek Burkholder - Principal Investigator

Curtis Slagle – Project Manager

Glenn Goodwin, Abby Nease – Assistant Project Managers

Nova Southeastern University  
Halmos College of Arts and Sciences  
8000 North Ocean Drive  
Dania Beach, Florida 33004

For the:

Broward County Board of County Commissioners  
Environmental Planning and Community Resilience Division  
115 South Andrews Avenue  
Room 329-H  
Fort Lauderdale, Florida 33301



## Table of Contents

Acknowledgements .....	6
Executive Summary .....	8
Introduction .....	10
Beach Renourishment Projects .....	10
Program Goals .....	11
Materials and Methods .....	11
Personnel .....	11
2020 BCSTCP Senior Staff .....	11
2020 BCSTCP Morning Staff .....	11
2020 BCSTCP Evening Staff .....	12
2020 BCSTCP Lighting Staff.....	12
Sea Turtle Nesting Surveys .....	12
Data Collection, Management, and Analysis .....	13
Treatment Zones .....	14
Nest Relocation .....	14
Restraining Cages .....	15
Reproductive Success Evaluations.....	15
Lighting Surveys .....	16
Strandings .....	17
Disorientation Events and Obstructed Nesting Attempts .....	17
Education and Outreach Initiatives .....	18
Results .....	18
Sea Turtle Nesting Surveys .....	18
Leatherback Sea Turtles ( <i>Dermochelys coriacea</i> ) .....	19
Overall Nesting Activity .....	19
Temporal Patterns.....	19
Spatial Patterns.....	19
Incubation Periods .....	19
Reproductive Success .....	19
Loggerhead Sea Turtles ( <i>Caretta caretta</i> ) .....	20
Overall Nesting Activity .....	20

Temporal Patterns.....	20
Spatial Patterns.....	20
Incubation Periods .....	20
Reproductive Success .....	20
Green Sea Turtles ( <i>Chelonia mydas</i> ) .....	21
Overall Nesting Activity .....	21
Temporal Patterns.....	21
Spatial Patterns.....	21
Incubation Periods .....	22
Reproductive Success .....	22
Beach Renourishment Projects .....	22
Hillsboro/Deerfield Beach Nourishment Project .....	22
Hillsboro Inlet Maintenance and Sand Bypass Project.....	23
FCCE Broward County Shore Protection Project Segment III.....	23
Relocation.....	24
Incubation Period .....	24
Reproductive Success .....	24
Disorientation Events.....	24
Predation and Poaching .....	25
Restraining Cages .....	26
Incubation Period .....	26
Reproductive Success .....	26
Washover and Washout Events .....	26
Strandings .....	26
Obstructed Nesting Attempts.....	27
Discussion.....	27
Yearly Nesting Trends .....	27
Seasonal Nesting Patterns .....	27
Countywide Nest Distribution.....	28
Nest Relocation .....	28
Restraining Cages .....	29
Disorientation Reports .....	30

Predation and Poaching .....	30
Challenges Encountered .....	30
Conclusions and Recommendations .....	31
References.....	32
Tables and Figures.....	34

## **Acknowledgements**

We would like to thank and acknowledge the tireless and dedicated efforts of the Broward County Sea Turtle Conservation Program (BCSTCP) staff. Their expertise, dedication, and hard work have made the program a success.

A program of this magnitude cannot be accomplished without the assistance and cooperation of numerous individuals, groups, and organizations. We would like to thank Brian Warrick for maintenance/repairs and custom fabrication to keep our all-terrain vehicles (ATVs) operational throughout the season. He worked at all hours of the day and night to keep the team moving! We are grateful to the following individuals and groups for logistical support: Mr. Dan Dodge of the Hillsboro Club who provided a storage area for our ATVs, the Hollywood Beach and Hallandale Beach Maintenance Departments, Fort Lauderdale Beach Maintenance and Public Works Departments, Fort Lauderdale and Pompano Beach Rakers, the Deerfield Beach Parks and Recreation Department, and the City of Pompano Beach Parking Garage for providing a storage area for our ATVs. The Sea Turtle Conservancy has provided sea turtle and environmental awareness products to aid our outreach efforts. Thanks to the Responsible Pier Initiative and Loggerhead Marinelifelife Center for helping to keep our fishing piers clean and educating people about ways to respond to a sea turtle that has been hooked. We also acknowledge the park employees of the Broward County Parks and Recreation Division at Anne Kolb Nature Center who assisted in the Sea Turtles and Their Babies hatchling release programs.

We acknowledge and thank the following agencies and local governments for their support and guidance in the continuation of this program: the Florida Department of Environmental Protection, Division of Recreation and Parks; the Florida Fish and Wildlife Conservation Commission (FWC), Florida Marine Research Institute; the Cities and Police Departments of Hallandale Beach, Hollywood, Dania Beach, Fort Lauderdale, Pompano Beach, Deerfield Beach; the Towns of Lauderdale-By-The-Sea and Hillsboro Beach; the Code Enforcement Departments in Deerfield Beach, Hillsboro, Pompano Beach, Lauderdale-By-The-Sea, Fort Lauderdale, Hollywood, and Hallandale Beach.

We would like to thank the Broward County Board of County Commissioners for program funding and administration. We thank the National Save the Sea Turtle Foundation for organizing, executing, and donating funds via the Adopt-a-Nest program. We would like to thank Rock The Ocean for their continued and generous support through the Tortuga Music Festival, and Rock The Ocean Conservation Village. We would like to thank LauderAle and Stoked on Salt, for hosting events or donating to benefit the BCSTCP. We would like to thank Weston Nissan/Weston Volvo, TheExtraCatch, and the Hooley/Zimmerman Family for their generous support of the program and the procurement of our new Nissan NV1500 cargo van.

We would like to thank Richard and Zen Whitecloud and the staff and volunteers of the Sea Turtle Oversight Protection (STOP) program, Doug Young and the staff and volunteers of South Florida Audubon Society (SFAS) program, and Kristine Halager and the staff and volunteers of the Sea Turtle Awareness Rescue Stranding (STARS) group for their dedicated hard work and assistance with nest cage monitoring, hatchling disorientation response, and support throughout the season.

Finally, we would like to thank all of the individuals and groups that participated in our education and outreach efforts this year, even in the challenges we all face with the global COVID-19 pandemic, we were excited to still bring some virtual education about Broward County's sea turtles!

## Executive Summary

The BCSTCP is funded and administered by the Broward County Board of County Commissioners through the Environmental Planning and Community Resilience Division (EPCRD) and carried out by Nova Southeastern University (NSU) to conduct sea turtle nesting surveys daily from March 1–October 31, 2020 for all Broward County beaches excluding Dr. Von D. Mizell-Eula Johnson State Park (Mizell-Eula State Park; monitored by Park staff). All loggerhead, green and leatherback turtle crawls (nests and false crawls) were identified to species and recorded by Geographic Positioning System (GPS). All nests were marked using wooden stakes and Red-Glo flagging tape and monitored throughout the season until they hatched or reached a maximum incubation time determined by FWC guidelines.

A total of 3,141 (2,835 loggerhead, 277 green, 29 leatherback) nests were deposited in Broward County from February 24 to October 9, 2020. Loggerhead turtles led the nesting again this year with 2,835 nests, which is 22 more nests than last year. Loggerheads fell a little short of the five-year average of 2,935 nests per season. Green turtles laid 277 nests, which was 511 nests below last year's record season. A low nesting year was anticipated since the local population of green turtles appears to have a biennial reproductive cycle where an individual may only return to nest every two years in most cases. The 2019 season was a record setting high nesting year for green turtles, and so lower green turtle nesting was expected in 2020. This season was much lower than the five-year average of 400 green turtle nests. Leatherback turtles are the least common nesters in Broward County, laying 29 nests in 2020. This season, leatherback nesting was slightly above the five-year average of 26 nests.

Nesting success (nests/(nests + false crawls)) averaged 48.32% for all species combined, 0.76% higher than the 2019 season (47.56%) and 3.86% higher than the five-year average of 44.46%. Loggerhead nesting success was 47.81%, about 2.35% higher than 2019 (45.46%), and about 3.07% higher than the five-year average of 44.74%. Green turtle nesting success was 51.39%, about 3.71% lower than 2019 (55.10%) and 0.95% lower than the five-year average of 52.34%. Leatherbacks showed an increased nesting success of 93.55%, compared to the 2019 season at 91.49% and fell about 1% above the five-year average of 92.34%.

Reproductive success was investigated for 2,094 nests after hatch-out (1,970 *in situ*, 49 relocated, and 75 restraining cage nests). Emergence success for *in situ* loggerhead nests in 2020 (74.35%) was about 3.21% lower than the emergence success to 2019 (77.56%). Emergence success for *in situ* green nests in 2020 was 79.75%, which was about 1.55% lower than 2019 (81.30%). Emergence success for *in situ* leatherback nests rose about 2.18% from 64.52% in 2019 to 66.70% in 2020.

The Hillsboro Beach survey zone had the most nesting in Broward County with an average of 275.58 nests/mile (169.29 nests/km; all species combined). The Hollywood



Beach survey zone had the lowest nesting density with an average of 35.34 nests/mile (21.81 nests/km; all species combined).

The BCSTCP monitored sea turtle nesting activity relative to two renourishment projects in recent years and one active maintenance/bypass project:

- Hillsboro/Deerfield Beach Nourishment Project (FDEP Permit No. 0289706-001 JC) placed approximately 70,350 cubic yards of sand from R6+750 feet south to R10. Sand placement concluded on March 24, 2020.
- Hillsboro Inlet Maintenance Dredging and Sand Bypass Project (FDEP Permit No. 0229394-001-JC) to place sand from R25 to R26+150 feet south. Sand placement is ongoing.
- FCCE Broward County Shore Protection Project Segment III (FDEP Permit No. 0135660-001-JC) placed approximately 134,810 cubic yards of sand from R98+400 feet south to R101 and R102 to R128+675 feet south. Sand placement concluded on May 10, 2019.

## Introduction

Since 1978, the EPCRD and Broward County Board of County Commissioners have provided for the conservation of endangered and threatened sea turtles in Broward County, Florida. Florida's coastline experiences the densest sea turtle nesting in the United States. Broward County is classified by FWC as a medium-density nesting area in Florida and is in the normal nesting ranges of three species of sea turtles: loggerhead (*Caretta caretta*), green (*Chelonia mydas*), and leatherback (*Dermochelys coriacea*) turtles. In the coastal waters around Broward County, Kemp's ridley (*Lepidochelys kempii*) and hawksbill (*Eretmochelys imbricata*) sea turtles can also be found, but do not nest regularly in the area.

The leatherback is categorized as endangered in this region, while the loggerhead and green turtles are listed as threatened. The North Atlantic distinct population segment of green turtles (including Florida) was recently down-listed from endangered to threatened in 2016. All species of sea turtles in U.S. waters are protected under the U.S. Endangered Species Act of 1973 and Florida's Marine Turtle Protection Act (379.2431, Florida Statutes). These statutes protect all life history stages of sea turtles and therefore all conservation, monitoring, or research efforts require permitting by FWC. Permitting is administered by the U.S. Fish and Wildlife Service for sea turtles on land and the National Oceanic and Atmospheric Association (NOAA) protects all in-water turtles. All monitoring and conservation efforts for this program were administered and supported by the Broward County EPCRD and conducted by NSU as part of the BCSTCP.

### **Beach Renourishment Projects**

Coastal development alters the natural accumulation and loss of sand on natural beaches. Broward County's highly developed and armored coastline calls for needed maintenance of beach profiles, beach width, and dune structures. To help mitigate erosion along sections of Broward County beaches, intermittent beach renourishment projects have been established in some areas of the County to ensure the continuation of coastal preservation, beach recreation and infrastructure protection. The EPCRD has maintained the sea turtle conservation and monitoring program in years with and without sand placement projects, to better understand the long- and short-term impacts of sand placement projects on nesting sea turtles. There have been three renourishment projects in recent years:

- Hillsboro/Deerfield Beach Nourishment Project (FDEP Permit No. 0289706-001 JC) placed approximately 70,350 cubic yards of sand from R6+750 feet south to R10. Sand placement concluded on March 24, 2020.
- Hillsboro Inlet Maintenance Dredging and Sand Bypass Project (FDEP Permit No. 0229394-001-JC) to place sand from R25 to R26+150 feet south. Sand placement is ongoing.
- FCCE Broward County Shore Protection Project Segment III (FDEP Permit

No. 0135660-001-JC) placed approximately 134,810 cubic yards of sand from R98+400 feet south to R101 and R102 to R128+675 feet south. Sand placement concluded on May 10, 2019.

## **Program Goals**

The BCSTCP goals in 2020 were to:

- 1) Conduct daily sea turtle nesting surveys and beach monitoring for mechanical beach cleaning and various permitted projects and beach events.
- 2) Relocate or protect imperiled sea turtle nests to maximize hatchling survival.
- 3) Conduct nest evaluations to examine hatching success.
- 4) Conduct stranding and salvage activities and maintain a 24-hour sea turtle emergency hotline.
- 5) Inform and educate the public through educational seminars, public hatchling releases, and table events about sea turtles and sea turtle conservation/management.
- 6) Provide accurate and timely reporting.

## **Materials and Methods**

### **Personnel**

The BCSTCP works with protected species, therefore all sea turtle monitoring and work is authorized by FWC's Imperiled Species Management section (ISM) and was conducted by permitted individuals under Marine Turtle Permits #214, #215, #148 issued to Curtis Slagle (January 1–December 31, 2020). The FWC Marine Turtle Permit, FWC Marine Turtle Conservation Handbook, and the contract with Broward County were used to set procedures for all monitoring, stranding, and survey protocols for this program.

#### *2020 BCSTCP Senior Staff*

Stephanie Kedzuf – Broward County Contract Administrator  
Derek Burkholder – Principal Investigator / Director  
Curtis Slagle – Project Manager / Permit Holder  
Glenn Goodwin – Assistant Project Manager / Outreach Coordinator  
Abby Nease – Assistant Project Manager / Data Manager

#### *2020 BCSTCP Morning Staff*

Jessica Boyd  
Sierra Ciciarelli  
Adrianna Coican  
Nicolas Colletier

Briana Coulter  
Kelly Detmer  
Miranda Fuller  
Rakin Khan  
Jacob Larsson  
Colleen McMaken  
Katherine Meurer  
Ashley Middleton  
Kristen Nelson  
Alexis Peterson  
Joscelyn Phillips  
Katerina Sawickij  
Kimberly Schmutz  
Caitlin Shanahan  
Will Sitterson  
Yvanna Strait  
Chloe Webb

*2020 BCSTCP Evening Staff*

Allison Banas  
Tyler Baskin  
Taylor Bertolini  
Andrew Blitman  
Noah Cohen  
Maria DeBianchi  
Sarah Gumbleton  
Shaquilla Hamlett  
Krista Scheuerman  
Mikaya Twiss  
Monica Winn  
Madison Yelle

*2020 BCSTCP Lighting Staff*

Noah Cohen  
Marshall Hawkins  
Alexis Peterson  
Kristen Nelson

**Sea Turtle Nesting Surveys**

Daily sea turtle nesting surveys were conducted by BCSTCP staff from February 26 – October 31, 2020 for all Broward County beaches (24 miles) excluding Mizell-Eula State

Park (previously John U. Lloyd State Park; 2.4 miles; Figure 1). Mizell-Eula State Park is an FWC Index Beach that is used by researchers following a standardized set of survey protocols and specific beaches to monitor the long-term nesting trends of marine turtles in Florida. Survey protocols and data collected on FWC Index Beaches are slightly different from the data that are collected throughout the rest of Broward's beaches, so some information may not be recorded in this area and therefore will be left out of parts of this technical report. Park rangers carried out surveys in Mizell-Eula State Park and they provided all data for this survey area.

Surveys began 30 minutes before sunrise each day and were conducted using ATVs (Honda Rancher 420, Honda Pioneer 500 Side x Side). For survey purposes, Broward County was divided into five survey zones: Hillsboro and Deerfield Beaches (Hillsboro), Pompano Beach including Lauderdale-By-The-Sea (Pompano), Fort Lauderdale, Mizell-Eula State Park, and Hollywood and Hallandale Beaches including Dania Beach (Hollywood; Table 1; Figure 2). For all survey zones, except Mizell-Eula State Park, nest locations were referenced to Florida Department of Environmental Protection (FDEP) range monuments (R-zone) numbered consecutively (north to south) from R1-R128.

### **Data Collection, Management, and Analysis**

All nesting and non-nesting emergences (false crawls) were recorded, and locations marked by GPS when they were first encountered on the survey. Data were recorded on paper data sheets and electronically using a Sonim XP-7 device with the VJGames GPS Coordinates and ZohoForms applications in the field. The VJGames GPS Coordinate application uses GPS, Wi-Fi, and mobile networks to determine location. All nests were additionally marked with a Trimble GeoExplorer 6000 Series or Trimble GeoExplorer 2008 Series (<1 m accuracy) to allow for precise nest reestablishment throughout the season if necessary (stakes lost, nest washout, vandalism, etc.). Nest GPS was taken over the center of the clutch when it was verified, the approximate clutch location when it was not known, or at the apex of a false crawl. To ensure crawls were not double counted, after all data were collected from a crawl and it was marked accordingly, the tracks (not the nest site) were driven over with an ATV to indicate they have already been documented.

The following information was recorded for each crawl:

- 1) Survey zone referenced to nearest property and R-zone monument marker
- 2) Crawl type (nest or false crawl)
- 3) A unique identifying number (generated using beach code and nest or false crawl number)
- 4) Date crawl was discovered
- 5) Species identification
- 6) Measurement from nest or apex of false crawl to the previous night's high tide line

- 7) Crawl characteristics (e.g. crawl width, number of body pits or abandoned egg chambers, etc.)
- 8) Final nest treatment (*in situ*, relocation, restraining cage)
- 9) If the turtle encountered an obstruction (ONA)
- 10) If the turtle disoriented

The Data Manager entered data daily into an Excel spreadsheet, all field data sheets were photocopied, and originals were held until all analysis and reporting requirements were complete. All data were verified by at least one additional senior staff member after being entered and before analysis. Data analyzed and presented in this report were compiled using Microsoft Excel 2008 for Mac and JMP Pro 12. All maps were constructed in ESRI ArcGIS 10.6.1 (GCS North American NAD 1983 projection). Historical nesting, nesting success, hatching success trends, and reproductive success were analyzed using analysis of variance for linear regression.

### **Treatment Zones**

Survey zones were further broken down into treatment zones based on different management tools/strategies to minimize unwanted natural and anthropogenic influences in the area. Treatment zones were broken down into “donor,” “*in situ* & recipient,” “restraining cage,” or “*in situ*” categories (Table 2, Figure 3).

All nests classified as “*in situ*” (did not undergo nest relocation) were marked with a minimum of four stakes (one signed stake [see Appendix 1 for example of nest sign], at least three non-signed stakes) with a circle of Red-Glo flagging tape with a radius of at least three feet centered on the clutch. The top of the signed stake was painted white to facilitate clear data recording on the stake. For sites where a clear dig sight could not be identified, the whole area of disturbed sand was encircled with flagging tape. If during the season the nest markers were lost, washed away, vandalized, etc. the nest was reestablished using the Trimble sub-meter GPS units. Upon reestablishment, nests were marked with a circle of Red-Glo flagging tape with at least a five feet radius centered on the nest site.

### **Nest Relocation**

Nests deposited in areas that were deemed “donor zones” by FWC or that were laid below the previous night’s high tide line were relocated to the nearest “recipient zone” or west of the original nest location, respectfully, to ensure the highest possible hatching success. All nests were relocated before 9 am the morning after they were deposited. Each nest was carefully dug by hand and the eggs were transported in buckets containing damp sand from the original nest chamber. Special care was taken to leave eggs in their natural orientation (how they were sitting in the original chamber created by the nesting mother) to minimize mortality of the embryos during transportation. A new “nest chamber” was dug by hand to the same depth/width/shape as the original nest

chamber, eggs were placed in the chamber and reburied following the FWC Marine Turtle Conservation Handbook (2016).

Relocated nests were marked with three stakes (one signed stake, two unsigned stakes) in a triangle with the egg chamber in the middle and surrounded with Red-Glo flagging tape. All relocated nests were evaluated post-hatching for hatching success unless extenuating circumstances (washout, vandalism, etc.) made post-hatching analysis impossible.

### **Restraining Cages**

Restraining cages were used as a temporary management tool for zones of high artificial lighting trespass on the beach, as specified by the FWC permit (Figure 3). In all “restraining cage” zones, egg chambers were located for each nest during the daily survey and nests were marked as per standard procedures for “*in situ*” nests.

Restraining cages were constructed for every other loggerhead nest in the “restraining cage” zones, as per the FWC permit. Cages were deployed at 45 days (the beginning of the hatch out window) and monitored until at least 72 hours post-emergence or until the nest reached 70 days incubation time.

Cages were constructed of a thick plastic mesh ( $\frac{3}{4}$  inch x  $\frac{3}{4}$  inch) lined with window screen on the inside of the cage to minimize hatchling entanglement in the cage and protect hatchlings from predators that may reach through the mesh. Cages were a cylinder (24-inch diameter and height), with a flat mesh top secured in place and an access hatch in the top to facilitate hatchling retrieval. Additionally, a door was cut into the eastern side of the cage that was opened during the day so hatchlings that may emerge during the day could escape and not desiccate in the cage during the heat of the day (Appendix 2a). An informative sign was affixed to the outside of the cage with the pertinent response phone numbers if a turtle was found in the cage (Appendix 2b).

