



Biodiversity of Reptiles and Amphibians in Everglades National Park

An Updated Species List with Habitat Associations

Natural Resource Report NPS/EVER/NRR—2015/1068





ON THIS PAGE

Photograph of newly hatched baby alligators (*Alligator mississippiensis*) in Everglades National Park. Photograph courtesy of the National Park Service.

ON THE COVER

Photograph of a Florida red-bellied cooter (*Pseudemys nelsoni*) at Everglades National Park. Photograph courtesy of S. Zenner and the National Park Service.

Biodiversity of Reptiles and Amphibians in Everglades National Park

An updated species list with habitat associations

Natural Resource Report NPS/EVER/NRR—2015/1068

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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 <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 reptile and amphibian 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 reptile and amphibian species and potential initiation of long-term monitoring of reptile and amphibian biodiversity in EVER. Other reports will address birds, mammals, and fish. Additional taxonomic groups will be addressed in separate reports as the information is collected and vetted as appropriate.

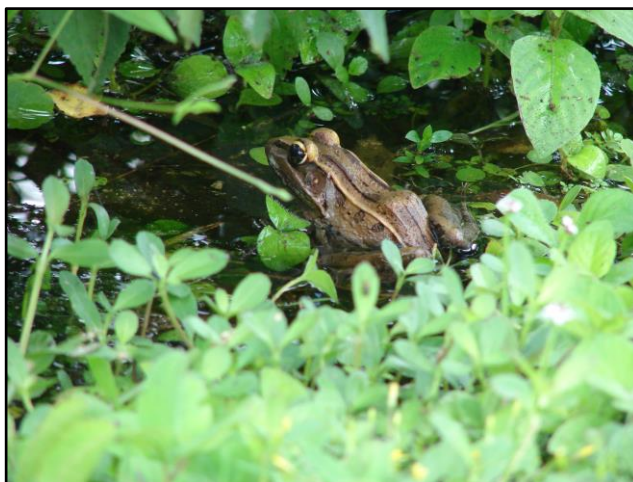


Photo 1. Southern leopard frog (*Rana utricularia*) in freshwater marsh. Photo courtesy of National Park Service.



Photo 2. Head of an island glass lizard (*Ophisaurus compressus*). Photo courtesy of National Park Service.

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Photo 3. Federally threatened Loggerhead sea turtle (*Caretta caretta*) coming onto the beach to build a nest in Everglades National Park. Photo courtesy of National Park Service.

Introduction

Calculating the native biodiversity of reptiles and amphibians 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?"

Studying the species richness of reptiles and amphibians is critical to understanding and predicting habitat community structure and disturbance (McDiarmid et al., 2012; Collins and Halliday, 2005; Meshaka and Babbitt, 2005). Tracking species richness (defined here as the number of native species in a specific area) is especially important in EVER where the habitats available for reptiles and amphibians include a uniquely diverse combination of water, land, and tropic and sub-tropic vegetation. The inventory of reptile and amphibian populations provides important information needed for their protection and persistence especially because of the increasing number of non-native species becoming established in Florida (Krysko et al., 2010). Evaluating biodiversity of reptiles and amphibians is part of an overall biodiversity assessment for the park, but is probably not predictive of biodiversity of other groups. Including reptiles and amphibians as part of a biodiversity assessment is important as analysis using only one taxonomic group, such as bird biodiversity, as a predictor of high overall biodiversity of a region has been shown to have limited utility (Larsen et al., 2012). As a baseline for consideration of biodiversity of animals in EVER, the species list of reptiles and amphibians was examined and updated using available databases and the literature. Biodiversity is expressed in this study as species richness, which is the number of different species of each taxonomic category, in this case reptiles and amphibians. Using what is known about each species' preferred habitat, a spatial distribution of the biodiversity of reptiles and amphibians among ecological regions in EVER was produced.

