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## Investigating Red Knot Migration Ecology along the Georgia and South Carolina Coasts: Spring 2019 Season Summaries

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INVESTIGATING RED KNOT MIGRATION ECOLOGY  
ALONG THE GEORGIA AND SOUTH CAROLINA  
COASTS: SPRING 2019 SEASON SUMMARY

# Investigating Red Knot Migration Ecology along the Georgia and South Carolina Coasts: Spring 2019 Season Summary

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Project Partners:  
US Fish and Wildlife Service  
US Geological Survey  
Georgia Department of Natural Resources  
South Carolina Department of Natural Resources  
The Center for Conservation Biology at William & Mary

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The Center for Conservation Biology is an organization dedicated to discovering innovative solutions to environmental problems that are both scientifically sound and practical within today's social context. Our philosophy has been to use a general systems approach to locate critical information needs and to plot a deliberate course of action to reach what we believe are essential information endpoints.

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## EXECUTIVE SUMMARY

The *rufa* subspecies of the Red Knot (*Calidris canutus*) has declined significantly in the past 35 years, leading to federal listing (US Fish and Wildlife Service Federal Register Vol. 79 No. 238, 2014a) under the Endangered Species Act in the United States (16 U.S.C. 1531 *et. seq*) and Canada (COSEWIC 2007, SARA 2007). Evidence for the decline is seen in long-term surveys of a major spring staging site (Dunne et al 1982, Clark et al. 1993, Niles et al. 2008) and the largest known over-wintering site (Morrison et al. 2004). In only 30 years, the estimated population has declined from 100,000-150,000 to possibly below 30,000 (Niles et al. 2007) leading some researchers to suggest the population is highly vulnerable to extinction (Baker et al. 2004). The determination of regional population estimates and identification of major stopover sites are considered to be the highest priority for the Georgia Department of Natural Resources State Wildlife Action Plan (2015), the Atlantic Flyway Shorebird Business Strategy (Winn et al. 2013), the US Shorebird Plan (Brown et al. 2001), the USFWS Red Knot Spotlight Species Action Plan (2010), and the Western Hemisphere Shorebird Reserve Network (WHSRN) Red Knot Conservation Plan for the Western Hemisphere (Niles et al. 2010a). The Georgia Department of Natural Resources State Wildlife Action Plan ranks the Red Knot as a high priority species (with state status of “Rare”) and ranks research of the Red Knot as one of the primary conservation actions needed within the state.

A band resight program was initiated along the Georgia coastal barrier islands during the fall of 2011 and spring of 2013 and 2015-2016 giving baseline information for those seasons (Lyons et al. 2017, Smith et al. 2017). A trapping and tagging project was initiated in South Carolina in recent years, though there has been no systematic resight effort within the state. The patterns observed in both studies suggest that Red Knots are using the south-Atlantic through Delaware Bay in spring as an open network of staging areas. Recent tagging results in South Carolina have documented direct spring flights from South Carolina to James Bay, suggesting that the south-Atlantic stopovers are more important in the life-cycle of shorebirds than is currently thought. It is currently unknown what percentage of Red Knots use the direct flight strategy vs. stopping in Delaware Bay on their northbound migration. Winter resighting work conducted in South Carolina suggests that virtually no Red Knots wintering along the south-Atlantic use Delaware Bay in spring migration. Although movement and settlement “decisions” are likely influenced by foraging conditions throughout the network, investigations into the factors driving movements during migration is necessary to better understand Red Knot migration ecology. This is critical in developing appropriate stopover models and adaptive management tools for land managers.

The Georgia Department of Natural Resources, the South Carolina Department of Natural Resources, the US Fish and Wildlife Service, and The Center for Conservation Biology will initiate a Red Knot tagging and resighting program along the Atlantic Coast of Georgia during the spring of 2019 to be paired with the ongoing programs within Delaware Bay and elsewhere along the flyway. This project will provide critical data that will be used to

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analyze the ongoing questions regarding Red Knot habitat choice decision making in the south Atlantic Coast in spring.

A large percentage (3-6%) of Red Knots have been previously captured and tagged with unique 2 to 3 digits alpha-numeric bands. This marked population allows for mark-resight studies of migratory populations of Red Knots with no capturing involved. A total of 27,356 Red Knots were detected during daily surveys in spring 2019 along the Georgia and South Carolina Coasts; of those, 4,917 were scanned for flags, and 315 individually banded Red Knots were resighted a total of 523 times from within the spring migrant population. A total of 71 marked to unmarked ratios were recorded during the field season, with an average of 3.6% of Red Knots individually marked over the course of the spring. The rough estimate for the total number of knots cycling through during the spring season is estimated superpopulation size for the spring 2019 season is 8,750 (3.6% of birds tagged and 315 individuals recorded).

The Georgia Coast is a major stopover area annually for *rufa* Red Knots in spring migration and in certain years in fall migration. The superpopulation utilizing the coast in fall migration can exceed 23,000 birds (Lyons et al. 2017) and the rough estimate of spring migration superpopulation from this study is approximately 8,750 birds. The total estimated population of *rufa* Red Knots is 42,000 birds (Andres et al. 2012), suggesting that a high percentage of *rufa* knots are using the Georgia Coast in spring and in some years fall migration. There appears to be less variation in spring migration superpopulations between years than in fall migration, suggesting a more stable (but less abundant) food source for spring migrants.

## BACKGROUND

### Context

The *rufa* subspecies of the Red Knot (*Calidris canutus*) has declined significantly in the past 35 years, leading to federal listing (US Fish and Wildlife Service Federal Register Vol. 79 No. 238, 2014a) under the Endangered Species Act in the United States (16 U.S.C. 1531 *et. seq*) and Canada (COSEWIC 2007, SARA 2007). Evidence for the decline is seen in long-term surveys of a major spring staging site (Dunne et al. 1982, Clark et al. 1993, Niles et al. 2008) and on wintering grounds (Morrison et al. 2004, Dey et. al 2011, Andres et al. 2012). In only 30 years, the estimated population has declined from 100,000-150,000 to below 30,000 (Niles et al. 2007), leading some researchers to suggest the *rufa* population is highly vulnerable to extinction (Baker et al. 2004).

Most research exploring the population decline has focused on studying the foraging conditions within the Delaware Bay (Atkinson et al. 2003, Baker et al. 2004, Haramis et al. 2007, McGowan et al. 2011). The Delaware Bay is a terminal spring staging site on the mid-Atlantic seacoast where birds refuel before moving north to their breeding grounds in the high arctic (Harrington and Flowers 1996, Harrington 2001) and was the first site recognized for its hemispheric importance under the Western Hemisphere Shorebird Reserve Network (WHSRN) program (Delaware Bay WHSRN Partners 1986). Red Knots staging within the Delaware Bay feed nearly exclusively on the eggs of the horseshoe crab (*Limulus polyphemus*) (Tsipoura and Burger 1999) and horseshoe crab egg densities have been related to spatial distribution (Karpanty et al. 2006), foraging rates (Atkinson et al. 2003, Gillings et al. 2007), rates of mass gain (Robinson et al. 2003, Atkinson et al. 2007, Gillings et al. 2009) and the associated ability of birds to reach threshold leaving weights (Baker et al. 2001, Niles et al. 2008, Morrison 2012). Leaving weights have been suggested to influence adult survivorship, indicating a link between conditions within the Delaware Bay and recent population declines (Baker et al. 2004). Horseshoe crabs have been harvested commercially in the Delaware Bay for decades, and the rapid emergence of the conch industry has dramatically increased harvest pressures in recent years (Walls et al. 2002). Increased harvest rates of horseshoe crabs may impact the magnitude of spawning events, resulting in egg densities well below those required by staging Red Knots and other shorebirds, and harvest of crabs has led to conflicts between the fishing industry and conservation groups (Odell et al. 2005).

A Red Knot band resight program was initiated by Manomet Center for Conservation Sciences, US Fish and Wildlife Service, and Georgia Department of Natural Resources Nongame Section in the Altamaha River basin during the fall of 2011. Prior to the 2011 study, no systematic resighting of migratory Red Knots had been conducted in Georgia in any season. The patterns observed suggest that Red Knots are using the Georgia Coast during fall migrations in large numbers when forage is abundant (Lyons et al. 2017). Fall coastal habitats in Georgia are used primarily by Red Knots wintering in southeastern states, coastal Texas, and into northeast Brazil, though long-distance migrant (wintering in Argentina and Chile) Red Knots refuel there as well (Lyons et al. 2017). Although movement and settlement “decisions” are likely influenced by foraging conditions throughout the network, and investigations into the factors driving movement during migration is necessary to better understand Red Knot migration ecology. There is an essential need for developing appropriate stopover models and adaptive management tools for land managers to better conserve the resource. Systematic resighting of individually tagged Red Knots along the Georgia Coast during spring and fall migrations fills a crucial knowledge gap in the life history of Red Knots.

The Center for Conservation Biology, US Fish and Wildlife Service, and Georgia Department of Natural Resources Nongame Section initiated a Red Knot band resight program along the Atlantic Coast of Georgia during the spring of 2013. This was the first systematic resight study of Red Knots in spring migration in Georgia. Previous population estimates of Red Knots along the South Atlantic coast focused on aerial or ground based surveys and



while these methods are useful for counting peak numbers, they are less than ideal for estimating accumulated numbers of the overall population of Red Knots cycling through a stopover site. McGowan et al. (2011) strongly recommend moving away from aerial or ground counts to methods that use mark-recapture and allow for estimation of variance from the data. Estimates of spring migration survival rates, stopover duration, and between-year fidelity rates to Georgia are impossible to calculate without a dedicated systematic mark-recapture program.

The determination of regional population estimates and identification of major stopover sites are considered to be the highest priority as outlined in the Georgia Department of Natural Resources State Wildlife Action Plan (2015), the Atlantic Flyway Shorebird Business Strategy (Winn et al. 2013), the US Shorebird Plan (Brown et al. 2001), the USFWS Red Knot Spotlight Species Action Plan (2010), and the WHSRN Red Knot Conservation Plan for the Western Hemisphere (Niles et al. 2010a). The Georgia Department of Natural Resources State Wildlife Action Plan (2015) ranks the Red Knot as a high priority species (with state status of “Rare”) and ranks research of the Red Knot as one of the primary conservation actions needed within the state.