For cage construction, the enclosure was placed centered over the top of the egg chamber, a trench was dug around the base of the cage, and the base of the cage was buried in the ground 4-6 inches and then secured to stakes to hold it in place. Daily cage monitoring consisted of closing the eastern door at sunset each day, checking the cage for hatchling activity at least once between 23:00 and 01:00 each night (any hatchlings encountered were removed from the cage and released), and opening the eastern door at sunrise each morning.

### **Reproductive Success Evaluations**

When possible, nests were excavated and assessed for reproductive success at least 72 hours post-hatchout. If a hatchout was not observed, nests were excavated and assessed after a 70-day incubation period for green and loggerhead nests and 80 days for leatherback turtles; after this time the nests are no longer considered viable (FWC Handbook, 2016). Each nest was carefully dug by hand.

The following data were collected for each inventoried nest:

- 1) Hatched eggs
- 2) Live hatchlings in nest (LIN)
- 3) Dead hatchlings in nest (DIN)
- 4) Live pipped hatchlings (LPIP)
- 5) Dead pipped hatchlings (DPIP)
- 6) Whole, unhatched eggs

Clutch size was calculated as: Hatched eggs, plus LPIP, plus DPIP, plus whole eggs.

Emergence success for each nest was calculated as: Hatched eggs, minus LIN, plus DIN; divided by clutch size.

Hatchlings released for each nest was calculated as: Hatched eggs, minus DIN, plus LPIP.

### **Lighting Surveys**

Surveys for artificial lighting on Broward County beaches were conducted once each month from March–September 2020 for all survey zones. Surveyors walked each section of beach after dark (commencing between 22:00 and 00:00) to document light fixtures that were potentially not in compliance with local lighting ordinances. A small lighting survey team worked the same sections of beach each month to allow the highest level of familiarity with the properties surveyed, minimizing human error and discretion thus providing better long-term tracking of lighting non-compliance throughout the season. Survey protocols followed standard techniques as described by the FWC Technical Report: Understanding, Assessing, and Resolving Light-Pollution Problems on Sea Turtle Nesting Beaches (Witherington et al., 2014) and Chapter 62B-55, Florida Administrative Code Model Ordinance for Marine Turtle Protection; both documents identify compliant and noncompliant fixtures/bulbs depending on fixture type, bulb type, light wavelength, etc. Properties that exhibited potentially impactful lighting were photographed to better track individual property lighting throughout the season. All lights/fixtures that may impact sea turtle nesting or hatchling behavior were documented on a standardized “BCSTCP Lighting Survey Data Sheet” which is broken down by light/fixture type and property/address. Each coastal municipality in Broward County has adopted and enforces their local Sea Turtle-Friendly Lighting Ordinance. These ordinances vary slightly, but follow the general recommendations outlined in the Model Ordinance. A list of common lighting types found in Broward County can be found in Appendix 3 and are more fully outlined in the Broward County Sea Turtle Conservation Program Lighting Survey 2019 Summary Report (Broward County, 2019).

Lighting survey reports were submitted to the Broward County Contract Administrator and FWC ISM staff monthly. These reports were ultimately sent to code enforcers in each Broward County coastal municipality for targeted rectification and enforcement actions if necessary.



## **Strandings**

A Sea Turtle Emergency Line is monitored year-round 24 hours a day in Broward County and most members of the BCSTCP are trained in sea turtle stranding response. The emergency line receives many calls throughout the year (Appendix 4), including turtle stranding calls. When a stranding call is received on the emergency line, a member of the sea turtle stranding team is dispatched with a stranding kit, which contains all of the necessary equipment (tag reader, measuring tape, data sheets, knife, pens/pencils, spray paint, trash bags, gloves, etc.) to document the event. Each stranding event is documented using a standardized form from FWC, and similar information is collected whether the animal is alive or deceased. Some of these data include species, sex (if mature), morphometrics, injuries, presence of tags, etc. Each stranding event is reported to the FWC Sea Turtle Stranding and Salvage Network Coordinator within 24 hours; depending on the state of the turtle, instructions are given on transportation to a rehabilitation facility (live stranding) or salvage/burial (deceased). If possible, deceased turtles are marked with spray paint to indicate that the animal has been documented and then are buried on or off the beach. A summary of the BCSTCP stranding responses in 2020 can be found in Appendix 5.

## **Disorientation Events and Obstructed Nesting Attempts**

Three volunteer organizations: STOP, SFAS, and STARS had a strong presence on Broward County beaches again this year. These programs monitored nest hatch outs at night and reported disorientation events separately from the BCSTCP. A disorientation event is defined as either an adult or hatchling sea turtle that does not orient or travel toward the sea, but instead travels in a direction that is more than 45 degrees from the beach-ocean interface. Most of these events can be tied to a bright anthropogenic light source that may be misleading from what would naturally be the brightest point on the horizon (how the nesting mothers and hatchlings typically orient themselves). Historically, the brightest point on the horizon was the moon and stars over the ocean. The STOP, SFAS, and STARS groups monitor most County beaches; however, their efforts are focused in the areas most impacted by anthropogenic lighting.

When an organization (BCSTCP, STOP, SFAS, or STARS) observed a hatchling disorientation event, the nest was marked with the date of hatch out on colored flagging tape to avoid report duplication among groups. In addition, each event was documented using a Marine Turtle Disorientation Report Form and logged into the FWC Online Disorientation Report mobile app. Analyses were conducted using BCSTCP data only as well as all disorientation reports logged by all groups in Broward County. Adult disorientations were observed and reported only by the BCSTCP; Disorientation Forms were filed for these instances, but no analysis was performed on these data.

When a nesting female encountered an obstruction (escarpment, beach furniture, sea wall, rocks, etc.) that impacted her nesting attempt, a Marine Turtle Obstructed Nesting Report (ONA) Form was submitted to FWC as well as recorded using the FWC ONA

Reporting mobile app. An impact to the female's nesting attempt was characterized by the obstruction causing her to change direction, become entangled, etc.

### **Education and Outreach Initiatives**

One of the leading missions of the BCSTCP is community outreach and education. Historically, the BCSTCP has been highly successful in this mission, reaching tens of thousands of individuals per year. However, 2020 has proven to be exceptional in many regards, including the postponement or ultimate cancellation of nearly every in-person outreach opportunity available to educate the public about the plights and conservation of these imperiled species. Due to the COVID-19 pandemic, an estimated 75 potential outreach opportunities were cancelled during 2020, reducing the potential estimated outreach impact by 44,000 individuals (see Burkholder and Slagle 2018, Burkholder and Slagle 2019). To prioritize the health and safety of staff and the public, the BCSTCP reconfigured its outreach for 2020 to include virtual programming to continue to reach as many people as possible.

In 2020, a total of 25 educational and outreach events were held, both in-person (n = 4, prior to the public health crisis) and virtual (n = 21), reaching over 5,090 individuals (Appendix 6). Each event educated residents and visitors of Broward County about sea turtles. With the introduction of virtual events, the BCSTCP was able to expand its outreach to a global audience. The BCSTCP continued to engage with its over 11,803 Facebook and 1,200 Instagram followers, generating unique educational content presented in over 115 social media posts. Through Facebook alone, over 3,200 people are reached per post (this metric was not available for Instagram).

## **Results**

### **Sea Turtle Nesting Surveys**

The 2020 sea turtle nesting surveys in Broward County started on February 26, 2020, and the first crawl of the season was a leatherback nest discovered on February 24, 2020. A total of 6,500 emergences were documented for all of Broward County resulting in 3,141 nests and 3,359 false crawls (Figure 4) or a 48.32% nesting success for all species (Figure 5). This is slightly above last year's nesting success at 47.56% and above the five-year average nesting success for all species of 45.84%.

Following the general trend, leatherback turtles were the first species to nest in Broward County in 2020 (Figure 6a), followed by loggerhead turtles (Figure 6b), and then green turtles (Figure 6c).

## **Leatherback Sea Turtles (*Dermochelys coriacea*)**

### *Overall Nesting Activity*

Leatherback turtles are historically the least frequent nesting species in Broward County. This trend continued again for the 2020 season. A total of 31 crawls were recorded in all of Broward County resulting in 29 nests and 2 false crawls for a County-wide nesting success for leatherback turtles of 93.55% (Table 3a). This represents a 2.06% increase in nesting success compared to 2019 and is 1.21% higher than the five-year average leatherback nesting success of 92.34% (Figure 7a). Leatherback nesting has experienced a significant increase over the life of the Program with an average increase of 0.68 nests per year from 1981-2020. Regression shows a highly significant positive trend ( $F(1,38) = 18.00, P < 0.001$ ; Figure 8a).

### *Temporal Patterns*

The first leatherback nest was deposited on February 24, 2020 and the first leatherback false crawl was documented on February 26, 2020 for the 2020 season. These are some of the earliest nests that have been documented in our survey area over the life of the program. March 9, April 12, and May 18 each saw 2 leatherback nests each day. The last leatherback nest was deposited on June 19, 2020 (Figure 6).

### *Spatial Patterns*

Leatherback crawls were recorded in all survey zones. County-wide, leatherback turtles laid an average of 1.21 nests/mile (0.75 nests/km). The highest leatherback nesting density was seen in Hillsboro with 3.95 nests/mile (2.43 nests/km) and was lowest in Fort Lauderdale with 0.30 nests/mile (0.19 nests/km) leatherback nests documented (Table 4a).

### *Incubation Periods*

Incubation periods were determined for 23 leatherback nests left *in situ* on Broward County beaches (excluding Mizell-Eula State Park) in 2020. The overall 2020 season incubation periods for leatherbacks ranged from 57-79 days with a mean incubation period of 66.65 days.

### *Reproductive Success*

Reproductive success was assessed for 21 leatherback nests left *in situ* in Broward County. The 21 nests resulted in 1,754 eggs were laid and 1,170 hatchlings released for an emergence success of 66.70% (Table 5a). This represents a 2.18% higher emergence success than was observed in 2019 (64.52%).

The highest emergence success for *in situ* nests was found on Pompano Beach at 90.48% (3 nests evaluated). The lowest emergence success of *in situ* nests was 47.86% (6 nests evaluated), observed on Hollywood Beach (Table 6a).

## **Loggerhead Sea Turtles (*Caretta caretta*)**

### *Overall Nesting Activity*

Loggerhead nesting made up most of the nesting activity in Broward County in 2020. A total of 5,930 crawls were recorded for loggerhead turtles in all of Broward County: 2,835 nests and 3,095 false crawls, which resulted in a nesting success of 47.81% (Table 3b). This is slightly higher than the loggerhead nesting success from last year (45.46%) and is ~3% higher than the five-year average of 44.74% (Figure 7b). Loggerhead nesting has experienced a significant increase over the life of the program with an average increase of 35.93 nests per year from 1981-2020. Regression shows a highly significant positive trend ( $F(1,38) = 39.88$ ,  $P < 0.001$ ; Figure 8b).

### *Temporal Patterns*

The first loggerhead nest was deposited on April 20, 2020 and the first loggerhead false crawl was documented on April 17, 2020. Highest daily nesting was recorded on June 17, 2020 when 63 loggerhead nests were discovered in Broward County. The last loggerhead nest was deposited on August 24, 2020, and the last false crawl was recorded on August 21, 2020 (Figure 6b).

### *Spatial Patterns*

Loggerhead nests and false crawls were recorded in all survey zones with an average of 118.62 nests/mile (73.45 nests/km) across the entire survey area. Hillsboro experienced the highest loggerhead nesting with 237.21 nests/mile (145.71 nests/km) and Hollywood showed the lowest loggerhead nesting density with 33.62 nests/mile (20.74 nests/km; Table 4b).

### *Incubation Periods*

Incubation periods were determined for 1,804 loggerhead nests left *in situ* on Broward County Beaches (excluding Mizell-Eula State Park) in 2020. Incubation periods ranged from 44 - 73 days with a mean incubation period of 51.76 days.

### *Reproductive Success*

Reproductive success was investigated in 1,803 *in situ* loggerhead nests across Broward County (excluding Mizell-Eula State Park) in 2020. In these evaluated nests 185,853 eggs were laid resulting in 138,183 hatchlings released for an emergence

success of 74.35% (Table 5a). This is slightly lower than the *in-situ* loggerhead emergence success from the 2019 season (77.56%).

The highest emergence success in loggerhead nests left *in situ* were those evaluated in Fort Lauderdale Beach with an emergence success of 78.70%; the lowest emergence success of *in situ* nests was in Hillsboro Beach at 70.23% (Table 7a).

Reproductive success was investigated in 47 relocated loggerhead nests across Broward County (excluding Mizell-Eula State Park) in 2020. In these evaluated nests 4,422 eggs were laid resulting in 2,556 hatchlings released for an emergence success of 58.33% (Table 7b). This was 4.44% lower than the relocated loggerhead emergence success from the 2019 season (62.77%).

Reproductive success was investigated in 75 caged loggerhead nests across Broward County (excluding Mizell-Eula State Park) in 2020. In these evaluated nests 7,785 eggs were laid resulting in 5,584 hatchlings released for an emergence success of 71.73% (Table 7c). This was 7.66% lower than the caged loggerhead emergence success from the 2019 season (79.39%).

## **Green Sea Turtles (*Chelonia mydas*)**

### *Overall Nesting Activity*

Green turtles are historically the second most frequent nesters in Broward County. This trend continued again for the 2020 nesting season. A total of 539 crawls were recorded for green turtles in all of Broward County. A total of 277 nests and 262 false crawls resulted in a County-wide green turtle nesting success of 51.39% (Table 3c). This represents a 3.71% decrease in nesting success compared to 2019 (55.10%) and is 0.95% higher than the five-year average green turtle nesting success of 52.34% (Figure 7c). Like the other species, green nesting has experienced a significant increase over the life of the program with an average increase of 10.36 nests per year from 1981-2020. Regression shows a highly significant positive trend ( $F(1,38) = 35.05$ ,  $P < 0.001$ ; Figure 8c).

### *Temporal Patterns*

The first green turtle nest was deposited on May 22, 2020 and the first green turtle false crawl was documented on May 23, 2020. Highest daily nesting was recorded on June 17, 28, and 30, 2020 when 9 green nests were discovered each morning in Broward County. The last green turtle nest was deposited on October 9, 2020 and the last green false crawl was deposited on September 29, 2020 (Figure 6c).

### *Spatial Patterns*

Green turtle nests and false crawls were recorded in all survey zones resulting in a County-wide green turtle average nesting density of 11.59 nests/mile (7.18 nests/km).

The highest green nesting density was in Hillsboro Beach with 34.42 nests/mile (21.14 nests/km), and the lowest was in Pompano Beach with 0.42 nests/mile (0.26 nests/km; Table 4c).

### *Incubation Periods*

Incubation periods were determined for 146 green turtle nests left *in situ* on Broward County Beaches (excluding Mizell-Eula State Park) in 2020. Incubation periods ranged from 46 - 66 days with a mean incubation period of 51.03 days.

### *Reproductive Success*

Reproductive success was evaluated for 146 green turtle nests that were left *in situ* in 2020. There were 16,865 eggs deposited in the evaluated nests resulting in 13,450 hatchlings released for an emergence success of 79.75% (Table 5a). The 2020 season had fewer nests evaluated than 2019, and the emergence success was about 1.55% lower than that recorded in 2019 (81.30%).

The highest emergence success for *in situ* nests was found on Fort Lauderdale Beach at 82.26% (58 nests evaluated). The lowest emergence success of *in situ* nests was 70.75% (1 nest evaluated), observed in Pompano Beach (Table 8a).

Reproductive success was investigated in 1 relocated green nest across Broward County (excluding Mizell-Eula State Park) in 2020. In this evaluated nest 125 eggs were laid resulting in 83 hatchlings released for an emergence success of 66.40% (Table 8b). This was 0.67% lower than the relocated green turtle emergence success of 8 nests evaluated from the 2019 season (67.07%).

## **Beach Renourishment Projects**

### *Hillsboro/Deerfield Beach Nourishment Project*

The Hillsboro/Deerfield Beach Nourishment Project (R6-R8) was a small renourishment project that placed approximately 375,000 cubic yards of sand across 7,175 linear feet of shoreline. This project concluded on April 11, 2011 but in 2015, an amendment to this project permitted the placement of an additional 50,000 cubic yards of truck haul fill from Broward County Borrow Area 1 in the same 7,175 linear feet of shoreline. In 2018 the project placed approximately 37,285 cubic yards of sand from R6+750 feet south to R9. In 2020 (FDEP Permit No. 0289706-001 JC) approximately 70,350 cubic yards of truck haul sand was placed from R6+750 feet south to R10. Sand placement concluded on March 24, 2020.

### **Nesting Success**

The Hillsboro/Deerfield Beach Nourishment Project accounted for 2 leatherback nests and 1 false crawl in the project area for a nesting success of 66.67% (Table 9a).

Loggerheads laid 109 nests and 144 false crawls for a nesting success of 43.08 (Table 9b). There were 15 green turtle nests laid and 9 false crawls in the project area for a nesting success of 62.50% (Table 9c).

### **Reproductive Success**

The Hillsboro/Deerfield Beach Nourishment Project had two leatherback nests that were evaluated for reproductive success with 103 eggs and 58 hatchlings released for an emergence success of 56.31% in the project area. There were 71 loggerhead nests that were evaluated for reproductive success. The 71 nests resulted in 7,344 eggs with 5,795 hatchlings released for an emergence success of 78.81%. There were 10 green nests evaluated for reproductive success resulting in 919 eggs with 808 hatchlings released for an emergence success of 87.92% (Table 10a).

#### *Hillsboro Inlet Maintenance and Sand Bypass Project*

The Hillsboro Inlet Maintenance and Sand Bypass Project in Hillsboro Beach (R25-R26) is a small maintenance and sand bypass project at the Hillsboro Inlet and moves sand as necessary across a 0.21 mile stretch of beach.

### **Nesting Success**

The Hillsboro Inlet Maintenance and Sand Bypass Project saw no leatherback or green crawls in the area this season (Tables 9a and 9c). However, 5 loggerhead nests and 11 false crawls were documented in the project area, resulting in a loggerhead nesting success in this project area of 31.25% (Table 9b).

### **Reproductive Success**

The Hillsboro Inlet Maintenance and Sand Bypass Project had 5 loggerhead nests evaluated for reproductive success. These nests resulted in 456 eggs and 342 hatchlings released for an emergence success of 75.00% (Table 10b).

#### *FCCE Broward County Shore Protection Project Segment III*

The FCCE Broward County Shore Protection Project Segment III (FDEP Permit No. 0135660-001-JC) placed approximately 134,810 cubic yards of sand from R98+400 feet south to R101 and from R102 to R128+675 feet south. Sand placement concluded on May 10, 2019, and environmental monitoring concluded on May 16, 2019.

### **Nesting Success**

The fill area had 6 leatherback nests and had no false crawls resulting in a nesting success of 100.00% (Table 9a). Loggerheads laid 180 nests and 184 false crawls for a loggerhead nesting success in the fill zone of 49.45% (Table 9b). Green turtles laid 4 nests and 8 false crawls for a nesting success of 33.33% (Table 9c).

## **Reproductive Success**

The FCCE Broward County Shore Protection Project Segment III had 6 leatherback nests evaluated for reproductive success resulting in 514 eggs and 246 hatchlings released for an emergence success of 47.86% in the project area for the 2020 season. There were 153 loggerhead nests evaluated for reproductive success. These nests resulted in 16,827 eggs and 12,561 hatchlings released for an emergence success of 74.86%. There were 4 green nests evaluated for reproductive success resulting in 436 eggs and 357 hatchlings released for a reproductive success of 81.88% (Table 10c).

## **Relocation**

A total of 55 nests (52 loggerhead, 2 green, 1 leatherback) were relocated throughout the 2020 nesting season. This accounted for 1.92% of all nests laid in Broward County (Figure 9). Of these 55 nests, 20 were relocated mid-incubation due to nest chamber washout or egg exposure, 7 were relocated because they were laid below the high tide line; of the remaining 28 nests, 27 were relocated because they were laid in a “donor” zone as specified by FWC and 1 was relocated as part of the Hillsboro/Deerfield Beach Renourishment Project during a period of active sand placement.

### *Incubation Period*

Incubation periods were determined for 39 relocated loggerhead nests. Relocated loggerhead nests had an incubation range of 45-62 days with a mean incubation period of 51.72 days. Incubation period was calculated for 1 relocated green nest that incubated for 47 days. Incubation period was calculated for 1 relocated leatherback nest that incubated for 68 days.

### *Reproductive Success*

Reproductive success was calculated for 49 relocated nests (47 loggerhead, 1 green, and 1 leatherback). The 1 leatherback nest resulted in 45 eggs with 16 hatchlings released for an emergence success of 35.56% (Table 6b). The 47 loggerhead nests resulted in 4,382 eggs with 2,556 hatchlings released for an emergence success of 58.33%. The 1 green turtle nest resulted in 125 eggs with 83 hatchlings released for an emergence success of 66.40% (Table 5b).

## **Disorientation Events**

The BCSTCP surveyors reported 362 (11 adult, 351 hatchling) disorientation events across Broward County on morning surveys (Figure 10). One hundred eighty of these disorientation events were in the Fort Lauderdale municipality and an additional 63 disorientation events were in the Town of Lauderdale-By-The-Sea/Sea Ranch Lakes. Together these two municipalities accounted for 67.13% of all disorientation events reported by BCSTCP staff this season. The 2020 season saw 219 more disorientation



events than the 2019 season and was much higher than the five-year Broward County average of 167.4 events (Figure 10). This was due to the COVID-19 Pandemic forcing the volunteer groups to not be able to work for many weeks during the season, so all disorientation events were reported by BCSTCP, where in the past, all groups would have shared these responsibilities.