Reptiles and amphibians that are part of the Everglades ecosystem include native residents that spend their entire lives in the park and local or regional vagrants (like sea turtles) that roam in and out of park boundaries looking for food or temporary refuge. There is also a growing population of non-native reptiles and amphibian species. Non-native reptiles and amphibians 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 of the non-native reptiles and amphibians in the Everglades, some non-native reptile and amphibian species potentially induce more harm to EVER's natural resources than others (NWF, 2014). Those that cause the greatest impact would be most likely to be targeted for management action, e.g., Burmese pythons (*Python bivittatus*).

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 reptiles and amphibians in NPSpecies for EVER has relied on the limited primary sources of information available, which are primarily park species lists and individual observations. The majority of the reptile and amphibian species in NPSpecies and the park's check list was last updated in 2006 (NPS, 2014; Robertson and Kushlan, 2006) and following the SFCN funded inventory by Rice et al. (2004).

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). Data managers who maintain NPSpecies as a source of information for the species that can be found in EVER can then also be prepared in the event of large-scale updates such as a bio-blitz or other 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 reptiles and amphibians species list using the information available from a study funded by the Critical Ecosystems Studies Initiative (CESI) and the NPSpecies with the assistance of the SFCN, EDDmaps.org (EDDmaps (2014) and other sources. The second objective was to provide habitat associations for each species, and to examine the distribution of reptiles and amphibians 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.

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 Steiner and Loftus (1991) EVER reptile and amphibian species check list for visitors. Initially, the preferred habitats of species on the reptile and amphibian species check list was determined by reviewing available literature references that describe observations of reptile and amphibians within EVER and south Florida and included USFWS (1999), Myers and Ewel (1990), and Bangs (1898). Updates to the preferred habitats were made using descriptions of reptile and amphibians found during inventories conducted by Meshaka et al. (2000) and Rice et al. (2004).

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. In 2014, the dataset was split to create a separate dataset file for reptiles and one for amphibians. The methods and references used to create and analyze each remained the same. The final lists of species, which has breeding, seasonal occurrence, and a general description of the preferred habitats, is provided in Howington (2015).

Habitat associations were made separately for each individual reptile and amphibian species by comparing the species preferred habitat in Florida using USFWS (1999), Myers and Ewel (1990), and personal knowledge and experience of the principle investigator, to the habitats within EVER as identified by the Florida GAP program (F-Gap) (Pearlstone et al. 2002). The hydroperiod associated with the habitat was also taken into account as developed by Wetzel (2001). Qualitative abundance and occurrence information that is reported in NPSpecies was not included in the CESI dataset. 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.

F-Gap Vegetative Community Types	F-Gap Code
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
Casuarina Compositional Complex	12
South Florida Slash Pine Forest	13

Table 1. (continued)

F-Gap Vegetative Community Types	F-Gap Code
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
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 reptile and amphibian-habitat dataset was first reviewed to identify species 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 (FFWCCa, 2014). Listings of species vulnerability were added for 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 (FFWCC 2014b and FFWCC 2014c) into the F-Gap vegetative communities. Krysko et al. (2011) was used to determine if any additional details are needed about the habitats where non-native reptiles and amphibians may be found in EVER.

For the purpose of examining patterns of reptile and amphibian diversity, and to facilitate the presentation of species lists, much of this analysis uses these three categories of reptile and amphibian 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 reptile and amphibian 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).

