



# Biodiversity of Birds in Everglades National Park

## *An Updated Species List with Habitat Associations*

Natural Resource Report NPS/EVER/NRR—2015/1042





**ON THIS PAGE**

Photograph of a diverse group of freshwater marsh birds taking flight at Everglades National Park. Photograph courtesy of S. Zenner and the National Park Service.

**ON THE COVER**

Photograph of a group of diverse birds feeding in the brackish waters of Mrazek Pond at Everglades National Park. Photograph courtesy of R. Parenti and the National Park Service.

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# **Biodiversity of Birds in Everglades National Park**

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Natural Resource Report NPS/EVER/NRR—2015/1042

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## Abstract

Protecting biodiversity is important for Everglades National Park (EVER). EVER was the first park to have its biodiversity recognized in its enabling legislation enacted in 1934. Field monitoring in EVER is challenging, and consequently, elucidating details of the park's biodiversity is a slow and complicated effort. In order to progress more rapidly, EVER updated the dataset of species and habitat associations developed under a project funded by the Critical Ecosystems

Studies Initiative (CESI) using a comprehensive literature review that included citizen science databases. EVER is recommending that the South Florida and

Caribbean Inventory and Monitoring Network (SFCN) use the CESI dataset to update the internet accessible species lists on the National Park Service website <https://irma.nps.gov/NPSpecies/> (NPSpecies). The SFCN provided a quality assurance and quality control (QAQC) analysis of the updated CESI species lists. Predictions were made of the spatial distribution of species by comparing their preferred habitats to vegetative communities found within EVER's physiographic regions.

This report addresses the bird species found within EVER. This analysis refined our understanding of how native, threatened and endangered, and non-native species may affect overall biodiversity. Recommendations are included regarding next steps for refining the list of bird species and potential initiation of long-term monitoring of bird biodiversity in EVER. Other reports will address mammals, fish, reptiles and amphibians. Additional taxonomic groups will be addressed in separate reports as the information is collected and vetted as appropriate.



**Photo 1.** American flamingos (*Phoenicopterus ruber*) at Mud Lake, Everglades National Park. Photo courtesy of F. Francis and National Park Service.



**Photo 2.** Swallow-tailed kite (*Elanoides forficatus*) flying over pinelands in Everglades National Park. Photo courtesy of R. Cammauf and National Park Service.

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**Photo 3.** Glossy ibis (*Plegadis falcinellus*) and roseate spoonbill (*Platalea ajaja*), a Species of Special Concern, in Everglades National Park. Photo courtesy of National Park Service.

## Introduction

Calculating the native biodiversity of birds in Everglades National Park (EVER) is a critical component of understanding, protecting, and enjoying the park's natural resources. Biodiversity is generally associated with the health of an ecosystem, and therefore it is an important indicator for park management to track. This is particularly true for areas that are expected to have few impacts of human development, such as large tracts of designated wilderness. The diversity of native species should be managed to remain stable over time and contribute to the resilience of the park's ecosystems (Ceausu, 2015; Hobbs et al., 2009; Walker, 2002). With 87% of EVER designated as the Marjory Stoneman Douglas Wilderness, actual resilience will be dependent on internal and external impacts to the large habitat buffers provided by the managed wilderness area. As scientific knowledge of the Everglades grows, we can continue to explore questions such as "How is biodiversity distributed across the Everglades landscape?"

Bird populations and the number of bird species have often been considered a good indicator of detectable change in the environment (North American Bird Conservation Initiative, 2014; Schwab et al., 2006; Mosley, 1930). This is especially true in EVER where the habitats available for birds include a uniquely diverse combination of water, land, and tropic and sub-tropic vegetation. Evaluating the biodiversity of birds alone may not be sufficient for identifying areas of high overall biodiversity and adding other taxa to the measured group can be more effective (Larsen et al., 2012). Biodiversity is expressed in this study as species richness, which is the number of different species of each taxonomic category, in this case birds. Using what is known about each species' preferred habitat, a spatial distribution of the biodiversity of birds among ecological regions in EVER can be produced.

Birds that are part of the Everglades ecosystem include native residents, migrants, and local and regional vagrants that fly in looking for food or shelter from an off-shore storm. There is also a growing population of non-native bird species. Non-native birds are considered to be those that were introduced by human activity either deliberately or by accident. Although little is known about the ecological impacts of many non-native birds in the Everglades, some non-native bird species potentially induce more harm to EVER's natural resources than others. Those that cause the greatest impact are likely to be targeted for management action, e.g., purple swamphen (FFWCC 2014b).

Park-wide information on species diversity is found on the National Park Service website National Park Service website for their Integrated Resource Management Application <https://irma.nps.gov/NPSpecies/> (NPSpecies). NPSpecies is an online database created to track the occurrence of species in park units across the nation (NPS, 2014). NPSpecies is used by land managers that need to have a general picture of species diversity within national park units. It is also available for public use. The NPSpecies dataset for EVER is managed by the South Florida Caribbean Inventory and Monitoring Network (SFCN). Creation of the current list of birds in NPSpecies for EVER has relied on the limited primary sources of information available, which are park species lists and inventory data available from pre-2001 Christmas Bird Counts led by the

National Audubon Society. The majority of the bird species in NPSpecies and the park's check list were last updated in 2006 (NPS, 2014; Cunningham and Bass, 2006).

Keeping NPSpecies up-to-date is a time-consuming process. EVER can provide information intended to update NPSpecies by reviewing the references used for the existing information, adding information from relevant literature previously not applied, and then maintaining the dataset using new information from recent field studies that may include citizen science databases.

The usefulness of the information provided by NPSpecies is reliant upon the application of consistent quality assurance (QA) and quality control (QC) methods to the data from inventories, including data entered from all-taxa inventories and bio-blitzes (Budde and Kingston, 2014; Selleck 2014). By applying a QAQC process, data managers who maintain NPSpecies as a source of information can then also be prepared in the event of large-scale updates such as a bio-blitz or small scale field inventories intended to verify the current species lists. Keeping NPSpecies current may also include more reliance on the use of on-line citizen science databases in the future with appropriate QAQC checks (NPS, 2013b). By implementing as much as possible a QAQC process and peer reviewed Natural Resource Reports of species lists prior to the data from any source being entered into NPSpecies, the accuracy of the information available in NPSpecies for EVER can be improved. For example, each species should be validated by associating it to a voucher specimen, photograph, report or paper.

This first objective of this project was to create a single current park bird list using the information available from an in-house study at EVER funded by the Critical Ecosystems Studies Initiative (CESI dataset), NPSpecies, eBird.org, EDDMaps.org, and other sources. A second objective was to provide habitat associations for each species, and to examine the distribution of bird species across broad physiographic regions in EVER. This work was done in cooperation with the SFCN. It should be noted that for this study neither species richness nor its spatial distribution is considered as a surrogate for the abundance of species. A citizen science database that potentially may be used to confirm the spatial distribution of bird species and provide references of observations for the list of observed species was identified.