To gain a more comprehensive understanding of the number of hatchling disorientation events in the entire County, all disorientation reports submitted to FWC by all sea turtle monitoring/volunteer groups (BCSTCP, STOP, SFAS, STARS) in Broward County (except Mizell-Eula State Park) were examined. A total of 567 nests experienced hatchling disorientation events out of 2,098 nests where a hatch out was observed, yielding a 27.03% disorientation rate (Table 11); however, variation existed among beaches within the County. Lauderdale-By-The-Sea/Sea Ranch Lakes experienced the highest hatchling disorientation rate at 44.26% (81 nests disoriented out of 183 observed hatch outs). Additionally, Fort Lauderdale and Pompano experienced at least 38% disorientation rates or higher. Hillsboro had the lowest hatchling disorientation rates with 2.75% (20 nests disoriented out of 726 observed hatchouts) (Table 11, Figure 11).

### **Predation and Poaching**

In 2020, 71 nests (or 2.47% of all nests) in Broward County (excluding Mizell-Eula State Park) experienced predation. This is slightly higher than the 2019 season that had an overall predation rate of 1.23% and is 1.03% lower than the five-year predation average percentage of 3.5% (Figure 12). Broward County has seen relatively low predation rates from 2005-2017, reaching an all-time low in 2018 with only a slight increase again in 2019 and 2020. A slight increase in predation in the 2013 and 2014 seasons was not continued during the 2015, 2016, or 2017 seasons, but fluctuating numbers suggest that continued monitoring of predation rates in this area would be beneficial. Traditionally, foxes are the primary predators of turtle nests in Broward County, however in 2019 and 2020 raccoons showed the highest rates of predation and several unknown bird species, crabs ants and foxes were also documented preying on nests. The Pompano and Hollywood survey zones experienced the lowest predation impact with one predation event each. The Hillsboro survey zone experienced the highest predation rate with 5.57% of nests experiencing predation (Figure 13). This is slightly higher than the 2019 predation rate of 2.42% in Hillsboro but is still greatly reduced from the 2017 season, which saw a 10.76% predation rate and is still considerably lower than the 25% predation rate documented in Hillsboro in 2014.

In addition to predation impacts, 9 nests in Broward County were impacted by human disturbance/poaching/vandalism (0.29% of all nests laid). This is up from the 2019 season, which saw 0.09% of nests impacted due to human disturbance.

## **Restraining Cages**

In the designated “restraining cage” zones, a total of 82 restraining cages were constructed on loggerhead turtle nests: 43 in Fort Lauderdale, 39 in Hollywood.

### *Incubation Period*

Incubation period was calculated for 71 caged nests and those ranged from 46-66 days with a mean incubation period of 52.68 days. This is very similar to the wider dataset of *in situ* loggerhead nests, which had incubation periods ranging from 44-73 days with a mean incubation period of 51.76 days in 2020.

### *Reproductive Success*

Seventy-five caged nests were excavated and analyzed for reproductive success. Seven of the 82 total caged nests could not be excavated due to washout and/or loss of cage/stakes that required reestablishment (egg chambers ultimately could not be located). A total of 7,785 eggs were deposited with 5,584 hatchlings released for an emergence success rate of 71.73% across all inventoried caged nests (Tables 5c and 7c).

## **Washover and Washout Events**

A total of 1,449 nests were impacted by washover (excluding Mizell-Eula State Park). Of these nests, 156 were washed out completely (clutch completely lost). A total of 50.49% of all nests throughout Broward County (excluding Mizell-Eula State Park) experienced washover at some point over the 2020 season. This is higher than the rate of washover that was experienced in the 2019 season, which had 1,087 (31.95% of nests) nests impacted; this year was 16.37% higher than the five-year average of 34.12% of nests impacted (Figure 14). Hurricanes Isaias and Teddy were responsible for 19.39% (n=281) of the washover and 85.26% (n=133) of the washout events in 2020.

## **Strandings**

There were 76 marine turtle strandings events reported for Broward County, BCSTCP responded to 74 from January 1–December 31, 2020 (the remaining 2 were handled by Gumbo Limbo Nature Center). Of these, 40 were live strandings and 36 were dead stranded turtles (Appendix 5). Stranding numbers increased by 20 in 2020 compared to the 2019 season (Appendix 7).

Of the 76 strandings, 6 were affected by fishing hooks (73 were live and able to be transported to a rehabilitation facility to remove the hooks and fishing line, 1 was dead upon arrival).

## **Obstructed Nesting Attempts**

Morning surveys documented 432 ONAs: 362 were loggerhead crawls, 69 green turtle crawls, and 1 leatherback crawl. Of the 432 ONAs, 214 resulted in false crawls and 218 resulted in nests. Turtles encountered various obstructions (sometimes multiple obstructions) including escarpments (159), beach furniture (105), seawalls (63), rock revetments (39), dune crossovers (30), rock outcroppings (7), boats (3), and cabanas (4). Turtles also encountered fences, garbage cans, lifeguard stands, sidewalks, jet skis, posts, stairs, signs, sprinklers, wheelchair access mat, benches, storage bins, roads, kayak racks, etc., and sometimes encountered multiple obstructions in a single crawl.

## **Discussion**

### **Yearly Nesting Trends**

All three species of nesting turtles in Broward County have shown significant increases in nest deposition over the history of the BCSTCP starting in 1981. Clear nesting trends are not demonstrated between seasons historically among nesting loggerhead and leatherback populations in Broward County. However, green turtle nesting trends in Broward County historically follow an annual oscillation between high nesting seasons and low nesting seasons. Leatherback nesting is following an increasing historical trend (Figure 8a). Broward County experienced four years of declining leatherback nest numbers from 2014-2017, however a slight increase in leatherback nesting was observed in 2018 followed by the most nests since 2012 laid in 2019. Similar nesting patterns have been documented in Broward County between seasons 2002 to 2005 and 2010 to 2012. Loggerheads are on an increasing trend of +35.93 nests per year since 1981; however, there was a 10-year period of decline from 1997-2007. Since 2007, there has been an increase in loggerhead nesting activity and the rate of increase is higher than the overall program trend. The 2020 season experienced a slight increase in loggerhead nesting numbers relative to the 2019 nesting season (Figure 8b). A large increase was observed in 2016, with a decrease in 2017, a slight decrease in 2018, and a slight increase in 2019, and a slight increase in 2020. Green turtle nesting has exhibited a steady positive historic trend in Broward County. Green sea turtles demonstrate extreme oscillation between high and low nesting seasons. The 2019 season experienced a record-setting year in green nests (Figure 8c), and showed a decrease as anticipated in the 2020 nesting season.

### **Seasonal Nesting Patterns**

The seasonal nesting pattern was consistent with what is normally found in Broward County: the first nesters to arrive were the leatherbacks, with leatherbacks laying some of the earliest nests in Broward (and statewide) on record in the 2020 season, followed by the loggerheads and then the green turtles. Nest deposition over the season

followed a normal distribution with the height of the season falling in June and July, similar to historic nesting patterns.

### **Countywide Nest Distribution**

Nest distributions this season closely resembled patterns that have been seen in Broward County for many years with the highest nesting densities in the Hillsboro survey zone, followed by Fort Lauderdale Beach, Pompano Beach, Mizell-Eula State Park and the lowest nesting activity was documented in the Hollywood survey zone. In addition, there was very little crawl/nest activity directly adjacent to most jetties and inlets. These types of beach armoring constructions disrupt the natural water flow and sand movement and often result in increased beach erosion near the structures, impacting sea turtle nesting (Mosier and Witherington, 2000; Rizkalla and Savage, 2011).

This nesting distribution could be influenced by a number of factors. Hillsboro Beach has one of the lowest human population densities and some of the lowest amount of artificial lighting of any of Broward County's beaches (Broward County, 2019). Additionally, a sea turtle hatchery facility was once located near the Hillsboro Beach Club. The hatchery was maintained through the 2005 nesting season and received nests from "donor" zones that were brightly lit by artificial lighting (Burney and Ouellette, 2005). These factors may play some role in the current high-density nesting observed on Hillsboro Beach (Brothers and Lohmann, 2015; Lohmann et al., 1997). However, the reason still remains unknown. Hollywood Beach was a long time "donor" zone since it is one of the brightest areas in Broward County, and therefore nests have historically been relocated out of Hollywood Beach. Female sea turtles return to their natal beaches when they are ready to deposit nests of their own (Lohmann et al., 1997), which may explain the underutilization of Hollywood beaches for sea turtle nesting in recent years. Additionally, Florida's east coast exhibits a general nesting trend of increasing nesting densities moving south to north from Miami to Brevard Counties. The same trend might be occurring within Broward County, as Hollywood is the southernmost zone while Hillsboro is the northernmost zone. Both historical relocations into hatcheries and the south-north nesting trend may influence the nest distributions seen in Broward County.

### **Nest Relocation**

Hatcheries were historically used quite extensively in Broward County as a management tool to protect marine turtles. An active hatchery facility was maintained near the Hillsboro Beach Club until 2005 (Burney and Ouellette, 2005). Hatchery facilities provide a sound management tool in heavily impacted coastal communities where nests left *in situ* will likely experience very high rates of disorientation, predation, washout, etc. However, the hatchery model is not without complications. The sex of marine turtle hatchlings is dependent on sand temperature during incubation (Standora and Spotila, 1985). A beach with all nests left *in situ* will experience a range of temperatures due to

variation in nest placement in relation to the high tide line, shading from dune vegetation, etc.; likewise, different nest chamber depths will likely experience different temperatures during development (Abella et al., 2008, Van et al., 2006). When all or most nests are relocated into a hatchery facility, this may eliminate some of the natural temperature variation found when nests are left *in situ*. Also, when nests are packed densely together in a hatchery facility, they become more vulnerable to disease and disease transmission, predation, and storm events (Izadjoo et al., 1987). In 2004, Hurricanes Frances and Jeanne had significant negative impacts on the hatchery nest facilities in Broward County (Burney and Ouellette, 2004).

Relocated sea turtle nests generally experience lower emergence success than *in situ* nests because the eggs are moved and placed into an artificial chamber and some eggs/embryos may be damaged in transport/handling (Moody, 1996). This was demonstrated in 2020 as the *in-situ* loggerhead emergence success (74.35%) was higher than the relocated loggerhead emergence success of 57.80%. In a hatchery system, some nests may travel a long distance in buckets before they are placed in their new man-made nests, increasing the likelihood of damage to the embryos. The final year of the hatchery facilities in Broward County resulted in loggerhead nests with an emergence success of 41.6% for relocated nests (N = 1151; Burney and Ouellette, 2005). Broward County has moved towards a more “hands-off” management strategy, relocating less nests due to non-compliant lighting. The final year of the hatchery facilities in the County relocated 56.04% of all nests, compared to just 1.92% in 2020 (Figure 9). The five-year average for nest relocation is currently 2.29%. As lighting compliance improves in Broward County, the more “hands-off” management strategy is strongly recommended. Future nesting, relocation, and reproductive success data will help determine the most effective suite of management tools for the dynamic and highly utilized beaches of Broward County.

### **Restraining Cages**

Restraining cages were found to be an effective short-term mitigation action in areas of bright anthropogenic beachfront lighting to minimize loss of sea turtle hatchlings that would likely disorient in these areas. The cages also provided an effective educational tool in the field with signage and allowed the BCSTCP team to speak to beachgoers about turtle friendly lighting and why the restraining cages were being used in certain areas. While effective as a temporary mitigation action, restraining cages are logistically difficult (time and labor) for Program staff to ensure hatchlings are not restrained for too long. Considering these challenges, working towards rectifying the underlying lighting issues at the source is recommended as a long-term management solution in these areas.

## **Disorientation Reports**

Disorientation reports provide a mechanism to document nests that experience adult or hatchling disorientation. Broward County has four organizations documenting these events each season: the BCSTCP, STOP, SFAS, and STARS. Recent innovations in disorientation reporting technology from FWC has improved the standardization of documenting disorientation events among all organizations in Broward County. However, all hatchling disorientation reports filed in Broward County this year were used to provide a more succinct and complete look at the impact of coastal lighting on hatchling sea turtles.

The trends in disorientation reports are similar this season to previous years. Fort Lauderdale Beach has some of the highest rates of disorientation annually and Hillsboro Beach show some of the lowest rates of disorientation. County wide, disorientation rates were nearly 20% lower in 2020 (27.03%) than the 2019 season (45.39%). This may very well be an indication of less people on the beach due to COVID-19 curfews and beach closures at night resulting in a positive influence on sea turtles this season. These disorientation reports and monthly lighting reports show a negative correlation between sea turtle nesting activities and non-compliant anthropogenic lighting. The results of this comprehensive analysis are being used to target future outreach efforts.

## **Predation and Poaching**

Drastic decreases in nest predation in the 2018, 2019, and 2020 seasons is a very positive sign. Since Hillsboro hosts the highest nesting density in Broward County and typically sees the highest nest predation rates in the County, maintaining these low predation rates is significant. Continued monitoring is needed to ensure predation stays low in this area, otherwise this area may warrant some degree of nest protection in future years.

## **Challenges Encountered**

The global COVID-19 pandemic made the sea turtle season very difficult for many reasons. Survey methodology needed to be modified to accommodate the CDC best practices for social distancing for the safety of staff and the public. Additionally, curfews and beach closures due to COVID and other issues in Broward required some survey timing changes as well as impacted overnight monitoring at times. However, Broward County worked hard to ensure that surveys were able to continue with only minimal impacts (no surveys were missed this season)

Both the nesting and hatching success of Broward County sea turtle nests were impacted by weather driven factors such as Hurricane Isaias and Hurricane Teddy, with lesser impacts from Hurricane Sally and Hurricane Laura as well as King Tide events. Broward County beaches sustained some flooding/sand erosion with these events

resulting in the loss of 145 nests (with an additional 307 nests that experienced wash over).

A small degree of vandalism was observed throughout the season that resulted in damage to nest stakes/perimeters of 5 nests, and an additional 4 nests were impacted by poaching events in 2020.

### **Conclusions and Recommendations**

Management of endangered nesting sea turtles in Florida is a monumental task. The current “hands-off” approach recommended by FWC is working very well to provide the highest nesting and hatching success for the beaches in Broward County. Hopefully as nest numbers continue to rise in this area, this approach will be even more effective and result in less overall impact on the local nesting female population and hatchlings.

The restraining cages currently being used in some zones in Broward County provide a good short-term management strategy for addressing areas of high concern with regard to artificial lighting and light fixtures. These areas experience high rates of hatchling disorientation and the cages help mitigate the negative impacts by allowing sea turtle professionals to ensure the hatchlings safely enter the water; however, this is not a feasible long-term solution to these issues. Continued efforts working with code enforcement in each municipality to generate targeted education and enforcement efforts with regard to turtle friendly lighting should be of the utmost priority.

Nesting numbers in Broward County this year and recent nesting trends indicate an overall positive trend, leaving local scientists cautiously optimistic about the status of the local nesting sea turtle populations in Broward County.

## References

- Abella, E., Sanz, P., Martins, S., Marco, A., and L. Lopez-Jurado (2008). Variability on incubation temperature and metabolic heating as a function of embryonic survival in loggerheads. NOAA Technical Memorandum NMFS SEFSC (569): 1.
- Brothers, J.R, and K.J. Lohmann (2015). Evidence for geomagnetic imprinting and magnetic navigation in the natal homing of sea turtles. *Current Biology* 25(3): 392-396.
- Broward County (2019). Broward County Sea Turtle Conservation Program Lighting Survey 2019 Summary Report. Environmental Protection and Growth Management Department, Environmental Planning and Community Resilience Division. Fort Lauderdale, Florida.
- Burney, C. M., and S. Ouellette. (2004). Sea Turtle Conservation Program, Broward County, Florida. 2004 Technical Report. Marine Resources Section, Biological Resources Division, Department of Natural Resource Protection. Fort Lauderdale, Florida.
- Burney, C. M., and S. Ouellette. (2005). Sea Turtle Conservation Program, Broward County, Florida. 2005 Technical Report. Marine Resources Section, Biological Resources Division, Department of Natural Resource Protection. Fort Lauderdale, Florida.
- Florida Fish and Wildlife Conservation Commission (2016). Marine Turtle Conservation Handbook.
- Izadjoo, M. J., Pantoja, C., and R.J. Siebeling (1987). Acquisition of salmonella flora by turtle hatchlings on commercial turtle farms. *Canadian Journal of Microbiology/Revue Canadienne De Microbiologie* 33(8): 718-724.
- Lohmann, K.L., Witherington, B.E., Lohmann, C.M.F., and M. Salmon. (1997). Orientation, navigation and natal beach homing in sea turtles. P.L. Lutz, J.A. Musick (Eds.), *The Biology of Sea Turtles*, CRC Press, Boca Raton (1997), pp. 107-135.
- Moody, K. (1996). The effects of nest relocation on hatching success and emergence success of the loggerhead sea turtle (*Caretta caretta*) in Florida. NOAA Technical Memorandum NMFS SEFSC (412).
- Mosier, A. E., and B.E. Witherington. (2000). Documented effects of coastal armoring structures on sea turtle nesting behavior. In: Mosier, A., Foley, A., and Brost, B. (eds.), *Proceedings of the 20th International Sea Turtle Symposium* (Orlando, Florida), pp. 304-306.
- Rizkalla, C.E., and A. Savage. (2011). Impact of seawalls on loggerhead sea turtle (*Caretta caretta*) nesting and hatching success. *Journal of Coastal Research* 27(1): 166-173.



Standora, E.A. and J.R. Spotila. (1985). Temperature dependent sex determination in sea turtles. 1985(3): pp 711-722.

Van, D. M., Ibrahim, K., and J. Whittier. (2006). Effects of nest depth, shading, and metabolic heating on nest temperatures in sea turtle hatcheries. *Chelonian Conservation and Biology* 5(2): 210-215.

Witherington, B. E., R. E. Martin, and R.N. Trindell (2014). Understanding, assessing, and resolving light-pollution problems on sea turtle nesting beaches. Florida Fish and Wildlife Conservation Commission FMRI Technical Report TR-2 Version 2.

## Tables and Figures

**Table 1:** Summary of the sea turtle nesting beach survey zones in Broward County, Florida, USA.

<b>Beach</b>	<b>Beach Length (miles)</b>	<b>Boundaries</b>	<b>FDEP Survey Marker</b>
<b>Hillsboro- Deerfield</b>	4.3	Palm Beach County line to Hillsboro Inlet	R1-24
<b>Pompano Beach including Lauderdale-By- The-Sea</b>	4.8	Hillsboro Inlet to Commercial Blvd.	R25-50
<b>Fort Lauderdale</b>	6.6	Commercial Blvd. to Port Everglades Inlet	R51-85
<b>Dr. Von D. Mizell- Eula Johnson State Park</b>	2.4	Port Everglades Inlet to Dania Beach fence	R86-96
<b>Hollywood- Hallandale including Dania</b>	5.8	Dania Beach fence to Miami-Dade County line	R97-128

**Table 2:** Summary of treatment zones by R-monument.

	<b>Donor</b>	<b><i>In Situ</i> &amp; Recipient</b>	<b><i>In Situ</i> Only</b>	<b>Restraining Cage</b>
<b>Description</b>	All nests were relocated from this area to the nearest “recipient” zones.	All nests left in place; nests from “donor” zones may be relocated to this area. Cages were not used.	All nests left in place; nests from “donor” zones may not be relocated in these zones.	All nests left in place; a restraining cage was installed on every other nest.
<b>R-Monuments</b>	R24 – Hillsboro Inlet R85 – Port Everglades	R6-R24 R26-R34 R39-R50 R51-R53 R58-R64 R80-R84 R102-R107 R124-R128	R1-R6 R25-R26 R34-R39 R50-R51 R53-R58 R64-R74 R78-R80 R84-R84.7 R97.5-R102	R74-R78 R107-R124

**Table 3a:** A summary of the total nests, false crawls (FC), and nesting success (NS) of all leatherback crawls by beach.

<b>Beach</b>	<b>Nests</b>	<b>FC</b>	<b>NS (%)</b>
<b>Hillsboro</b>	17	2	89.47%
<b>Pompano</b>	3	0	100.00%
<b>Fort Lauderdale</b>	2	0	100.00%
<b>Mizell-Eula</b>	1	0	100.00%
<b>Hollywood</b>	6	0	100.00%
<b>Overall</b>	29	2	93.55%

**Table 3b:** A summary of the total nests, false crawls (FC), and nesting success (NS) of all loggerhead crawls by beach.

<b>Beach</b>	<b>Nests</b>	<b>FC</b>	<b>NS (%)</b>
<b>Hillsboro</b>	1020	916	52.69%
<b>Pompano</b>	458	539	45.94%
<b>Fort Lauderdale</b>	923	995	48.12%
<b>Mizell-Eula</b>	239	451	34.64%
<b>Hollywood</b>	195	194	50.13%
<b>Overall</b>	2835	3095	47.81%

**Table 3c:** A summary of the total nests, false crawls (FC), and nesting success (NS) of all green turtle crawls by beach.