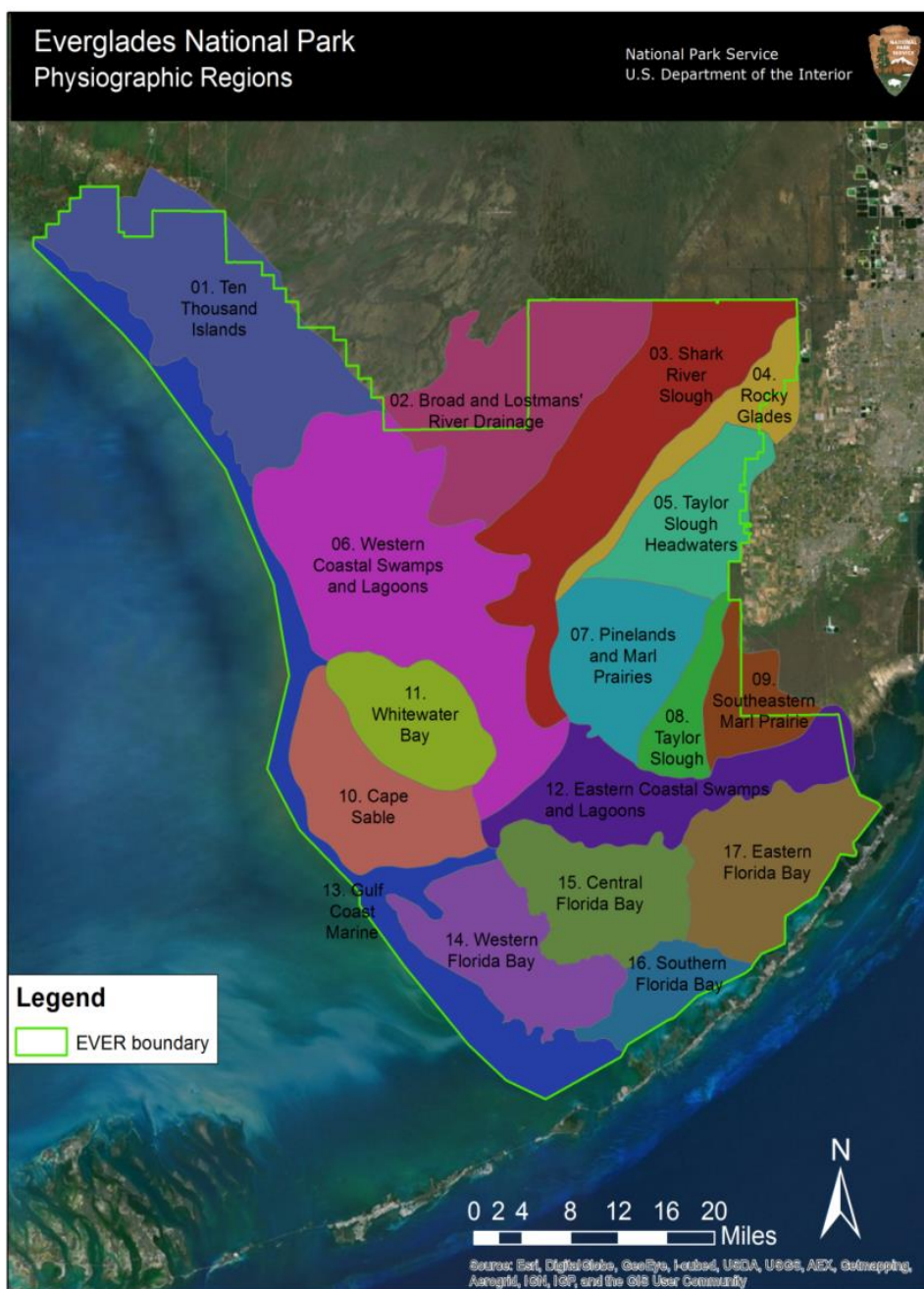


Figure 1. The map of EVER's 17 physiographic regions created as part of the NRCA.

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
Region 3 - Shark River Slough	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
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

The third step of this study was performed by the SFCN. For each update of the species listed by taxonomic group submitted, they provided an independent QAQC of the final species list of reptiles and amphibians in the CESI dataset when compared to the species list provided in NPSpecies. This QAQC was intended to facilitate the process of transferring the CESI dataset to the SFCN to use as their first step toward updating NPSpecies, which was the first objective of this study. 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 reptile and amphibian lists in NPSpecies, and the most recent park reptile and amphibian 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". 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 are 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.

Results and Discussion

The EVER NPSpecies dataset includes 60 reptile species (NPS, 2014). This list includes 52 native reptile species and 8 non-native reptile species. The native species includes 6 species of reptiles listed as T&E species. The EVER NPSpecies dataset includes 21 amphibians species including 18 native amphibians species and 3 non-native amphibians species. There are no amphibian species listed as T&E species. The NPSpecies dataset of reptile and amphibian species is based on Rice et al. (2004) and Meshaka et al. (2000).

