



Landbird Community Monitoring 2017: Data Summary

Michael C. Parrish¹ and Elizabeth Kurimo-Beechuk

¹Southeast Coast Network, NPS, 135 Phoenix Road, Athens, Georgia 30605.

Overview

Birds play several critical roles in park ecosystems. They occupy and interact with multiple levels of the food web. Predatory birds regulate prey species populations, notably helping to control rodents and insects. Scavenging species remove dead animals from the environment. Many other bird species act as pollinators or seed dispersers. Because many avian species are associated with specific habitat types and ecosystem services, we can gain insights about the condition of specific habitat components in the park by monitoring what birds are present and where in the park landscape they occur.

Many active members of the recreational birding community enjoy opportunities to engage in bird and wildlife watching in protected park settings. Birds contribute beauty and song to the natural setting and provide great appeal to the public. Birding has become one of the most popular outdoor recreational activities pursued by Americans, who substantially contribute to local economies while pursuing their hobby.

The Southeast Coast Network (SECN) parks—located in Alabama, Florida, Georgia, South Carolina, and North Carolina—are mainly located within the Atlantic Flyway, and host high bird diversity. More than 400 avian species use SECN parks while breeding, wintering, or stopping over during migration (NPS 2022). Surrounded by human-altered landscapes in a region of increasing urbanization and land conversion, our inland and coastal parks represent important, ecologically-intact areas that contain a multitude of habitat types important to the conservation of wildlife diversity.

Bird communities respond quickly to environmental stressors or changes. Changes in avian species composition, richness, and distribution on the landscape may indicate changes in the underlying ecological condition of park resources. Shifting species distributions alter species interactions and the food-web structure, thereby producing cascading effects on ecosystem processes (Montoya and Raffaelli 2010). Long-term monitoring projects can potentially detect trends in breeding bird populations and use them to assess ecosystem integrity and sustainability. Park managers can use monitoring data as a tool to help inform land management decisions.

Objectives

This report summarizes data collected with the SECN landbird community monitoring protocol (Byrne et al. 2014) to address the following Vital Signs Monitoring Program objectives:



A Florida scrub-jay (*Aphelocoma coerulescens*), one of numerous species detected during monitoring in 2017. NPS photo (NPGallery).

1. Evaluate landbird community species richness in the park during the breeding season.
2. Assess landbird occupancy and spatial distribution in the park during the breeding season.

We use the term ‘community’ herein to refer to an assemblage of species populations occurring together in time and space (Begon et al. 1986). We consider the vocal avian species assemblage within the park as a de facto community (Byrne et al. 2014).

Significant Results

This brief summarizes data collected during implementation of the Southeast Coast Network’s landbird community monitoring protocol at Canaveral National Seashore in 2017.

- Automated recording devices captured bird vocalizations at 25 spatially-balanced random sampling locations during the April–May breeding season of 2017.
- Fifteen-hundred minutes of audio were recorded and all discernable bird vocalizations were reviewed and classified to species.
- We detected 58 species of native birds and one non-native species, (house finch [*Haemorrhous mexicanus*]). Carolina wren (*Thryothorus ludovicianus*), northern cardinal (*Cardinalis cardinalis*), red-bellied woodpecker (*Melanerpes carolinus*), eastern towhee (*Pipilo erythrophthalmus*), and white-eyed vireo (*Vireo griseus*) were the most frequently-detected species, occurring at greater than or equal to 80% of sample locations.
- Eastern bluebird was detected—a species not yet included on the park’s NPSpecies taxa list.

Significant Results (continued)

The full dataset and metadata are available from the NPS data store at the Integrated Resource Management Applications portal (<https://irma.nps.gov/DataStore/Reference/Profile/2288414>).

Study Area

Canaveral National Seashore (CANA) is on the east coast of central Florida (Figure 1). The park is approximately 23,067 hectares (57,000 acres), including Mosquito Lagoon, with the southern portion jointly managed by the National Park Service and the U.S. Fish and Wildlife Service's (USFWS) Merritt Island National Wildlife Refuge. The natural resources at the seashore include a diverse assemblage of wildlife, vegetation communities, geophysical features, and natural processes that reflect the complexity of the land/lagoon/sea interface of east-central Florida. Mosquito Lagoon, extending along the backside of the CANA barrier island, is the northernmost part of the Indian River Lagoon and was designated an Estuary of National Significance by the Environmental Protection Agency (EPA) in 1990 (Indian River Lagoon National Estuary Program 2019) and an Outstanding Florida Water by the State of Florida. The lagoon acts as an important nursery area for a wide variety of wildlife species.