## **ACTIVITIES and OBJECTIVES**

The Center for Conservation Biology, Manomet Center for Conservation Sciences, Georgia Department of Natural Resources Nongame Section, US Geological Survey, and the US Fish and Wildlife Service objectives for the Red Knot project in Coastal Georgia are to:

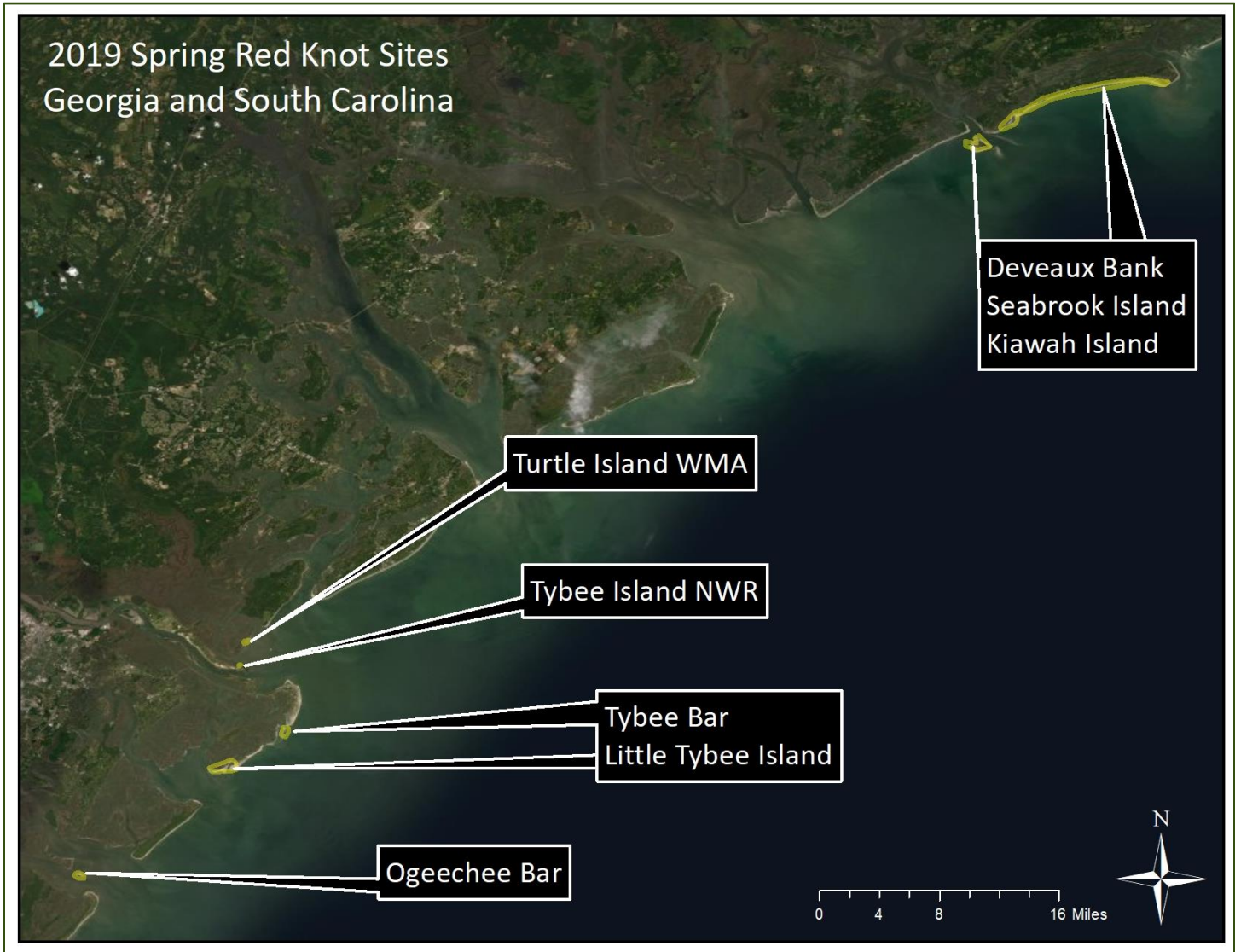
- **Activity 1) Trap and radio tag Red Knots in SC and GA.** Georgia Department of Natural Resources, South Carolina Department of Natural Resources, US Fish and Wildlife Service, and the Center for Conservation Biology staff proposed to trap and tag Red Knots (*Calidris canutus rufa*) along the Georgia and South Carolina coasts in an effort to determine stopover length, localized and large scale migration movements, and to increase knowledge and awareness of key foraging areas. We proposed to tag Knots using nanotags and utilize the existing MOTUS network to facilitate local and continental migration monitoring (Mann et al. 2017, Taylor et al. 2017). There were no discrepancies between this proposed activity and work performed.
- **Activity 2) Resight previously tagged Red Knots along the SC and GA coast.** We proposed to focus resight efforts at 4 primary stopover locations in both South Carolina and Georgia, following previously established protocols. There were no discrepancies between this proposed activity and work performed.
- **Activity 3) Delineate important Horseshoe Crab spawning areas in SC.** We proposed to work with local biologists and land managers to create a GIS database of important HSC spawning areas. There were no discrepancies between this proposed activity and work performed.

- **Activity 4) Map shorebird disturbance issues.** Project partners proposed to map disturbance issues encountered along the coast. There were no discrepancies between this proposed activity and work performed.
- **Activity 5) Increase public awareness of the conservation issues surrounding the Red Knot and other shorebirds in Georgia and South Carolina through all publicly available media and social media avenues.** Project partners were effective in communicating the story of shorebird conservation and during the project duration were involved in numerous outreach events, including presentations in professional and general public settings, outreach to beach goers, publication of newsletter stories, and volunteer opportunities for citizen scientists to contribute to the project.

## **METHODS**

### **Study Area**

The primary study area is the Georgia barrier island chain in Liberty, Bryan, and Chatham Counties and Charleston and Beaufort Counties, South Carolina (Figure 1). Study sites were determined based on Red Knot concentrations in prior years, and were comprised of a mixture of federal, state, and private lands. The primary study sites in spring 2019 were Kiawah Island, Seabrook Island, Deveaux Bank, Turtle Island WMA (South Carolina), and Tybee Bar, Little Tybee Island, and Ogeechee Bar (Georgia)(Figures 2-4).

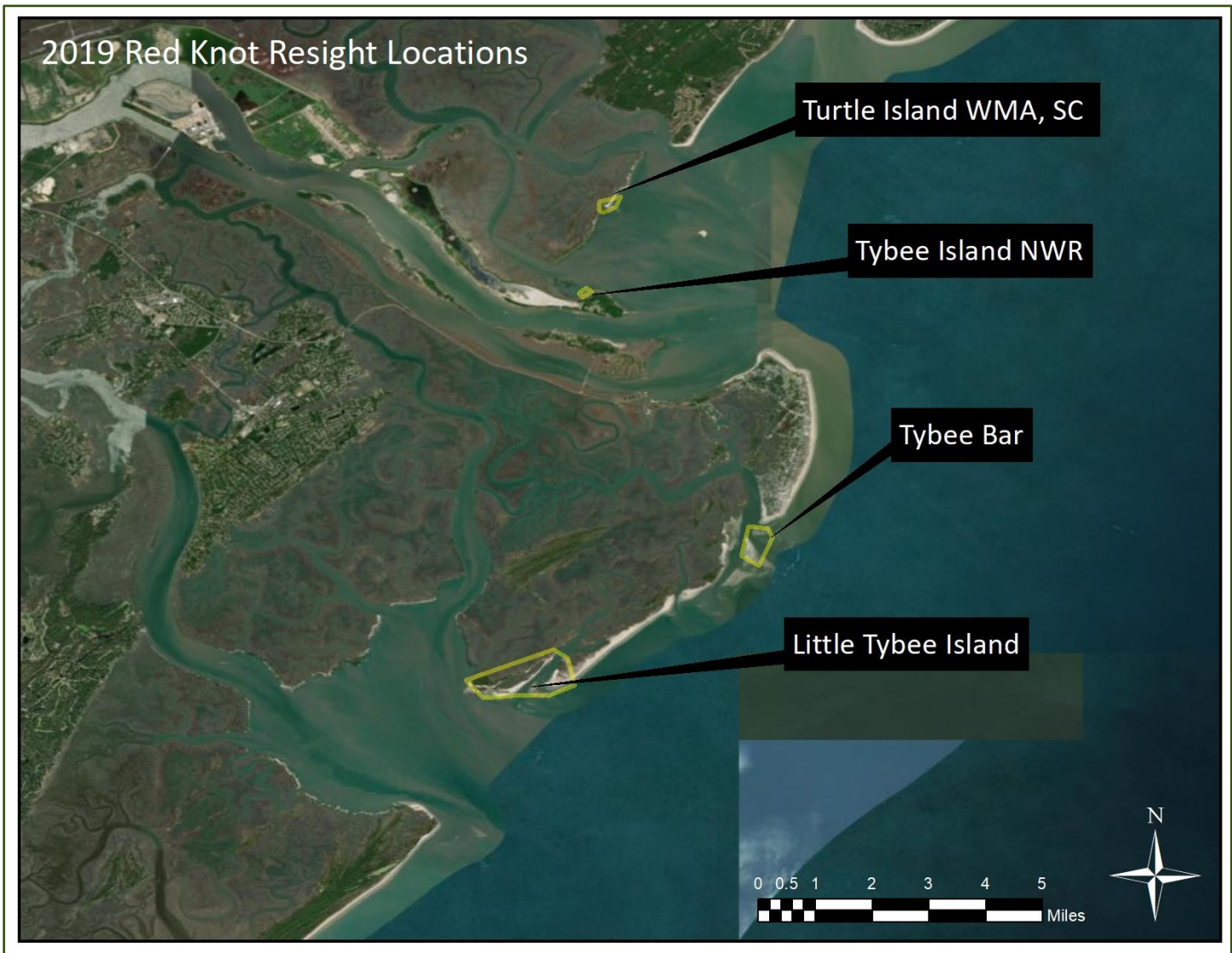


**Figure 1.** Resight locations for the spring 2019 field season, Georgia and South Carolina coasts.



**Figure 2.** Red Knot resight project boundaries on Kiawah and Seabrook Islands and Deveaux Bank, South Carolina.





**Figure 3.** Red Knot resight project boundaries on Turtle Island WMA and Tybee Island NWR, South Carolina, and Tybee Bar and Little Tybee Island, Georgia.



**Figure 4.** Red Knot resight project boundaries on Ogeechee Bar, Georgia.

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## Field Methods and Sampling Design (Resighting and Banding)

The peak of Red Knot spring migration in Georgia and South Carolina is from early to mid-April through late-May to early-June and knots use barrier islands located along the entire Georgia and South Carolina coastline. Red Knots are easiest to observe in Georgia and South Carolina when they concentrate at foraging and roost sites, therefore we focused resight and survey efforts beginning 2.5 hours before high tide (mid-rising tide) to 2.5 hours after high tide (mid-falling tide) during daylight hours. We surveyed along transects that we could complete within a 5-6 hour observation period. During each survey, we used high-quality spotting scopes and digital cameras with 600mm zoom lens to read flag codes from individually marked Red Knots and recorded data following standardized resighting protocol (Kalasz 2006, Smith 2013, Lyons 2016 *unpublished draft protocol*). Marked to unmarked ratios, flag color and alpha-numeric combination were noted (Lyons 2016).

Red Knots were captured and tagged on Deveaux Bank, South Carolina, during the spring 2019 season. A total of 72 knots were captured and field readable bands were placed on the legs of these birds. Nanotags were glued on to the synsacrum of the birds using super glue gel.

## Data Verification

Prior to analysis of mark-resight data, we reported each individually-marked Red Knot to other researchers for confirmation of the existence of each band combination and flag code (Bandedbirds.org, P. M. Gonzales, N.M. Soledad Curci, pers. comm.). We excluded observations that did not correspond to any banding databases.

## Resight Training

We solicited volunteers who were subsequently trained in standardized resighting protocols (Kalasz 2006, Smith 2013, Lyons et al. 2016) to collect Red Knot resight data prior to the spring 2019 field efforts.

## Data Storage

Red Knot resight data is stored at Bandedbirds.org, under the Georgia and South Carolina Project portals. This data is accessible to larger demographic studies being conducted for this species.