After the QAQC provided by the SFCN, the CESI dataset includes 78 reptile species (Howington, 2015). This list includes 42 native, non-T&E reptile species, 10 T&E reptile species, and 26 non-native reptile species. The CESI dataset contains 16 native amphibian species and 3 non-native amphibian species. No amphibians listed as T&E were added.

The final review of the QAQC found 3 native reptile species that were in the original CESI dataset and appear in Steiner and Loftus (1991), the park list for visitors, but these same species do not appear in NPSpecies. These species were removed from the CESI dataset because these species also did not appear in the Rice et al. (2004) or Meshaka et al. (2000) inventories. No reptile species were recommended to add or remove from NPSpecies.

The CESI dataset contained all the amphibians in NPSpecies with the exception of 4 native species of amphibians that lack vouchers and references and do not appear on the Steiner and Loftus (1991), Meshaka et al. (2000), or Rice et al. (2004) inventories. This study recommended their removal from the NPSpecies dataset until confirmation is made of their presence in EVER. The reptile and amphibian species recommended for removal from the CESI dataset and NPSpecies are listed in Table 3. One native species of amphibian, the eastern spadefoot toad (*Scaphiopus holbrookii*) was found in the CESI dataset that does appear in NPSpecies and is recommended to for removal because Rice et al. (2004) suggests it is a historical record and has not been seen in EVER in decades.

Table 3. Reptile and amphibian species recommended to be removed from the CESI dataset as a result of the SFCN QAQC.

Reptile species to remove from the CESI dataset	Amphibian species to remove from NPSpecies
Eastern glass lizard (<i>Ophisaurus ventralis</i>)	Barking treefrog (<i>Hyla gratiosa</i>)
Eastern hognose snake (<i>Heterodon platyrhinos</i>)	Dwarf salamander (<i>Eurycea quadridigitata</i>)
Eastern coachwhip (<i>Masticophis flagellum</i>)	Lesser siren (<i>Siren intermedia</i>)
	Pine woods treefrog (<i>Hyla femoralis</i>)

The species list in the CESI dataset identifies 6 different reptile guilds in EVER (see Table 4). Guilds are defined in this report as a grouping of species having similar traits of behavior, such as feeding strategy, or habitat preferences. Amphibians have only 2 guilds: Frogs and toads* and sirens and newts.

Table 4. List of the reptile 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.

Alligator and crocodiles*	Skinks
Geckos*	Snakes*
Lizards*	Turtles, Tortoises, Terrapins*

An average of 21 native, non-T&E reptile species and 10 native, non-T&E, amphibian species are predicted to be found in any one of EVER's physiographic regions (see Figure 2). Three physiographic regions each include more than 35 species native reptile species found in EVER including Region 2 – Broad and Lostmans River Drainage, Region 5 – Taylor Slough Headwaters, and Region 7 – Pineland and Southwestern Marl Prairies.

Region 2 – Broad and Lostmans River Drainage has 16 native, non-T&E species of amphibians. Six regions have 15 native, non-T&E amphibian species including Region 3 – Shark River Slough, Region 4 – Rocky Glades, Region 5 – Taylor Slough Headwaters, Region 7 – Pineland and Southwestern Marl Prairies, Region 8 – Taylor Slough, and Region 9 – Southeastern Marl Prairies.