Unlike many barrier islands, Canaveral National Seashore has a less-complex dune system (i.e., primary and secondary) separating the lagoon from the ocean, and generally consists of a single primary dune averaging 3.7 meters (12 feet) in height. The distribution and juxtaposition of vegetation community types at the park generally follows subtle variations in topography, a salinity gradient, and differences in hydrologic properties. Predominant vegetation communities at the park include coastal dune/coastal strand, dominated by *Serenoa repens*, *Coccoloba uvifera*, *Myrcianthes fragrans*, and *Morella cerifera*, hardwood hammock, mangroves, salt marsh, oak (*Quercus* spp.) scrub, and pine flatwoods (*Pinus elliotii* and *P. palustris*) interspersed with a variety of freshwater wetland types. This unique and complex habitat mosaic supports a high species diversity in many taxa.

Canaveral National Seashore has 322 known bird species (NPS 2022). A .csv file with a list of all species on NPSpecies, as well as a list of species located in 2017 monitoring, is with the full dataset at <https://irma.nps.gov/DataStore/Reference/Profile/2288414>.



An Osprey (*Pandion haliaetus*), one of numerous species detected during monitoring in 2017. NPS photo (NPgallery).

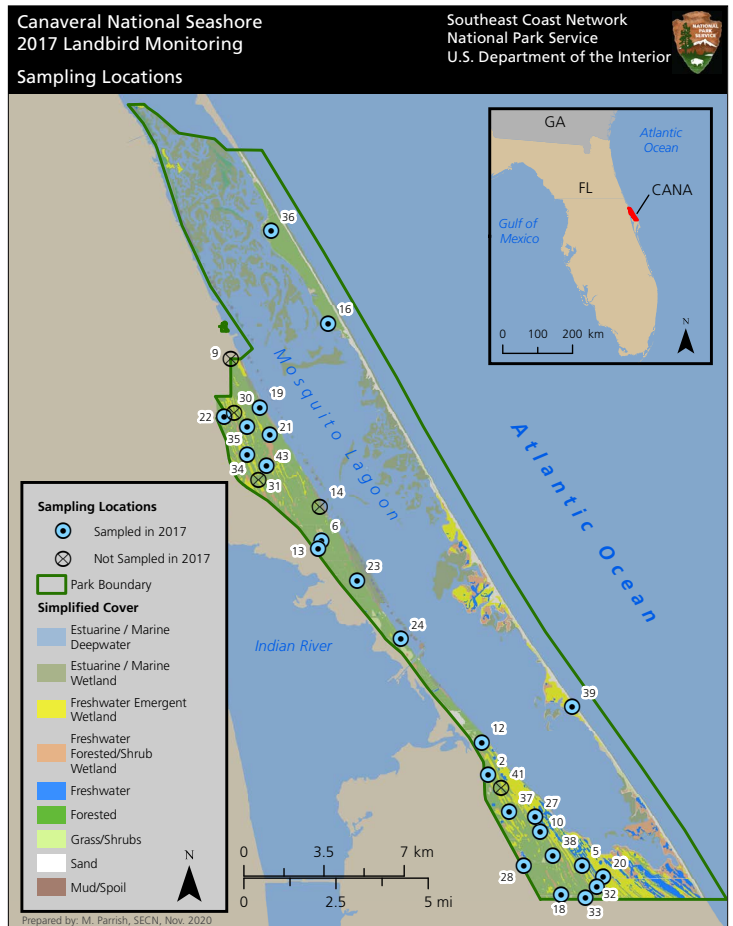


Figure 1. Landbird monitoring was conducted at 25 of 30 sampling locations at Canaveral National Seashore in 2017. Sample location ID numbers are indicated.