<b>Beach</b>	<b>Nests</b>	<b>FC</b>	<b>NS (%)</b>
<b>Hillsboro</b>	148	86	63.25%
<b>Pompano</b>	2	25	7.41%
<b>Fort Lauderdale</b>	92	106	46.46%
<b>Mizell-Eula</b>	31	37	45.59%
<b>Hollywood</b>	4	8	33.33%
<b>Overall</b>	277	262	51.39%

**Table 4a:** A summary of the total leatherback nests laid and nesting densities by beach.

<b>Beach</b>	<b>Total Nests</b>	<b>Beach Length</b>	<b>Nests per Mile</b>
<b>Hillsboro</b>	17	4.3	3.95
<b>Pompano</b>	3	4.8	0.63
<b>Fort Lauderdale</b>	2	6.6	0.30
<b>Mizell-Eula</b>	1	2.4	0.42
<b>Hollywood</b>	6	5.8	1.03
<b>Overall</b>	29	23.9	1.21

**Table 4b:** A summary of the total loggerhead nests laid and nesting densities by beach.

<b>Beach</b>	<b>Total Nests</b>	<b>Beach Length</b>	<b>Nests per Mile</b>
<b>Hillsboro</b>	1020	4.3	237.21
<b>Pompano</b>	458	4.8	95.42
<b>Fort Lauderdale</b>	923	6.6	139.85
<b>Mizell-Eula</b>	239	2.4	99.58
<b>Hollywood</b>	195	5.8	33.62
<b>Overall</b>	2835	23.9	118.62

**Table 4c:** A summary of the total green turtle nests laid and nesting densities by beach.

<b>Beach</b>	<b>Total Nests</b>	<b>Beach Length</b>	<b>Nests per Mile</b>
<b>Hillsboro</b>	148	4.3	34.42
<b>Pompano</b>	2	4.8	0.42
<b>Fort Lauderdale</b>	92	6.6	13.94
<b>Mizell-Eula</b>	31	2.4	12.92
<b>Hollywood</b>	4	5.8	0.69
<b>Overall</b>	277	23.9	11.59

**Table 5a:** Emergence success for all *in situ* nests by species.

<b>Species</b>	<b>Evaluated Nests</b>	<b>Unevaluated Nests</b>	<b>Total Eggs</b>	<b>Hatchlings Released</b>	<b>Emergence Success (%)</b>
<b>Leatherback</b>	21	6	1754	1170	66.70
<b>Loggerhead</b>	1803	662	185853	138183	74.35
<b>Green Turtle</b>	146	92	16865	13450	79.75
<b>Total</b>	1970	760	204472	152803	74.73

**Table 5b:** Emergence success for all relocated nests by species.

<b>Species</b>	<b>Evaluated Nests</b>	<b>Unevaluated Nests</b>	<b>Total Eggs</b>	<b>Hatchlings Released</b>	<b>Emergence Success (%)</b>
<b>Leatherback</b>	1	0	45	16	35.56
<b>Loggerhead</b>	47	2	4382	2556	58.33
<b>Green Turtle</b>	1	1	125	83	66.40
<b>Total</b>	49	3	4552	2655	58.33

**Table 5c:** Emergence success for all restraining cage nests by species.

<b>Species</b>	<b>Evaluated Nests</b>	<b>Unevaluated Nests</b>	<b>Total Eggs</b>	<b>Hatchlings Released</b>	<b>Emergence Success (%)</b>
<b>Loggerhead</b>	75	7	7785	5584	71.73
<b>Total</b>	75	7	7785	5584	71.73

**Table 6a:** Excavation information for all *in situ* leatherback nests by beach. See text for details.

<b>Beach</b>	<b>Evaluated Nests</b>	<b>Total Eggs</b>	<b>Emerged (%)</b>	<b>LIN (%)</b>	<b>DIN (%)</b>	<b>Live Pipped (%)</b>	<b>Dead Pipped (%)</b>
<b>Hillsboro</b>	11	880	68.98	1.02	6.02	0.00	2.39
<b>Pompano</b>	3	336	90.48	3.57	0.60	0.00	1.79
<b>Fort Lauderdale</b>	1	24	54.17	16.67	0.00	0.00	8.33
<b>Hollywood</b>	6	514	47.86	3.31	12.26	0.00	10.12
<b>Overall</b>	21	1754	66.70	2.39	6.73	0.00	4.62

**Table 6b:** Excavation information for all relocated leatherback nests by beach. See text for details.

<b>Beach</b>	<b>Evaluated Nests</b>	<b>Total Eggs</b>	<b>Emerged (%)</b>	<b>LIN (%)</b>	<b>DIN (%)</b>	<b>Live Pipped (%)</b>	<b>Dead Pipped (%)</b>
<b>Hillsboro</b>	1	45	35.56	4.44	0.00	0.00	6.67
<b>Overall</b>	1	45	35.56	4.44	0.00	0.00	6.67

**Table 7a:** Excavation information for all *in situ* loggerhead nests by beach. See text for details.

Beach	Evaluated Nests	Total Eggs	Emerged (%)	LIN (%)	DIN (%)	Live Pipped (%)	Dead Pipped (%)
Hillsboro	663	68048	70.23	2.08	2.32	0.33	4.99
Pompano	347	35494	73.12	1.65	2.48	0.33	3.59
Fort Lauderdale	662	67853	78.70	1.08	1.28	0.23	3.25
Hollywood	131	14458	76.39	1.44	1.02	0.13	2.61
Overall	1803	185853	74.35	1.58	1.87	0.28	3.90

**Table 7b:** Excavation information for all relocated loggerhead nests by beach. See text for details.

Beach	Evaluated Nests	Total Eggs	Emerged (%)	LIN (%)	DIN (%)	Live Pipped (%)	Dead Pipped (%)
Hillsboro	6	317	68.45	19.56	0.95	1.89	12.30
Pompano	9	995	50.15	8.24	3.12	1.41	7.64
Fort Lauderdale	30	2880	61.88	5.42	2.33	1.01	5.42
Hollywood	2	230	25.22	0.87	2.17	0.00	3.04
Overall	47	4422	57.80	6.83	2.40	1.11	6.29

**Table 7c:** Excavation information for all caged loggerhead nests by beach. See text for details.

Beach	Evaluated Nests	Total Eggs	Emerged (%)	LIN (%)	DIN (%)	Live Pipped (%)	Dead Pipped (%)
Fort Lauderdale	41	4235	73.11	1.89	1.16	0.92	5.01
Hollywood	34	3550	70.08	1.30	1.41	0.37	4.31
Overall	75	7785	71.73	1.62	1.27	0.67	4.69



**Table 8a:** Excavation information for all *in situ* green turtle nests by beach. See text for details.

<b>Beach</b>	<b>Evaluated Nests</b>	<b>Total Eggs</b>	<b>Emerged (%)</b>	<b>LIN (%)</b>	<b>DIN (%)</b>	<b>Live Pipped (%)</b>	<b>Dead Pipped (%)</b>
<b>Hillsboro</b>	83	9175	77.80	2.18	1.16	0.63	4.41
<b>Pompano</b>	1	106	70.75	0.94	0.00	0.00	0.00
<b>Fort Lauderdale</b>	58	7148	82.26	2.14	1.12	0.24	2.21
<b>Hollywood</b>	4	436	81.88	3.21	5.73	0.23	2.52
<b>Overall</b>	146	16865	79.75	2.10	1.10	0.44	3.34

**Table 8b:** Excavation information for all relocated green turtle nests by beach. See text for details.

<b>Beach</b>	<b>Evaluated Nests</b>	<b>Total Eggs</b>	<b>Emerged (%)</b>	<b>LIN (%)</b>	<b>DIN (%)</b>	<b>Live Pipped (%)</b>	<b>Dead Pipped (%)</b>
<b>Fort Lauderdale</b>	1	125	66.40	8.80	1.60	0.00	5.60
<b>Overall</b>	1	125	66.40	8.80	1.60	0.00	5.60

**Table 9a:** A summary of the nests, false crawls (FC), and nesting success (NS) for leatherbacks in relation to County-sponsored beach renourishment projects.

<b>Project</b>	<b>Nests</b>	<b>FC</b>	<b>NS (%)</b>
<b>Deerfield</b>	2	1	66.67%
<b>Hillsboro Inlet Bypass</b>	0	0	N/A
<b>Segment III</b>	6	0	100.00%
<b>Overall</b>	8	1	88.89%

**Table 9b:** A summary of the nests, false crawls (FC), and nesting success (NS) for loggerheads in relation to County-sponsored beach renourishment projects.

<b>Project</b>	<b>Nests</b>	<b>FC</b>	<b>NS (%)</b>
<b>Deerfield</b>	109	144	43.08%
<b>Hillsboro Inlet Bypass</b>	5	11	31.25%
<b>Segment III</b>	180	184	49.45%
<b>Overall</b>	294	339	46.45%

**Table 9c:** A summary of the nests, false crawls (FC), and nesting success (NS) for green turtles in relation to County-sponsored beach renourishment projects.

<b>Project</b>	<b>Nests</b>	<b>FC</b>	<b>NS (%)</b>
<b>Deerfield</b>	15	9	62.50%
<b>Hillsboro Inlet Bypass</b>	0	0	N/A
<b>Segment III</b>	4	8	33.33%
<b>Overall</b>	19	17	52.78%

**Table 10a:** Reproductive success of leatherback, loggerhead, and green turtles in relation to the Hillsboro/Deerfield Beach Nourishment Project.

<b>Species</b>	<b>Evaluated Nests</b>	<b>Unevaluated Nests</b>	<b>Number of Eggs Laid</b>	<b>Hatchlings Released</b>	<b>Emerged (%)</b>
<b>Leatherback</b>	2	0	103	58	56.31
<b>Loggerhead</b>	71	38	7344	5795	78.91
<b>Green Turtle</b>	10	5	919	808	87.92

**Table 10b:** Reproductive success of leatherback, loggerhead, and green turtles in relation to the Hillsboro Inlet Maintenance Dredging and Sand Bypass Project.

<b>Species</b>	<b>Evaluated Nests</b>	<b>Unevaluated Nests</b>	<b>Number of Eggs Laid</b>	<b>Hatchlings Released</b>	<b>Emerged (%)</b>
<b>Leatherback</b>	0	0	N/A	N/A	N/A
<b>Loggerhead</b>	5	0	456	342	75.00
<b>Green Turtle</b>	0	0	N/A	N/A	N/A

**Table 10c:** Reproductive success of leatherback, loggerhead, and green turtles in relation to the FCCE Broward County Shore Protection Project Segment III.

<b>Species</b>	<b>Evaluated Nests</b>	<b>Unevaluated Nests</b>	<b>Number of Eggs Laid</b>	<b>Hatchlings Released</b>	<b>Emerged (%)</b>
<b>Leatherback</b>	6	0	514	246	47.86
<b>Loggerhead</b>	153	27	16827	12561	74.65
<b>Green Turtle</b>	4	0	436	357	81.88

**Table 11:** A summary of the hatchling disorientation (DIS) reports by municipality as reported by BCSTCP, STOP, SFAS, and STARS.

<b>Municipality</b>	<b>Hatch DIS</b>	<b>Hatch Total</b>	<b>% Hatch DIS</b>
<b>Deerfield</b>	14	59	23.73
<b>Hillsboro</b>	20	726	2.75
<b>Pompano</b>	80	209	38.28
<b>Lauderdale-By-The-Sea and Sea Ranch Lakes</b>	81	183	44.26
<b>Fort Lauderdale</b>	330	749	44.06
<b>Dania</b>	2	28	7.14
<b>Hollywood</b>	34	126	26.98
<b>Hallandale</b>	6	18	33.33
<b>Total (excludes State Park)</b>	567	2098	27.03

**Figure 1:** Location of Broward County, Florida, USA.



**Figure 2:** Boundaries of the 2020 Sea Turtle Survey Zones.



**Figure 2:** Boundaries of the 2020 Sea Turtle Survey Zones.

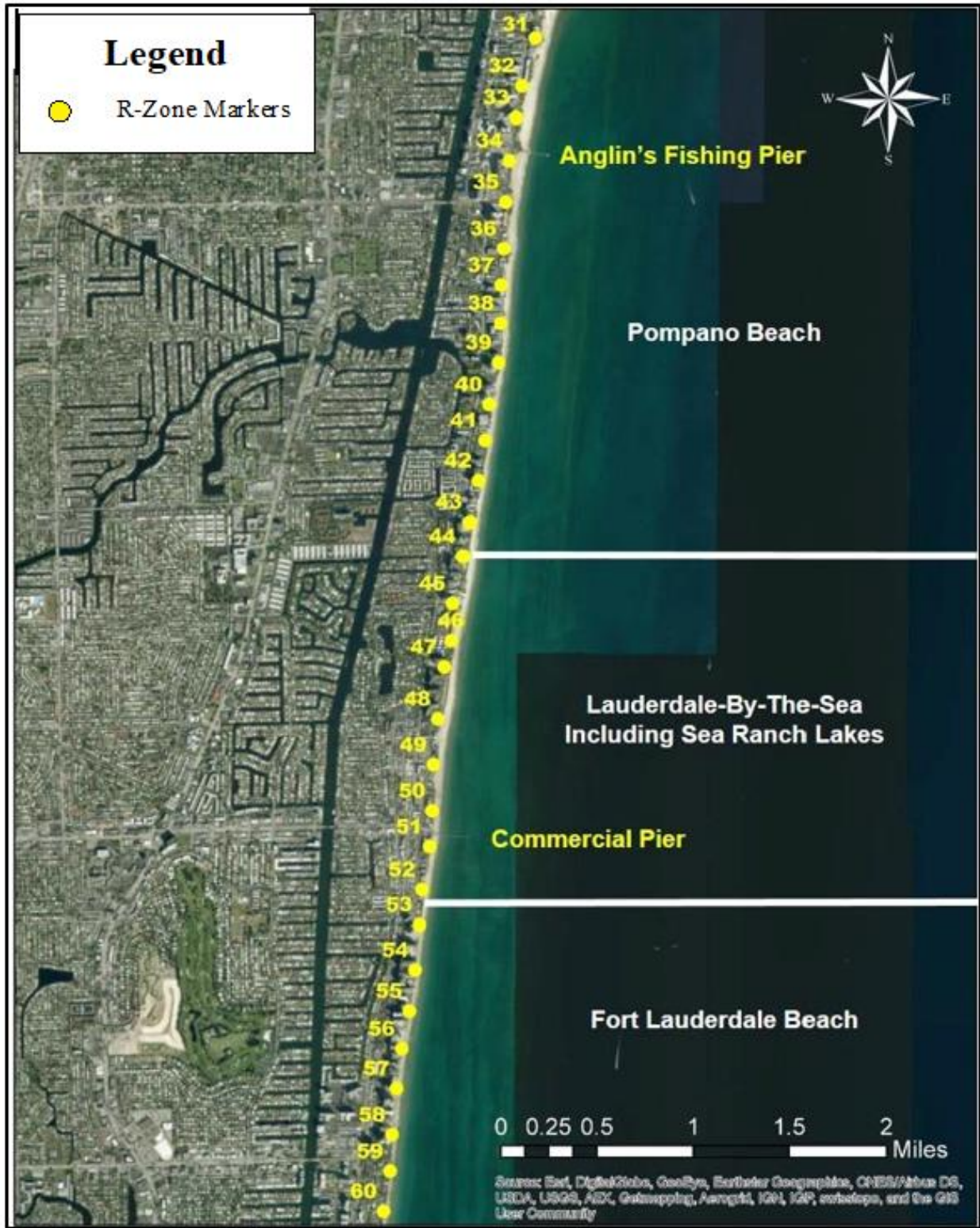


Figure 2: Boundaries of the 2020 Sea Turtle Survey Zones.





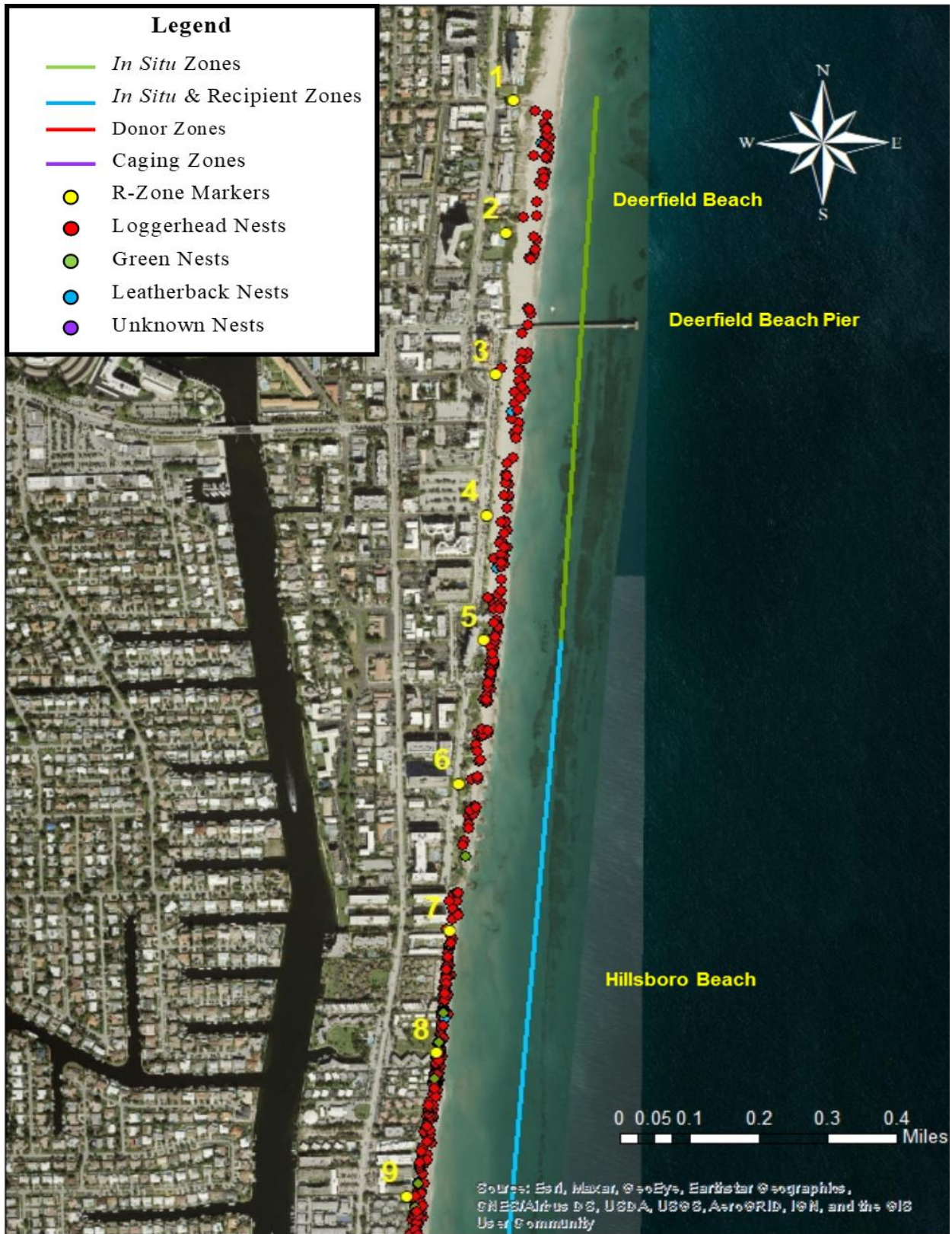
**Figure 2:** Boundaries of the 2020 Sea Turtle Survey Zones.



Figure 2: Boundaries of the 2020 Sea Turtle Survey Zones.



Figure 3: Locations of 2020 Turtle Crawls and Treatment Zones.