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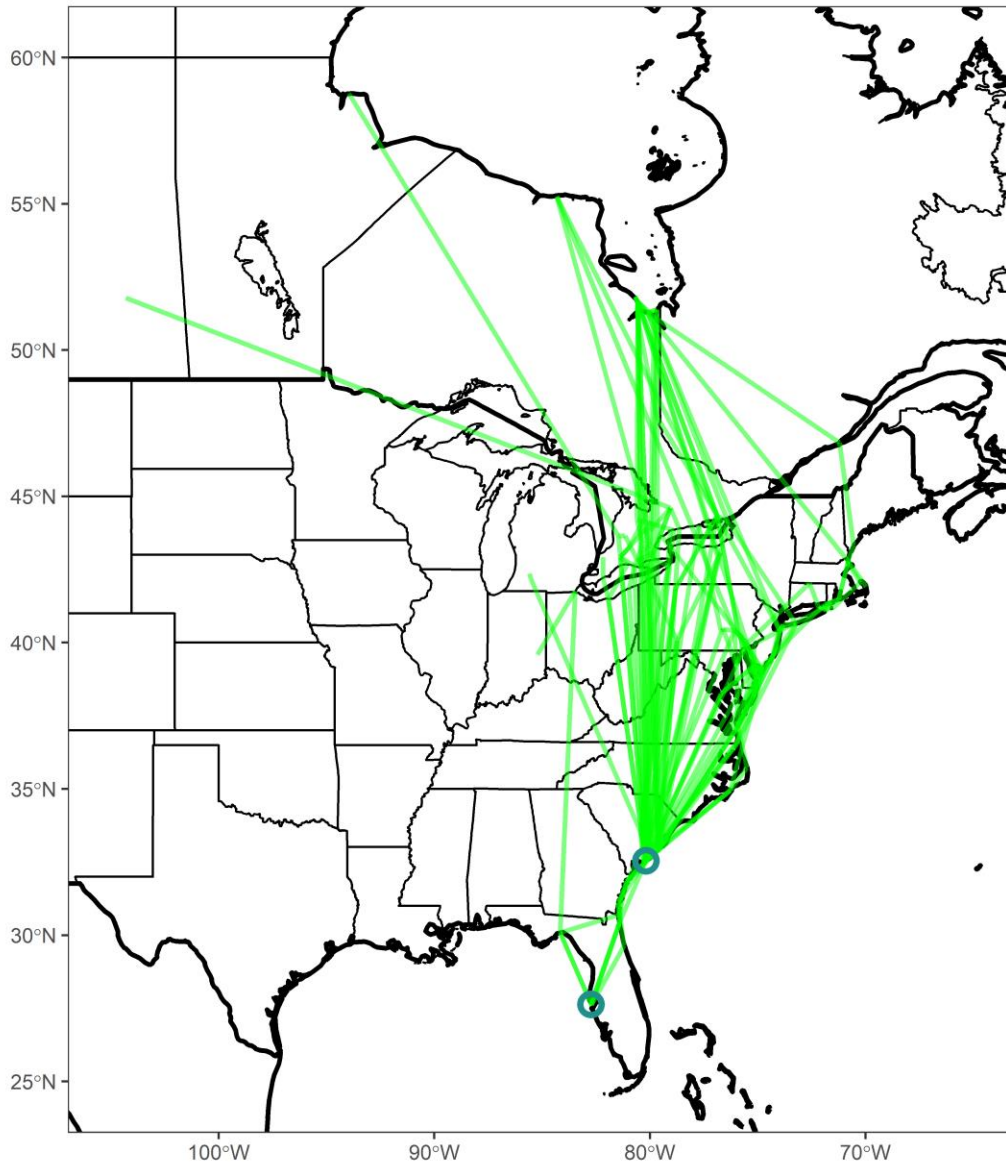
## RESULTS and OUTCOMES

### Spring 2017-2019 Nanotag Tracking Results

**Objective 1: Trapping and radio tagging of Red Knots in SC and GA.** Georgia Department of Natural Resources, South Carolina Department of Natural Resources, US Fish and Wildlife Service, and the Center for Conservation Biology successfully trapped and tagged 72 Red Knots (*Calidris rufa*) during the 2019 spring season. Tracking data from the 2019 season and from two previous seasons is currently being analyzed and prepped for a manuscript describing migration tracks of Southeastern Red Knots during spring migration. We used the existing MOTUS network to document flights during the spring stopover period and to document flights away from the SE towards Delaware Bay or to the breeding grounds. We had proposed to collect a feather sample to identify the wintering grounds of captured birds but due to the possibility of capture stress that objective was dropped during the one capture event.



Spring REKN detections 2017 - 2019 (n = 74)  
Deployment through mid-June



**Figure 1.** Nanotag tracks for 74 Red Knot tagged in Florida and South Carolina, showing approximately 2/3 bypassing Delaware Bay on their northward migration in spring.

### Spring 2019 Resighting Field Season Results

**Objective 2: Resighting of previously tagged Red Knots along the SC and GA coast.** Resight efforts were focused on 4 locations along the Georgia and South Carolina coasts: 1) Kiawah, Seabrook, and Deveux Bank, 2) Turtle Island and Tybee National Wildlife Refuge, 3) Little Tybee and Tybee Bar, and 4) Ogeechee Bar. Staff followed previously established protocols (Kalasz 2006, Smith 2013, Lyons 2017, Smith 2017). A total of 315

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individually tagged Red Knots were resighted during the season. These birds were resighted a total of 863 times throughout the season. Resights were entered into the bandedbirds.org database. Two full time staff were dedicated to resighting once/week at each location. A total of 4 volunteers contributed approximately 120 hours of time towards resighting Red Knots, outreach towards beach goers on Seabrook Island, and during the capture event on Deveaux Bank.

Seven barrier islands were chosen for intensive resighting efforts during the 2019 spring season. Little Tybee Island (Williamson and Beach Hammock), Tybee Bar, Ogeechee Bar, Tybee Island National Wildlife Refuge, Turtle Island Wildlife Management Area, Deveaux Bank, Seabrook Island, and Kiawah Island were surveyed once/weekly during the spring 2019 field season. Project biologists surveyed a total of 46 out of 59 potential days during the spring migration window.

A total of 27,356 Red Knots were detected during daily surveys in spring 2019 along the Georgia and South Carolina Coasts; of those, 4,917 were scanned for flags, and 315 individually banded Red Knots were resighted a total of 523 times from within the spring migrant population. A total of 71 marked to unmarked ratios were recorded during the field season, with an average of 3.6% of Red Knots individually marked over the course of the spring. The rough estimate for the total number of knots cycling through during the spring season is estimated superpopulation size for the spring 2019 season is 8,750 (3.6% of birds tagged and 315 individuals recorded).

**Objective 3: Delineate important Horseshoe Crab spawning areas in SC.** Staff documented any large HSC spawning areas found in South Carolina during the spring season while resighting. High levels of harvest of horseshoe crabs were observed at two study sites, Turtle Island WMA and Tybee Island NWR. The level of harvest was unexpected, and project partners are considering ways to help reduce the impact of harvest to shorebirds, including Red Knots.

**Objective 4: Map shorebird disturbance issues.** Project partners mapped disturbance issues encountered along the coast.

## **Public Outreach Overview 2014-2020**

**Objective 5: Increase Public Awareness.** Project partners have made a concerted effort to educate the public about Red Knot and shorebird conservation issues (linked stories below). The conservation implications of Red Knots and human interactions, dog interactions, wind turbine siting near high use shorebird areas, and general interest stories were presented to over 40,000 members of the general public in 2019.

<https://ccbbirds.org/2019/09/23/ccb-team-spends-fifth-spring-with-red-knots-along-south-atlantic-coast/>  
<https://ccbbirds.org/2018/04/04/georgia-coast-critical-migrating-red-knots/>  
<http://savannahnow.com/news/2016-05-22/georgia-coast-critical-long-distance-fliers>  
<http://shorebirdscience.org/chasing-the-tides-and-running-from-storms-the-quest-for-red-knots-in-georgia/>  
<http://www.ccbbirds.org/2016/04/04/studying-the-red-knot-in-coastal-georgia/>  
<http://www.ccbbirds.org/2015/07/01/ccb-completes-successful-season-of-red-knot-resighting-in-georgia/>  
<http://gpbnews.org/post/19000-mile-journey-red-knot>  
<http://www.ccbbirds.org/2017/03/28/people-and-shorebirds-flock-to-beaches/>  
<http://savannahnow.com/news-latest-news/2014-12-09/red-knot-ga-visitor-gains-endangered-species-act-protection>  
<http://www.georgiawildlife.com/node/4120>  
<http://www.myaic.com/news/state--regional/birds-need-the-beach-too/Xj54W8YvHUBFLMYaLJAXAN/>  
<http://www.washingtontimes.com/news/2016/apr/16/biologists-warn-that-dogs-birds-dont-mix-on-georgi/>  
<http://archive.northjersey.com/news/world/ga-island-considers-birds-fate-if-turbine-built-1.665835?page=all>  
<http://www.windaction.org/posts/39496-on-tybee-the-question-is-blowin-in-the-wind#.WN3MXWd5EZI>

## Public Presentations

Project partners contributed significant outreach effort in professional and general public settings. Citations showing location, date, and title or general description is found below.

Smith, F. M. December 2019. Summary of Red Knot research along the Georgia coast 2013-2019. Southeast Red Knot Working Group, St. Mary's, GA.

Sterling, Abby. 13 April 2019. One Hundred Miles Choosing to Lead Conference, Savannah, GA. "Taking Flight: Citizen Science for Shorebird Conservation". Attendance: 22

Sterling, Abby. 5 December 2019. Southeastern Red Knot Working Group Meeting, Crooked River State Park, GA. "Disturbance and Dredging: Addressing Threats to Georgia's Red Knots". Attendance: 20

2/7/2019 "Island Managers Meeting" T. Keyes gave a talk on restoration of shorebird and seabird sites on Little St Simons to all the land managers from every island on the Georgia coast. This began some fruitful discussions which are progressing towards shorebird management on multiple islands.

1/18-1/21/2019 – Led by T. Keyes. Shorebird Identification and Conservation workshops Sapelo Island – Teacher workshop where we highlighted conservation work including the disturbance, migration and restoration projects.

5/3/2019 T. Keyes Shorebird Conservation talk to Atlanta Audubon Society

Smith, F. M. December 2018. Field Ecology Projects, Methods, and Techniques Overview. College of William & Mary "Field Methods in Ecology" course, Williamsburg, VA. 20 total students in class.

Smith, F. M. November 2018. Research and Life Above the Arctic Circle. Williamsburg Bird Club, Williamsburg, VA. 60 members in attendance.

Duval, L. D., C. H. Hines, F. M. Smith. November 2018. Ethics, Techniques, and Guidance in Shorebird Research. The XXII Congress of the Mesoamerican Society for Biology and Conservation, Panama City, Panama. 50 in attendance.

Smith, F.M. November 2018. Shorebird Conservation in the Americas. Keynote address presented to the XXII Congress of the Mesoamerican Society for Biology and Conservation, Panama City, Panama. 200 in attendance.

Smith, F. M. 2018. Summary of Red Knot research along the Georgia coast 2013-2018. Southeast Red Knot Working Group, St. Mary's, GA.

## **Volunteer Training**

Project partners trained 12 citizen scientists in Georgia and South Carolina during the spring 2019 season, with volunteers contributing approximately 200 hours to the project. This accounting of volunteer effort does not take into account travel costs and vacation days used to assist the project. Various federal, state, and private professionals contributed over 25 Red Knot surveys while working on projects along the barrier islands of Georgia.

## **DISCUSSION and PROJECT OUTCOMES**

The magnitude of the horseshoe crab harvest in critical shorebird foraging locations in South Carolina is likely the most significant shorebird conservation issue moving forward in the region. Most research exploring the Red Knot population decline has focused on studying the foraging conditions within the Delaware Bay (e.g. Atkinson et al. 2003, Baker et al. 2004, Haramis et al. 2007). The Delaware Bay is a terminal spring-staging site on the mid-Atlantic seacoast where birds refuel before moving to their breeding grounds in the high arctic (Harrington and Flowers 1996, Harrington 2001). South Carolina and Georgia also act as terminal staging grounds with up to 67% of birds bypassing Delaware Bay en route to breeding grounds. Birds staging within the Delaware Bay site feed nearly exclusively on the eggs of the horseshoe crab (*Limulus polyphemus*) (Tsipoura and Burger 1999) and egg densities have been related to foraging rates (Atkinson et al. 2003, Gillings et al. 2007), rates of mass gain

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(Robinson et al. 2003, Atkinson et al. 2007) and the associated ability of birds to reach threshold leaving weights (Baker et al. 2001, Niles et al. 2008). Leaving weights have been suggested to influence adult survivorship, providing evidence of a link between conditions within the Delaware Bay and recent population declines (Baker et al. 2004). Horseshoe crabs have been harvested commercially in the Delaware Bay for decades, and the rapid emergence of the conch industry has dramatically increased harvest pressures in recent years (Walls et al. 2002). Claims that harvest rates are impacting the strength of spawning events, resulting in egg densities well below those required by staging Red Knots, have led to conflicts between the fishing industry and conservation groups (Odell et al. 2005). Though none of these issues have been studied along the South Carolina coast, heavy harvesting of horseshoe crabs was observed in two locations during the spring 2019 season. Harvest levels are likely unsustainable in the few locations where significant numbers of spawning horseshoe crabs and shorebirds were observed. A mark/recapture study to look at population levels at critical shorebird foraging sites should be a priority moving forward. There is no current protection for these sub-tidal sites.