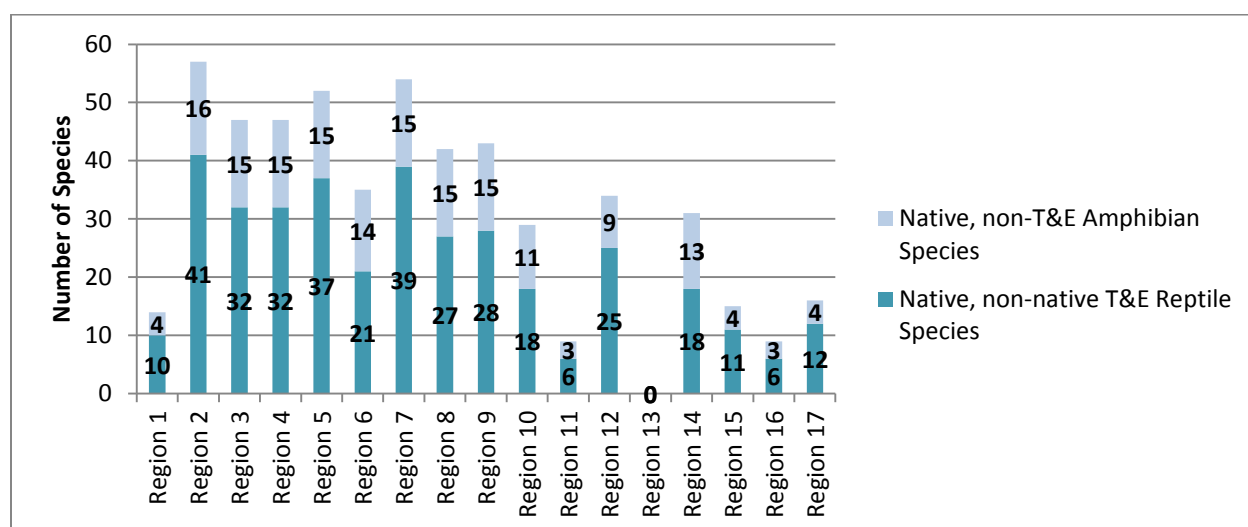


Figure 2. Graph of the total number of native, non-T&E reptile and amphibian species predicted to be found in each physiographic region of EVER.

One explanation for why these seven regions have the highest number of native reptile and native amphibian species relates back to the complexity of the habitats within these regions. Individual species of reptiles and amphibians often prefer many different types of habitats, and these regions contain the highest number of different F-Gap forest community types. Regions that contain uplands of forests of tropical hardwood hammocks, pine, oak and sable palm tend to have high numbers of reptiles and the regions that have short hydroperiod wetlands, such as marl prairie and emergent freshwater wetlands, have higher numbers of amphibians.

The location of these regions relative to each other may also account for the high number of species. The six physiographic regions that contain the highest number of reptile and amphibian species in

EVER form what is the floodplain wetlands of Shark River Slough and Taylor Slough. 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). How the biodiversity of reptile communities responds to changes in floodplains that are irregularly forested with tree islands and have large expanses of flooded grasses such as that of Shark River Slough is not well understood.

To better understand general patterns of reptile and amphibians 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. Two native, non-T&E species were most broadly distributed and may be found within at least 16 of EVER's physiographic regions. The species considered to have the narrowest distribution across EVER are those that may be found within at least 3 physiographic regions, and this description includes 4 native, non-T&E reptile species. Three amphibian species were fairly broadly distributed and may be found in 16 physiographic regions or all regions except Region 13 – Central Florida Bay. The narrow-striped dwarf siren (*Pseudobranchius axanthus*) is the most narrowly distributed and may be found in 7 physiographic regions. The native, non-T&E reptile and amphibian species with the most broad and most narrow distributions are listed below in Table 5.

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

Native non-T&E reptile species with broadest distributions	Native non-T&E reptile species with narrowest distributions
Florida red-bellied cooter (turtle) (<i>Pseudemys nelson</i>)	Blue-striped garter snake (<i>Thamnophis sirtalis similis</i>)
Florida cottonmouth (<i>Agkistrodon piscivorus conanti</i>)	Bluestriped ribbon snake (<i>Thamnophis sauritus nita</i>)
Native, non-T&E amphibian species with broadest distributions	Corn snake (Red rat snake) (<i>Elaphe guttata guttata</i>)
Green treefrog (<i>Hyla cinerea</i>)	Scarlet kingsnake (<i>Lampropeltis triangulum elapsoides</i>)
Southern leopard frog (<i>Rana utricularia</i>)	Native non-T&E amphibian species with narrowest distribution
Florida leopard frog (<i>Rana utricularia sphenoccephala</i>)	Narrow-striped dwarf siren (<i>Pseudobranchius axanthus</i>)

Five (5) of EVER's physiographic regions have 8 species out of the 10 T&E reptile species. This list includes the same physiographic regions that have the highest number of native, non-T&E reptile species with the addition of Region 12 – Eastern Coastal Swamps and Lagoons (see Figure 3). Five of the T&E species in the regions with open water are sea turtles.