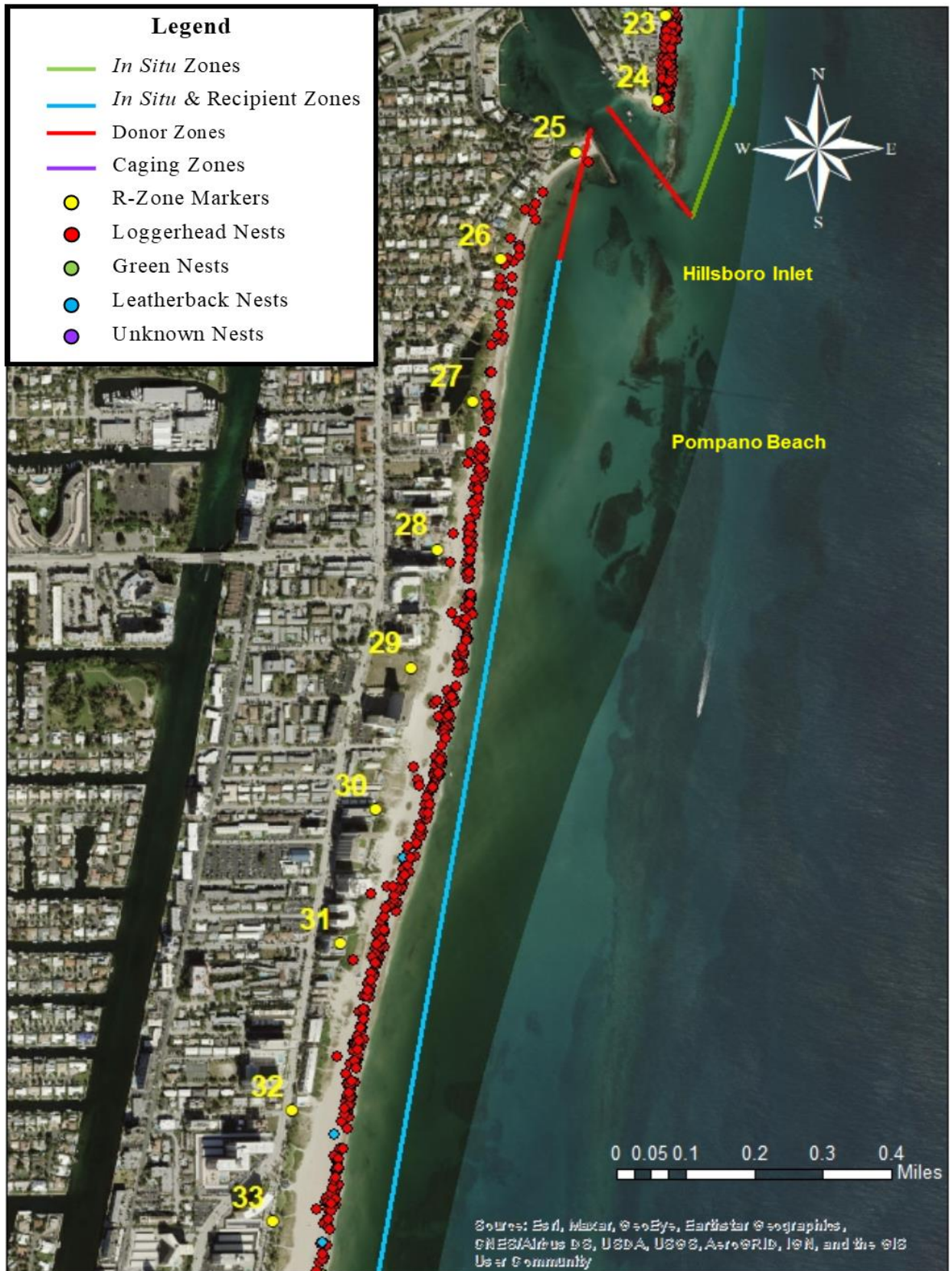
**Figure 3:** Locations of 2020 Turtle Crawls and Treatment Zones.



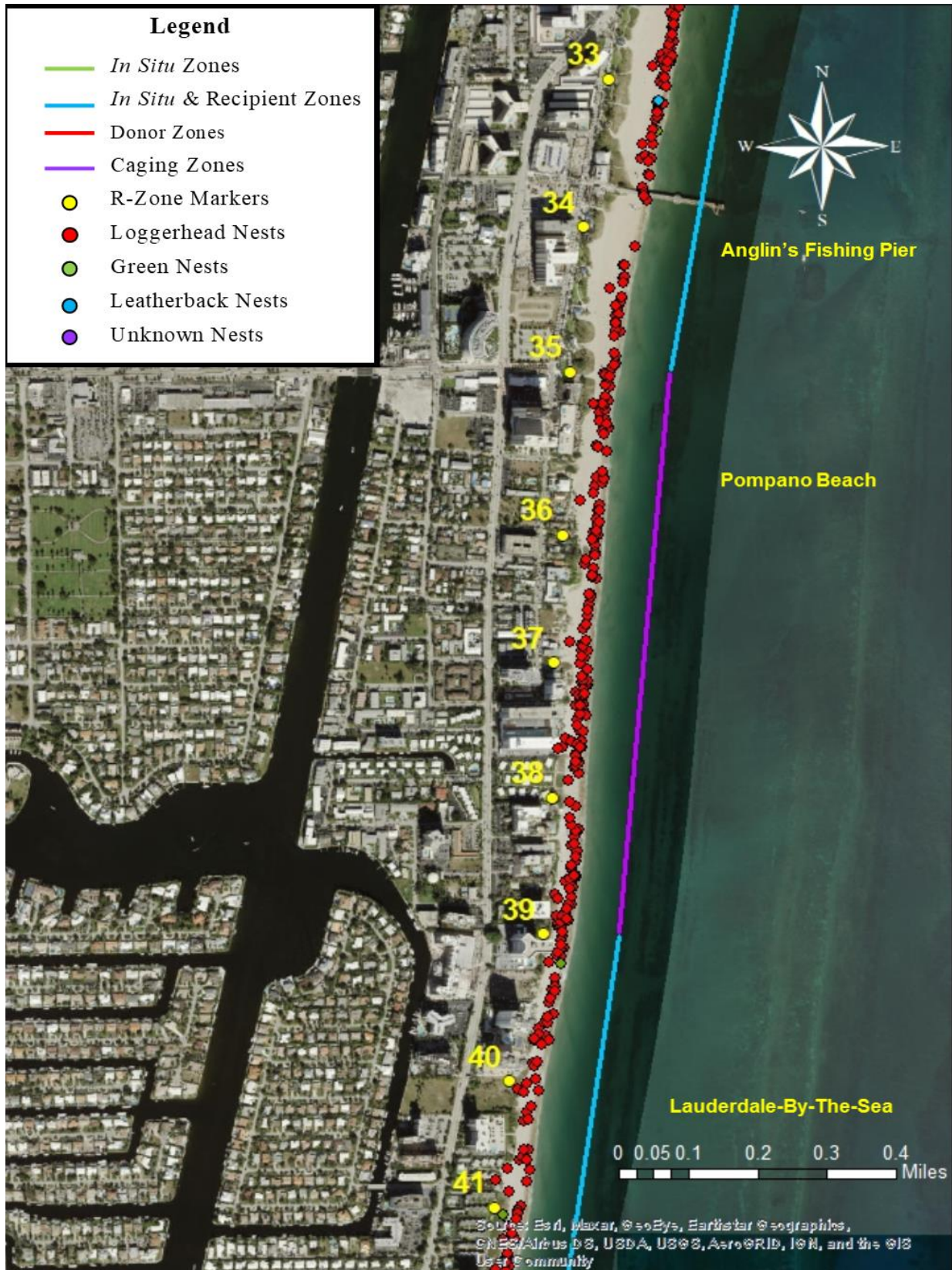
Figure 3: Locations of 2020 Turtle Crawls and Treatment Zones.



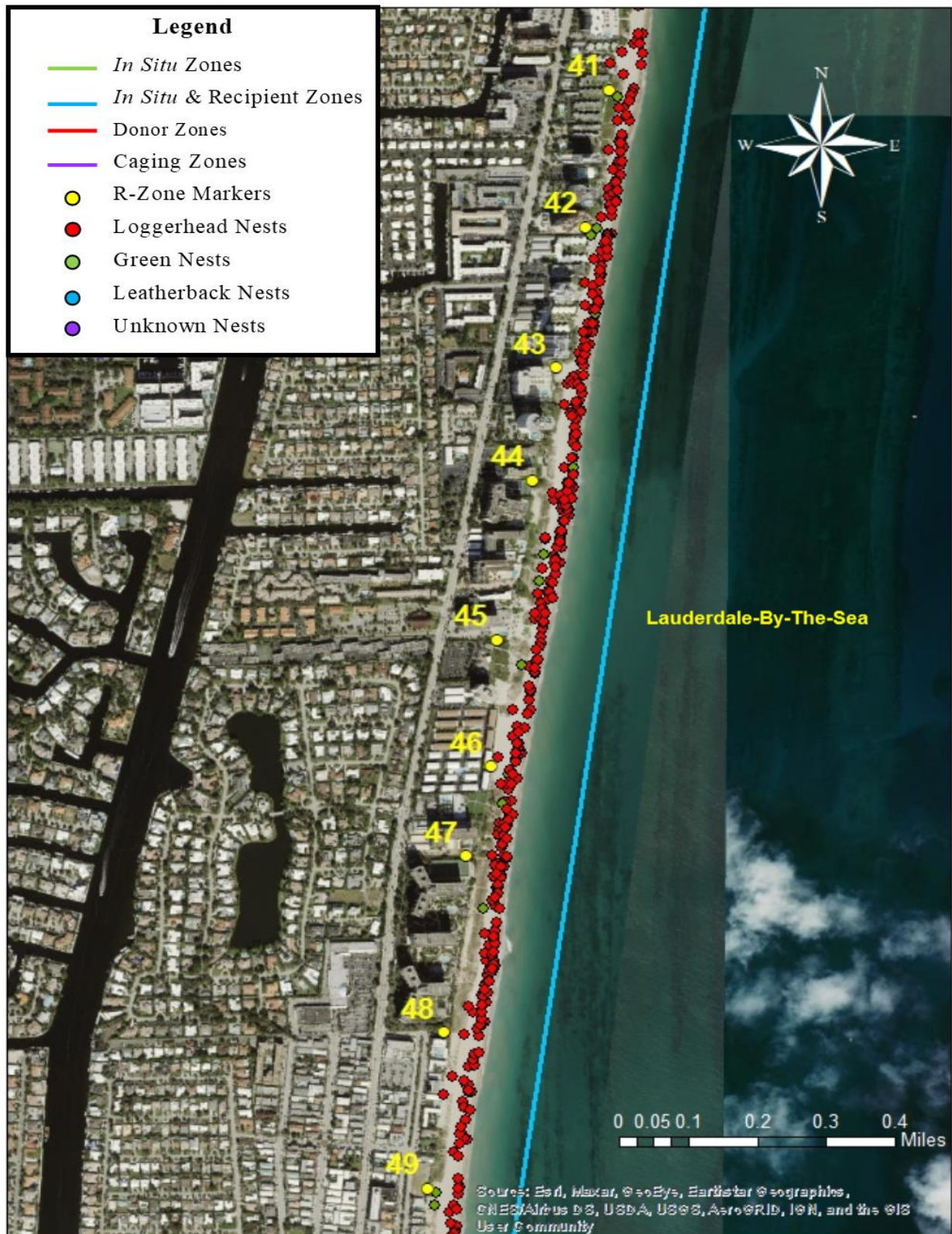
Figure 3: Locations of 2020 Turtle Crawls and Treatment Zones.



**Figure 3:** Locations of 2020 Turtle Crawls and Treatment Zones.



**Figure 3:** Locations of 2020 Turtle Crawls and Treatment Zones.





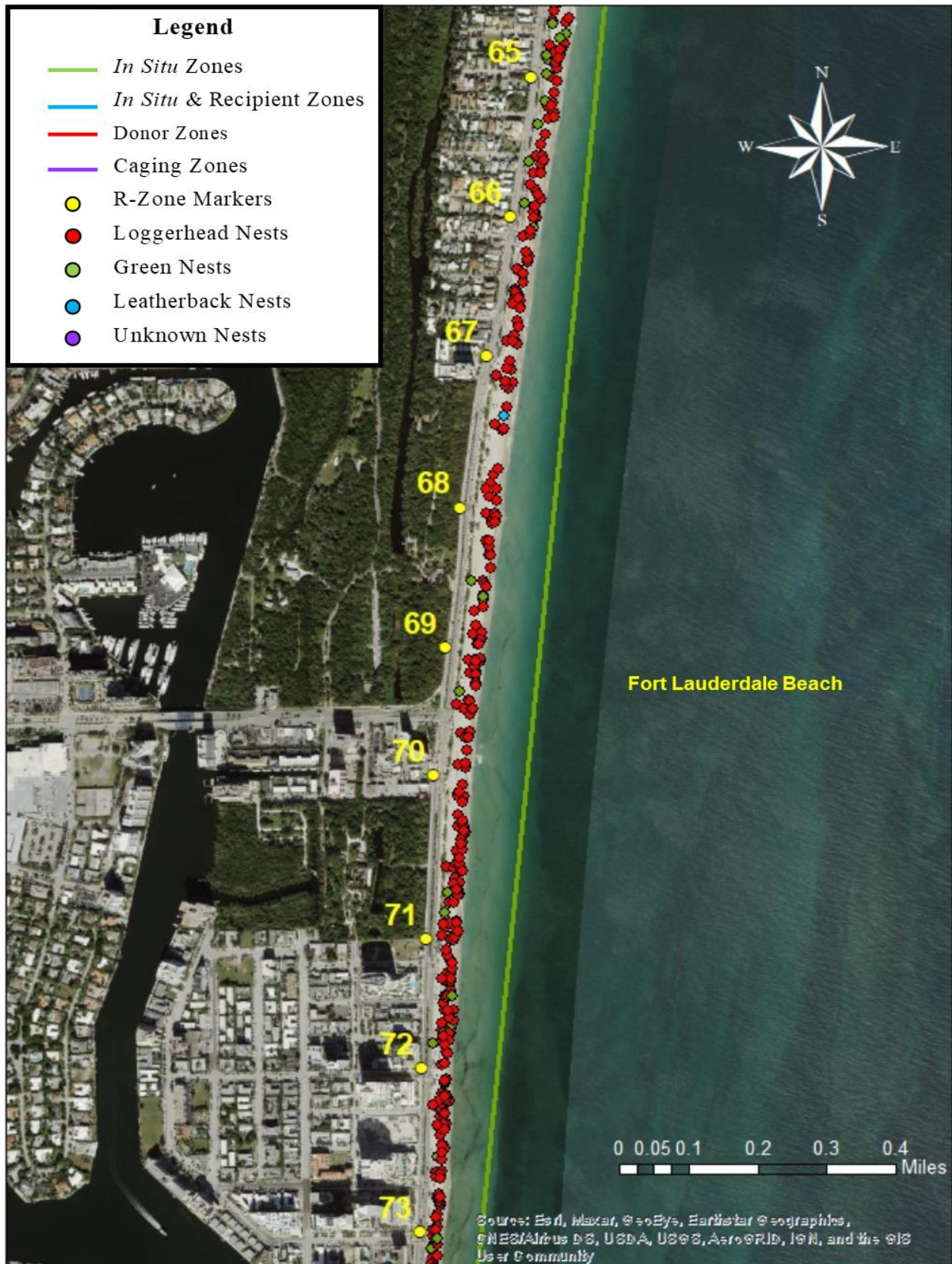
**Figure 3:** Locations of 2020 Turtle Crawls and Treatment Zones.



**Figure 3:** Locations of 2020 Turtle Crawls and Treatment Zones.



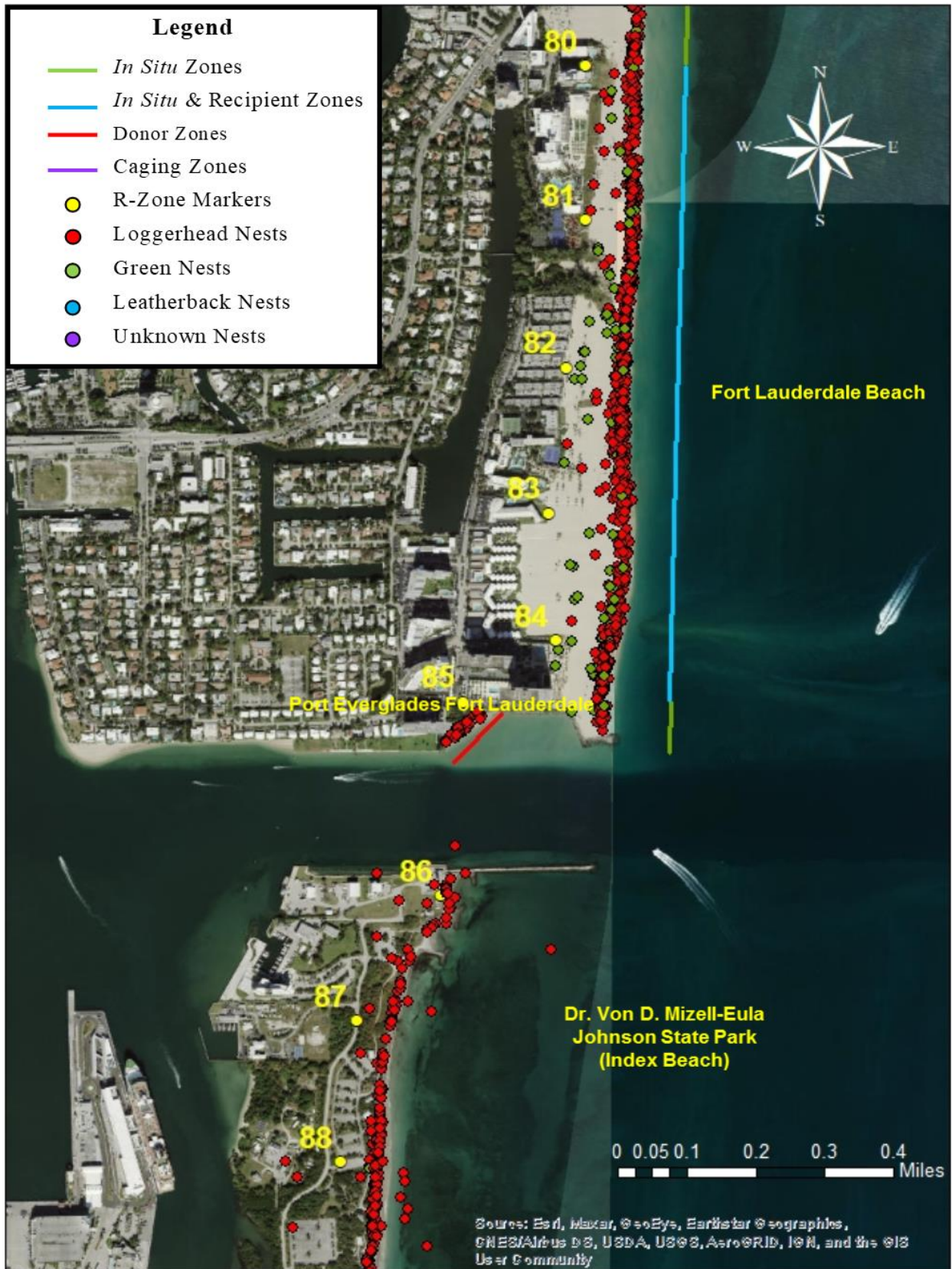
**Figure 3:** Locations of 2020 Turtle Crawls and Treatment Zones.



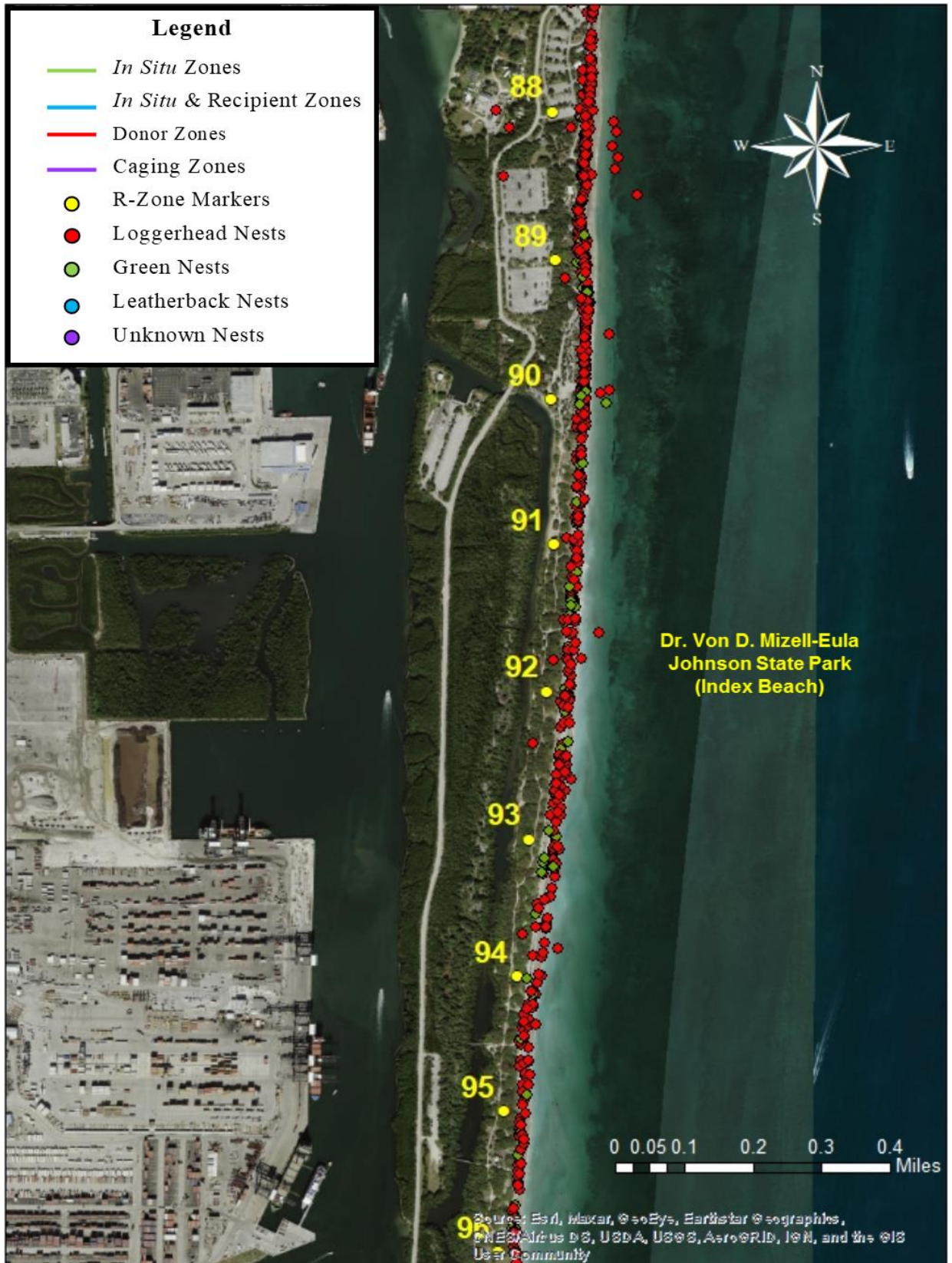
**Figure 3:** Locations of 2020 Turtle Crawls and Treatment Zones.