The Georgia and South Carolina Coasts are a major stopover area for *rufa* Red Knots in spring migration. The superpopulation utilizing the Georgia Coast in fall migration can exceed 23,000 birds (Lyons et al. 2017) and the estimates of spring migration superpopulation from this study ranges between 8,000 and 14,000 birds. A total of nearly 5,000 Red Knots were observed on Kiawah Island in late April, suggesting that South Carolina likely supported similar numbers as Georgia. The total estimated population of *rufa* Red Knots is 42,000 birds (Andres et al. 2012), suggesting that a high percentage of *rufa* knots are using the Georgia and South Carolina Coasts in spring and in some years fall migration. There appears to be less variation in spring migration superpopulations between years than in fall migration, suggesting a more stable (but less abundant) food source for spring migrants.

One of the most important conservation issues along the Atlantic Coast flyway is the impact of human disturbance on migrating shorebirds (Winn et al. 2013, Watts 2017). The focus of regulatory agencies along the Georgia and South Carolina Coasts has typically been on protection of resident nesting shorebirds. Three of the most critical spring shorebird stopover sites in Georgia (Tybee Bar, Beach Hammock, and Ogeechee Bar) were completely overrun by humans and dogs during multiple weekends of 2013, 2015, 2016, and 2019 seasons (CCB unpublished data) and Kiawah Island, Deveaux Bank, Seabrook Island, Turtle Island WMA, and Tybee National Wildlife Refuge had significant human disturbance events during the spring 2019 season.

Horseshoe crab spawning events were highly variable between years spatially and temporally. Substantial horseshoe crab spawning was observed during the 2019 spring season on Little Tybee Island, Turtle Island WMA, and Tybee NWR. Spawning was also observed on Deveaux Bank and Ogeechee Bar in lower densities. The importance of crab eggs to the survival of Red Knots in the Delaware Bay is well documented (Atkinson et al. 2003, Baker et al. 2004, Karpanty et al. 2006, Gillings et al. 2007, Niles et al. 2009, McGowan et al. 2011), and further studies should be undertaken to monitor the cycles of horseshoe crab spawning and egg abundance along the Georgia Bight. Predation of gravid female horseshoe crab by feral hogs was observed on Little Tybee

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during the spring 2019 season, and efforts to reduce the predation of crabs should be a high priority for resource managers on this island. In Georgia, horseshoe crab spawning events typically take place on sub-tidal sandy flats, and those same sand flats have long been used by recreational boaters along the Georgia Coast. A directed outreach campaign to inform boaters of the overlap of people and critical foraging habitat is currently underway by project partners with the goal of reducing occurrences of human disturbance at the most critical sites in the Georgia Bight. Continued monitoring of this issue moving forward should be a focus of biologists and land managers protecting these resources.

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## LITERATURE CITED

- Alerstam, T., G.A. Gudmundsson, and K. Johannesson. 1992. Resources for long distance migration-intertidal exploitation of *Littorina* and *Mytilus* by knots *Calidris canutus* in Iceland. *Oikos* 65:179-189.
- Andres, B.A., P.A. Smith, R.I.G. Morrison, C.L. Gratto-Trevor, S.C. Brown, and C.A. Friis. 2012. Population estimates of North American shorebirds, 2012. *Wader Study Group Bulletin* 119: 178–194.
- Atkinson, P. W., G. F. Appleton, J. A. Clark, N. A. Clark, S. Gillings, I. G. Henderson, R. A. Robinson, and R. A. Stillman. 2003. Red Knots *Calidris canutus* in Delaware Bay 2002. Survival, foraging and marking strategy. British Trust for Ornithology Research Report 308, Thetford, UK.
- Atkinson, P. W., A. J. Baker, K. A. Bennett, N. A. Clark, J. A. Clark, K. B. Cole, A. Dekinga, A. Dey, S. Gillings, P. M. Gonzalez, and others. 2007. Rates of mass gain and energy deposition in Red Knot on their final spring staging site is both time- and condition-dependent. *Journal of Applied Ecology* 44:885-895.
- Atlantic Flyway Shorebird Initiative Group. 2015. Accessed on 11 March at:  
[http://www.nfwf.org/amoy/Documents/afsi\\_biz\\_plan.pdf](http://www.nfwf.org/amoy/Documents/afsi_biz_plan.pdf)
- Baker, A. J., P. M. González, T. Piersma, L. J. Niles, I. de L. S. do Nascimento, P. W. Atkinson, N. A. Clark, C. D. T. Minton, M. K. Peck, and G. Aarts. 2004. Rapid population decline in Red Knots: Fitness consequences of decreased refueling rates and late arrival in Delaware Bay. *Proceedings of the Royal Society of London, Series B* 271:875-882.
- Baker, A. J., P. M. Gonzalez, C. D. T. Minton, D. B. Carter, L. J. Niles, I. do Nascimento, and T. Piersma. 2001. Hemispheric problems in the conservation of red knots (*Calidris canutus rufa*). In *Proceedings of the VI Neotropical Ornithological Congress, International Shorebird Symposium*, Monterey, Mexico. Manomet, MA.
- Beuhler, D.M. and A.J. Baker. Population Divergence Times and Historical Demography in Red Knots and Dunlins. *Condor* 107(3):497-513.
- Brown, S., C. Hickey, B. Harrington, and R. Gill, eds. 2001. *The U.S. Shorebird Conservation Plan*, 2nd ed. Manomet Center for Conservation Sciences, Manomet, MA.
- Clark, K., L. Niles, and J. Burger. 1993. Abundance and distribution of shorebirds migrating on Delaware Bay, 1986-1992. *Condor* 95:694-705.
- COSEWIC. 2007. Canadian Wildlife Species at Risk. Committee on the Status of Endangered Wildlife in Canada. Accessed 9 March at:  
[http://www.sararegistry.gc.ca/virtual\\_sara/files/cosewic/as%5Fcalidris%5Fcanutus%5Fe%2Epdf](http://www.sararegistry.gc.ca/virtual_sara/files/cosewic/as%5Fcalidris%5Fcanutus%5Fe%2Epdf)



- Dunne, P., D. Sibley, C. Sutton, and W. Wander. 1982. 1982 aerial shorebird survey of Delaware Bay. *Records of New Jersey Birds* 8:68-75.
- Georgia Department of Natural Resources. 2015. Georgia State Wildlife Action Plan. Social Circle, GA: Georgia Department of Natural Resources.
- Gillings, S., P. W. Atkinson, S. L. Bardsley, N. A. Clark, S. E. Love, R. A. Robinson, R. A. Stilman, and R. G. Weber. 2007. Shorebird predation of horseshoe crab eggs in Delaware Bay: species contrasts and availability constraints. *Journal of Animal Ecology* 76:503-514.
- Haramis, G. M., W. A. Link, P. S. Osenton, D. B. Carter, R. G. Weber, N. A. Clark, M. A. Teece, and D.S. Mizrahi. 2007. Stable isotope and pen feeding trial studies confirm the value of horseshoe crab *Limulus polyphemus* eggs to spring migrant shorebirds in Delaware Bay. *Journal of Avian Biology* 38:367-376.
- Harrington, B.A., B. Winn, and S.C. Brown. 2007. Molt and Body Mass of Red Knots in the Eastern United States. *Wilson Journal of Ornithology* 119(2):35-42.
- Harrington, B. A. 2001. Red knot (*Calidris canutus*). In *The Birds of North America*, No. 563 (ed. A. Poole and F. Gill), pp. 1-32. Philadelphia, PA: The Birds of North America.
- Harrington, B. and C. Flowers. 1996. *The Flight of the Red Knot*. W. W. Norton and Company, New York, NY.
- Kalasz, K., 2006. Resighting Individually Marked Red Knots of Delaware Beaches. Protocol from the Delaware Fish and Wildlife Shorebird Project.
- J. Lyons. 2016. Study Design Guidelines for Mark-resight Investigations of Red Knots in Delaware Bay. Draft of study design circulated 4/25/2016.
- Lyons, J. E., W. L. Kendall, J. A. Royle, S. J. Converse, B. A. Andres, and J. B. Buchanan. 2016. Population size and stopover duration estimation using mark-resight data and Bayesian analysis of a superpopulation model. *Biometrics* 72:262–271.
- Lyons, James & Winn, B., Keyes, T. and K. Kalasz. 2017. Post-breeding migration and connectivity of red knots in the Western Atlantic. *The Journal of Wildlife Management*. 82. 10.1002/jwmg.21389.
- McGowan, C.P., J.E. Hines, J.D. Nichols, J.E. Lyons, D.R. Smith, K. S. Kalasz, L.J. Niles, A.D. Dey, N.A. Clark, P.W. Atkinson, C.D.T. Minton, and W. Kendall. 2011. Demographic consequences of migratory stopover: linking red knot survival to horseshoe crab spawning abundance. *Ecosphere* 2: article 69.
- Morrison, R. I. G., R. K. Ross, and L. J. Niles. 2004. Declines in wintering populations of red knots in southern South America. *Condor* 106:60–70.



- Morrison, R.I.G., D.S Mizrahi, R.K. Ross, O.H. Ottema, N. de Pracontal, and A. Narine. 2012. Dramatic declines of Semipalmated Sandpipers on their major wintering areas in the Guianas, Northern South America. *Waterbirds* 34:120-134.
- Newstead, D.J., Niles, L.J., Porter, R.R., Dey, A.D., Burger, J. & Fitzsimmons, O.N. 2013. Geolocation reveals mid-continent migratory routes and Texas wintering areas of Red Knots *Calidris canutus rufa*. *Wader Study Group Bull.* 120(1): 53–59.
- Niles, L.J., J. Burger, R.R. Porter, A.D. Dey, S. Koch, B.A. Harrington, K. Iaquinto, and M. Boaman. 2012. Migration pathways, migration speeds, and nonbreeding areas used by northern hemisphere wintering Red Knots (*Calidris canutus*) of the subspecies *rufa*. *Wader Study Group Bulletin* 119(2).
- Niles, L., H. Sitters, A. Dey, and Red Knot Status Assessment Group. 2010a. Red Knot Conservation Plan for the Western Hemisphere (*Calidris canutus*), Version 1.1. Manomet Center for Conservation Sciences, Manomet, Massachusetts, USA.
- Niles, L.J., H.P. Sitters, A.D. Dey, N. Arce, P.W. Atkinson, V. Ayala-Perez, A.J. Baker, J.B. Buchanon, R. Carmona, N.A. Clark, C. Espoz, J.D. Fraser, P.M. Gonzalez, B.A. Harrington, D.E. Hernandez, K.S. Kalasz, R. Matus, B.J. McCaffery, C.D.T. Minton, R.I.G. Morrison, M.K. Peck, W. Pitts, I.L. Serrano & B.D. Watts. 2010b. Update to the Status of the Red Knot *Calidris canutus* in the Western Hemisphere, April 2010b.
- Niles, L. J., H. P. Sitters, A. D. Dey, P. W. Atkinson, A. J. Baker, K. A. Bennett, R. Carmona, K. E. Clark, N. A. Clark, C. Espoz, P. M. Gonzalez, B. A. Harrington, D. E. Hernandez, K. S. Kalasz, R. G. Lathrop, R. N. Matus, C. D. T. Minton, R. I. G. Morrison, M. K. Peck, W. Pitts, R. A. Robinson, and I. L. Serrano. 2008. Status of the red knot (*Calidris canutus rufa*) in the western hemisphere. *Studies in Avian Biology* 36:1–185.
- Niles L.J., Sitters H.P., Dey A.D., Atkinson P.W., Bennett K.A., Clark K.E., Clark N.A., Espoz C., González P.M., Harrington B.A., Hernandez D.E., Kalasz K.S., Matus R., Minton C.D.T., Morrison R.I.G., Peck M.K. & Serrano I.L. 2007. Status of the Red Knot, *Calidris canutus rufa*, in the Western Hemisphere. US Fish and Wildlife Service, Ecological Services, Region 5, Pleasantville, New Jersey. Odell, J., M. E. Mather, and R. M. Muth. 2005. A biosocial approach for analyzing environmental conflicts: A case study of horseshoe crab allocation. *BioScience* 55:735-748.
- Robinson, R. A., P. W. Atkinson, and N. A. Clark. 2003. Arrival and weight gain of Red Knot *Calidris canutus*, Ruddy Turnstone *Arenaria interpres* and Sanderling *Calidris alba* staging in Delaware Bay in spring. British Trust for Ornithology Research Report 307, Thetford, UK.
- Smith, F.M. 2013. Resighting Protocol for Individually Color-marked Red Knots in South Atlantic Coast and Virginia, Version 2.1. 9pp.