## Methods

The first step in this study was an update of the CESI dataset. The CESI dataset was created during 2001-2003 (Howington, 2008), initially using the 1996 EVER bird species check list for visitors (Robertson et al., 1996). The CESI dataset was updated in 2006 when the park list was updated (Cunningham and Bass, 2006). The dataset was originally created in Excel in a format required to facilitate a GIS application intended as a modeling tool for ecosystem restoration; however, the dataset can be used independently of the GIS application. The final list of species, which has breeding, seasonal occurrence, and a general description of the preferred habitats, is provided in Howington (2015).

Habitat associations were determined for each individual bird species by using published information on the species preferred habitat in Florida that includes Peterson (2002), USFWS (1999), Myers and Ewel (1990), and personal knowledge and experience of the principle investigator and determining the corresponding habitats within EVER as identified by the Florida GAP program (F-Gap) (Pearlstine et al., 2002). The hydroperiod associated with the habitat, available as part of the original ecosystem modeling effort, was also taken into account (Wetzel, 2001). Table 1 provides the list of F-Gap vegetative communities used in this study. Qualitative abundance and occurrence information that is reported in NPSpecies was not included in the CESI dataset.

**Table 1. The list of F-Gap vegetative communities used in this study and F-Gap codes.**

| <b>F-Gap Vegetative Community Types</b>                             | <b>F-Gap Code</b> |
|---|-------------------|
| Open Saltwater/Seagrass/Sandy Bottom                                | 1                 |
| Tropical Hardwood Hammock Formation                                 | 2                 |
| Semi-Deciduous Ecological Complex Tropical/Subtropical Swamp Forest | 3                 |
| Xeric-Mesic Live Oak Ecological Complex                             | 4                 |
| Mesic-Hydric Live Oak, Sabal Palm Ecological Complex                | 5                 |
| Bay/Gum/Cypress Ecological Complex                                  | 6                 |
| Lobolly Bay Forest  | 7                 |
| Cajeput Forest  | 8                 |
| Mixed Mangrove Forest Formation                                     | 9                 |
| Black Mangrove Forest   | 10                |
| Red Mangrove Forest   | 11                |

**Table 1. (continued).**

| <b>F-Gap Vegetative Community Types</b>             | <b>F-Gap Code</b> |
|---|-------------------|
| Casuarina Compositional Complex                     | 12                |
| South Florida Slash Pine Forest                     | 13                |
| Mesic-Hydric Pine Forest                            | 16                |
| Swamp Forest Ecological Complex                     | 17                |
| Cypress Forest                                      | 18                |
| Buttonwood Woodland                                 | 20                |
| Mixed Mangrove Woodland                             | 21                |
| Black Mangrove Woodland                             | 22                |
| Red Mangrove Woodland                               | 23                |
| South Florida Slash Pine Woodland                   | 25                |
| Dry Prairie Ecological Complex                      | 29                |
| Gallberry/Saw Palmetto                              | 30                |
| Brazilian Pepper Shrubland                          | 31                |
| Dwarf Mangrove Ecological Complex                   | 32                |
| Coastal Strand                                      | 33                |
| Groundsel-tree/Marsh Elder Tidal Shrubland          | 34                |
| Saturated-Flooded Cold Ecological Complex Shrubland | 37                |
| Saltwort/Glasswort Ecological Complex               | 38                |
| Graminoid Emergent Marsh                            | 42                |
| Sawgrass Marsh                                      | 43                |
| Spikerush Marsh                                     | 44                |
| Muhly Grass Marsh                                   | 45                |

**Table 1. (continued).**

| <b>F-Gap Vegetative Community Types</b>  | <b>F-Gap Code</b> |
|--|-------------------|
| Cattail Marsh                            | 46                |
| Salt Marsh Ecological Complex            | 47                |
| Sand Cordgrass Grassland                 | 48                |
| Black Needle Rush Marsh                  | 49                |
| Saltmarsh Cordgrass Marsh                | 50                |
| Saltmeadow Cordgrass/Salt Grass Marsh    | 51                |
| Sparsely Wooded Wet Prairie              | 52                |
| Dwarf Cypress Prairie                    | 53                |
| Temperate Wet Prairie                    | 54                |
| Maidencane Marsh                         | 55                |
| Forb Emergent Marsh                      | 56                |
| Water Lily or Floating Leaved Vegetation | 57                |
| Periphyton                               | 58                |
| Sand, Beach                              | 59                |

This comprehensive bird-habitat dataset was reviewed to identify species that are listed by the federal and/or state government as threatened or endangered (T&E) following the guidelines in the Endangered Species Act of 1973 with amendments (Title 16 of the United States Code). Updates were obtained from information available on the US Fish and Wildlife Service website (USFWS, 2014) and the Florida Fish and Wildlife Conservation Commission website (FFWCC, 2014). Listings of species vulnerability were added for migratory species (USFWS, 2014) and those species considered as potentially in need of greater management protection by the Florida Natural Areas Inventory (FNAI) website (FNAI, 2014). Species considered as vulnerable and not threatened or endangered were not included as part of the T&E category in this study.

The list of non-native species in the dataset was updated using the Early Detection and Distribution Mapping System (EDDmaps) on-line citizen science database (EDDmaps, 2014). Habitat associations were made for non-native species by interpreting the preferred habitats of non-native

species in Florida provided by the Florida Fish and Wildlife Conservation Commission (FFWCCb, 2014) into the F-Gap vegetative communities.

For the purpose of examining patterns of bird diversity, and to facilitate the presentation of species lists, much of this analysis uses these three categories of bird species within EVER: 1) native, non-T&E species (no special status), 2) T&E species (special status species), and 3) non-native species. Howington (2015), which contains the data and graphics associated with this report, is organized accordingly.

The second step of this study was to determine distribution of the species among EVER physiographic regions. As part of the Natural Resource Condition Assessment (NRCA) for EVER, the SFCN analyzed available vegetation and landscape information and created a map of 17 physiographic regions based on dominant physical and biological features of the landscape (NPS, *in press*). Figure 1 shows the map resulting from the analysis. This map was overlaid on the map of the F-Gap vegetative communities so that the bird species in the CESI dataset could be associated with the physiographic regions.

A full description of each physiographic region can be found in the EVER NRCA (NPS, *in press*). The distribution of F-Gap vegetative communities within the physiographic regions is provided in Table 2. The detailed results of this step and metadata are provided in the dataset associated with this report (Howington, 2015).