Methods

Sampling Design

A spatially-balanced set of sampling locations was randomly selected. The sample size was chosen based on considerations including park size, hypothesized variability in wildlife populations, and logistics. Sampling locations are visited on a three-year rotation. More details regarding study design, data collection, and data analyses can be found in the SECN landbird community monitoring protocol (Byrne et al. 2014) and SECN standard operating procedure (SOP) 1.1.01 (Byrne 2012).

Data Collection

In 2017, automated recording devices (ARDs) were deployed at 29 sampling locations from February 14 to June 20 (Figure 1). Automated recording device equipment failure prematurely ended recording at four sampling locations, so 25 locations were ultimately sampled in the park. Each ARD was programmed to record audio from 08:00 to 08:12, every other day, for a period of 95 days. Recording periods at each location varied due to equipment performance, but 56 to 62 recordings were captured at 24 sampling locations and 39 recordings were captured at one additional location during the spring migratory period and breeding season. The ARDs were collected from the field in early summer and recordings were downloaded to a computer for classification and analyses.

Methods (continued)

Manual Classification of Recordings

Recordings were systematically selected from the following dates: April 1, April 15, May 1, May 15, and May 30. Loud ambient noise (e.g., traffic, surf, insect droning, or wind) in recordings negatively affects discernment of bird sounds. Therefore, recordings made on the above dates were initially screened using the software package Kaleidoscope Pro (Wildlife Acoustics, Inc. 2019) to assess clarity and determine whether background noise was disruptive to the listener's ability to interpret bird sounds. If recording quality was poor on a given date, we systematically evaluated and selected for analysis alternate recordings from proximate dates. The ARD at one sample location failed midway through the season and we selected five recordings from April for that device.

Selected recordings were methodically reviewed by an experienced technician with strong familiarity with the vocalizations of birds of the southeastern U.S. The technician evaluated recordings using Kaleidoscope Pro (Wildlife Acoustics, Inc. 2019), which allowed them to view spectrograms (graphical representations of vocalizations) and to manipulate playback on the fly to maximize acoustical clarity. The technician classified all vocalizations identifiable to the species level, a process requiring from one-half to two hours per 12-minute recording depending on the complexity of the captured soundscape. A wildlife biologist later reviewed the technician's classifications for data quality assurance and control.

Taxonomic Standards

Our use of taxonomic nomenclature followed the Integrated Taxonomic Information System (ITIS 2022). The National Park Service maintains the NPSpecies online database (NPS 2022), which documents the occurrence and status of species found in parks.

Data Analysis

The focus was limited to the analysis of species richness and related characteristics, including occupancy and spatial distribution of the park's breeding-season landbird community. The results were derived from the manual evaluation of 1,500 minutes of audio from 125 recordings across 25 sample locations. Only detections of birds identified to the species level were included in analyses. We calculated metrics separately for native versus non-native species, as managers may consider the latter a special consideration.

Species Richness and Composition

Using the SpadeR package (Chao et al. 2016) in program R, total observed species richness for the park (S_{obs}) and mean species richness per sample location (S_{SL}) were calculated. Species richness is defined as the number of unique species detected at least once at the scale of interest.

Field methods for sampling species richness (e.g., point-counts or audio sampling) inherently produce incomplete counts, due to imperfect detection of cryptic species that may be present but are difficult to record during surveys. Observed species richness, therefore, is expected to be an underestimate of true species richness, though it



Automated recording device (ARD) used for landbird community monitoring, mounted on a tree in Canaveral National Seashore. NPS photo / SECN staff.

offers utility as an index of the true diversity of a sample unit. Various methods exist to adjust incidence data to provide an estimated species richness that may be closer to the true value. The SpadeR package in R is used to calculate the iChao2 estimator of species richness with an associated 95% confidence interval (Chiu et al. 2014). The iChao2 estimator uses the detection frequencies of rarely-detected species to adjust the observed richness upward to account for species that may be present but not detected. The iChao2 estimator is expected to perform well for communities that are highly heterogeneous with regard to species incidence or occupancy (Chiu et al. 2014).

Occupancy

Naïve occupancy (i.e., frequency of occurrence) was calculated as the percent of sampling locations where a species was detected in one or more reviewed recordings. Occupancy estimates were not adjusted for probability of detection (i.e., detectability). Species with greater naïve occupancy occur at more locations than those with low values.