- SARA. 2007. Species at Risk Public Registry. CWS-Quebec Species at Risk Recovery Unit. Accessed 9 March: [http://www.sararegistry.gc.ca/species/speciesDetails\\_e.cfm?sid=980](http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=980)
- Truitt, B. R., B. D. Watts, B. L. Brown, and W. Dustan. 2001. Red Knot densities and invertebrate prey availability on the Virginia barrier islands. Wader Study Group Bulletin 95:12.
- Tsipoura, N. and J. Burger. 1999. Shorebird diet during spring migration stopover on Delaware Bay. Condor 101:635-644.
- US Fish and Wildlife Service. 2010. Red Knot (*Calidris canutus rufa*) Spotlight Species Action Plan. Lead Field Office: New Jersey Field Office.
- US Fish and Wildlife Service. 2014a. Endangered and Threatened Wildlife and Plants; Proposed Threatened Status for the Rufa Red Knot (*Calidris canutus rufa*). Federal Register Vol. 79 No. 238.
- US Fish and Wildlife Service. 2014b. Rufa Red Knot Background Information and Threats Assessment. Supplement to: Endangered and Threatened Wildlife and Plants; Final Threatened Status for the Rufa Red Knot (*Calidris canutus rufa*). Docket No. FWS-R5-ES-2013-0097; RIN AY17.
- Walls, E. A., J. Berkson, and S. A. Smith. 2002. The horseshoe crab, *Limulus polyphemus*: 200 million years of existence, 100 years of study. Review of Fisheries Science 10:39-73.
- Winn, B., S. Brown, C. Spiegel, D. Reynolds, S. Johnston and the Atlantic Flyway Shorebird Initiative Group. 2013. Atlantic Flyway Shorebird Business Strategy. Accessed 9 March 2017 at: [http://manometcenter.pairserver.com/sites/default/files/publications\\_and\\_tools/AtlanticFlywayShorebirdBusinessStrategy.pdf](http://manometcenter.pairserver.com/sites/default/files/publications_and_tools/AtlanticFlywayShorebirdBusinessStrategy.pdf)

## APPENDICES

**APPENDIX I. TABLE WITH ALL INDIVIDUALLY TAGGED RED KNOTS ENCOUNTERED DURING THE SPRING 2019 SEASON IN COASTAL GEORGIA AND SOUTH CAROLINA, SHOWING RESIGHT DATE, LOCATION, FLAG COLOR AND CODE, AND CAPTURE ORIGINS.**

Date	Location	Flag Color/Code	Banding Origin
4/11/2019	Tybee/Little Tybee Bar	FEDG-802	USA
4/11/2019	Tybee/Little Tybee Bar	FEDG-802	USA
4/11/2019	Tybee/Little Tybee Bar	FEDG-EET	USA
4/11/2019	Tybee/Little Tybee Bar	FEDG-ELA	USA
4/11/2019	Tybee/Little Tybee Bar	FEDG-EYJ	USA
4/11/2019	Tybee/Little Tybee Bar	FEDG-MYJ	USA
4/11/2019	Tybee/Little Tybee Bar	FEDG-NPV	USA
4/11/2019	Tybee/Little Tybee Bar	FEDG-PMJ	USA
4/11/2019	Tybee/Little Tybee Bar	FELG-+AJ	USA
4/11/2019	Tybee/Little Tybee Bar	FELG-1E9	USA
4/11/2019	Tybee/Little Tybee Bar	FELG-369	USA
4/11/2019	Tybee/Little Tybee Bar	FELG-397	USA
4/11/2019	Tybee/Little Tybee Bar	FELG-6A1	USA
4/11/2019	Tybee/Little Tybee Bar	FELG-7K9	USA
4/11/2019	Tybee/Little Tybee Bar	FELG-LCL	USA
4/17/2019	Tybee/Little Tybee Bar	FEDG-CVP	USA
4/17/2019	Tybee/Little Tybee Bar	FEDG-EAX	USA
4/18/2019	Beach Hammock	FEDG-EAM	USA
4/18/2019	Beach Hammock	FELG-2E0	USA
4/18/2019	Beach Hammock	FELG-5E4	USA

Date	Location	Flag Color/Code	Banding Origin
4/18/2019	Beach Hammock	FELG-7HM	USA
4/18/2019	Tybee/Little Tybee Bar	FEDG-EYJ	USA
4/18/2019	Tybee/Little Tybee Bar	FEDG-PAC	USA
4/18/2019	Tybee/Little Tybee Bar	FELG-1E9	USA
4/18/2019	Tybee/Little Tybee Bar	FELG-1MV	USA
4/18/2019	Tybee/Little Tybee Bar	FELG-687	USA
4/18/2019	Tybee/Little Tybee Bar	FELG-AE3	USA
4/18/2019	Tybee/Little Tybee Bar	FELG-UU5	USA
4/20/2019	Kiawah Island	FEDG-PHC	USA
4/20/2019	Kiawah Island	FELG-397	USA
4/20/2019	Kiawah Island	FELG-6C9	USA
4/21/2019	Kiawah Island	FEDG-PHT	USA
4/21/2019	Kiawah Island	FELG-1E8	USA
4/21/2019	Kiawah Island	FELG-526	USA
4/21/2019	Kiawah Island	FELG-74X	USA
4/21/2019	Kiawah Island	FELG-9KT	USA
4/21/2019	Kiawah Island	FELG-MX2	USA
4/21/2019	Kiawah Island	FELG-TE8	USA
4/22/2019	Kiawah Island	FEDG-026	USA
4/22/2019	Kiawah Island	FEDG-NHH	USA
4/22/2019	Kiawah Island	FELG-480	USA
4/22/2019	Turtle Island	FEDG-ALT	USA
4/22/2019	Turtle Island	FEDG-EJL	USA
4/22/2019	Turtle Island	FEDG-MAK	USA
4/22/2019	Turtle Island	FEDG-MNH	USA

Date	Location	Flag Color/Code	Banding Origin
4/22/2019	Turtle Island	FEDG-MTN	USA
4/22/2019	Turtle Island	FELG--3M	USA
4/22/2019	Turtle Island	FELG-02H	USA
4/22/2019	Turtle Island	FELG-369	USA
4/22/2019	Turtle Island	FELG-3CL	USA
4/22/2019	Turtle Island	FELG-531	USA
4/22/2019	Turtle Island	FELG-569	USA
4/22/2019	Turtle Island	FELG-684	USA
4/22/2019	Turtle Island	FELG-7XK	USA
4/22/2019	Turtle Island	FELG-U57	USA
4/22/2019	Turtle Island	FEW-LTK	Canada
4/23/2019	Beach Hammock	FELG-513	USA
4/23/2019	Tybee/Little Tybee Bar	FEDG-CVP	USA
4/23/2019	Tybee/Little Tybee Bar	FEDG-HUJ	USA
4/23/2019	Tybee/Little Tybee Bar	FEDG-NUH	USA
4/23/2019	Tybee/Little Tybee Bar	FEDG-PAC	USA
4/23/2019	Tybee/Little Tybee Bar	FELG-510	USA
4/23/2019	Tybee/Little Tybee Bar	FELG-687	USA
4/23/2019	Tybee/Little Tybee Bar	FELG-AE3	USA
4/23/2019	Tybee/Little Tybee Bar	FELG-LCL	USA
4/23/2019	Tybee/Little Tybee Bar	FELG-XE4	USA
4/24/2019	Kiawah Island	FEDG-CXK	USA
4/24/2019	Kiawah Island	FEDG-EEC	USA
4/24/2019	Kiawah Island	FEDG-EJP	USA
4/24/2019	Kiawah Island	FEDG-EJU	USA

Date	Location	Flag Color/Code	Banding Origin
4/24/2019	Kiawah Island	FEDG-EJX	USA
4/24/2019	Kiawah Island	FEDG-EKX	USA
4/24/2019	Kiawah Island	FEDG-EMV	USA
4/24/2019	Kiawah Island	FEDG-EPL	USA
4/24/2019	Kiawah Island	FEDG-EUY	USA
4/24/2019	Kiawah Island	FEDG-EYV	USA
4/24/2019	Kiawah Island	FEDG-KNP	USA
4/24/2019	Kiawah Island	FEDG-MCT	USA
4/24/2019	Kiawah Island	FEDG-MNH	USA
4/24/2019	Kiawah Island	FEDG-MTC	USA
4/24/2019	Kiawah Island	FEDG-MXM	USA
4/24/2019	Kiawah Island	FEDG-NTC	USA
4/24/2019	Kiawah Island	FEDG-NUN	USA
4/24/2019	Kiawah Island	FEDG-PAY	USA
4/24/2019	Kiawah Island	FEDG-PEE	USA
4/24/2019	Kiawah Island	FEDG-PEI	USA
4/24/2019	Kiawah Island	FEDG-PEJ	USA
4/24/2019	Kiawah Island	FEDG-PEP	USA
4/24/2019	Kiawah Island	FEDG-PHA	USA
4/24/2019	Kiawah Island	FEDG-PHC	USA
4/24/2019	Kiawah Island	FEDG-PJT	USA
4/24/2019	Kiawah Island	FEDG-PJU	USA
4/24/2019	Kiawah Island	FEDG-PKK	USA
4/24/2019	Kiawah Island	FEDG-PKU	USA
4/24/2019	Kiawah Island	FEDG-PKV	USA

Date	Location	Flag Color/Code	Banding Origin
4/24/2019	Kiawah Island	FEDG-PMA	USA
4/24/2019	Kiawah Island	FEDG-PMC	USA
4/24/2019	Kiawah Island	FEDG-PMH	USA
4/24/2019	Kiawah Island	FELG-=4N	USA
4/24/2019	Kiawah Island	FELG-072	USA
4/24/2019	Kiawah Island	FELG-07V	USA
4/24/2019	Kiawah Island	FELG-0C0	USA
4/24/2019	Kiawah Island	FELG-0E6	USA
4/24/2019	Kiawah Island	FELG-10Y	USA
4/24/2019	Kiawah Island	FELG-157	USA
4/24/2019	Kiawah Island	FELG-157	USA
4/24/2019	Kiawah Island	FELG-18E	USA
4/24/2019	Kiawah Island	FELG-1E8	USA
4/24/2019	Kiawah Island	FELG-2=V	USA
4/24/2019	Kiawah Island	FELG-27E	USA
4/24/2019	Kiawah Island	FELG-289	USA
4/24/2019	Kiawah Island	FELG-297	USA
4/24/2019	Kiawah Island	FELG-297	USA
4/24/2019	Kiawah Island	FELG-2E0	USA
4/24/2019	Kiawah Island	FELG-2JA	USA
4/24/2019	Kiawah Island	FELG-397	USA
4/24/2019	Kiawah Island	FELG-3C3	USA
4/24/2019	Kiawah Island	FELG-3CL	USA
4/24/2019	Kiawah Island	FELG-504	USA
4/24/2019	Kiawah Island	FELG-512	USA