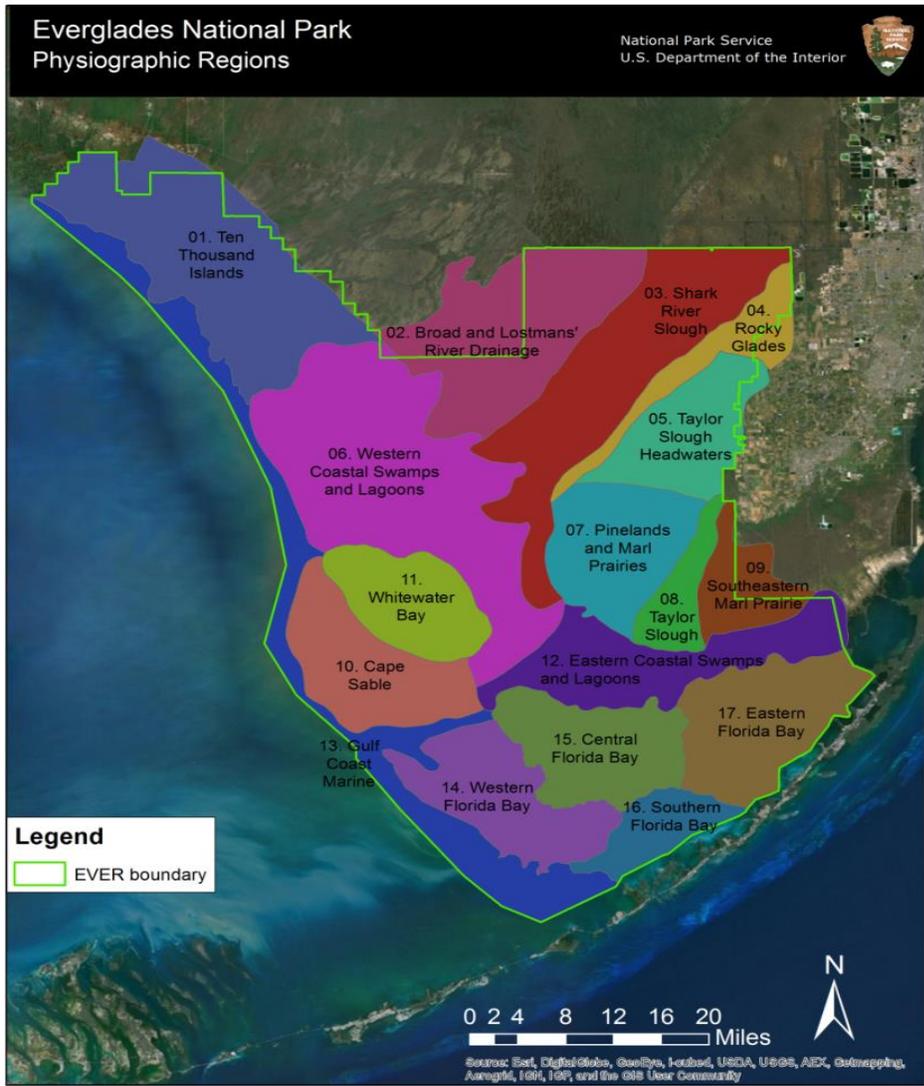


Figure 1. The map of EVER's 17 physiographic regions created as part of the NRCA.

Table 2. Assignments of F-Gap codes to EVER NRCA regions.

| Physiographic Regions                        | F-Gap codes of vegetative communities found within physiographic regions |
|--|--|
| Region 1 - Ten Thousand Islands              | 1, 9, 10, 11, 21, 22, 23, 33   |
| Region 2 - Broad and Lostmans River Drainage | 2, 3, 5, 21, 22, 23, 30, 43, 44, 46, 55, 56, 57, 58, 59                  |

**Table 2. (continued).**

| <b>Physiographic Regions</b>                       | <b>F-Gap codes of vegetative communities found within physiographic regions</b>  |
|--|--|
| Region 3 - Shark River Slough                      | 2, 3, 5, 17, 43, 44, 55, 56, 57  |
| Region 4 - Rocky Glades                            | 5, 8, 12, 43, 44, 45, 46, 55, 56, 58   |
| Region 5 - Taylor Slough Headwaters                | 2, 3, 4, 5, 8, 25, 30, 43, 44, 45, 46, 52, 55, 56, 58                            |
| Region 6 - Western Coastal Swamps and Lagoons      | 9, 10, 11, 17, 18, 21, 22, 23, 33, 59  |
| Region 7 - Pineland and Southwestern Marl Prairies | 2, 3, 4, 5, 6, 7, 13, 16, 18, 25, 29, 30, 31, 32, 42, 45, 46, 52, 53, 55, 56, 58 |
| Region 8 - Taylor Slough                           | 6, 32, 42, 43, 44, 45, 53, 54, 55, 56, 57, 58                                    |
| Region 9 - Southeastern Marl Prairies              | 3, 8, 6, 17, 18, 42, 43, 44, 45, 46, 54, 55, 56, 58                              |
| Region 10 - Cape Sable                             | 1, 9, 10, 11, 21, 22, 23, 34, 38, 42, 47, 48, 49, 50, 51, 59                     |
| Region 11 - Whitewater Bay                         | 1, 9, 10, 11, 21, 22, 23   |
| Region 12 - Eastern Coastal Swamps and Lagoons     | 9, 10, 6, 11, 20, 21, 22, 23, 32, 33, 34, 37, 38, 47, 48, 49, 50, 51, 59         |
| Region 13 - Gulf Coast Marine                      | 1  |
| Region 14 - Western Florida Bay                    | 1, 11, 17, 20, 23, 59  |

**Table 2. (continued).**

| <b>Physiographic Regions</b>     | <b>F-Gap codes of vegetative communities found within physiographic regions</b> |
|----------------------------------|---|
| Region 15 - Central Florida Bay  | 1, 9, 11, 23, 33, 50, 51, 59  |
| Region 16 - Southern Florida Bay | 1, 11, 23   |
| Region 17 - Eastern Florida Bay  | 1, 9, 11, 20, 21, 23, 33, 50, 51, 59  |

As a third step, the SFCN provided an independent QAQC of the final species list of birds in the CESI dataset when compared to the species list provided in NPSpecies. The QAQC considered the various attributes describing the species and their populations that are documented in NPSpecies and include nativeness, qualitative abundance, general occurrence or frequency of presence in the park, and threatened and endangered status as listed by the federal and state governments. The QAQC reviewer's recommendations as to which species should not be considered to be in the park and which might be added to the NPSpecies list were incorporated as an update to the CESI dataset. The QAQC also included whether species in NPSpecies and the CESI dataset were equally identified in terms of the common and scientific names being used.

As a fourth step to this study, a final review was conducted of the SFCN QAQC recommendations, the EVER bird list in NPSpecies, and the most recent park bird list. Decisions were made as to what would remain and what might be changed in the updated CESI species list based on the following criteria:

- If SFCN recommended the species not be considered in the park, it was removed from the dataset.
- If SFCN recommended that the species should be considered at species level only and not variety, the dataset was updated to reflect only species level identification.
- Some species listed in NPSpecies but not in most recent park check list were not added to the CESI dataset. The species in this category are all considered vagrants, occur not more than occasionally, and have only 1 or no observation references listed in the dataset in the NPSpecies dataset. The rationale is to ensure that all species occurring in the final list are the result of more than one documented observation. This should help to eliminate errors of inclusion, and is conservative when estimating biodiversity.
- EDDMaps was used as the current authority for the occurrence of non-native species in the park. This eliminated some species that are currently in NPSpecies. Use of the

EDDmaps.org website is recommended in the future to determine the status of a species as “native” or “non-native” though there are known examples of the limitations of this resource such as the listing of Wild Turkey (*Meleagris gallopavo*) as a non-native species in south Florida. Species that are native but not residents in EVER are identified as “vagrants” under the NPSpecies field called “NPS Tags” that includes a description of the seasonality of the species occurrence.