Spatial Distribution

Species incidence records in the park were mapped to provide a means of visually assessing spatial distributions of detected birds across the park. An understanding of landbird distribution is crucial for informed management of species and their requisite habitats. In 2025, following the fourth scheduled park visit, trend analysis of data is planned in order to assess changes in species distribution and community makeup across time. This has potential to provide insights into influences on park diversity (e.g., land use change and habitat condition, climate issues, and hydrological processes).

Results

Species Richness

Overall total observed native species richness (S_{obs}) for breeding landbirds at Canaveral National Seashore in 2017 was 58. Mean $\pm$ SD observed native species richness per sample location (S_{SL}) was 14.4 ± 3.4 (range: 8–22; Figure 2). The iChao2 species richness estimate (S_{iChao2}) was 88.7 (95% CI: 75.4, 112.2). The adjusted richness estimator S_{iChao2} was approximately 53% greater than S_{obs} . We also detected one non-native landbird species in the park (house finch [*Haemorrhous mexicanus*]).

Results (continued)

Occupancy and Spatial Distribution

Naïve occupancy was greatest for Carolina wren (*Thryothorus ludovicianus*), northern cardinal (*Cardinalis cardinalis*), red-bellied woodpecker (*Melanerpes carolinus*), eastern towhee (*Pipilo erythrophthalmus*), and white-eyed vireo (*Vireo griseus*), which were detected at greater than or equal to 80% ($n \geq 20$) of sampling locations (Table 1). Many species were infrequently detected. Thirty-nine species were detected at less than or equal to 20% ($n \leq 5$) sample locations (Table 1). Nineteen species were detected at only one sample location (Table 1).

One non-native species (house finch) occurred at one of 25 sample locations. We documented one species (eastern bluebird) that was not listed on the park's taxa list on NPSpecies (NPS 2022). We updated NPSpecies to include eastern bluebird (Table 2). Bluebirds are relatively common, so their absence from the NPSpecies record was likely an oversight. Distribution maps for all detected species are available at <https://irma.nps.gov/DataStore/Reference/Profile/2288416> and indicate the sampling location(s) in which detections of each species occurred. See Table 3 to review site occupancy by species.

Table 1. Naïve occupancy estimates (i.e., proportion of sampling locations ($n = 25$) in which a species was detected) for birds at Canaveral National Seashore in 2017, ranked from high to low occupancy.

Common Name	Scientific Name	% sites
Carolina wren	<i>Thryothorus ludovicianus</i>	100
Northern cardinal	<i>Cardinalis cardinalis</i>	100
Red-bellied woodpecker	<i>Melanerpes carolinus</i>	88
Eastern towhee	<i>Pipilo erythrophthalmus</i>	84
White-eyed vireo	<i>Vireo griseus</i>	84
Pileated woodpecker	<i>Dryocopus pileatus</i>	72
Gray catbird	<i>Dumetella carolinensis</i>	64
Common yellowthroat	<i>Geothlypis trichas</i>	60
Mourning dove	<i>Zenaida macroura</i>	60
Great crested flycatcher	<i>Myiarchus crinitus</i>	56
Red-winged blackbird	<i>Agelaius phoeniceus</i>	52
Tufted titmouse	<i>Baeolophus bicolor</i>	52
Blue jay	<i>Cyanocitta cristata</i>	48
Blue-gray gnatcatcher	<i>Polioptila caerulea</i>	44
Northern bobwhite	<i>Colinus virginianus</i>	44
Northern flicker	<i>Colaptes auratus</i>	28
Greater yellowlegs	<i>Tringa melanoleuca</i>	24
Northern parula	<i>Setophaga americana</i>	24
Red-eyed vireo	<i>Vireo olivaceus</i>	24
Downy woodpecker	<i>Dryobates pubescens</i>	20
Eastern kingbird	<i>Tyrannus tyrannus</i>	20
Killdeer	<i>Charadrius vociferus</i>	20
Red-shouldered hawk	<i>Buteo lineatus</i>	20
Boat-tailed grackle	<i>Quiscalus major</i>	16

Table 1 (continued). Naïve occupancy estimates (i.e., proportion of sampling locations ($n = 25$) in which a species was detected) for birds at Canaveral National Seashore in 2017, ranked from high to low occupancy.