Date	Location	Flag Color/Code	Banding Origin
4/24/2019	Kiawah Island	FELG-512	USA
4/24/2019	Kiawah Island	FELG-517	USA
4/24/2019	Kiawah Island	FELG-528	USA
4/24/2019	Kiawah Island	FELG-533	USA
4/24/2019	Kiawah Island	FELG-538	USA
4/24/2019	Kiawah Island	FELG-538	USA
4/24/2019	Kiawah Island	FELG-54T	USA
4/24/2019	Kiawah Island	FELG-556	USA
4/24/2019	Kiawah Island	FELG-569	USA
4/24/2019	Kiawah Island	FELG-586	USA
4/24/2019	Kiawah Island	FELG-588	USA
4/24/2019	Kiawah Island	FELG-5E3	USA
4/24/2019	Kiawah Island	FELG-5T8	USA
4/24/2019	Kiawah Island	FELG-5U5	USA
4/24/2019	Kiawah Island	FELG-645	USA
4/24/2019	Kiawah Island	FELG-653	USA
4/24/2019	Kiawah Island	FELG-684	USA
4/24/2019	Kiawah Island	FELG-695	USA
4/24/2019	Kiawah Island	FELG-6A6	USA
4/24/2019	Kiawah Island	FELG-6C6	USA
4/24/2019	Kiawah Island	FELG-73K	USA
4/24/2019	Kiawah Island	FELG-74X	USA
4/24/2019	Kiawah Island	FELG-75M	USA
4/24/2019	Kiawah Island	FELG-7A5	USA
4/24/2019	Kiawah Island	FELG-7HM	USA



Date	Location	Flag Color/Code	Banding Origin
4/24/2019	Kiawah Island	FELG-7XK	USA
4/24/2019	Kiawah Island	FELG-8T2	USA
4/24/2019	Kiawah Island	FELG-9A8	USA
4/24/2019	Kiawah Island	FELG-9HE	USA
4/24/2019	Kiawah Island	FELG-9HP	USA
4/24/2019	Kiawah Island	FELG-AJ6	USA
4/24/2019	Kiawah Island	FELG-C67	USA
4/24/2019	Kiawah Island	FELG-E96	USA
4/24/2019	Kiawah Island	FELG-EX2	USA
4/24/2019	Kiawah Island	FELG-H16	USA
4/24/2019	Kiawah Island	FELG-H1A	USA
4/24/2019	Kiawah Island	FELG-H65	USA
4/24/2019	Kiawah Island	FELG-J58	USA
4/24/2019	Kiawah Island	FELG-JJ6	USA
4/24/2019	Kiawah Island	FELG-MJ1	USA
4/24/2019	Kiawah Island	FELG-N18	USA
4/24/2019	Kiawah Island	FELG-NT1	USA
4/24/2019	Kiawah Island	FELG-NV8	USA
4/24/2019	Kiawah Island	FELG-NVP	USA
4/24/2019	Kiawah Island	FELG-P12	USA
4/24/2019	Kiawah Island	FELG-PX2	USA
4/24/2019	Kiawah Island	FELG-UT+	USA
4/24/2019	Kiawah Island	FELG-V5C	USA
4/24/2019	Kiawah Island	FELG-V5M	USA
4/24/2019	Kiawah Island	FELG-X6M	USA

Date	Location	Flag Color/Code	Banding Origin
4/24/2019	Kiawah Island	FELG-X6V	USA
4/24/2019	Kiawah Island	FELG-X81	USA
4/24/2019	Kiawah Island	FEDG-CPK	USA
4/24/2019	Kiawah Island	FEDG-MCP	USA
4/24/2019	Kiawah Island	FELG-=LX	USA
4/24/2019	Kiawah Island	FELG-273	USA
4/24/2019	Kiawah Island	FELG-653	USA
4/24/2019	Kiawah Island	FELG-T44	USA
4/26/2019	Kiawah Island	FEDG-175	USA
4/26/2019	Kiawah Island	FEDG-ETJ	USA
4/26/2019	Kiawah Island	FEDG-KNP	USA
4/26/2019	Kiawah Island	FEDG-NTC	USA
4/26/2019	Kiawah Island	FELG- 65T	USA
4/26/2019	Kiawah Island	FELG-0C0	USA
4/26/2019	Kiawah Island	FELG-27E	USA
4/26/2019	Kiawah Island	FELG-9HE	USA
4/26/2019	Kiawah Island	FELG-H36	USA
4/26/2019	Kiawah Island	FELG-PX2	USA
4/27/2019	Kiawah Island	FEDG-EUY	USA
4/27/2019	Kiawah Island	FEDG-MTC	USA
4/27/2019	Kiawah Island	FELG-=7H	USA
4/27/2019	Kiawah Island	FELG-289	USA
4/27/2019	Kiawah Island	FELG-529	USA
4/27/2019	Kiawah Island	FELG-9HL	USA
4/27/2019	Kiawah Island	FELG-T68	USA

Date	Location	Flag Color/Code	Banding Origin
4/29/2019	Turtle Island	FEDG-304	USA
4/29/2019	Turtle Island	FEDG-EET	USA
4/29/2019	Turtle Island	FEDG-EHX	USA
4/29/2019	Turtle Island	FEDG-EKN	USA
4/29/2019	Turtle Island	FEDG-EKN	USA
4/29/2019	Turtle Island	FEDG-ELH	USA
4/29/2019	Turtle Island	FEDG-EYJ	USA
4/29/2019	Turtle Island	FEDG-MUY	USA
4/29/2019	Turtle Island	FEDG-NUP	USA
4/29/2019	Turtle Island	FELG-02H	USA
4/29/2019	Turtle Island	FELG-103	USA
4/29/2019	Turtle Island	FELG-203	USA
4/29/2019	Turtle Island	FELG-369	USA
4/29/2019	Turtle Island	FELG-510	USA
4/29/2019	Turtle Island	FELG-513	USA
4/29/2019	Turtle Island	FELG-527	USA
4/29/2019	Turtle Island	FELG-531	USA
4/29/2019	Turtle Island	FELG-545	USA
4/29/2019	Turtle Island	FELG-67A	USA
4/29/2019	Turtle Island	FELG-687	USA
4/29/2019	Turtle Island	FELG-7C5	USA
4/29/2019	Turtle Island	FELG-7K9	USA
4/29/2019	Turtle Island	FELG-7XK	USA
4/29/2019	Turtle Island	FELG-8C5	USA
4/29/2019	Turtle Island	FELG-9C7	USA

Date	Location	Flag Color/Code	Banding Origin
4/29/2019	Turtle Island	FELG-E53	USA
4/29/2019	Turtle Island	FELG-H=2	USA
4/29/2019	Turtle Island	FELG-JJ6	USA
4/29/2019	Turtle Island	FELG-JTA	USA
4/29/2019	Turtle Island	FELG-U57	USA
5/1/2019	Kiawah Island	FEDG-AHV	USA
5/1/2019	Kiawah Island	FEDG-CPK	USA
5/1/2019	Kiawah Island	FEDG-EET	USA
5/1/2019	Kiawah Island	FEDG-EJP	USA
5/1/2019	Kiawah Island	FEDG-EJX	USA
5/1/2019	Kiawah Island	FEDG-EMJ	USA
5/1/2019	Kiawah Island	FEDG-ENL	USA
5/1/2019	Kiawah Island	FEDG-EPJ	USA
5/1/2019	Kiawah Island	FEDG-FMJ	USA
5/1/2019	Kiawah Island	FEDG-HAX	USA
5/1/2019	Kiawah Island	FEDG-KNP	USA
5/1/2019	Kiawah Island	FEDG-MTC	USA
5/1/2019	Kiawah Island	FEDG-MXM	USA
5/1/2019	Kiawah Island	FEDG-NHC	USA
5/1/2019	Kiawah Island	FEDG-PEI	USA
5/1/2019	Kiawah Island	FEDG-PEJ	USA
5/1/2019	Kiawah Island	FEDG-PEP	USA
5/1/2019	Kiawah Island	FEDG-PHL	USA
5/1/2019	Kiawah Island	FEDG-PJM	USA
5/1/2019	Kiawah Island	FELG-0C0	USA

Date	Location	Flag Color/Code	Banding Origin
5/1/2019	Kiawah Island	FELG-10Y	USA
5/1/2019	Kiawah Island	FELG-512	USA
5/1/2019	Kiawah Island	FELG-528	USA
5/1/2019	Kiawah Island	FELG-529	USA
5/1/2019	Kiawah Island	FELG-54T	USA
5/1/2019	Kiawah Island	FELG-588	USA
5/1/2019	Kiawah Island	FELG-636	USA
5/1/2019	Kiawah Island	FELG-642	USA
5/1/2019	Kiawah Island	FELG-6YL	USA
5/1/2019	Kiawah Island	FELG-73K	USA
5/1/2019	Kiawah Island	FELG-910	USA
5/1/2019	Kiawah Island	FELG-9HV	USA
5/1/2019	Kiawah Island	FELG-9T0	USA
5/1/2019	Kiawah Island	FELG-K39	USA
5/1/2019	Kiawah Island	FELG-N18	USA
5/1/2019	Kiawah Island	FELG-P12	USA
5/1/2019	Kiawah Island	FELG-T68	USA
5/1/2019	Kiawah Island	FELG-UTM	USA
5/1/2019	Kiawah Island	FELG-X3Y	USA
5/1/2019	Kiawah Island	FELG-X6A	USA
5/1/2019	Kiawah Island	FELG-X6E	USA
5/2/2019	Kiawah Island	FEDG-CPK	USA
5/2/2019	Kiawah Island	FEDG-CPN	USA
5/2/2019	Kiawah Island	FEDG-CTU	USA
5/2/2019	Kiawah Island	FEDG-EJX	USA

Date	Location	Flag Color/Code	Banding Origin
5/2/2019	Kiawah Island	FEDG-MXM	USA
5/2/2019	Kiawah Island	FEDG-PEI	USA
5/2/2019	Kiawah Island	FEDG-PEJ	USA
5/2/2019	Kiawah Island	FEDG-PEP	USA
5/2/2019	Kiawah Island	FEDG-PFJ	USA
5/2/2019	Kiawah Island	FEDG-PHL	USA
5/2/2019	Kiawah Island	FELG-023	USA
5/2/2019	Kiawah Island	FELG-2EO	USA
5/2/2019	Kiawah Island	FELG-504	USA
5/2/2019	Kiawah Island	FELG-528	USA
5/2/2019	Kiawah Island	FELG-54T	USA
5/2/2019	Kiawah Island	FELG-569	USA
5/2/2019	Kiawah Island	FELG-586	USA
5/2/2019	Kiawah Island	FELG-588	USA
5/2/2019	Kiawah Island	FELG-635	USA
5/2/2019	Kiawah Island	FELG-636	USA
5/2/2019	Kiawah Island	FELG-642	USA
5/2/2019	Kiawah Island	FELG-73K	USA
5/2/2019	Kiawah Island	FELG-7HM	USA
5/2/2019	Kiawah Island	FELG-8T2	USA
5/2/2019	Kiawah Island	FELG-9A6	USA
5/2/2019	Kiawah Island	FELG-9HE	USA
5/2/2019	Kiawah Island	FELG-9HV	USA
5/2/2019	Kiawah Island	FELG-K39	USA
5/2/2019	Kiawah Island	FELG-T68	USA