- Species listed as having unknown nativeness in NPSpecies is listed as non-native in the CESI dataset if the species appears in EDDmaps.org as non-native. Otherwise, the species is listed as native in the CESI dataset.

The final step in this study was a QAQC by the SFCN to validate the physiographic region associations for the bird species that were made through the literature review process and the F-Gap study when the CESI dataset was developed. This intent of this QAQC was to address the second objective of this study, which was to predict the spatial distribution of bird species across EVER habitats using the best available information. In order to perform the QAQC of valid physiographic region associations with bird species, the SFCN downloaded a dataset of observations of birds in EVER from a citizen science database known as eBird.org (Sullivan et al., 2009). The eBird.org website was developed and is maintained by the Cornell Lab of Ornithology and the National Audubon Society. The downloaded dataset contains observations of birds in EVER from 1954-2014.

Observations in eBird identify a bird by its common name, scientific name, the date of the observation, the name of the observer, and the location of the observation as a GPS coordinate. The eBird dataset, the CESI dataset, the EVER bird species park list, and NPSpecies are quasi-independent data sources with regards to their respective list of species that occur in EVER. Though group entries are not identified as such in eBird, Christmas Bird Count data from the Audubon Society has been entered into eBird for some years. The EVER bird species park list is based partially on the Christmas Bird Counts; hence, so is the NPSpecies and the CESI dataset. The result is that these species lists have a majority of bird species in common. The main difference between the sources of bird lists for EVER is that eBird also accepts bird observations from individual birders year around so that the Christmas Bird Count data only accounts for observations in December and early January for those years that data was entered. Observations in eBird also do not identify birds by their nativeness.

Permission to download eBird data was requested directly from eBird administrators through an eBird account created for this purpose. Once permission was granted, the dataset that encompassed the EVER geographic location was downloaded as a compressed file comma-separated file (.csv). In the downloaded dataset, not all of the records were of sufficient quality for this project. Before analysis of the dataset, the following data clean-up filters were applied:

Some records were submitted as generic locations where a centroid coordinate is plotted on the map. Records with a ‘LOCALITY TYPE’ of T (town), PC (postal code), C (county) or S (state) were removed.

Some records were not identified to the species level. Records with a **'CATEGORY'** of **'spuh'** or **'slash'** were removed.

Some checklists were traveling counts and the observer may have moved between multiple physiographic regions. All observations with an **'EFFORT DISTANCE KM'**  $\geq 50$  were removed.

Some hybrid bird species were observed. All observations with a **'COMMON NAME'** that included **'(hybrid)'** were removed.

Some bird species can be listed in both a wild and domestic form. In order to avoid counting these as two separate species, all observations with a **'COMMON NAME'** that included **'(Domestic type)'** had the **'(Domestic type)'** tag removed.

The most subjective of the filters was a scan of the **'LOCALITY'** names. Any observation with a generic name that did not give confidence that the checklist coordinates were specific and accurate was removed. Examples of vague localities include: Everglades National Park, ENP, ENP – Monroe County, Main Park Road, Tamiami Trail, Florida, Miami, Ochopee, and US-1. Since the **'LOCALITY'** name is chosen by each eBird user, there were dozens of derivations of these vague locations that had to be removed.

Using the coordinates of the observations made in eBird, the SFCN determined the physiographic regions where birds were observed. Duplicate entries of the same species that occurred within the same physiographic region were filtered out in the analysis. The SFCN then compared the numbers of bird species found in each physiographic region to the number of birds found in each region as determined by the CESI dataset habitat-species associations.



**Photo 4.** Eastern meadow lark (*Sturnella magna*) in Hole-in-the-Donut area of Everglades National Park. Photo courtesy of V. Nimwegen and National Park Service.

## Results and Discussion

The EVER NPSpecies dataset includes 366 bird species (NPS, 2014). This list includes 277 native species, 84 non-native species, and 5 species documented as having “unknown” nativeness. The native species include 6 T&E species. The NPSpecies dataset also includes 9 additional species of birds that are considered not to be in the park and are listed as being falsely reported or a historical record of a now extirpated species.

After the QAQC provided by the SFCN, the CESI dataset includes a total of 343 bird species (Howington, 2015). The dataset includes 322 native bird species and 21 non-native bird species. The CESI dataset includes 14 native species that are listed as T&E species.

The QAQC provided by the SFCN recommended that the CESI dataset maintain 5 species of birds as potential additions to the NPSpecies dataset. In contrast, the QAQC recommended the removal of 7 bird species from the CESI dataset that were determined not likely to be found within park boundaries. These recommendations are provided in Table 3.

**Table 3.** Bird species recommended to be added to NPSpecies and removed from NPSpecies as a result of the SFCN QAQC.

| Bird species to be added to NPSpecies from the CESI Dataset     | Bird species to be removed from CESI Dataset                            |
|---|---|
| Everglades snail kite ( <i>Rostrhamus sociabilis plumbeus</i> ) | Whooping crane ( <i>Grus Americana</i> )                                |
| Bachman’s warbler ( <i>Vermivora bachmanii</i> )                | Florida grasshopper sparrow ( <i>Ammodramus savannarum floridanus</i> ) |
| Henslow’s sparrow ( <i>Ammodramus henslowii</i> )               | Wilson's phalarope ( <i>Steganopus tricolor</i> )                       |
| Long-eared owl ( <i>Asio otus</i> )                             | Nashville warbler ( <i>Vermivora ruficapilla</i> )                      |
| Antillean night hawk ( <i>Chordeiles gundlachii</i> )           | White-throated sparrow ( <i>Zonotrichia albicollis</i> )                |
|   | Florida scrub-jay ( <i>Aphelocoma coerulescens</i> )                    |
|   | Hudsonian godwit ( <i>Limosa haemastica</i> )                           |

The QAQC identified 4 species of birds in the CESI dataset be listed only to the species level as it is in NPSpecies rather than to the variety. Detailed results of the QAQC are provided in Howington (2015).