The five regions with the lowest number of T&E reptile species are those with open water and few upland habitat types. The T&E species that are in these regions include the American alligator (*Alligator mississippiensis*) and striped mud turtle (*Kinosternon baurii*). Eastern indigo snake

(*Drymarchon corais*) may be found only in Regions 5 and 8, which are predominately freshwater wetlands.

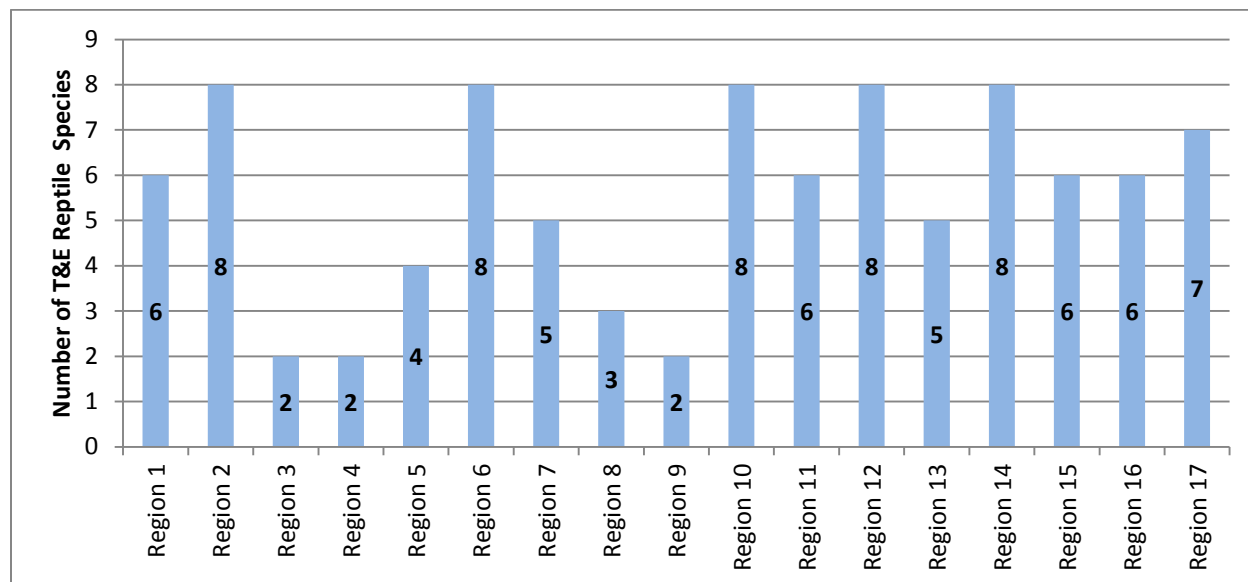


Figure 3. Graph of the total number of T&E reptile species predicted to be found in each physiographic region of EVER.

There were no T&E reptiles that could be considered as broadly distributed. The striped mud turtle (*Kinostemon baurii*) and gopher tortoise (*Gopherus Polyphemus*) are the most narrowly distributed T&E species and may be found only in 2 physiographic regions, Region 5 – Taylor Slough Headwater and Region 7 – Pinelands and Southwestern Marl Prairies.

The number of non-native reptiles and amphibians is highest in Regions 5 – Taylor Slough Headwaters and Region 7 – Pinelands and Southwestern Marl Prairies. Both regions have 24 non-native reptiles and 3 non-native amphibians (see Figure 4.). Three regions, 2 – Broad and Lostmas River Drainage, 4 – Rocky Glades, and Region 9 – Southeast Marl Prairies, have between 16 and 17 non-native reptiles and 3 non-native amphibians. Two regions, 11 - Whitewater Bay and 16 - Southern Florida Bay, have 1 species.

