Southern Coastal Systems – Invasive Reptiles in the Mangrove Ecotone Conceptual Ecological Model

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Introduction: Florida has more nonnative reptiles and amphibians than anywhere else in the world, with 180 introduced species and more than 60 that are established (i.e., breeding) (Krysko et al. 2016). South Florida is particularly susceptible to nonnative wildlife invasions due to its subtropical climate, island-like geography, major ports of entry for animals into the United States, thriving trade in exotic pets, and occasional destructive hurricanes which increase risk of escapes and subsequent spread. Invasive aquatic species have already been recognized as a potential barrier to successful ecological restoration of greater Everglades ecosystems (National Research Council 2005, South Florida Ecosystem Restoration Task Force 2015).

The restoration of natural systems in South Florida is also under increasing threat of invasion by nonnative reptiles, including Burmese pythons (*Python molurus bivittatus*), green iguanas (*Iguana iguana*), Nile monitors (*Varanus niloticus*), Argentine black and white tegus (*Salvator merianae*), and spectacled caiman (*Caiman crocodilus*) (South Florida Ecosystem Restoration Task Force 2015). Multiple state and federal agencies along with universities and non-governmental organizations have joined together in a cooperative effort to manage this invasion and minimize impacts on ecosystem restoration (South Florida Ecosystem Restoration Task Force 2015). Information on impacts of management activities for these nonnative reptiles is variable and anecdotal. The purpose of this report is to organize and present information on the status of invasive reptiles in the Southern Coastal Systems Mangrove Ecotone Conceptual Ecological Model (CEM).

Data Sources: Data sources included EDDMapS data on distribution and occurrence of invasive reptiles, and data from the Everglades Invasive Reptile and Amphibian Monitoring Program.

Species Selection: Burmese pythons, green iguanas, Argentine black and white tegus, Nile monitors, and spectacled caiman were selected based on current or past presence in or near Southern Coastal Systems Mangrove Ecotone, potential to impact valued ecological attributes in the Mangrove Ecotone CEM (Figure 1, Table 1), relevance as targets of interagency management efforts, and existence of adequate information for scoring.

Using the federally threatened American Crocodile (*Crocodylus acutus)* as an attribute in our CEM (Figure 1), we illustrate the ecological impacts that may be linked to the spread of invasive reptiles in the Southern Coastal Systems Mangrove Ecotone. Invasive reptiles potentially impact the life history and ecology of American crocodiles and may cause adverse effects to growth rates, survival, relative density, body condition, and nesting through competition, predation on smaller crocodiles, and depredation or destruction of nests (Figure 1, Table 1). For example, although Burmese pythons have not been documented to eat American crocodiles, they do eat alligators. Burmese pythons have also been reported in areas known to host nesting crocodiles such as on Keys in Florida Bay, Crocodile Lake National Wildlife Refuge (CLNWR) and the Florida Power Company Turkey Point Power plant site (TP). Argentine black and white tegus have been documented to eat alligator eggs in Florida (Mazzotti et al. 2015) and are also found in areas where crocodiles are found such as Everglades National Park (ENP), at Key Largo, and at TP.

Nile monitors could potentially prey on small crocodiles and are known to be major predators of nests of Nile crocodiles (Cott 1960, Mohda 1965). Green iguanas have destroyed nests of American crocodiles in Panama and Mexico (Dugan et al. 1981, Charrau et al. 2021) and have been observed on crocodile nests in ENP and CLNWR. Furthermore, Thorbjarson and Hernandez (1992) hypothesized that the expansion of spectacled caiman population into areas formerly occupied by Orinoco crocodiles prior to harvesting has inhibited the reintroduction of Orinoco crocodiles in Venezuela. Spectacled caimans are found in and around the Biscayne Bay Wetlands Complex and the C-111, Frog Pond, and 8.5 square mile area restoration projects.