Common Name	Scientific Name	% sites
Common grackle	<i>Quiscalus quiscula</i>	16
Black-necked stilt	<i>Himantopus mexicanus</i>	12
Common gallinule	<i>Gallinula galeata</i>	12
Eastern meadowlark	<i>Sturnella magna</i>	12
Fish crow	<i>Corvus ossifragus</i>	12
Great blue heron	<i>Ardea herodias</i>	12
Osprey	<i>Pandion haliaetus</i>	12
Willet	<i>Tringa semipalmata</i>	12
American redstart	<i>Setophaga ruticilla</i>	8
Barn swallow	<i>Hirundo rustica</i>	8
Brown-headed cowbird	<i>Molothrus ater</i>	8
Black-throated blue warbler	<i>Setophaga caerulescens</i>	8
House wren	<i>Troglodytes aedon</i>	8
Prairie warbler	<i>Setophaga discolor</i>	8
Swallow-tailed kite	<i>Elanoides forficatus</i>	8
American robin	<i>Turdus migratorius</i>	4
Bald eagle	<i>Haliaeetus leucocephalus</i>	4
Belted kingfisher	<i>Megasceryle alcyon</i>	4
Cedar waxwing	<i>Bombcilla cedrorum</i>	4
Common ground dove	<i>Columbina passerina</i>	4
Chipping sparrow	<i>Spizella passerina</i>	4
Common nighthawk	<i>Chordeiles minor</i>	4
Eastern bluebird	<i>Sialia sialis</i>	4
Florida scrub-jay	<i>Aphelocoma coerulescens</i>	4
Green heron	<i>Butorides virescens</i>	4
Indigo bunting	<i>Passerina cyanea</i>	4
Laughing gull	<i>Leucophaeus atricilla</i>	4
Least sandpiper	<i>Calidris minutilla</i>	4
Lesser yellowlegs	<i>Tringa flavipes</i>	4
Orange-crowned warbler	<i>Leiothlypis celata</i>	4
Pine warbler	<i>Setophaga pinus</i>	4
Red-headed woodpecker	<i>Erythrocephalus</i>	4
Ruby-throated hummingbird	<i>Archilochus colubris</i>	4
Sandhill crane	<i>Antigone canadensis</i>	4

Table 2. Undocumented species detected at Canaveral National Seashore in 2017 with recommended NPSpecies classifications [MP—Management Priority and EC—Exploitation Concerns].

Common Name	Abundance	Residency	Nativity	Pest	MP	EC
Eastern bluebird	Common	Resident	Native	No	No	No
House finch	Common	Resident	Non-native	No	No	No

Table 3. Landbird species detected (x=detected) at Canaveral National Seashore by sampling location number in 2017. See Figure 1 for a map of sampling locations.