Four native species that appear in NPSpecies were not included in the CESI dataset because they had one or zero sightings in the last 10 years, or they had no documentation. Twenty-five species that

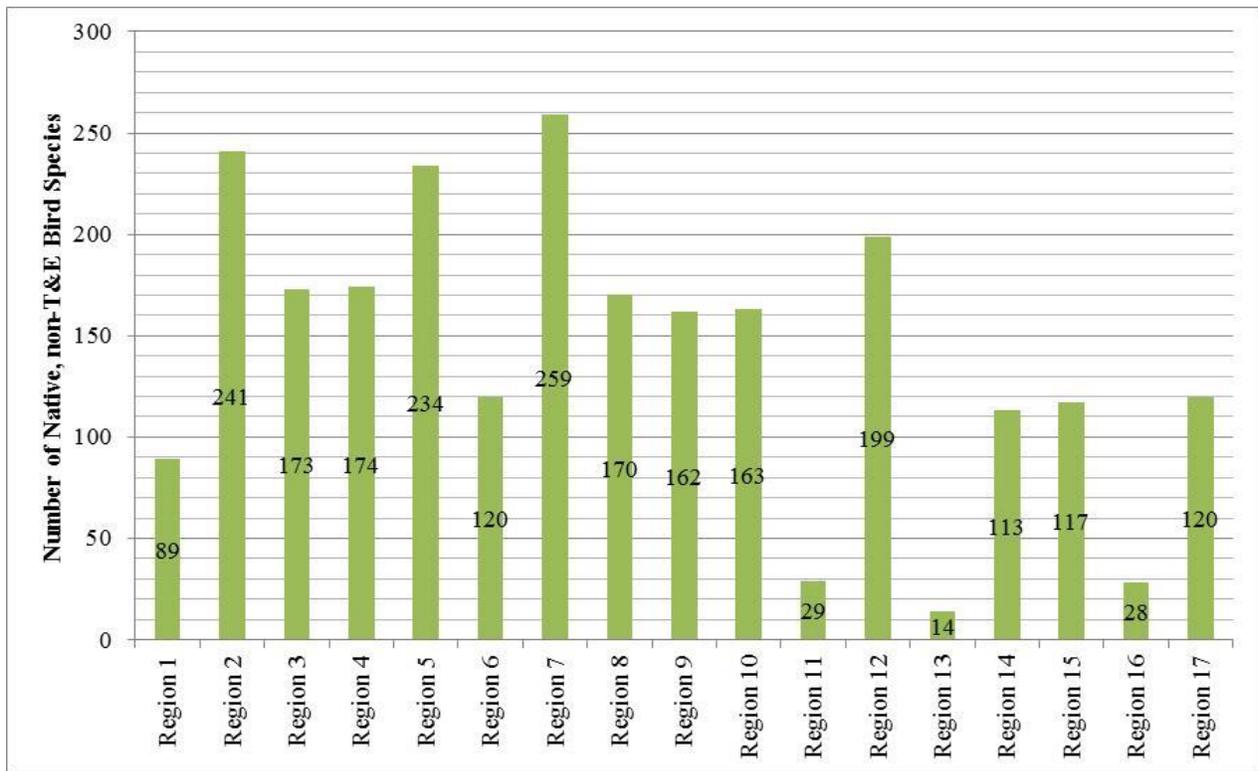
appear as non-native in NPSpecies were not included in the CESI dataset because they are not listed as non-native occurrences in EDDMaps.

The species list in the CESI dataset identifies 52 different avian guilds in EVER (see Table 4). Guilds are defined as grouping of species having similar traits of behavior, such as feeding strategy, or habitat preferences.

**Table 4.** List of the avian guilds found in EVER identified in this study. Guilds with one asterisk [\*] contain non-native species and those with two asterisks [\*\*] only contain non-native species.

|                                      |                                    |                              |                        |
|--------------------------------------|------------------------------------|------------------------------|------------------------|
| Bitterns, Herons, Egrets and Allies* | Goatsuckers                        | Oystercatchers               | Storks*                |
| Blackbirds and Orioles               | Grebes                             | Parrots and Parakeets**      | Swallows               |
| Boobies and Gannets                  | Hummingbirds                       | Pelicans                     | Swifts                 |
| Cardinals and Buntings               | Ibises and Spoonbills              | Pigeons and Doves*           | Tanagers               |
| Chicken**                            | Jaegers, Gulls, Terns and Skimmers | Pipits                       | Threskiornithidae      |
| Cranes                               | Jays and Crows                     | Plovers                      | Titmice and Nuthatches |
| Creepers and Wrens                   | Kingfishers                        | Rails, Gallinules and Coots* | Tyrant Flycatchers     |
| Cuckoos and Anis                     | Limpkins                           | Sandpipers and Phalaropes    | Vireos                 |
| Darters and Cormorants               | Loons                              | Shearwaters and Petrels      | Vultures               |
| Ducks, Geese and Swans*              | Mockingbirds and Thrashers*        | Shrikes                      | Waxwings               |
| Falcons, Grouse and Ptarmigans       | Old World Warblers and Thrushes    | Sparrows*                    | Weavers                |
| Finches                              | Osprey, Kites, Eagles and Harriers | Starlings                    | Wood Warblers          |
| Frigate birds                        | Owls                               | Stilt and Avocets            | Woodpeckers            |

An average of 150 bird species is predicted to be found in any one of EVER’s physiographic regions. Three physiographic regions each include 70-80% of the entire complement of native bird species found in EVER: Region 2 Broad and Lostsman River Drainage (250 species), Region 5 – Taylor Slough Headwaters (243 species), and Region 7 – Pinelands and Marl Prairies (270 species) (See Figure 2).



**Figure 2.** Graph of the total number of native, non-T&E bird species predicted to be found in each physiographic region of EVER.

One explanation for why Regions 2, 5, and 7 have the highest number of native, non-T&E bird species relates back to the complexity of the habitats within these regions. Individual species of birds often prefer many different types of habitats, and these three regions contain the highest number of different F-Gap community types. Regions that contain emergent freshwater marsh or forests of pine, oak and sable palm, or cypress tend to have high numbers of passerines and wading birds. Region 12 – Eastern Coastal Swamps and Lagoons (210 species) has the fourth highest species richness and is located along the west and north border of Region 3 – Shark River Slough. Region 12 includes the freshwater to estuarine transition zone of sawgrass to cypress to mangroves and coastal prairies along Florida Bay.

The regions that have predominately freshwater sloughs or marl prairies are similar to each other in their species richness. These regions include Region 3 – Shark River Slough (177 species), Region 4 – Rocky Glades (179 species), Region 8 – Taylor Slough (177 species), and Region 9 – Southeastern Marl Prairies (168 species).

The physiographic regions with a higher than average numbers of bird species are all within the Shark River Slough and Taylor Slough floodplain wetlands. Floodplains are well known as areas of high biological productivity. High productivity in EVER has been commonly attributed to the alternating pulse of surface water flowing downstream following the wet and dry seasons of South Florida’s climate. Many studies have attributed high species richness to climate and high

productivity at large scales (Field et al., 2008). It is, however, not well understood how the biodiversity of avian communities responds to changes in floodplains that are irregularly forested with tree islands that may have high species richness and large expanses of flooded grasses such as that of Shark River Slough.

The region with the lowest number of total native, non-T&E bird species is Region 13 – Gulf Coast Marine (15 species). Region 13 is entirely open water. Regions 11 – Whitewater Bay and 16 - Southern Florida Bay are predominately open water and mangrove forests and have more species than Region 13 though very relatively low number of species in comparison to the other regions (32 and 31 bird species, respectively).

To better understand general patterns of bird species distributions in EVER, the number of physiographic regions associated with a particular species was analyzed, starting with the subset of native, non-T&E species. Birds occurring in 14 or more physiographic regions were defined as having a broad distribution. Twenty-five native, non-T&E species fell into this category, or approximately 8%. Birds with a narrow distribution were defined as those occurring in 3 or fewer physiographic regions. Thirty-three, or about 10% of native, non-T&E species fell into this category. The species with the broadest and most narrow distribution are listed below in Table 5.