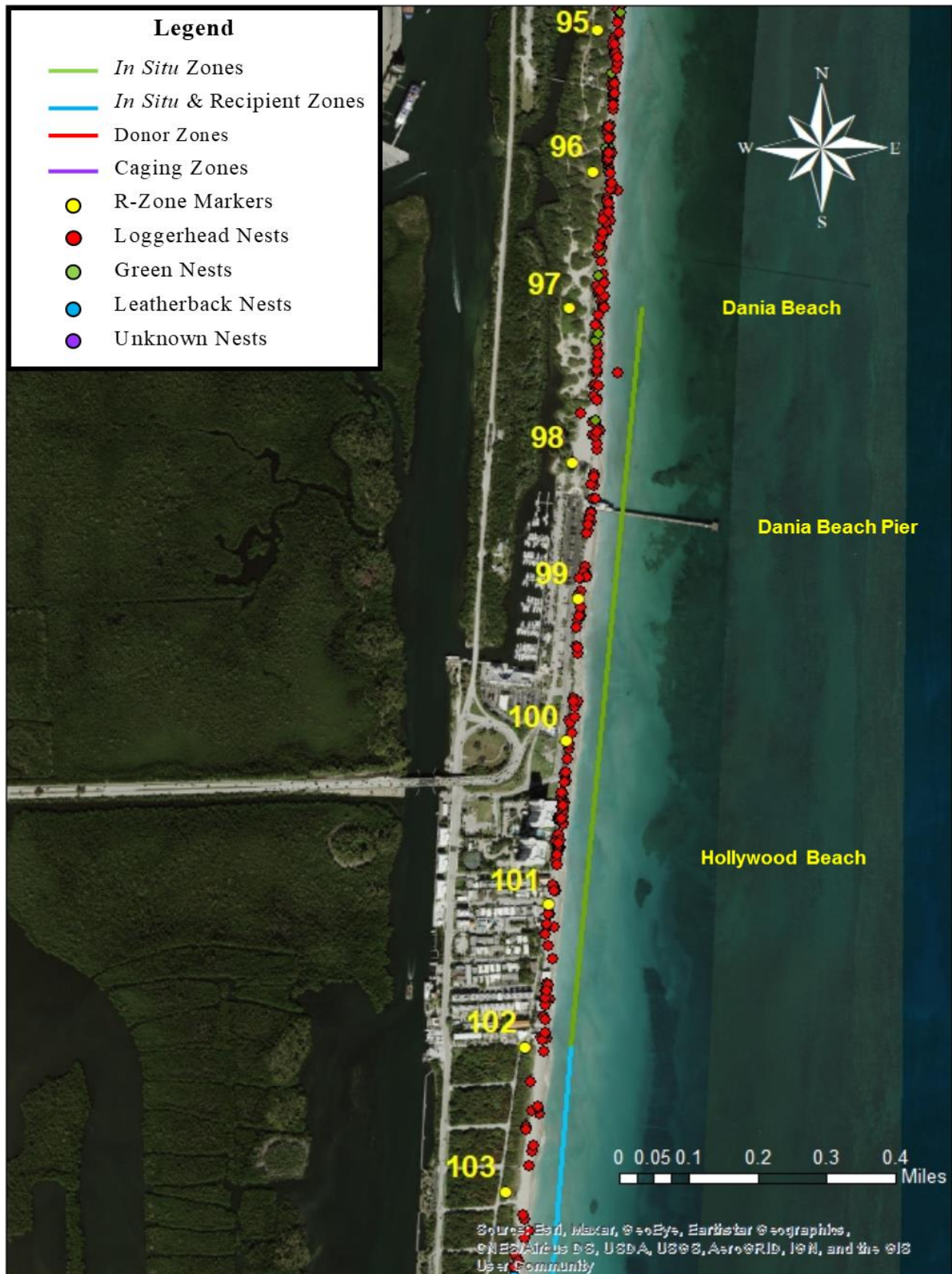
**Figure 3:** Locations of 2020 Turtle Crawls and Treatment Zones.



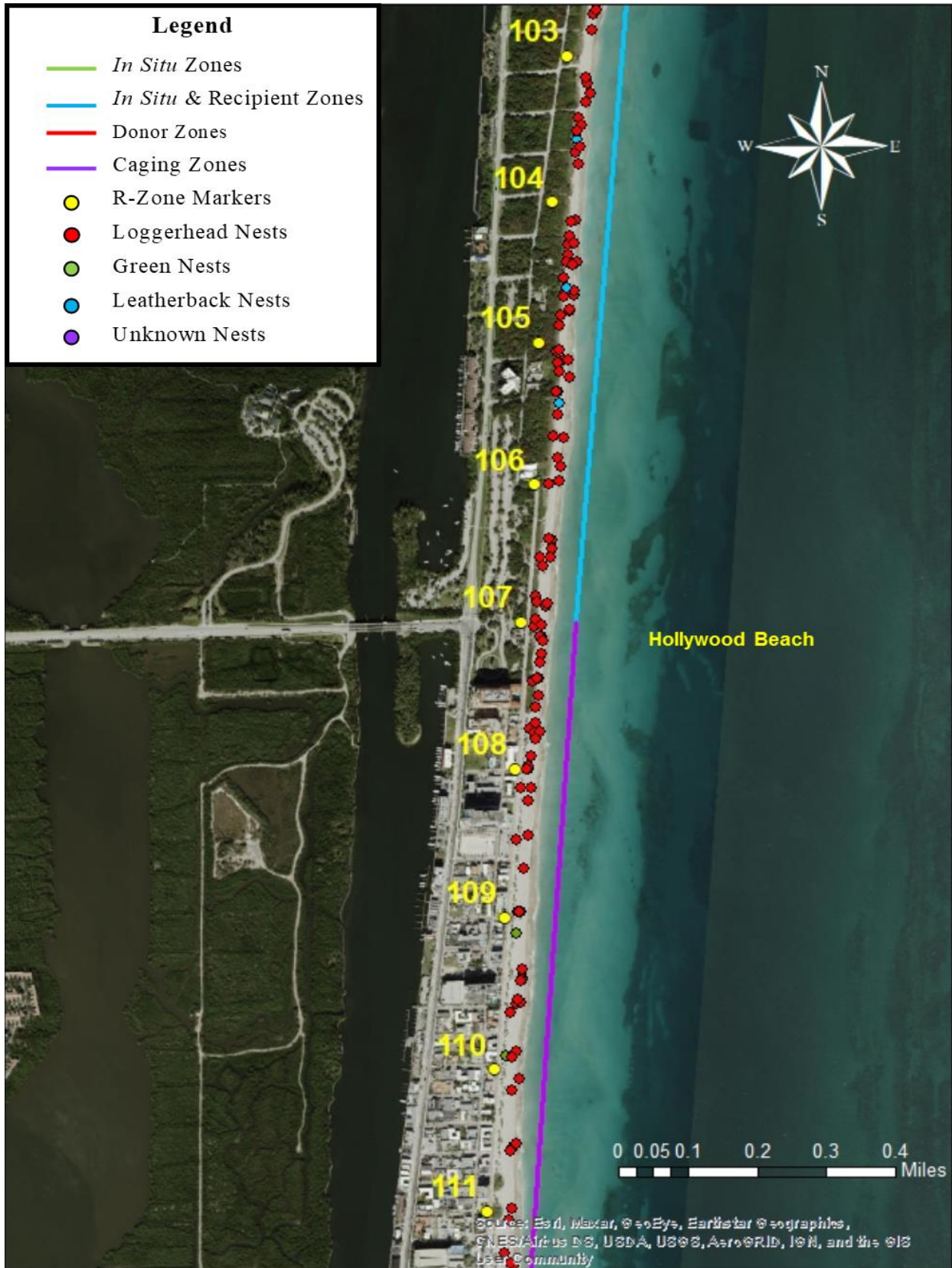
**Figure 3:** Locations of 2020 Turtle Crawls and Treatment Zones.



**Figure 3:** Locations of 2020 Turtle Crawls and Treatment Zones.



**Figure 3:** Locations of 2020 Turtle Crawls and Treatment Zones.

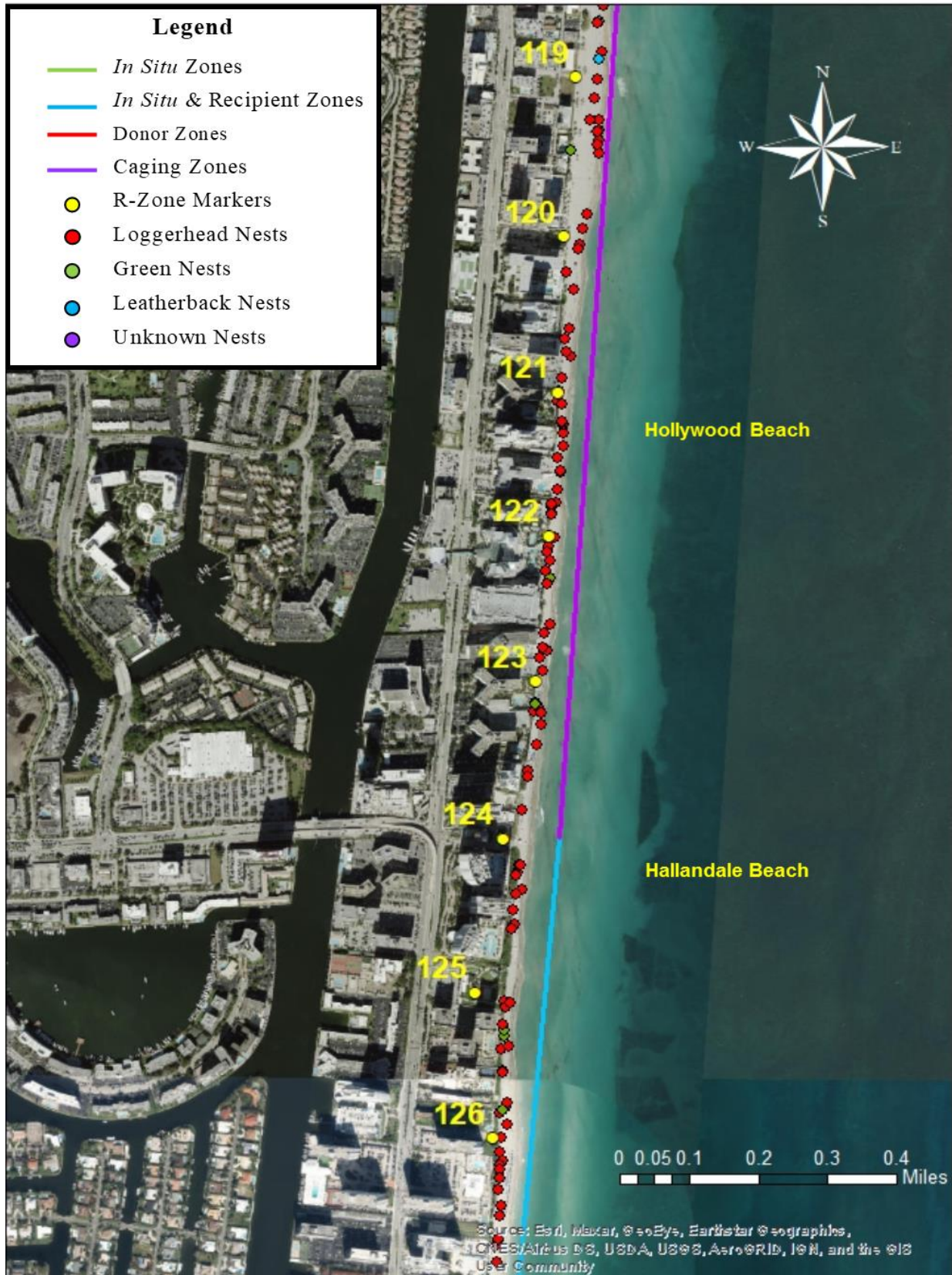




**Figure 3:** Locations of 2020 Turtle Crawls and Treatment Zones.



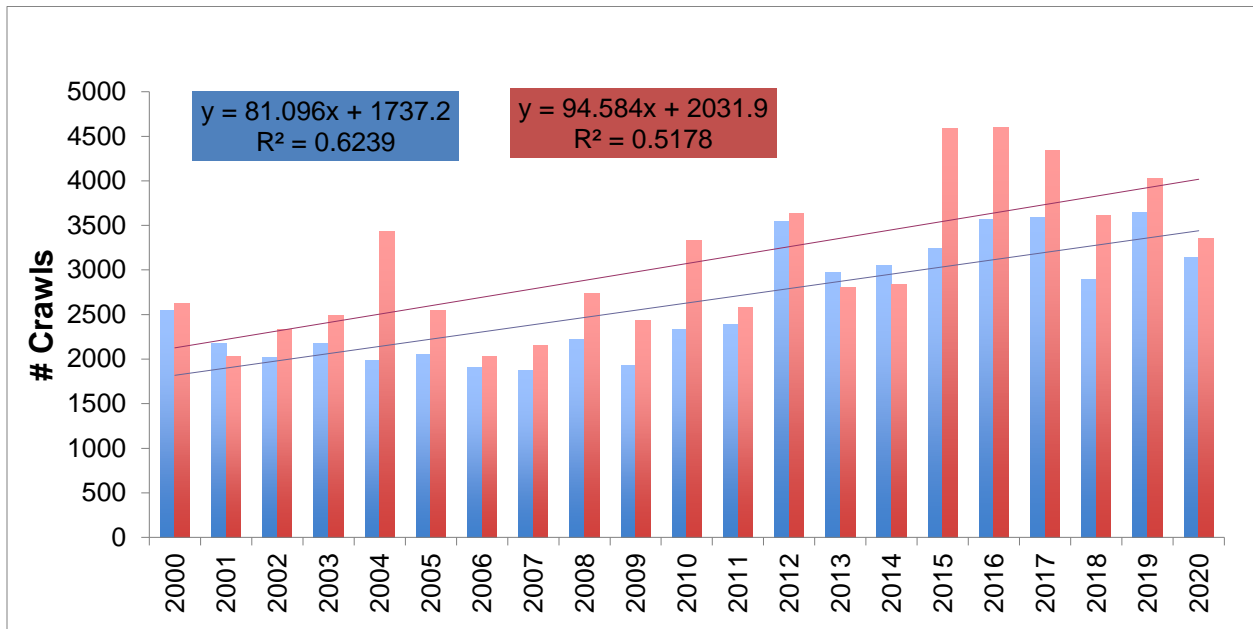
**Figure 3:** Locations of 2020 Turtle Crawls and Treatment Zones.



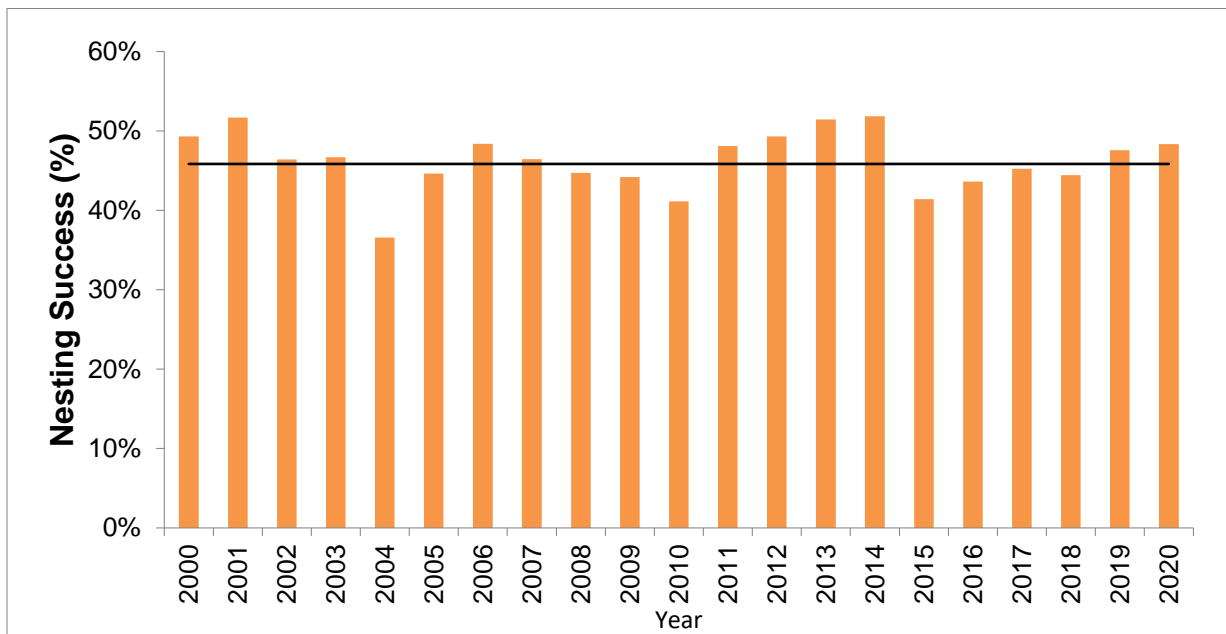
**Figure 3:** Locations of 2020 Turtle Crawls and Treatment Zones.



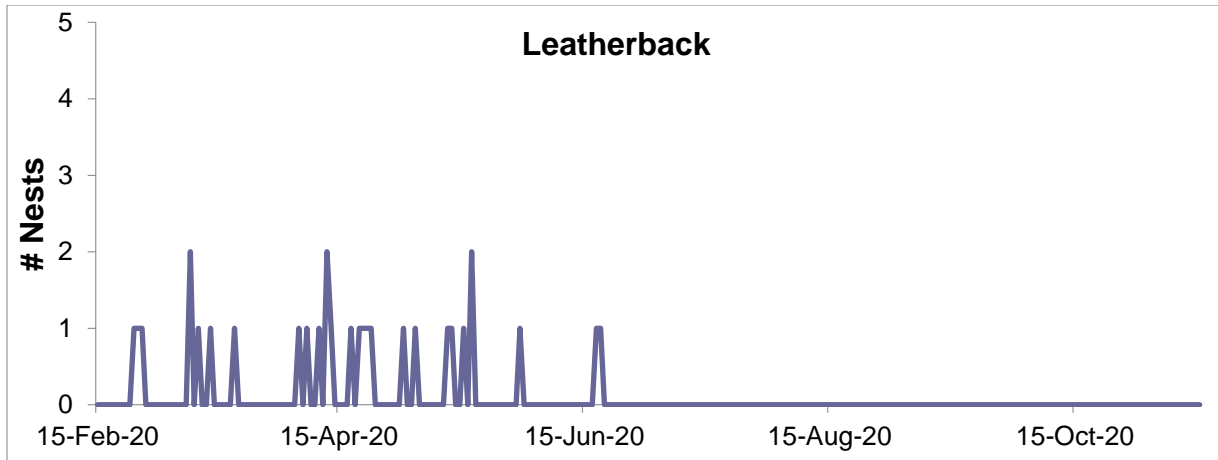
**Figure 4:** Historical crawl totals for all species combined for Broward County (2000-2020). Nests are designated by blue bars and false crawls are designated by red bars. Solid lines indicate trend lines for nesting (blue) and false crawls (red).



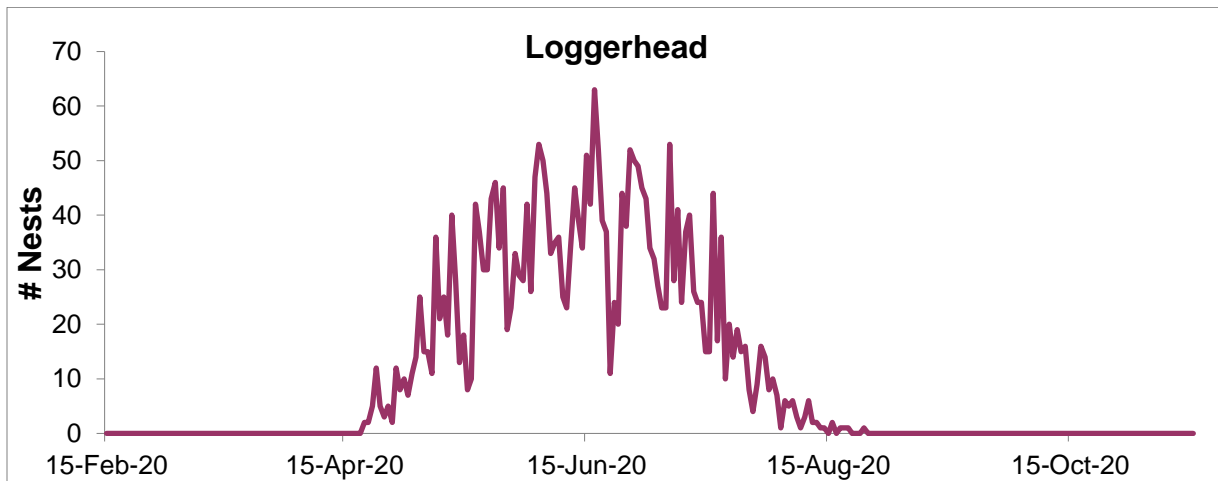
**Figure 5:** Historical nesting success, all species combined for Broward County (2000-2020). Five-year average is indicated by the solid black line.