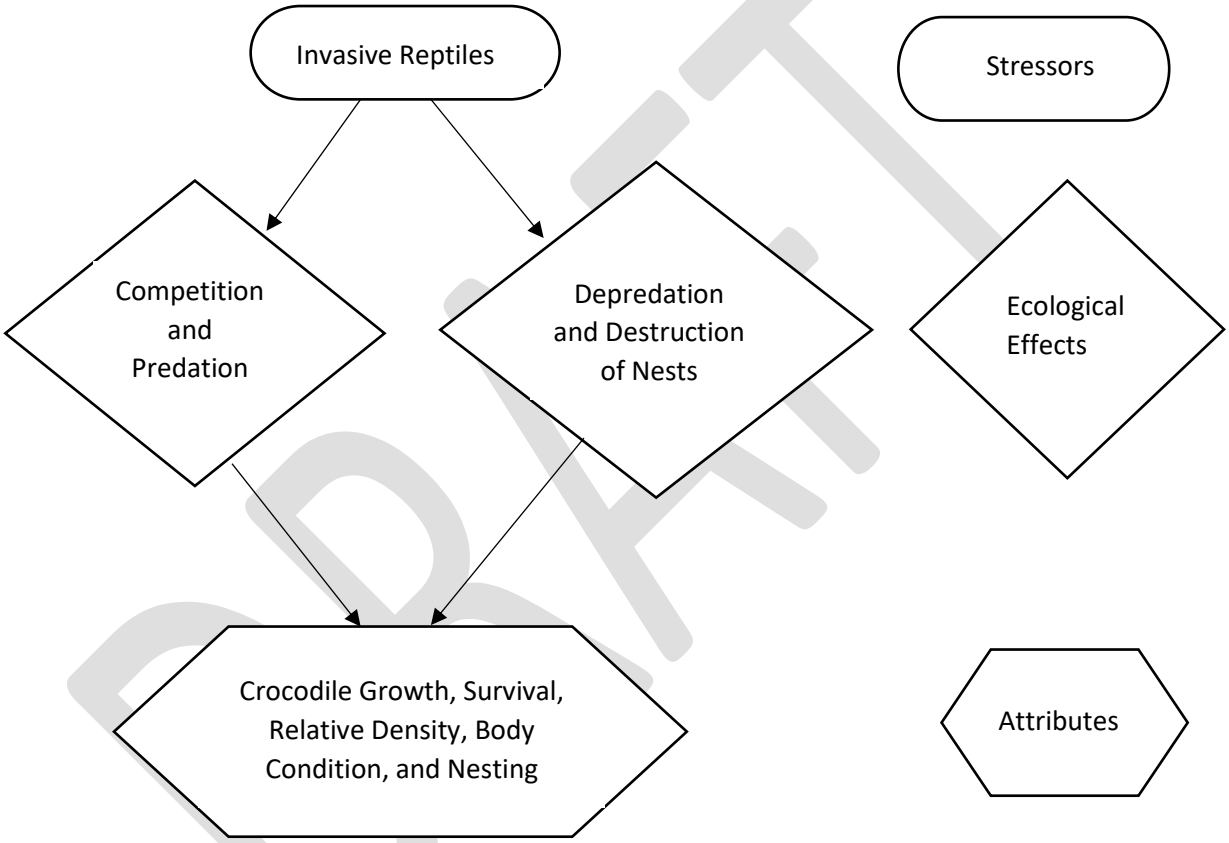

Figure 1. Inclusion of invasive reptiles into the Southern Coastal Systems Mangrove Ecotone Conceptual Ecological Model.

Scoring: Species were scored based on three metrics: abundance, spread, and impacts. Scoring for each metric is described in Table 2. The scores for each species are totaled and assigned a stoplight color and grade based on the species score. Species scores are assigned a stoplight color and grade (Table 3) and then summed into a regional score, stoplight color, and grade (Table 4). Water Years (1 May – 30 April) were used for analysis. In this manner we have scores for individual species or invasive reptiles as a group.

Table 1. Potential impacts of invasive reptiles on the American crocodile attribute of the Southern Coastal Systems Mangrove Ecotone Conceptual Ecological Model.

Species	**Impact Hypothesis**	**Source/Citation**
Burmese python	Depredation	Snow et al. 2007, predation on alligators
Argentine Black and White Tegu	Depredation on nests and hatchlings	Mazzotti et al. 2015, depredation on alligator nest
Nile Monitor	Depredation on nests and hatchlings	Cott, 1960; Mohda, 1965, depredation on Nile crocodile nests
Green iguana	Destruction (digging) of nests	Dugan et al. 1981; Charrau et al. 2021, digging up American crocodile nests in Panama and Mexico
Spectacled caiman	Competition for space and food Predation on hatchlings and juveniles	Thorbjarnason and Hernanadez 1992, competition between spectacled caimans and Orinoco crocodiles

Table 2. How metrics are scored for invasive reptiles.

Metric	**Status**	**Score**
Abundance	Increasing	2
	No change	1
	Decreasing/Absent	0
Spread	Expanding	2
	No change	1
	Contracting	0
Impacts	Established	2
	Potential	1
	Minimal	0

Table 3. Assigning stoplight colors and grades to species scores.

Score	**Stoplight color**	**Grade**
0	Green	A
1	Green	B
2	Yellow	C+
3	Yellow	C
4	Yellow	C-
5	Red	D

6	Red	F

Table 4. Species scores are summed into an overall score. The observed overall score is divided by the total possible score, multiplied by 100, and then assigned a stoplight color and grade for the region.

Overall Score	Stoplight	Grade
0-10	Green	A
11-25	Green	B
26-40	Yellow	C+
41-60	Yellow	C
61-75	Yellow	C-
76-90	Red	D
91-100	Red	F

Literature Cited:

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Southern Coastal Systems – Stoplight and Report Card for Water Years 2012 – 2021

Please score each metric, for each species, for each year that you can. Please use the scoring system in Table 2. Impact should be considered for the American crocodile attribute in the Mangrove Ecotone CEM (Figure 1). Don't know = DK. WY is water year and WY21 is defined as 1 May 2020 – 30 April 2021. WY 21 was completed as an example

Species	WY17	WY18	WY19	WY20	WY21
Burmese python					
Abundance =					2
Spread =					1
Impact =					1
Green Iguana					
Abundance =					2
Spread =					2
Impact =					1
Argentine black and white tegu					
Abundance =					2
Spread =					2
Impact =					1
Nile monitor					
Abundance =					0
Spread =					0
Impact =					1
Spectacled caiman					
Abundance =					1
Spread =					1
Impact =					1