Common Name	02	05	06	10	12	13	16	18	19	20	21	22	23	24	27	28	32	33	34	35	36	37	38	39	43
Northern bobwhite	x	—	—	—	x	x	—	x	—	—	—	x	x	—	—	—	—	x	x	x	—	—	x	—	x
Common ground dove	—	—	—	—	x	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mourning dove	x	—	x	—	x	—	—	x	—	—	x	x	x	x	—	x	x	—	—	x	x	x	x	—	x
Common nighthawk	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	x	—	—	—	—	—	—	—	—
Ruby-throated hummingbird	—	—	—	—	—	—	—	x	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Common gallinule	—	x	—	—	—	—	—	—	—	x	—	—	—	—	—	—	—	—	—	—	—	—	x	—	—
Sandhill crane	—	—	—	—	—	x	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Black-necked stilt	—	x	—	—	—	—	—	—	—	x	—	—	—	—	—	—	x	—	—	—	—	—	—	—	—
Killdeer	—	—	—	x	x	—	—	—	—	x	—	—	—	—	x	—	x	—	—	—	—	—	—	—	—
Least sandpiper	—	—	—	—	—	—	—	—	—	x	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lesser yellowlegs	—	—	—	—	—	—	—	—	—	—	—	—	—	—	x	—	—	—	—	—	—	—	—	—	—
Willet	—	x	—	—	—	—	—	—	—	x	—	—	—	—	—	—	—	—	—	—	—	—	—	x	—
Greater yellowlegs	x	x	—	—	—	—	x	—	—	x	—	—	—	—	—	—	x	—	—	—	x	—	—	—	—
Laughing gull	—	x	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Great blue heron	—	x	—	x	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	x	—	—	—	—
Green heron	—	—	—	—	—	—	—	—	—	x	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Osprey	—	—	—	—	—	x	—	—	—	—	—	—	x	x	—	—	—	—	—	—	—	—	—	—	—
Swallow-tailed kite	—	—	—	—	—	x	—	—	—	—	—	—	x	—	—	—	—	—	—	—	—	—	—	—	—
Bald eagle	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	x	—	—	—	—	—
Red-shouldered hawk	—	—	—	—	—	—	—	—	x	—	x	—	x	—	—	—	—	—	—	x	—	—	x	—	—
Belted kingfisher	x	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Red-headed woodpecker	—	—	—	—	—	—	—	—	—	—	—	—	x	—	—	—	—	—	—	—	—	—	—	—	—
Red-bellied woodpecker	x	—	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	—	x	x	x	x	—	x
Downy woodpecker	x	—	—	—	—	—	—	—	—	—	x	x	x	—	—	—	—	—	—	—	x	—	—	—	—
Northern flicker	x	x	x	x	x	—	—	—	—	—	—	—	x	—	—	—	—	—	x	—	—	—	—	—	—
Pileated woodpecker	x	—	—	x	x	x	x	x	—	—	x	x	x	x	x	x	x	—	x	x	x	—	x	—	x
Great crested flycatcher	x	—	—	—	x	x	x	—	x	—	x	x	x	—	—	x	—	x	x	—	—	x	—	x	x
Eastern kingbird	—	x	—	x	—	—	—	—	—	—	—	x	—	—	—	—	—	—	x	—	x	—	—	—	—
White-eyed vireo	x	x	x	x	x	x	x	x	—	—	x	x	x	x	x	—	x	x	—	x	x	x	x	x	x
Red-eyed vireo	—	—	—	—	—	—	—	x	x	—	x	—	—	—	x	—	—	—	—	—	x	—	—	—	x
Blue jay	x	—	x	—	x	x	x	x	x	—	x	—	x	x	—	x	—	—	—	—	x	—	—	—	—
Florida scrub-jay	—	—	—	—	—	—	—	—	—	—	—	—	x	—	—	—	—	—	—	—	—	—	—	—	—
Fish crow	—	x	—	—	—	—	—	—	—	—	—	—	x	—	—	—	—	—	—	—	—	—	—	x	—
Barn swallow	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	x	x	—

Table 3 (continued). Landbird species detected (x=detected) at Canaveral National Seashore by sampling location number in 2017. See Figure 1 for a map of sampling locations.

Common Name	02	05	06	10	12	13	16	18	19	20	21	22	23	24	27	28	32	33	34	35	36	37	38	39	43
Tufted titmouse	–	–	–	–	–	x	x	–	x	–	x	x	x	x	–	x	x	–	–	x	x	–	x	–	x
House wren	–	–	–	–	–	x	–	–	–	–	–	–	–	–	–	–	–	–	x	–	–	–	–	–	–
Carolina wren	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Blue-gray gnatcatcher	x	–	–	–	–	–	x	x	x	–	x	x	x	–	–	x	–	–	–	x	x	–	–	–	x
Eastern bluebird	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	x	–	–	–	–	–	–	–	–	–
American robin	–	–	–	–	–	–	–	–	–	–	–	x	–	–	–	–	–	–	–	–	–	–	–	–	–
Gray catbird	x	–	–	–	–	x	–	x	x	–	x	x	–	x	x	–	x	x	x	x	x	x	x	–	x
Cedar waxwing	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	x	–	–	–	–	–
House finch	–	–	–	–	x	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Chipping sparrow	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	x	–	–	–	–	–
Eastern towhee	x	x	x	x	x	x	–	x	–	–	–	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Eastern meadowlark	–	x	–	x	–	–	–	–	–	–	–	–	–	–	x	–	–	–	–	–	–	–	–	–	–
Red-winged blackbird	x	x	–	x	x	–	x	–	–	x	–	–	–	x	x	–	x	x	x	–	–	–	x	x	–
Brown-headed cowbird	–	–	–	–	–	–	–	–	–	–	x	–	–	–	–	–	–	x	–	–	–	–	–	–	–
Common grackle	–	–	–	–	–	–	–	x	–	–	–	x	x	–	–	–	–	–	–	–	–	x	–	–	–
Boat-tailed grackle	–	x	–	–	–	–	–	–	–	x	–	–	–	–	–	–	x	–	–	–	–	–	–	–	x
Orange-crowned warbler	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	x	–	–	–	–	–
Common yellowthroat	x	–	–	x	–	x	–	–	–	x	–	x	x	x	x	–	x	x	x	x	–	x	x	–	x
American redstart	–	–	–	–	–	–	–	–	–	–	x	–	–	x	–	–	–	–	–	–	–	–	–	–	–
Northern parula	–	–	–	–	–	–	–	x	x	–	x	x	–	–	–	x	–	–	–	–	x	–	–	–	–
Black-throated blue warbler	–	–	–	–	–	–	–	x	–	–	–	–	–	–	–	–	x	–	–	–	–	–	–	–	–
Pine warbler	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	x
Prairie warbler	–	–	–	–	–	x	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	x
Northern cardinal	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Indigo bunting	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	x	–	–	–	–	–
Sampling Location Observed Species Richness	18	16	8	13	15	17	11	16	11	13	17	18	22	14	13	12	17	11	12	18	17	10	15	9	17