Date	Location	Flag Color/Code	Banding Origin
5/2/2019	Kiawah Island	FELG-UTK	USA
5/2/2019	Kiawah Island	FELG-UTM	USA
5/2/2019	Kiawah Island	FELG-V5C	USA
5/2/2019	Ogeechee Bar/Raccoon Bar	FEDG-NNK	USA
5/2/2019	Seabrook Island	FEDG-CVH	USA
5/2/2019	Seabrook Island	FEDG-EJP	USA
5/2/2019	Seabrook Island	FEDG-KNP	USA
5/2/2019	Seabrook Island	FEDG-PKK	USA
5/2/2019	Seabrook Island	FEDG-PMA	USA
5/2/2019	Seabrook Island	FELG-0C0	USA
5/2/2019	Seabrook Island	FELG-3YL	USA
5/2/2019	Seabrook Island	FELG-541	USA
5/2/2019	Seabrook Island	FELG-684	USA
5/2/2019	Seabrook Island	FELG-7=L	USA
5/2/2019	Seabrook Island	FELG-N18	USA
5/2/2019	Seabrook Island	FELG-V5M	USA
5/3/2019	Tybee/Little Tybee Bar	FELG-XE4	USA
5/4/2019	Deveaux Bank	FEDG-MAM	USA
5/4/2019	Deveaux Bank	FEDG-O7V	USA
5/4/2019	Deveaux Bank	FEDG-PAU	USA
5/4/2019	Deveaux Bank	FEDG-PKK	USA
5/4/2019	Deveaux Bank	FEDG-PKV	USA
5/4/2019	Deveaux Bank	FEDG-PKY	USA
5/4/2019	Deveaux Bank	FELG-190	USA
5/4/2019	Deveaux Bank	FELG-287	USA

Date	Location	Flag Color/Code	Banding Origin
5/4/2019	Deveaux Bank	FELG-2E7	USA
5/4/2019	Deveaux Bank	FELG-3C3	USA
5/4/2019	Deveaux Bank	FELG-538	USA
5/4/2019	Deveaux Bank	FELG-588	USA
5/4/2019	Deveaux Bank	FELG-6A6	USA
5/4/2019	Deveaux Bank	FELG-K39	USA
5/4/2019	Deveaux Bank	FELG-PP6	USA
5/4/2019	Deveaux Bank	FEO-200	Argentina
5/4/2019	Turtle Island	FEDG-CVP	USA
5/4/2019	Turtle Island	FEDG-EHX	USA
5/4/2019	Turtle Island	FEDG-EKN	USA
5/4/2019	Turtle Island	FEDG-ELA	USA
5/4/2019	Turtle Island	FEDG-EYJ	USA
5/4/2019	Turtle Island	FEDG-MTN	USA
5/4/2019	Turtle Island	FEDG-MUY	USA
5/4/2019	Turtle Island	FEDG-NLN	USA
5/4/2019	Turtle Island	FEDG-NPV	USA
5/4/2019	Turtle Island	FEDG-NUH	USA
5/4/2019	Turtle Island	FEDG-NUY	USA
5/4/2019	Turtle Island	FEDG-PAC	USA
5/4/2019	Turtle Island	FELG-0N	USA
5/4/2019	Turtle Island	FELG-103	USA
5/4/2019	Turtle Island	FELG-1MV	USA
5/4/2019	Turtle Island	FELG-387	USA
5/4/2019	Turtle Island	FELG-510	USA



Date	Location	Flag Color/Code	Banding Origin
5/4/2019	Turtle Island	FELG-515	USA
5/4/2019	Turtle Island	FELG-527	USA
5/4/2019	Turtle Island	FELG-531	USA
5/4/2019	Turtle Island	FELG-533	USA
5/4/2019	Turtle Island	FELG-545	USA
5/4/2019	Turtle Island	FELG-5C8	USA
5/4/2019	Turtle Island	FELG-7C5	USA
5/4/2019	Turtle Island	FELG-7K9	USA
5/4/2019	Turtle Island	FELG-7XK	USA
5/4/2019	Turtle Island	FELG-9C7	USA
5/4/2019	Turtle Island	FELG-9C9	USA
5/4/2019	Turtle Island	FELG-NU5	USA
5/4/2019	Tybee NWR	FEDG-ELH	USA
5/4/2019	Tybee NWR	FELG-203	USA
5/4/2019	Tybee NWR	FELG-398	USA
5/4/2019	Tybee NWR	FELG-513	USA
5/4/2019	Tybee/Little Tybee Bar	FELG-3E1	USA
5/7/2019	Deveaux Bank	FEDG-PHA	USA
5/7/2019	Deveaux Bank	FELG-203	USA
5/8/2019	Turtle Island	FEDG-EET	USA
5/8/2019	Turtle Island	FEDG-EHX	USA
5/8/2019	Turtle Island	FEDG-EKN	USA
5/8/2019	Turtle Island	FEDG-HUJ	USA
5/8/2019	Turtle Island	FEDG-NPV	USA
5/8/2019	Turtle Island	FEDG-PAC	USA

Date	Location	Flag Color/Code	Banding Origin
5/8/2019	Turtle Island	FELG-=8J	USA
5/8/2019	Turtle Island	FELG-128	USA
5/8/2019	Turtle Island	FELG-3HY	USA
5/8/2019	Turtle Island	FELG-510	USA
5/8/2019	Turtle Island	FELG-513	USA
5/8/2019	Turtle Island	FELG-531	USA
5/8/2019	Turtle Island	FELG-7K9	USA
5/8/2019	Turtle Island	FELG-9C9	USA
5/8/2019	Tybee NWR	FEDG-EET	USA
5/8/2019	Tybee NWR	FEDG-EHX	USA
5/8/2019	Tybee NWR	FEDG-ELA	USA
5/8/2019	Tybee NWR	FEDG-ELH	USA
5/8/2019	Tybee NWR	FEDG-EYJ	USA
5/8/2019	Tybee NWR	FEDG-KPH	USA
5/8/2019	Tybee NWR	FEDG-MUY	USA
5/8/2019	Tybee NWR	FEDG-NLN	USA
5/8/2019	Tybee NWR	FEDG-NUH	USA
5/8/2019	Tybee NWR	FEDG-NUP	USA
5/8/2019	Tybee NWR	FEDG-PLH	USA
5/8/2019	Tybee NWR	FELG-=9N	USA
5/8/2019	Tybee NWR	FELG-158	USA
5/8/2019	Tybee NWR	FELG-1A1	USA
5/8/2019	Tybee NWR	FELG-1MU	USA
5/8/2019	Tybee NWR	FELG-273	USA
5/8/2019	Tybee NWR	FELG-569	USA

Date	Location	Flag Color/Code	Banding Origin
5/8/2019	Tybee NWR	FELG-5E3	USA
5/8/2019	Tybee NWR	FELG-67A	USA
5/8/2019	Tybee NWR	FELG-7C5	USA
5/8/2019	Tybee NWR	FELG-8C5	USA
5/8/2019	Tybee NWR	FELG-909	USA
5/8/2019	Tybee NWR	FELG-915	USA
5/8/2019	Tybee NWR	FELG-9CC	USA
5/8/2019	Tybee NWR	FELG-J58	USA
5/8/2019	Tybee NWR	FELG-TMN	USA
5/8/2019	Tybee NWR	FEO-154	Argentina
5/9/2019	Kiawah Island	FEDG-CXK	USA
5/9/2019	Kiawah Island	FEDG-EJP	USA
5/9/2019	Kiawah Island	FEDG-MAM	USA
5/9/2019	Kiawah Island	FEDG-PEP	USA
5/9/2019	Kiawah Island	FEDG-PHL	USA
5/9/2019	Kiawah Island	FEDG-PLL	USA
5/9/2019	Kiawah Island	FEDG-PLN	USA
5/9/2019	Kiawah Island	FEDG-PLT	USA
5/9/2019	Kiawah Island	FEDG-PNE	USA
5/9/2019	Kiawah Island	FEDG-PNN	USA
5/9/2019	Kiawah Island	FEDG-PPC	USA
5/9/2019	Kiawah Island	FEDG-PPH	USA
5/9/2019	Kiawah Island	FEDG-PPJ	USA
5/9/2019	Kiawah Island	FEDG-PPT	USA
5/9/2019	Kiawah Island	FEDG-PPX	USA

Date	Location	Flag Color/Code	Banding Origin
5/9/2019	Kiawah Island	FEDG-PTJ	USA
5/9/2019	Kiawah Island	FELG-54T	USA
5/9/2019	Kiawah Island	FELG-556	USA
5/9/2019	Kiawah Island	FELG-588	USA
5/9/2019	Kiawah Island	FELG-U3Y	USA
5/9/2019	Kiawah Island	FELG-V5C	USA
5/9/2019	Kiawah Island	FELG-V5M	USA
5/10/2019	Deveaux Bank	FEDG-CPN	USA
5/10/2019	Deveaux Bank	FEDG-MAM	USA
5/10/2019	Deveaux Bank	FEDG-MCP	USA
5/10/2019	Deveaux Bank	FEDG-PCP	USA
5/10/2019	Deveaux Bank	FEDG-PMU	USA
5/10/2019	Deveaux Bank	FEDG-PNY	USA
5/10/2019	Deveaux Bank	FEDG-PPT	USA
5/10/2019	Deveaux Bank	FEDG-PTM	USA
5/10/2019	Deveaux Bank	FELG-3E2	USA
5/10/2019	Deveaux Bank	FELG-9HE	USA
5/13/2019	Ogeechee Bar/Raccoon Bar	FELG-75X	USA
5/13/2019	Ogeechee Bar/Raccoon Bar	FELG-9C7	USA
5/13/2019	Ogeechee Bar/Raccoon Bar	FELG-9CL	USA
5/13/2019	Ogeechee Bar/Raccoon Bar	FELG-X3X	USA
5/14/2019	Beach Hammock	FEDG-EET	USA
5/14/2019	Beach Hammock	FEDG-NUH	USA
5/14/2019	Beach Hammock	FELG-513	USA
5/14/2019	Beach Hammock	FELG-53E	USA

Date	Location	Flag Color/Code	Banding Origin
5/14/2019	Beach Hammock	FEDG-NUA	USA
5/14/2019	Beach Hammock	FEDG-PPE	USA
5/14/2019	Beach Hammock	FELG-1E9	USA
5/14/2019	Beach Hammock	FELG-1VP	USA
5/14/2019	Beach Hammock	FELG-3E1	USA
5/14/2019	Beach Hammock	FELG-5E3	USA
5/14/2019	Beach Hammock	FELG-5L6	USA
5/14/2019	Beach Hammock	FELG-687	USA
5/14/2019	Beach Hammock	FELG-7C5	USA
5/14/2019	Beach Hammock	FEO-S3X	Argentina
5/14/2019	Beach Hammock	FER-110	Chile
5/15/2019	Turtle Island	FEDG-EET	USA
5/15/2019	Turtle Island	FEDG-EVJ	USA
5/15/2019	Turtle Island	FEDG-PPE	USA
5/15/2019	Turtle Island	FELG-683	USA
5/15/2019	Tybee NWR	FELG-TJ=	USA
5/15/2019	Tybee NWR	FEO-COL	Argentina
5/17/2019	Deveaux Bank	FEDG-020	USA
5/17/2019	Deveaux Bank	FEDG-CPN	USA
5/17/2019	Deveaux Bank	FEDG-JLC	USA
5/17/2019	Deveaux Bank	FEDG-MCP	USA
5/17/2019	Deveaux Bank	FEDG-PCL	USA
5/17/2019	Deveaux Bank	FEDG-PCP	USA
5/17/2019	Deveaux Bank	FEDG-PCY	USA
5/17/2019	Deveaux Bank	FEDG-PHE	USA