**Table 5.** Native, non-T&E species with broadest distribution and most narrow distribution across EVER's physiographic regions.

| Native, non-T&E species with broadest distributions          | Native, non-T&E species with narrowest distributions                |
|--|---|
| Great blue heron ( <i>Ardea Herodias</i> )                   | Bobolink ( <i>Dolichonyx oryzivorus</i> )                           |
| Great white heron (Egret) ( <i>Ardea alba</i> )              | Spot-breasted oriole ( <i>Icterus pectoralis</i> )                  |
| Green heron ( <i>Butorides virescens</i> )                   | Yellow-headed blackbird<br>( <i>Xanthocephalus xanthocephalus</i> ) |
| Little blue heron ( <i>Egretta caerulea</i> )                | Dickcissel ( <i>Spiza Americana</i> )                               |
| Snowy egret ( <i>Egretta thula</i> )                         | Brown creeper ( <i>Certhia Americana</i> )                          |
| Tricolor heron ( <i>Egretta tricolor</i> )                   | Winter wren ( <i>Troglodytes troglodytes</i> )                      |
| Yellow-crowned night heron<br>( <i>Nyctanassa violacea</i> ) | Cinnamon teal ( <i>Anas cyanoptera</i> )                            |
| American wigeon ( <i>Anas americana</i> )                    | Red-breasted merganser ( <i>Mergus serrator</i> )                   |
| Black scoter ( <i>Melanitta nigra</i> )                      | Whip-poor-will ( <i>Caprimulgus vociferous</i> )                    |

**Table 5. (continued).**

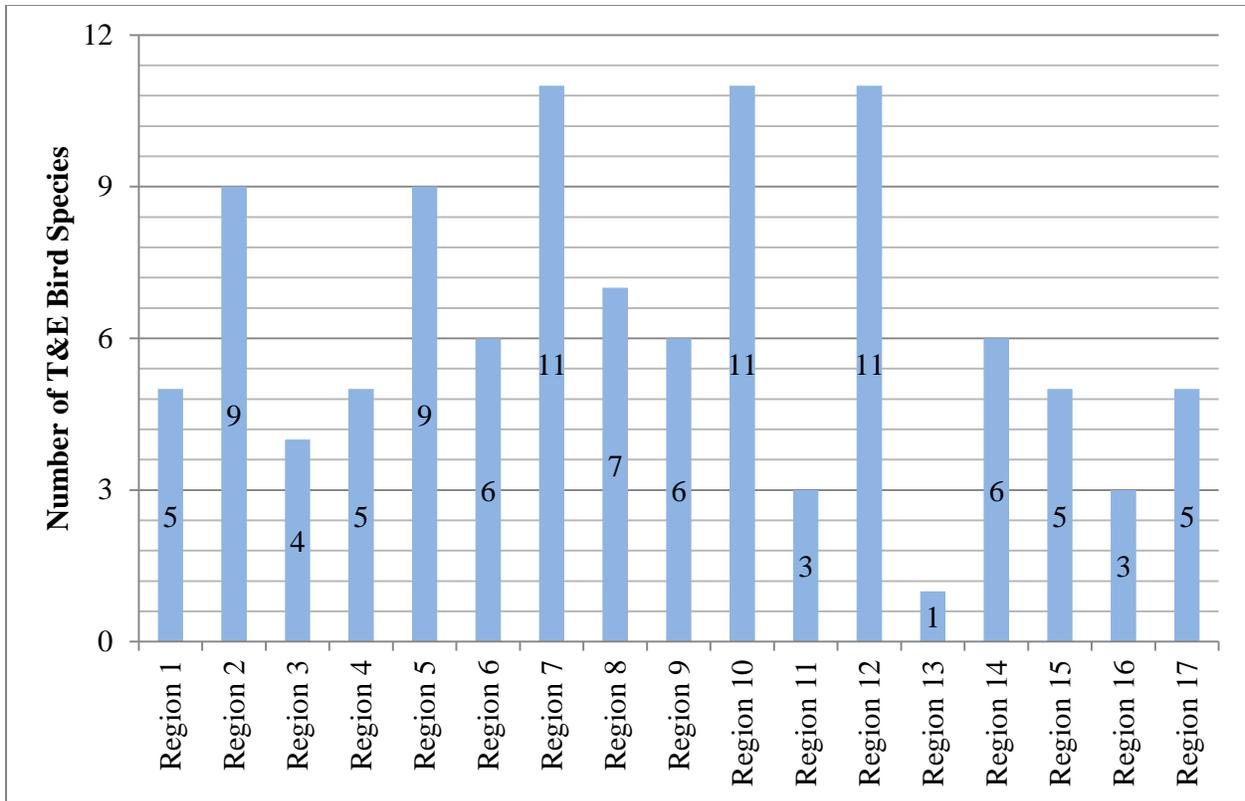
| <b>Native, non-T&amp;E species with broadest distributions</b> | <b>Native, non-T&amp;E species with narrowest distributions</b> |
|--|---|
| Blue-winged teal ( <i>Anas discors</i> )                       | Eastern bluebird ( <i>Sialia sialis</i> )                       |
| Brant ( <i>Branta bernicla</i> )                               | Gray-cheeked thrush ( <i>Catharus minimus</i> )                 |
| Bufflehead ( <i>Bucephala albeola</i> )                        | Hermit thrush ( <i>Catharus guttatus</i> )                      |
| Common goldeneye ( <i>Bucephala clangula</i> )                 | Ruby-crowned kinglet ( <i>Rugulus calendula</i> )               |
| Long-tailed duck (Oldsquaw) ( <i>Clangula hyemalis</i> )       | Swainson's hawk ( <i>Buteo swainsoni</i> )                      |
| Red-necked grebe ( <i>Podiceps grisegena</i> )                 | White-tailed kite ( <i>Elanus leucurus</i> )                    |
| Roseate spoonbill ( <i>Platalea ajaja</i> )                    | Buff-breasted sandpiper ( <i>Tryngites subruficollis</i> )      |
| White ibis ( <i>Eudocimus albus</i> )                          | Chipping sparrow ( <i>Spizella passerina</i> )                  |
| Black tern ( <i>Chlidonias niger</i> )                         | Dark-eyed junco ( <i>Junco hyemalis</i> )                       |
| Royal tern ( <i>Sterna maxima</i> )                            | Lark sparrow ( <i>Calamospiza melanocorys</i> )                 |
| Sandwich tern ( <i>Sterna sandvicensis</i> )                   | Bank swallow ( <i>Riparia riparia</i> )                         |
| Red-throated loon ( <i>Gavia stellata</i> )                    | Barn swallow ( <i>Hirundo rustica</i> )                         |
| Osprey ( <i>Pandion haliaetus</i> )                            | Cliff swallow ( <i>Petrochelidon pyrrhonota</i> )               |
| Brown pelican ( <i>Pelecanus erythrorhynchos</i> )             | Chimney swift ( <i>Chaetura pelagica</i> )                      |
| Marbled godwit ( <i>Limosa fedoa</i> )                         | Summer tanager ( <i>Piranga rubra</i> )                         |