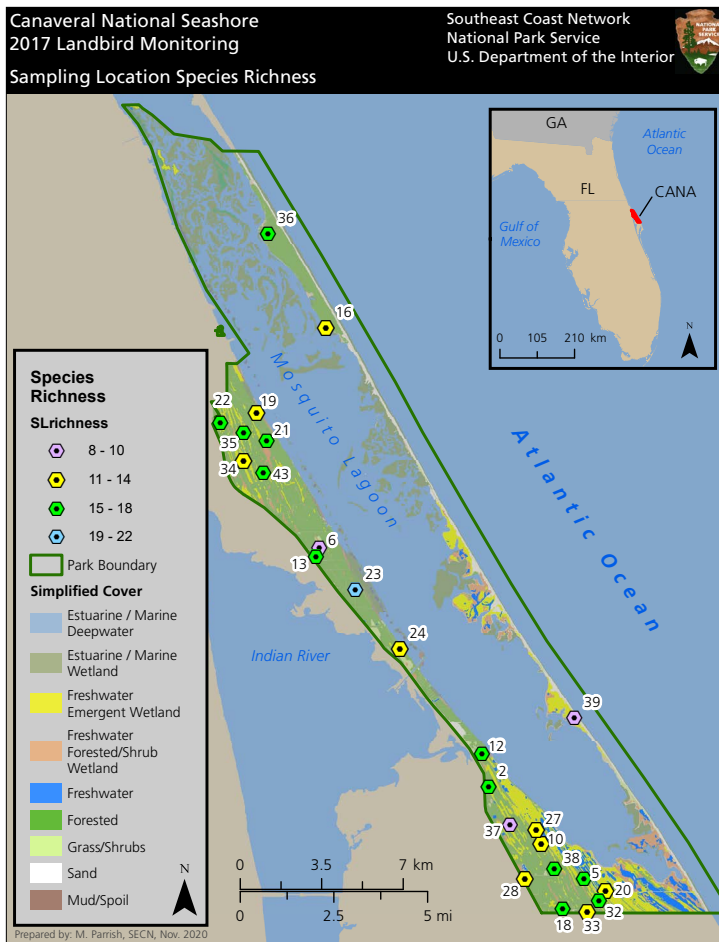


Figure 2. Species richness at 25 sampling locations at Canaveral National Seashore in 2017. Sample location ID numbers are indicated.