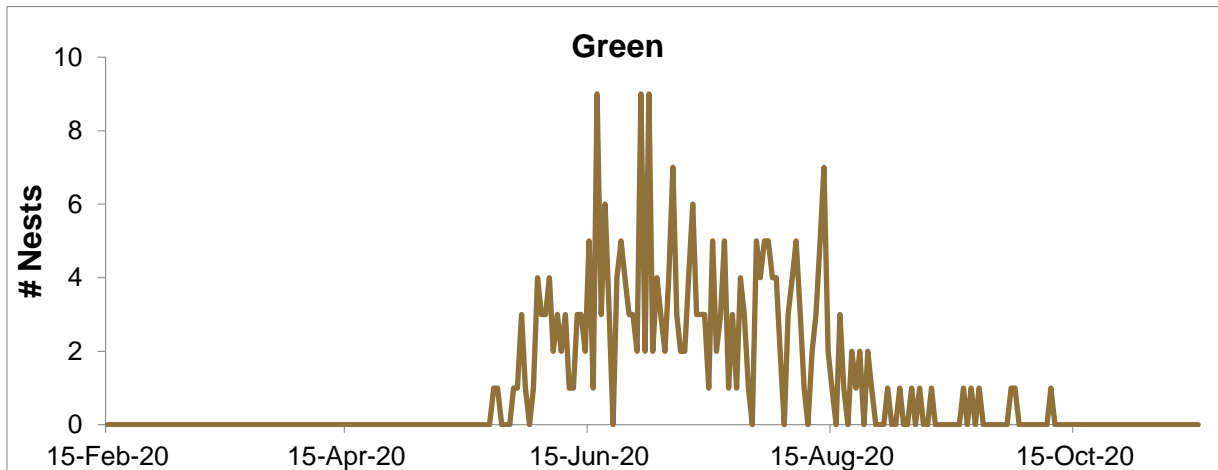
**Figure 6a:** Number of leatherback nests laid per day in Broward County.



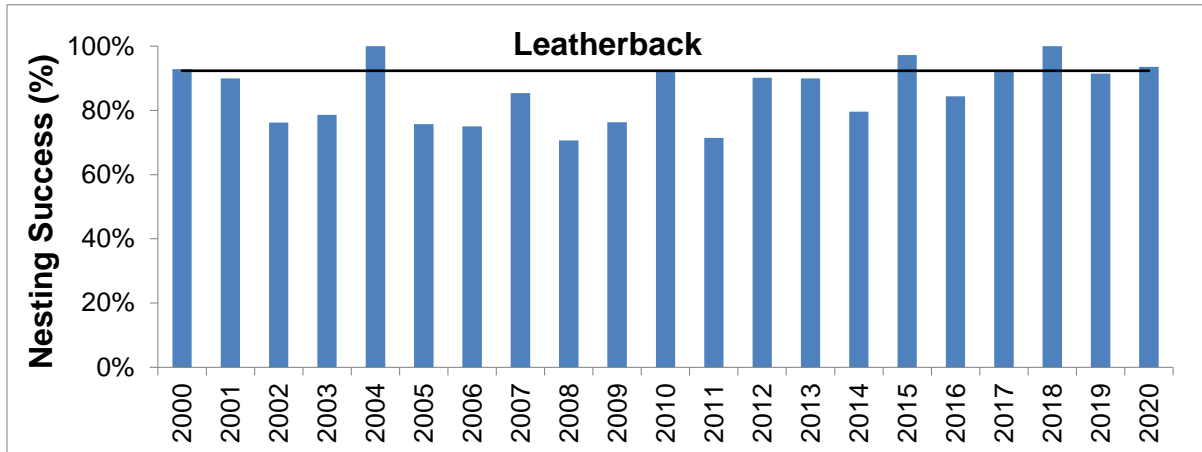
**Figure 6b:** Number of loggerhead nests laid per day in Broward County.



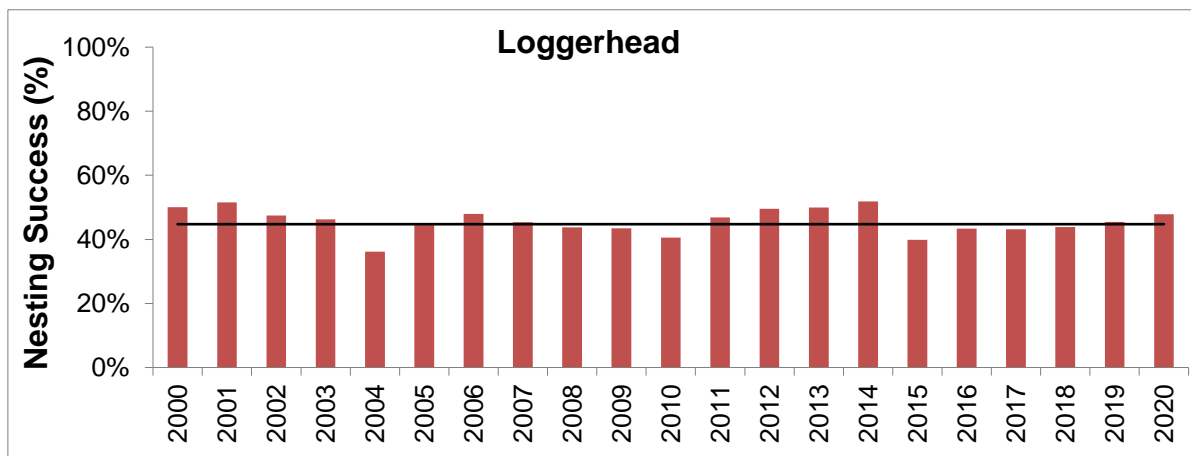
**Figure 6c:** Number of green turtle nests laid per day in Broward County.



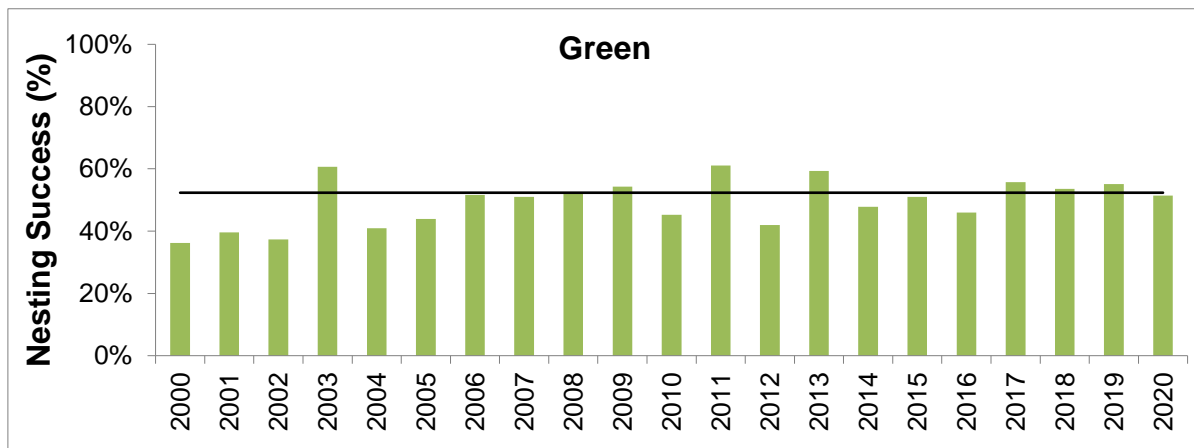
**Figure 7a:** Historical nesting success for leatherbacks in Broward County from 2000-2020. Five-year average is indicated by the solid black line.



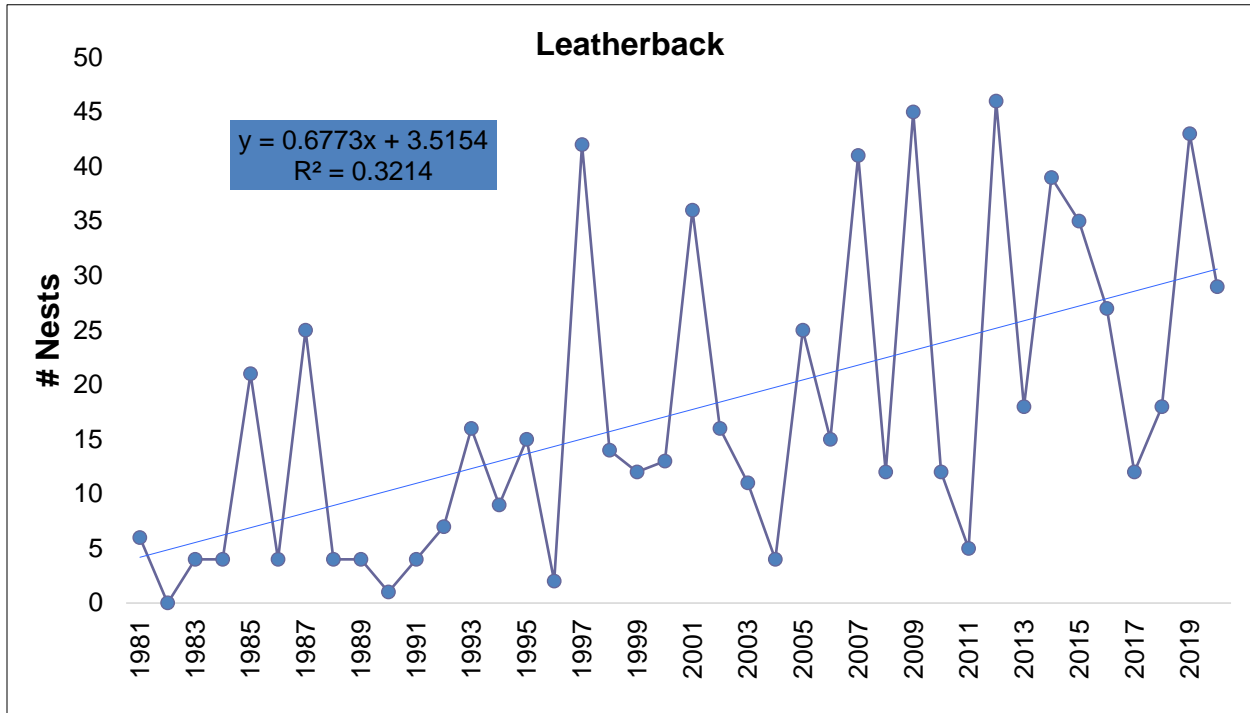
**Figure 7b:** Historical nesting success for loggerheads in Broward County from 2000-2020. Five-year average is indicated by the solid black line.



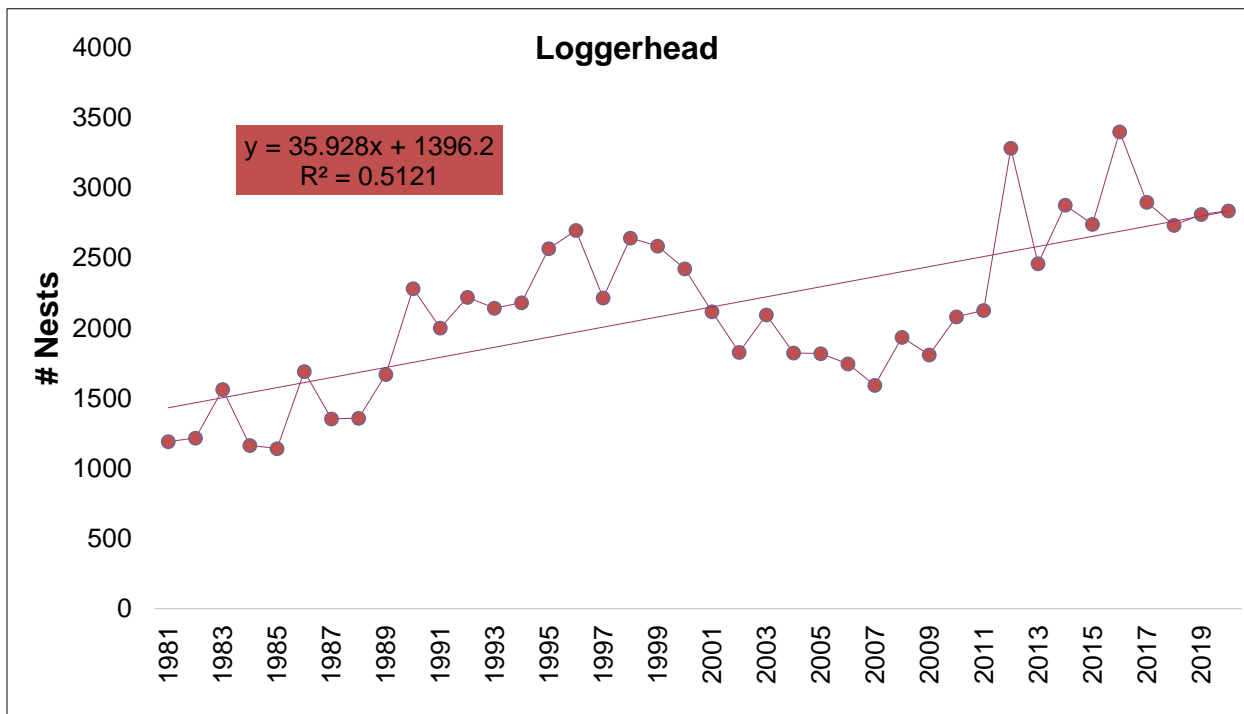
**Figure 7c:** Historical nesting success for green turtles in Broward County from 2000-2020. Five-year average is indicated by the solid black line.



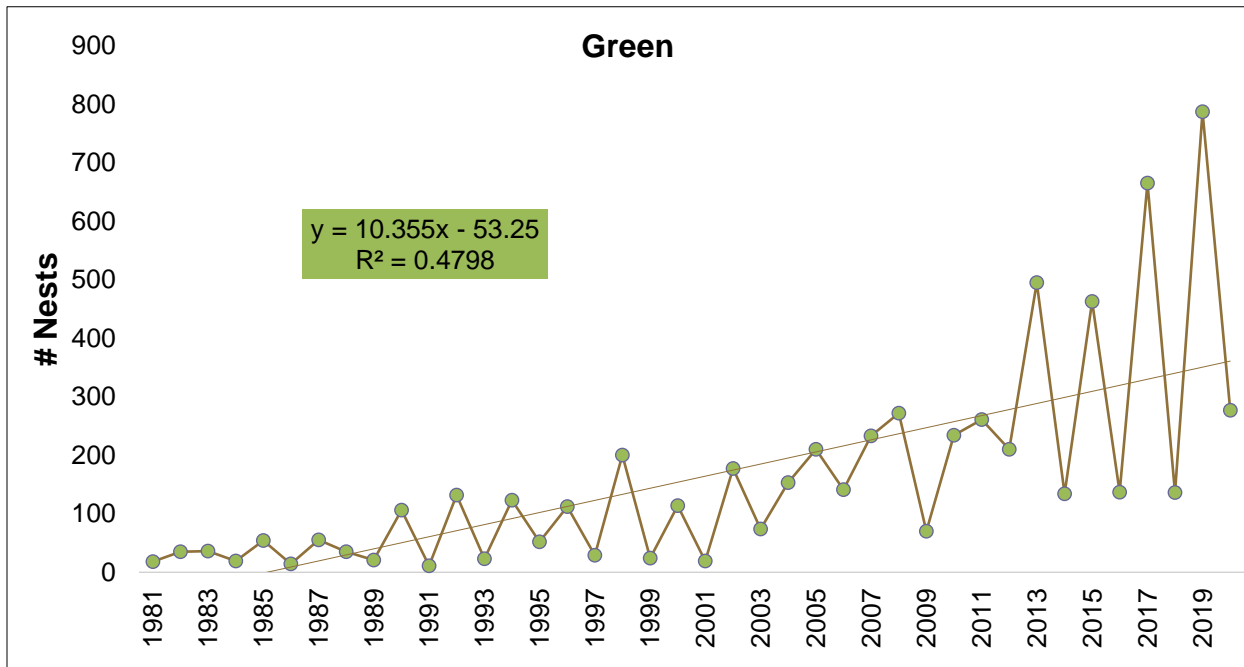
**Figure 8a:** Historical leatherback nest activity (number of nests) in Broward County from 1981-2020. Solid black line indicates linear trend line of nest activity.



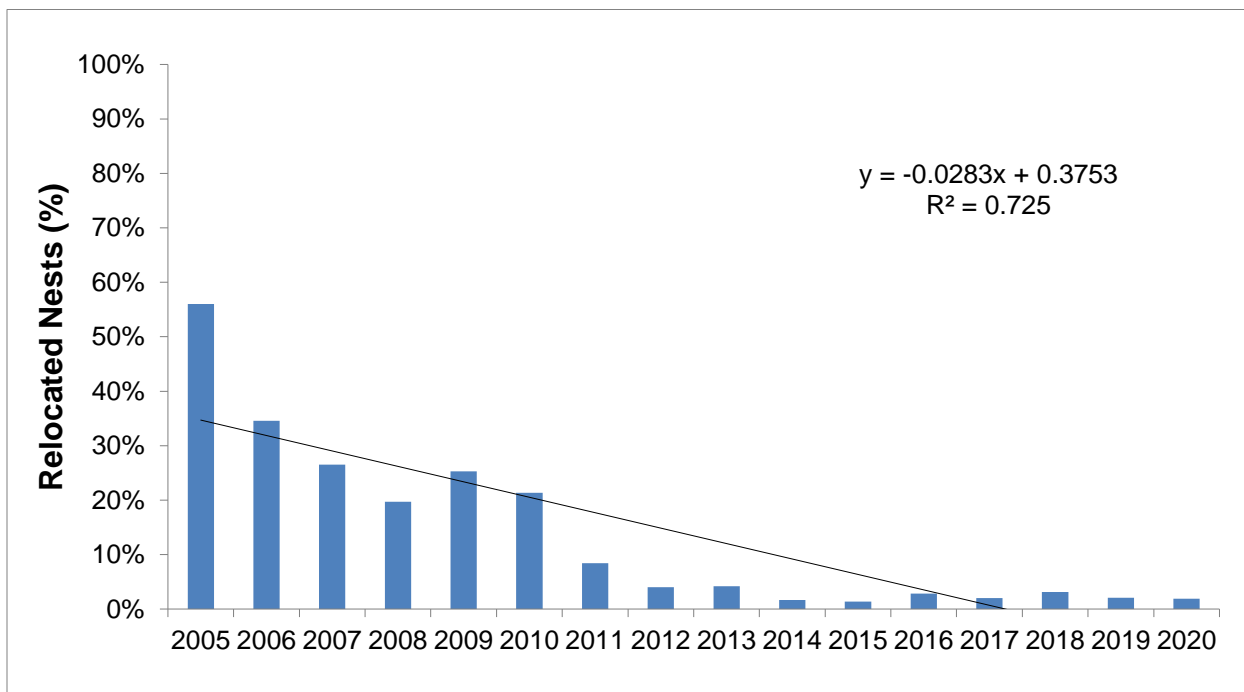
**Figure 8b:** Historical loggerhead nest activity (number of nests) in Broward County from 1981-2020. Solid black line indicates linear trend line of nest activity.



**Figure 8c:** Historical green turtle nest activity (number of nests) in Broward County from 1981-2020. Solid black line indicates linear trend line of nest activity.

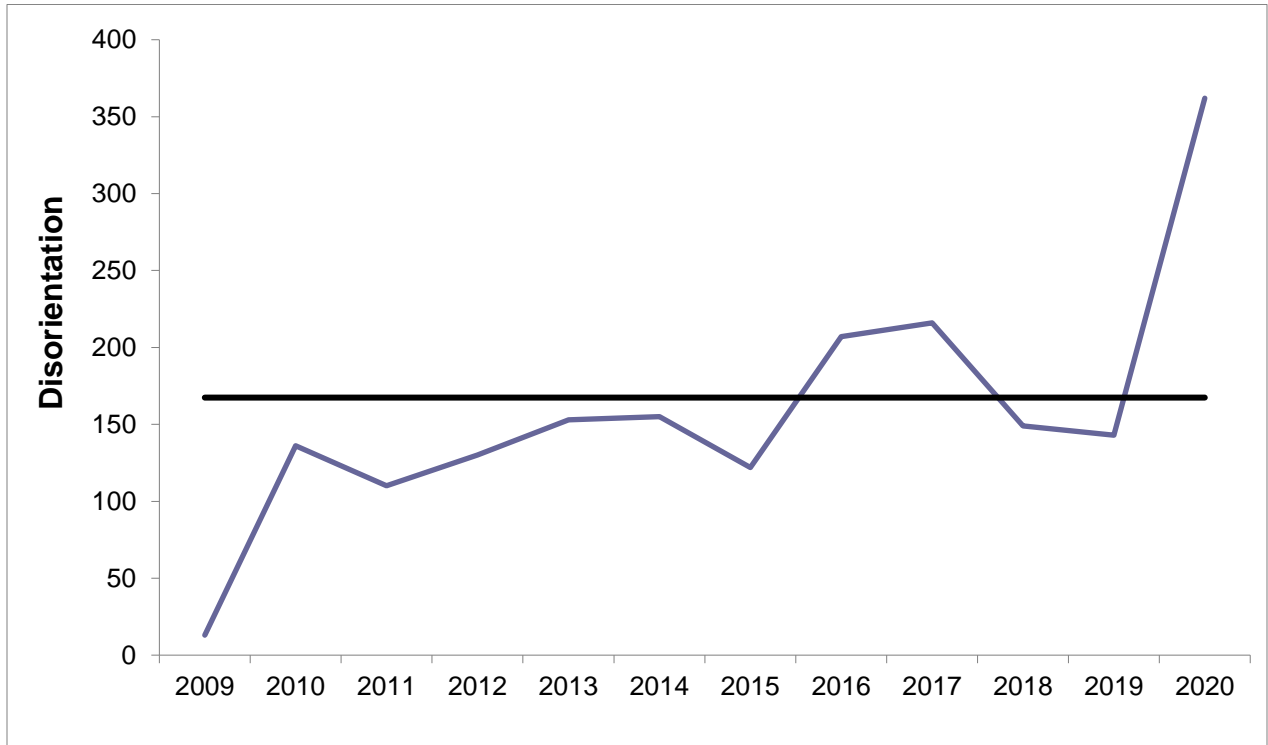


**Figure 9:** Historical nest relocation activity in Broward County (excluding Mizell-Eula State Park) from 2005-2020. Solid black line indicates linear trend line of nest relocations.