**Table 5. (continued).**

| Native non-T&E species with broadest distributions | Native non-T&E species with narrowest distributions    |
|--|--|
| American avocet ( <i>Recurvirostra Americana</i> ) | Brown-headed nuthatch ( <i>Sitta pusilla</i> )         |
|  | Eastern phoebe ( <i>Sayornis phoebe</i> )              |
|  | Say's phoebe ( <i>Sayornis saya</i> )                  |
|  | Vermillion flycatcher ( <i>Pyrocephalus rubinus</i> )  |
|  | Philadelphia vireo ( <i>Vireo philadelphicus</i> )     |
|  | White-eyed vireo ( <i>Vireo griseus</i> )              |
|  | Bay-breasted warbler ( <i>Dendrocica castanea</i> )    |
|  | Golden-winged warbler ( <i>Vermivora chrysoptera</i> ) |
|  | Palm warbler ( <i>Dendroica palmarum</i> )             |

The Swainson's hawk (*Buteo swainsoni*) and Say's phoebe (*Sayornis saya*) are the two species that may be found in only one of EVER's physiographic regions, which is Region 7 – Pinelands and Southwestern Marl Prairies.

The three regions with the highest number of T&E species each have 12 species out of the 22 T&E species found in EVER: Region 7 – Pinelands and Marl Prairies, which also has the highest number of total native species, Region 10 – Cape Sable, and Region 12 – Eastern Coastal Swamps and Lagoons (see Figure 3). Ten T&E species are predicted to be found in regions with high total native species, Region 2 – Broad and Lottsman River Drainage and Region 5 – Taylor Slough Headwaters. Region 13 – Gulf Coast Marine, which is entirely open water, only has one T&E species. Those regions that have open water also have relatively low numbers of T&E species, which includes Region 3 – Shark River Slough, Region 11 – Whitewater Bay, and Region 16 – Southern Florida Bay (3 species each).



**Figure 3.** Graph of the total number of T&E bird species predicted to be found in each physiographic region of EVER.

Only one T&E species is found within at least 14 of EVER’s physiographic regions. The most narrowly distributed T&E species are those that may be found within 3 of EVER’s physiographic regions.

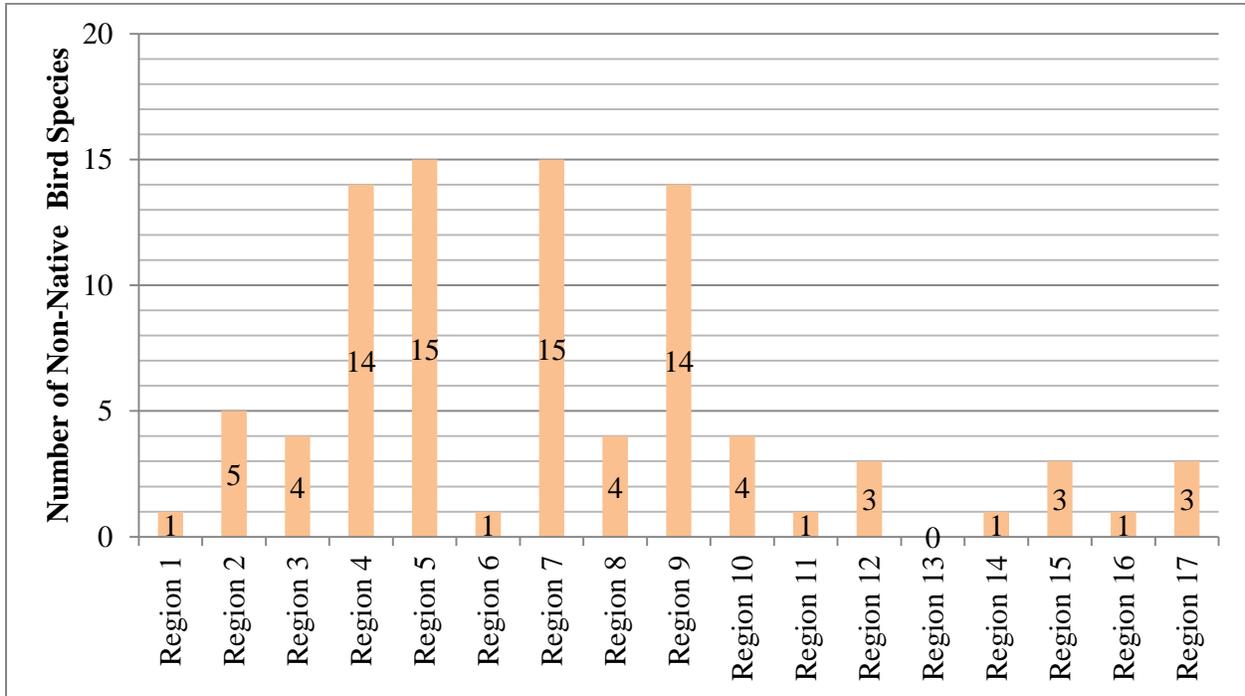
The T&E species with the most broad and most narrow distributions are listed in Table 6.

**Table 6.** T&E species with broadest distribution and most narrow distribution across EVER’s physiographic regions.

| T&E species with broadest distributions                     | T&E species with narrowest distributions                  |
|---|---|
| White-crown pigeon ( <i>Patagioenas leucocephala</i> ) (ST) | Crested caracara ( <i>Caracara cheirway</i> ) (FT)        |
|   | Kirtland’s warbler ( <i>Dendroica kirtlandii</i> ) (FE)   |
|   | Red-cockaded woodpecker ( <i>Picoides borealis</i> ) (FE) |

Four physiographic regions in EVER contain the majority of the non-native birds. Regions 5 – Taylor Slough Headwaters (16 species) and Region 7 – Pinelands and Southwestern Marl Prairies

(16 species) contain the most non-native bird species. Region 4 – Rocky Glades (15 species) and Region 9 – Southeastern Marl Prairies (15 species) have the next highest number of non-native birds (see Figure 4). The physiographic regions closest to Florida Bay contain no more than 5 non-native birds.



**Figure 4.** Graph of the total number of non-native bird species predicted to be found in each physiographic region of EVER.