The Burmese python (*Python molurus*) is potentially common to all the regions except Region 13 – Gulf Coast Marine. Because of the potential for dry coastal scrub habitat, the bearded dragon (*Pogona vitticeps*) and Tokay gecko (*Gekko gecko*) may inhabit Region 14 – Western Florida Bay; otherwise, these species are the most narrowly distributed non-native reptile species.

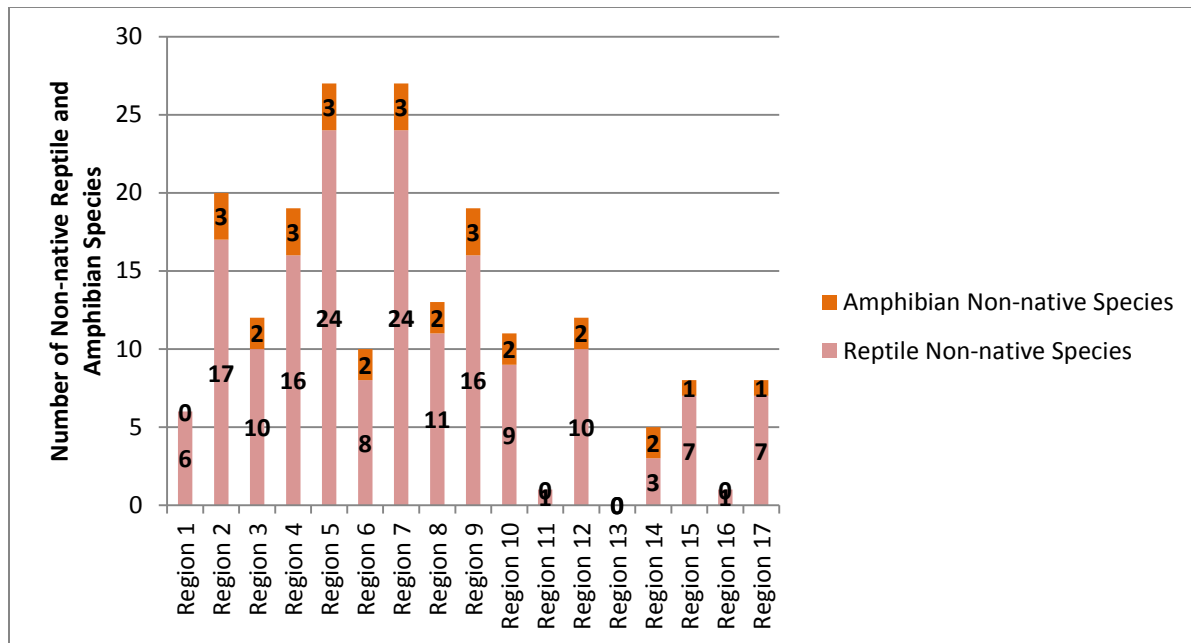


Figure 4. Graph of the total number of non-native reptile and amphibian species predicted to be found in each physiographic region of EVER.

Management of non-native reptiles and non-native amphibians is a priority for EVER. Many of non-native reptiles and amphibian species in EVER originated from the urbanized areas in South Florida and were formerly kept as pets, such as the Burmese python (*Python bivittatus*) and cane toad (*Rhinella marina*). Areas where non-native reptiles and non-native amphibians tend to occur in highest number are likely to contain the highest number of habitats. The number of species of non-native reptile and non-native amphibian species are relatively low in regions near the coast such as those with mostly open water and mangrove forests.



Photo 4. American crocodile (*Crocodylus acutus*) walking into nearshore waters of Florida Bay in Everglades National Park. Photo courtesy of A. Bosse and National Park Service.

Conclusions

The CESI dataset provided here is currently the most updated park-wide species list of reptiles and amphibians 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 CESI dataset is provided for the purposes of creating an updated EVER reptile and amphibian 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.

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. Everglades National Park interpretative staff holds an Everglades rat snake (*Elaphe obsoleta rossalleni*). Photo courtesy of National Park Service.

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Photo 6. Eastern diamondback rattlesnake (*Crotalus adamanteus*) in Mud Lake at Everglades National Park. Photo courtesy of National Park Service.

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