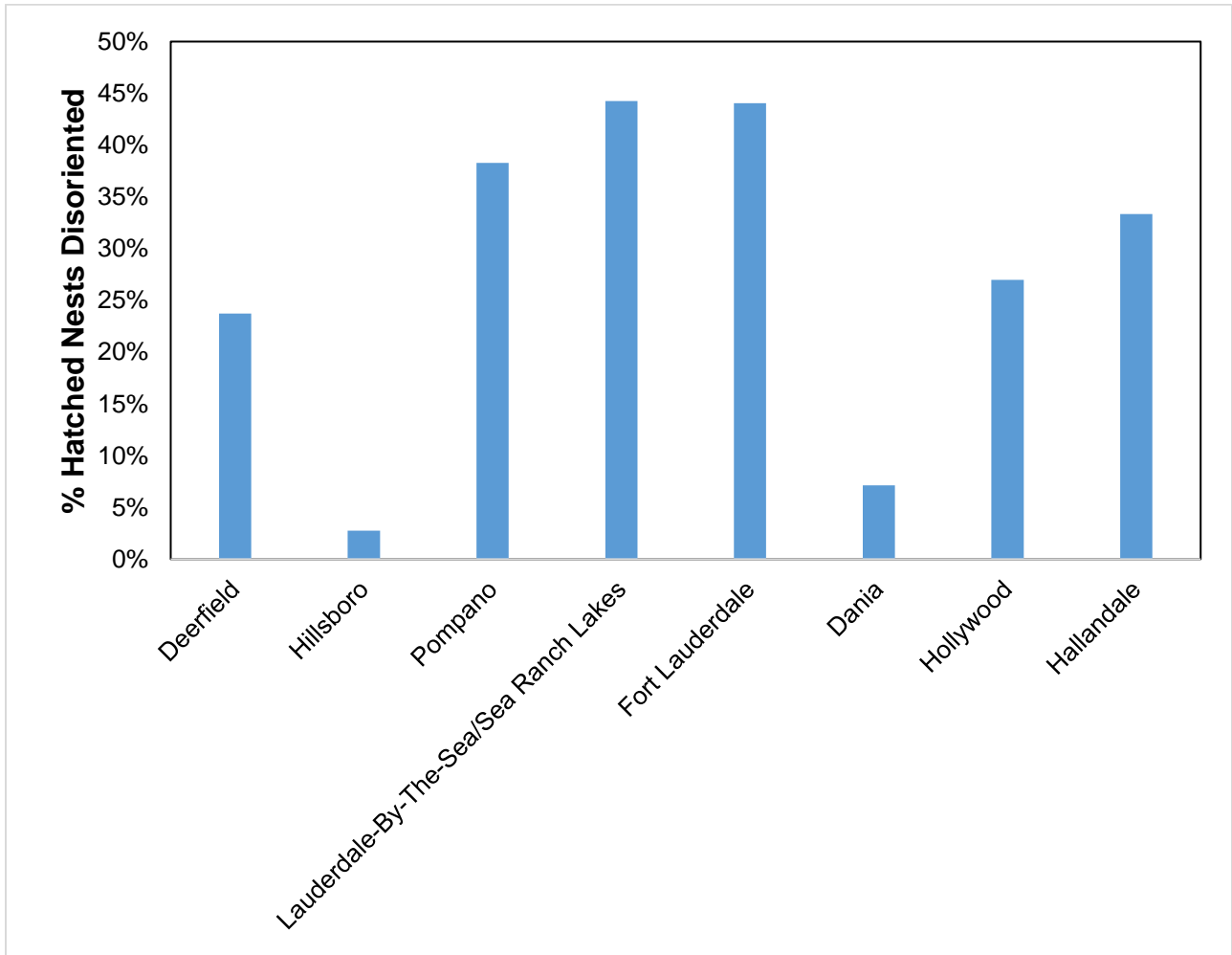




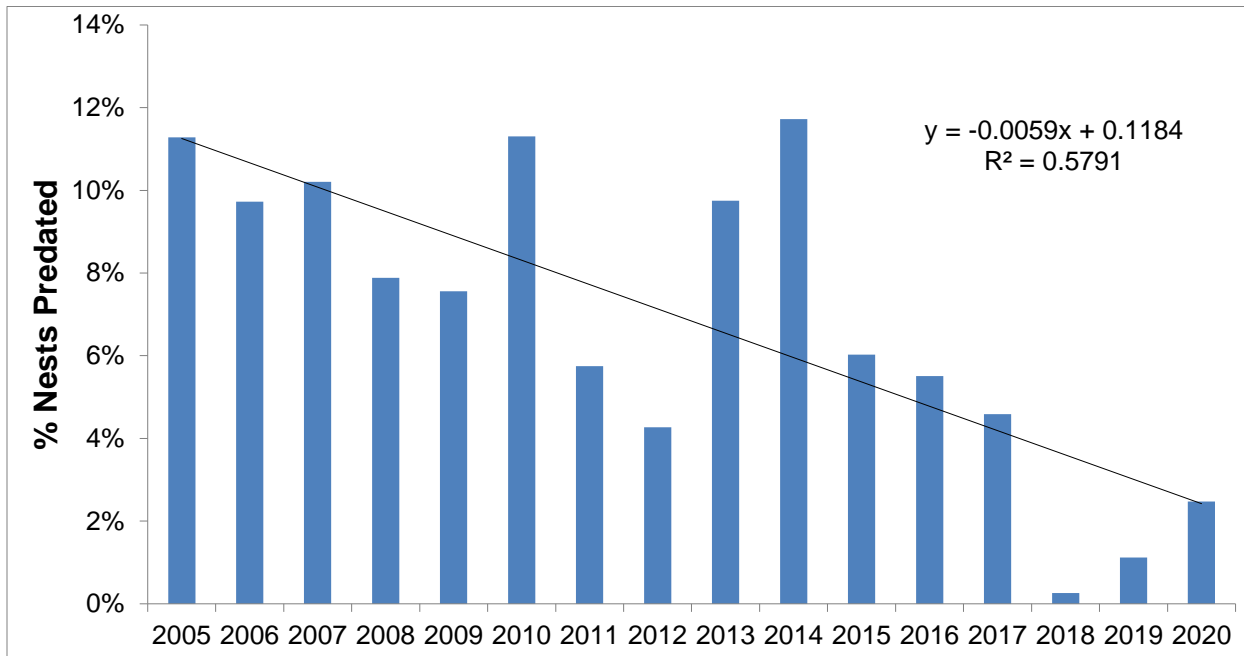
**Figure 10:** Historical disorientation reporting (adult and hatchling disorientations) by the BCSTCP in Broward County (excluding Mizell-Eula State Park) in 2009-2020. Five-year average is indicated by the solid black line.



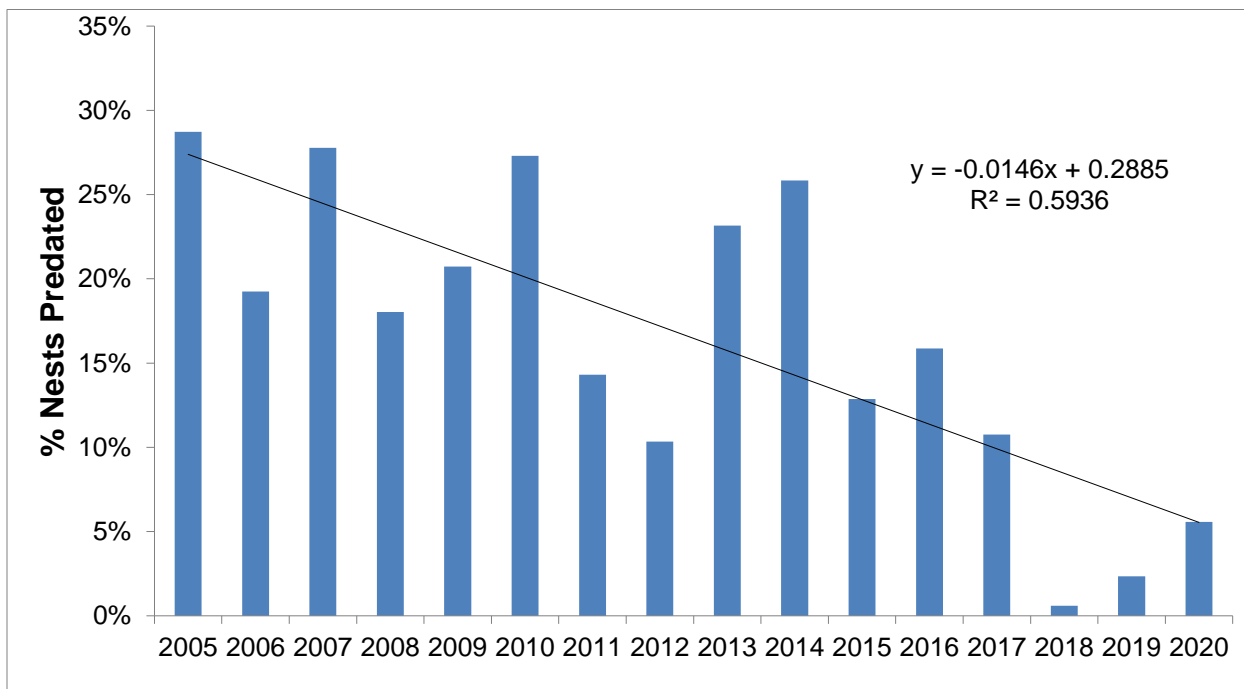
**Figure 11:** All hatchling disorientation reports by municipality recorded in 2020 as reported by BCSTCP, STOP, SFAS, and STARS.



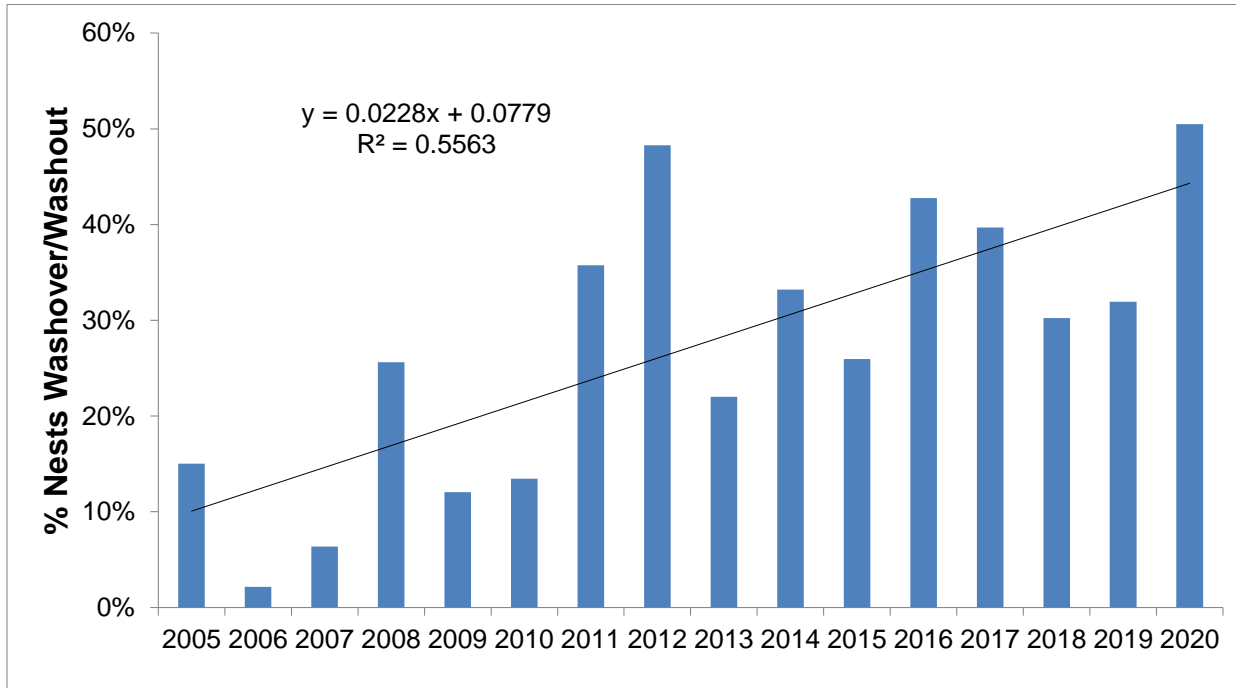
**Figure 12:** Percentage of nests that experienced predation in Broward County, all species and survey zones combined, 2005-2020. Solid black line indicates trend line of nest predation.



**Figure 13:** Percentage of nests that experienced predation in the Hillsboro survey zone, all species combined, 2005-2020. Solid black line indicates trend line of nest predation.



**Figure 14:** Historical nest washover/inundation in Broward County (excluding Mizell-Eula State Park), all species combined, 2005-2020. Solid black line indicates trend line of nest washover/inundation.



Appendix 1: Sea turtle nest sign. Size: 5.5 inches by 8.5 inches.



**Appendix 2a:** Sea turtle hatchling restraining cage design with escape door. Size: ~24 inches height by 24 inches diameter.



**Appendix 2b:** Restraining cage informational sign. Size: 8.5 inches by 11 inches.



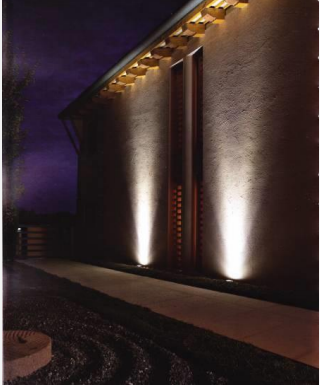





**Appendix 3:** Examples of light types commonly observed on lighting surveys.




Light Fixture Type	Description	Example
<b>Cobra</b>	Streetlights that look like a snake head.	
<b>Acorn</b>	Streetlights that resemble acorns.	
<b>Floodlight</b>	Lights that are typically attached to corners of buildings and illuminate a broad area.	


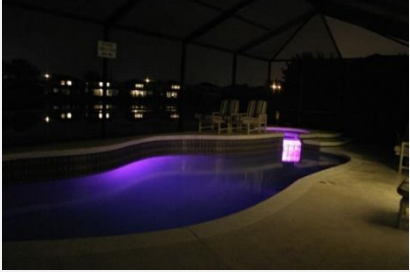

Light Fixture Type	Description	Example
<b>Globe</b>	Circular, posted lights. May be “shielded” on one side with black paint, canvas, or inside the fixture.	
<b>Bell</b>	Pole-mounted lights with a bell-shaped fixture.	
<b>Wall Mount</b>	A light fixture that is mounted to a wall that is not described elsewhere.	


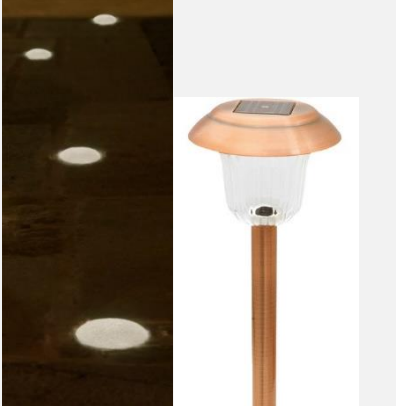



Light Fixture Type	Description	Example
<b>Ceiling Mount</b>	A light fixture that is mounted to a ceiling that is not described elsewhere.	
<b>NEMA</b>	Streetlight with a circular covering and open bottom.	
<b>Up Lighting</b>	Lights that are directed upward.	

Light Fixture Type	Description	Example
<b>Bollards</b>	Lighting that is inside posts attached to ground; usually less than 4 feet in height.	
<b>Landscape</b>	Lighting that illuminates trees or other vegetation.	
<b>Spotlights</b>	Lighting that is directed toward something specific.	

<b>Light Fixture Type</b>	<b>Description</b>	<b>Example</b>
<b>Interior</b>	Lights that are located inside a property and turned on.	
<b>Rope</b>	Multiple small lights attached to a rope.	
<b>Posted</b>	Any other lights on a pole not previously described.	

Light Fixture Type	Description	Example
UFO	Streetlights with round, saucer-like fixtures.	
Pool Lighting	Lights that are found underwater in swimming pools.	
Neon	True neon lighting of various colors (e.g., blue, green, purple, etc.).	

Light Fixture Type	Description	Example
<b>Signage</b>	Signs that are illuminated internally.	
<b>Fluorescent</b>	Long tube lights that are typically seen in parking garages.	
<b>Walkway</b>	Lights that illuminate a pathway.	

Light Fixture Type	Description	Example
<b>Step Lights</b>	Lights that illuminate stairs.	

**Appendix 4:** Summary of 2020 sea turtle emergency line use.

Call Subject	Number of Calls
<b>Caging Inquires</b>	1
<b>Dead Strandings</b>	28*
<b>Disorientations</b>	7
<b>Exposed Eggs</b>	5
<b>Hatchling Pick-up</b>	22
<b>Lighting Concerns</b>	9
<b>Live Strandings</b>	37*
<b>Hatchout</b>	25
<b>Nest/crawl Locations</b>	8
<b>Non-emergency Sea Turtle Inquires</b>	39
<b>Other Wildlife Emergencies</b>	9
<b>Other Wildlife Non-emergencies</b>	22
<b>Potential Poaching/Vandalism/Digging</b>	0
<b>Spam</b>	157
<b>Strandings Outside Broward</b>	4
<b>Wrong Number</b>	15
<b>Overall</b>	388

\*includes events responded to by Gumbo Limbo Nature Center.

**Appendix 5:** Summary of sea turtle strandings.

There were 76 marine turtle strandings events reported for Broward County, BCSTCP responded to 74 from January 1–December 31, 2020 (the remaining 2 were handled by Gumbo Limbo Nature Center). Of the 76 stranding events, 36 turtles were dead upon

arrival (4 *Caretta caretta*, 31 *Chelonia mydas*, and 1 *Lepidochelys kempii*). Of the dead stranding responses, 15 were unknown causes of death, 10 turtles suffered from vessel strikes and/or blunt force trauma, 7 from entanglement, 3 from predatory attacks, and 1 was hooked. Forty strandings were in response to live turtles (7 *Caretta caretta*, 30 *Chelonia mydas*, 1 *Dermochelys coriacea*, 1 *Lepidochelys kempii*, and 1 *Eretmochelys imbricata*). Seventeen live turtles were washbacks, 5 were accidentally hooked by fisherman, 4 were removed from an FPL intake canal, 4 had evidence of vessel strikes and/or blunt force trauma, 3 had evidence of predatory attack, 2 were found offshore or in a canal and brought to shore, 2 were found washed ashore, 1 was found entangled, 1 was found stranded under a jet ski while nesting, and 1 was caught under beach stairs after nesting. Thirty-seven of the live turtles were transported to Gumbo Limbo Nature Center in Boca Raton, Florida and 1 was transported to Miami Seaquarium for treatment and rehabilitation. Neither of the sea turtles that were stranded while attempting to nest sustained any injuries and each were released immediately.

#### **Appendix 6:** Summary of education and outreach activities.

A primary goal of the BCSTCP is to provide engaging educational and outreach opportunities to the general public and students. In doing so, the program brings awareness to individuals, businesses, beach users, and coastal residents, and nurtures stewardship towards sustaining a suitable environment for these imperiled species. Educational flyers are regularly distributed throughout the season to interested parties on the beach, at turtle talks, classroom/school visits, and hatchling releases.

In 2020, the BCSTCP conducted a total of 25 educational/outreach events, both live (n = 4, prior to the public health crisis) and virtual (n = 21) connecting with over 5,090 individuals. Due to the COVID-19 pandemic, this was a reduction of ~77% in the number of events and ~90% of individuals reached compared to the previous year.

- Virtual Turtle talks (7 presentations, ~170 participants)
  - Marine Environmental Education Center- Marine Science Webinar Series
  - NSU Libraries- STEM for Tweens
- Virtual Turtle talks serving as virtual hatchling releases (14 presentations; ~820 participants)
  - NSU Alumni Association
  - NSU Ambassador's Board
  - NSU President's Associates
  - NSU-Fellow's Society
  - Public
- Table events (2 events, ~3,500 participants)
  - Gumbo Limbo Nature Center Sea Turtle Day
  - Tri-Rail's Rail Fun Day
- Professional research presentations (2 presentations, ~600 participants)
  - Southeast Regional Sea Turtle Network- Annual Southeast Regional Sea

### Turtle Meeting

- Estimated social media impact (>100 total posts)
  - Facebook- 11,803 followers, average 3,200 people reached per post
  - Instagram- 1,200 followers

**Appendix 7:** Historical sea turtle strandings in Broward County, 2004-2020. Solid bars indicate dead strandings and open bars indicate live strandings.