Date	Location	Flag Color/Code	Banding Origin
5/17/2019	Deveaux Bank	FEDG-PHJ	USA
5/17/2019	Deveaux Bank	FEDG-PHP	USA
5/17/2019	Deveaux Bank	FEDG-PKV	USA
5/17/2019	Deveaux Bank	FEDG-PLA	USA
5/17/2019	Deveaux Bank	FEDG-PLJ	USA
5/17/2019	Deveaux Bank	FEDG-PLN	USA
5/17/2019	Deveaux Bank	FEDG-PLT	USA
5/17/2019	Deveaux Bank	FEDG-PLV	USA
5/17/2019	Deveaux Bank	FEDG-PLY	USA
5/17/2019	Deveaux Bank	FEDG-PMU	USA
5/17/2019	Deveaux Bank	FEDG-PMY	USA
5/17/2019	Deveaux Bank	FEDG-PNA	USA
5/17/2019	Deveaux Bank	FEDG-PNL	USA
5/17/2019	Deveaux Bank	FEDG-PNY	USA
5/17/2019	Deveaux Bank	FEDG-PPH	USA
5/17/2019	Deveaux Bank	FEDG-PPM	USA
5/17/2019	Deveaux Bank	FEDG-PPN	USA
5/17/2019	Deveaux Bank	FEDG-PPU	USA
5/17/2019	Deveaux Bank	FEDG-PTA	USA
5/17/2019	Deveaux Bank	FEDG-PTC	USA
5/17/2019	Deveaux Bank	FEDG-PTE	USA
5/17/2019	Deveaux Bank	FEDG-PTH	USA
5/17/2019	Deveaux Bank	FEDG-PTM	USA
5/17/2019	Deveaux Bank	FEDG-PTV	USA
5/17/2019	Deveaux Bank	FELG-07V	USA

Date	Location	Flag Color/Code	Banding Origin
5/17/2019	Deveaux Bank	FELG-0C8	USA
5/17/2019	Deveaux Bank	FELG-190	USA
5/17/2019	Deveaux Bank	FELG-2E7	USA
5/17/2019	Deveaux Bank	FELG-342	USA
5/17/2019	Deveaux Bank	FELG-3C3	USA
5/17/2019	Deveaux Bank	FELG-504	USA
5/17/2019	Deveaux Bank	FELG-588	USA
5/17/2019	Deveaux Bank	FELG-5U5	USA
5/17/2019	Deveaux Bank	FELG-684	USA
5/17/2019	Deveaux Bank	FELG-7=L	USA
5/17/2019	Deveaux Bank	FELG-9HE	USA
5/17/2019	Deveaux Bank	FELG-9HL	USA
5/17/2019	Deveaux Bank	FELG-9HV	USA
5/17/2019	Deveaux Bank	FELG-A63	USA
5/17/2019	Deveaux Bank	FELG-C96	USA
5/17/2019	Deveaux Bank	FELG-E60	USA
5/17/2019	Deveaux Bank	FELG-NT1	USA
5/17/2019	Deveaux Bank	FELG-OC8	USA
5/17/2019	Deveaux Bank	FELG-PP6	USA
5/17/2019	Deveaux Bank	FELG-X3N	USA
5/17/2019	Kiawah Island	FEDG-PHT	USA
5/17/2019	Kiawah Island	FEDG-PMH	USA
5/17/2019	Kiawah Island	FELG-556	USA
5/17/2019	Kiawah Island	FELG-V5C	USA
5/17/2019	Kiawah Island	FELG-V5M	USA

Date	Location	Flag Color/Code	Banding Origin
5/18/2019	Ogeechee Bar/Raccoon Bar	FELG-3C4	USA
5/18/2019	Ogeechee Bar/Raccoon Bar	FELG-9C7	USA
5/19/2019	Beach Hammock	FELG-151	USA
5/19/2019	Beach Hammock	FELG-1A1	USA
5/19/2019	Beach Hammock	FELG-1MU	USA
5/19/2019	Beach Hammock	FELG-513	USA
5/19/2019	Beach Hammock	FELG-538	USA
5/19/2019	Beach Hammock	FELG-5L6	USA
5/19/2019	Beach Hammock	FELG-9A6	USA
5/19/2019	Beach Hammock	FELG-9C7	USA
5/19/2019	Beach Hammock	FELG-AE3	USA
5/19/2019	Beach Hammock	FELG-C47	USA
5/19/2019	Beach Hammock	FEO-154	Argentina
5/19/2019	Beach Hammock	FEO-S3X	Argentina
5/19/2019	Beach Hammock	FEW-ZE	Canada
5/19/2019	Beach Hammock	FEDG-302	USA
5/19/2019	Beach Hammock	FEDG-EKN	USA
5/19/2019	Beach Hammock	FEDG-EKX	USA
5/19/2019	Beach Hammock	FEDG-MNH	USA
5/19/2019	Beach Hammock	FEDG-NUH	USA
5/19/2019	Beach Hammock	FEDG-PLH	USA
5/19/2019	Beach Hammock	FELG-1MV	USA
5/19/2019	Beach Hammock	FELG-273	USA
5/19/2019	Beach Hammock	FELG-387	USA
5/19/2019	Beach Hammock	FELG-397	USA



Date	Location	Flag Color/Code	Banding Origin
5/19/2019	Beach Hammock	FELG-510	USA
5/19/2019	Beach Hammock	FELG-533	USA
5/19/2019	Beach Hammock	FELG-545	USA
5/19/2019	Beach Hammock	FELG-687	USA
5/19/2019	Beach Hammock	FELG-8C5	USA
5/19/2019	Beach Hammock	FELG-C4Y	USA
5/19/2019	Beach Hammock	FELG-UU5	USA
5/19/2019	Beach Hammock	FELG-X3X	USA
5/19/2019	Beach Hammock	FER-110	Chile
5/19/2019	Beach Hammock	FER-ETT	Chile
5/23/2019	Ogeechee Bar/Raccoon Bar	FEDG-PPX	USA
5/28/2019	Turtle Island	FELG-+01	USA
5/29/2019	Ogeechee Bar/Raccoon Bar	FELG-=69	USA
5/29/2019	Ogeechee Bar/Raccoon Bar	FEO-JU2	Argentina

**APPENDIX II. TABLE WITH ALL RED KNOTS CAPTURED AT DEVEAUX BANK, SOUTH CAROLINA ON 6 MAY 2019.**

<b>Flag Color</b>	<b>Flag Code</b>	<b>Age</b>	<b>Nanotag Code</b>
Dark Green	PPP	ASY	25
Dark Green	PPC	ASY	42
Dark Green	PPT	SY	43
Dark Green	PPM	ASY	44
Dark Green	PPJ	ASY	36
Dark Green	PPY	ASY	38
Dark Green	PPH	ASY	30
Dark Green	PPN	ASY	33
Dark Green	PPE	ASY	26
Dark Green	PPL	ASY	28
Dark Green	PPX	ASY	23
Dark Green	PPA	SY	
Dark Green	PPV	ASY	16
Dark Green	PPU	AHY	11
Dark Green	PJH	ASY	18
Dark Green	PKV	ASY	12
Dark Green	PPK	ASY	14
Dark Green	PNE	SY	7
Lime	7=L	ASY	9
Dark Green	PNL	ASY	5

Flag Color	Flag Code	Age	Nanotag Code
Dark Green	PNX	ASY	275
Dark Green	PNA	ASY	278
Dark Green	PNP	SY	
Dark Green	PNK	ASY	270
Dark Green	PNJ	ASY	271
Dark Green	PNY	ASY	273
Dark Green	PNC	ASY	267
Dark Green	PNN	ASY	268
Dark Green	PNH	ASY	269
Dark Green	PNT	ASY	260
Dark Green	PNM	ASY	262
Dark Green	PNU	ASY	264
Dark Green	PNV	ASY	71
Dark Green	PCY	ASY	66
Dark Green	PCN	ASY	68
Dark Green	PCL	ASY	61
Dark Green	PCP	ASY	62
Dark Green	PCM	ASY	63
Dark Green	PCX	ASY	56
Dark Green	PCT	SY	57
Dark Green	PLA	AHY	40
Dark Green	PLC	ASY	41
Dark Green	PLE	ASY	29

Flag Color	Flag Code	Age	Nanotag Code
Dark Green	PLP	ASY	32
Dark Green	PLK	ASY	35
Dark Green	PLL	ASY	
Dark Green	PLJ	ASY	20
Dark Green	PLM	ASY	37
Dark Green	PLN	ASY	39
Dark Green	PLH	ASY	31
Dark Green	PLT	ASY	34
Dark Green	PLU	ASY	27
Dark Green	PLV	ASY	22
Dark Green	PLY	ASY	24
Dark Green	PLX	ASY	17
Dark Green	PMP	ASY	19
Dark Green	PMN	SY	10
Dark Green	PMT	ASY	13
Dark Green	PMV	SY	367
Dark Green	PMU	ASY	276
Dark Green	PMY	ASY	277
Dark Green	PMX	SY	279
Dark Green	PTA	AHY	-
Dark Green	PTE	ASY	272
Dark Green	PTC	ASY	265
Dark Green	PTH	ASY	266

Flag Color	Flag Code	Age	Nanotag Code
Dark Green	PTP	-	-
Dark Green	PTM	ASY	261
Dark Green	PTJ	ASY	263
Dark Green	PTN	ASY	70
Dark Green	PTL	ASY	65
Dark Green	PTK	ASY	67
Dark Green	PTT	ASY	69
Dark Green	PTU	ASY	60
Dark Green	PTV	ASY	64
Dark Green	PTY	SY	55

**APPENDIX III. TABLE WITH DATE, SURVEY LOCATION, SURVEY ROUND, AND TOTAL NUMBER OF RED KNOTS DETECTED AT EACH LOCATION DURING THE 2019 SPRING SEASON.**

<b>Date</b>	<b>Location</b>	<b>Survey Round</b>	<b># of Knots</b>
4/10/2019	Ogeechee Bar	1	2
4/11/2019	Tybee Bar	1	600
4/12/2019	Turtle Island	1	0
4/16/2019	Deveaux Bank	1	125
4/16/2019	Kiawah Island	1	0
4/17/2019	Beach Hammock/Little Tybee	1	40
4/18/2019	Beach Hammock/Little Tybee	2	1600
4/18/2019	Ogeechee Bar	2	0
4/22/2019	Turtle Island	2	500
4/23/2019	Beach Hammock/Little Tybee	3	150
4/23/2019	Tybee Bar	2	250
4/24/2019	Deveaux Bank	2	5
4/24/2019	Kiawah Island	2	5000
4/25/2019	Ogeechee Bar	3	0
4/29/2019	Turtle Island	3	700

Date	Location	Survey Round	# of Knots
5/2/2019	Kiawah Island	3	741
5/2/2019	Seabrook	3	550
5/3/2019	Tybee Bar	3	~250
5/4/2019	Tybee Bar	4	~140
5/8/2019	Turtle Island	4	2750
5/8/2019	Tybee NWR	4	~1000
5/9/2019	Kiawah/Seabrook	4	~150
5/10/2019	Deveaux Bank	4	800
5/13/2019	Ogeechee Bar	4	~75
5/14/2019	Beach Hammock/Little Tybee	5	~2700
5/14/2019	Tybee Bar	5	~150
5/15/2019	Turtle Island	5	300
5/15/2019	Tybee NWR	5	100
5/17/2019	Deveaux Bank	5	1300
5/17/2019	Kiawah Island	5	55
5/19/2019	Beach Hammock/Little Tybee	6	~2700
5/20/2019	Turtle Island	6	50
5/23/2019	Ogeechee Bar	6	63

<b>Date</b>	<b>Location</b>	<b>Survey Round</b>	<b># of Knots</b>
5/24/2019	Deveaux Bank	6	0
5/24/2019	Kiawah Island	6	0
5/28/2019	Turtle Island	7	20
5/29/2019	Ogeechee Bar	7	80
5/30/2019	Beach Hammock/Little Tybee	7	5