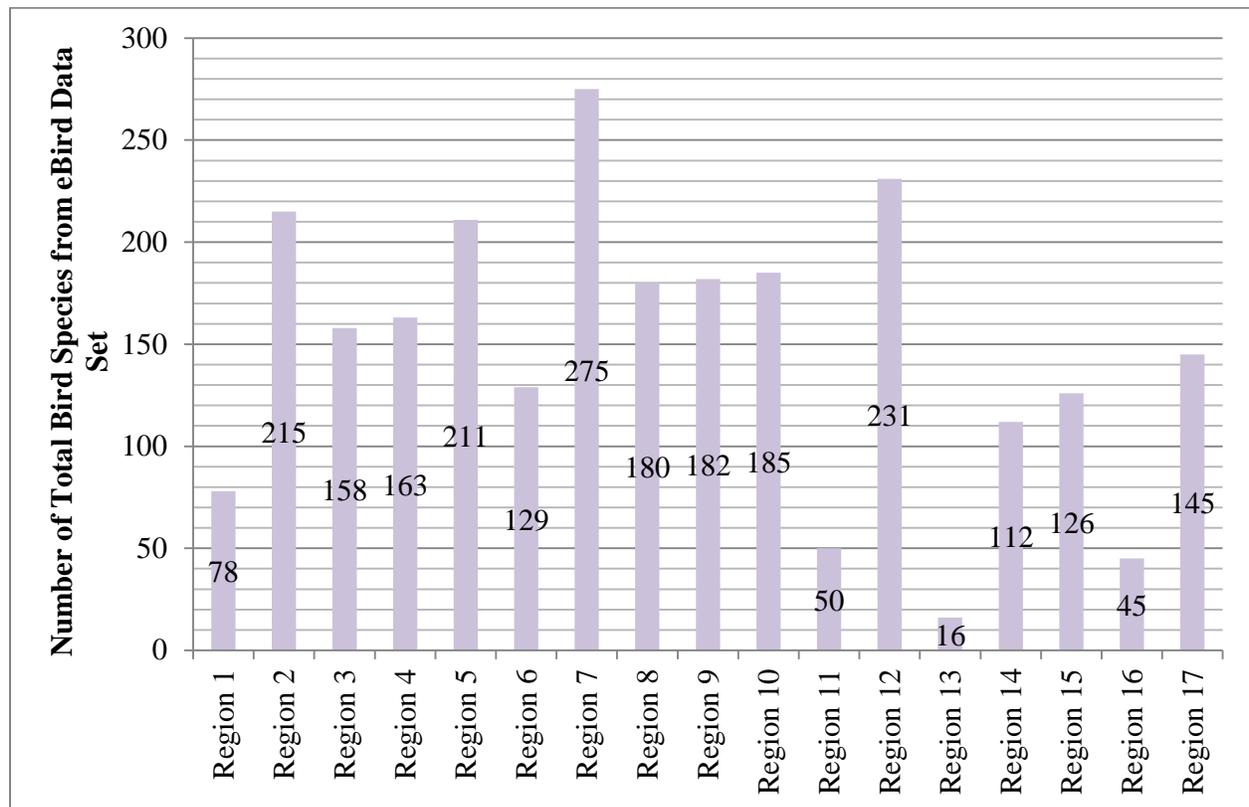
The majority of non-native birds in EVER originated from the urbanized areas in South Florida. These birds were brought into the United States to be pets. There are both New World parrots from the Caribbean and South America and Old World parrots from Africa and Asia in EVER. The regions highest in non-native birds are those that border the eastern edge of the park, which is closest to the urban areas where the non-native birds most likely originate.

Three non-native species were considered to be the most broadly distributed and were associated with more than 8 physiographic regions. Four species were the most narrowly distributed and were associated with less than 3 physiographic regions. The most broadly and most narrowly distributed non-native species are listed in Table 6.

**Table 7.** Non-native species with broadest distribution and most narrow distribution across EVER’s physiographic regions.

| Non-native species with broadest distributions | Non-native species with narrowest distributions  |
|--|--|
| Purple swamphen ( <i>Porphyrio porphyria</i> ) | Black swan ( <i>Cygnus atratus</i> )             |
| Scarlet ibis ( <i>Eudocimus ruber</i> )        | Chicken (feral) ( <i>Gallus gallus</i> )         |
|  | Egyptian geese ( <i>Alopochen aegyptiacus</i> )  |
|  | White-cheeked pintail ( <i>Anas bahamensis</i> ) |

After filtering the eBird database so that it includes only those observations that can be geo-located in one of EVER’s physiographic regions, over 140,000 observations remained. The resulting dataset does not distinguish native from T&E species, nor from non-native species. These observations were graphed and show that the distribution of observed bird species in EVER is very close to the predicted distribution resulting from the CESI dataset of native bird species (see Figures 2 and 5).



**Figure 5.** Graph of the number of total species found in EVER as provided in the eBird.org dataset.

The CESI data and the eBird dataset, when taken as quasi-independent sources of information, both underscore the importance of Regions 2, 5, 7 and 12 to the species richness of birds in EVER.

The eBird website is a data source that should be examined further to improve the bird species list for EVER. Our initial examination of the eBird database indicated that there may be additional species in eBird that are not currently included in NPSpecies. Species identified in eBird were not added to the CESI database: further analysis of the eBird dataset is needed to warrant inclusion of these species in an updated list for EVER.

eBird is an excellent resource for identifying species richness, but is not particularly effective at associating species with habitats given that citizen scientists do not commonly specify location precisely and instead use park map landmarks well known to frequent park visitors.

## Conclusions

The CESI dataset provided here is currently the most updated park-wide species list of birds found in EVER. It is useful as a source of fully-referenced information about native, T&E, and non-native species found in EVER, and associates these species with habitats in EVER as well as with the broader physiographic regions defined in the EVER NRCA.

The eBird.org dataset was identified as an important source of information to update NPSpecies in the future, primarily with respect to species occurrence in EVER. The quantity and frequency of observations in eBird make it a good source for information on rarely-seen and T&E species. The eBird dataset can also serve as a source for information on non-native species, as a complement to EDDMaps. Because sighting location information is quite variable in eBird, and habitats are not routinely documented, at this time eBird should likely not be viewed as a primary source for species-habitat associations. It is recommended to encourage a more specific level of spatial resolution into Christmas Bird Counts done in the park: as these are incorporated into eBird we can continue to improve what is known about birds and the habitats they are using in EVER.

At the larger spatial resolution of physiographic regions, the eBird data can provide a good indicator of the distribution of the species richness of birds across EVER. An added value of eBird is the availability of data describing observations of bird species in EVER year around, and thus the ability to discern seasonal patterns. Further analysis of the eBird dataset could provide information regarding the diversity and patterns of bird migration in EVER, as well as long-term changes in species richness at the spatial resolution of physiographic regions.

The CESI dataset is provided for the purposes of creating an updated EVER bird list for NPSpecies. It is recommended that the information on preferred habitats and seasonal occurrence of species be incorporated into NPSpecies as additional data fields. Inclusion of species-habitat associations in NPSpecies can provide a wealth of information for further analysis, from comparison of different taxonomic groups in park habitats, to examination of long-term changes that can occur throughout park landscapes with time.

A reasonable goal would be to periodically check eBird for new observations of birds in EVER, to take into account when updating NPSpecies. Frequent examination of both EDDMaps and eBird is recommended to keep up with new observations of non-native birds in the park.

Additional studies of interest in the future include tracking biodiversity over time in EVER and looking at the ecosystem-wide effects of climate change and regional ecosystem restoration. As the data in NPSpecies is updated using new information such as the data included in this report, these comparative studies become more feasible, providing pertinent information to resource managers about the status of biodiversity in the park.



**Photo 5.** Willets (*Catoptrophorus semipalmatus*) and marbled godwits (*Limosa fedoa*) taking flight in Florida Bay. Photo courtesy of S. Cotrell and National Park Service.

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