Literature Cited

- Begon, M., J. L. Harper, and C. R. Townsend. 1986. *Ecology: Individuals, Populations and Communities*. Blackwell Scientific, Oxford, UK.
- Byrne, M. W. 2012. Generating a Spatially-balanced Random Sample with the RRQRR tool in ArcGIS 9.1 and ArcGIS 9.3.1. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—1.1.1. National Park Service, Athens, Georgia. Available at: <https://irma.nps.gov/DataStore/Reference/Profile/2215882> (last accessed November 2021).
- Byrne, M. W., C. J. Wright, E. Thompson, and C. D. Jones. 2014. Protocol for monitoring landbird communities in Southeast Coast Network Parks. Natural Resource Report NPS/SECN/NRR—2014/853. National Park Service, Fort Collins, Colorado. Available at: <https://irma.nps.gov/DataStore/Reference/Profile/2216122> (last accessed November 2021).
- Chao, A., K. H. Ma, T. C. Hsieh, and C. H. Chiu. 2016. SpadeR (Species-richness Prediction And Diversity Estimation in R): an R package in CRAN. Program and User's Guide available online at: <http://chao.stat.nthu.edu.tw/> (last accessed November 2021).
- Chiu, C. H., and Y. Wang, B. Walther, and A. Chao. 2014. An improved nonparametric lower bound of species richness via a modified good-turing frequency formula. *Biometrics*. 70. 10.1111/biom.12200.
- Indian River Lagoon National Estuary Program. 2019. Annual Report 2019. Indian River Lagoon National Estuary Program, Sebastian, Florida.
- Integrated Taxonomic Information System (ITIS). 2022. Integrated Taxonomic Information System (ITIS) Online Database. Available at: <http://www.itis.gov> (last accessed March 2022).
- Montoya, J. M., and D. Raffaelli. 2010. Climate Change, Biotic Interactions and Ecosystem Services. *Philosophical Transactions of the Royal Society B* 365:2013–2018.
- National Park Service (NPS). 2022. NPSpecies: Information on species in national parks. Available at: <https://irma.nps.gov/NPSpecies/> (last accessed March 2022).
- Wildlife Acoustics, Inc. 2019. Kaleidoscope Pro 5 User Guide. Available at: <https://www.wildlifeacoustics.com/images/documentation/Kaleidoscope-Pro-5-User-Guide.pdf> (last accessed November 2021).

Acknowledgements

Data analysis and reporting were performed by the protocol lead, Michael Parrish. Former SECN staff member Jason Gardner deployed and collected ARDs in the Canaveral National Seashore in 2017. We wish to thank Lily Martin, UGA Graduate Intern, for assistance with data processing and SECN Physical Scientist Stephen Cooper for cartographical assistance.

About the Southeast Coast Network

In 1999, the National Park Service initiated a long-term ecological monitoring program, known as “Vital Signs Monitoring,” to provide the minimum infrastructure to allow more than 270 national park system units to identify and implement long-term monitoring of their highest-priority measurements of resource condition. Monitoring resources in parks develops scientifically sound information on the current status and long-term trends in the composition, structure, and function of park ecosystems, and determines how well current management practices are sustaining those ecosystems.

The NPS Vital Signs Monitoring Program addresses five goals for all parks with significant natural resources:

- Determine the status and trends in selected indicators of the condition of park ecosystem,
- Provide early warning of abnormal conditions,
- Provide data to better understand the dynamic nature and condition of park ecosystems,
- Provide data to meet certain legal and Congressional mandates, and
- Provide a means of measuring progress towards performance goals.

The Southeast Coast Network (SECN) includes eighteen administrative areas containing twenty park units, fifteen of which contain significant and diverse natural resources. In total, SECN parks encompass more than 184,000 acres of federally-managed land across North Carolina, South Carolina, Georgia, Alabama, and Florida. The parks serve a wide diversity of cultural and natural resource missions and include: five national monuments, four national seashores, three national battlefield parks, two national historic parks, a national memorial, a national recreation area, an ecological and historic preserve, and a single national park. The parks range in size from slightly more than 20 acres to nearly 60,000 acres, and when considered with non-federal lands jointly managed with NPS, the network encompasses more than 253,000 acres.

For More Information

SECN Home Page:

<https://www.nps.gov/im/secn/index.htm>

SECN Reports & Publications:

<https://www.nps.gov/im/secn/reports-publications.htm>

About the NPS Inventory & Monitoring Program:

<https://www.nps.gov/im/index.htm>

Data Downloads via the Natural Resource Information Portal:

<https://irma.nps.gov/Portal/>



A great blue heron (*Ardea herodias*), one of numerous species detected during monitoring in 2017. NPS Photo / Steele.