

# The Effects of Burmese Pythons on Everglades Ecosystems

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## **Abstract**

The Burmese Python (*Python bivittatus*), native to various parts of Southeast Asia, was originally imported to the United States as a popular exotic pet. At the end of the 20<sup>th</sup> century, scientists noticed an established population of the invasive snakes in the Everglades National Park in Florida and deemed them dangerous to the ecosystem. Although the cause behind the population's establishment in the Everglades is unknown, scientists believe the snakes ended up in the wild after escaping from their owners or from being abandoned into the wild after the owners longer wanted to care for them.

The Everglades are perfect for Burmese Pythons to thrive, which is evident from their exponential growth over the years. Scientists believe the population may be in the hundreds of thousands, however getting an accurate count is difficult because the snakes are not always easy to find. One way that scientists can guess the population number is by monitoring the damage they do to other wildlife populations in the Everglades, including many threatened and endangered species. The Burmese Pythons exhibit a top-down pressure in the ecosystem; their large numbers ultimately threaten the ecosystem as a whole, particularly by reducing populations of wildlife that contribute to the overall shape and health of the environment.

Threats to an ecosystem as fragile as the Everglades require management strategies, which so far have been largely unsuccessful. A major concern is that the snakes will expand their range further inland and along the southern coast of the United States; however, there are still arguments about whether the environments in those areas are appropriate to

sustain a population. Overall, the threat to wildlife and potentially the entire Everglades ecosystem makes finding effective management techniques extremely important.

## **Introduction**

Invasive species cause detrimental, often permanent damage to native species. An entire ecosystem can fail when there is an imbalance in nature. The Florida Everglades is one such ecosystem that is being threatened by an invasive species: the Burmese python (Nolen 2012). The past few decades have sparked great concern for both the various animal species and the ecosystem as a whole due to the effects of the Burmese python's presence. The damage primarily comes from the snakes' feeding habits; as a general rule, whatever they can kill has the potential to become the python's next meal. The exponential growth of the Burmese python population in the Everglades has caused many common animal species to become scarce and the ecosystem may be damaged as a result (Nolen 2012). Management strategies have been implemented, and new ideas are being formed. With the Everglades being such a fragile environment, controlling the pythons is vital to the future of the ecosystem.

## **Everglades Background**

One of the most ecologically diverse areas in the United States is the Everglades (United States National Park Service 2015). This natural region is full of life and is an extremely important ecosystem. The Everglades National Park was created and listed by the Ramsar Convention and the United Nations Educational, Scientific and Cultural Organization (UNESCO) as a wetland of international importance, an International Biosphere Reserve, and a World Heritage Site in the 1970s (Ramsar Convention 2015). At least two dozen federally threatened and endangered species live in the Everglades (US

Geological Survey 2015), which is a major reason why large portions of it are protected. Although there is less danger to it from direct human impact, invasive species—namely the Burmese python—threaten the native wildlife and the ecosystem as a whole. Found in southern Florida, the Everglades are a natural tropical wetland. The ecosystem is made up of various wetland types including sawgrass marshes and boughs, tropical hardwood hammocks, pineland, Cyprus swamps, coastal prairies, and mangroves. The Everglades are from forty to fifty miles wide and one hundred and thirty miles long (United States Geological Survey 2015), but the wetlands are about half as large as they used to be due to drainage for agriculture and development.

The Everglades is home to a wide variety of native wildlife. Over 350 bird species inhabit the ecosystem, including both wading birds and migratory birds (US National Park Service 2015). Some species of birds that populate the area are endangered, such as the snail kite (*Rostrhamus sociabilis*) and Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*). Over forty mammal species call the Everglades home as well (US National Park Service 2015). White-tailed deer (*Odocoileus virginianus*), marsh rabbits (*Sylvilagus palustris*), bobcats (*Lynx rufus*), raccoons (*Procon lotor*), gray foxes (*Urocyon cinereoargenteus*), and the highly endangered Florida panther (*Felis concolor coryi*) are some of the most well-known mammals in the ecosystem. Reptiles include the American alligator (*Alligator mississippiensis*), cornsnakes (*Elaphe guttata*), Florida mud turtle (*Kinosternon subrubrum*), and the Florida kingsnake (*Lempropeltis getulus*) (US National Park Service 2015).

## **Burmese Python Background**

The Burmese python (*Python bivittatus*) is a large snake that is native to various countries throughout Southeast Asia. It is classified as a “vulnerable” species in its native environment under the Endangered Species Act (IUCN Red List of Threatened Species 2012). At a length of anywhere from twelve to nineteen feet long in adulthood, it is one of the largest snakes in the world. They are sometimes described as being semiaquatic due to the fact that they are usually found near sources of water. They climb and swim expertly, with the ability to stay underwater for up to thirty minutes (IUCN Red List of Threatened Species 2012). This allows them to thrive in marshes and swamps; however grasslands, woodlands, and rocky foothills also provide a good habitat for these snakes.

Typically the Burmese python is nocturnal and is presumed to hunt for prey at night, but they have sometimes been seen feeding during the day. Their prey varies according to the snake’s size. Smaller snakes or juveniles will usually eat mostly smaller mammals such as rabbits and rats as well as birds and reptiles. Larger snakes require larger mammals, sometimes even taking down full-sized adult deer. They kill their prey by holding it with their backwards-facing teeth and then constricting, wrapping their body around their prey and suffocating it before swallowing it whole. They reach sexual maturity at about five years old and the breeding season typically runs from January to April. The clutch size can vary from a dozen to several dozen eggs. The female snake will care for her eggs until they hatch by wrapping her body around the clutch and repeatedly contracting her muscles along her body to raise the temperature around the eggs (Krysko et al. 2008). Once they hatch, the baby snakes are independent of the mother, who stops caring for them. The Burmese python lives an average of thirty years in the wild.

## **Invasive Species**

At the end of the 20<sup>th</sup> century, a population of Burmese pythons became an invasive species in the Everglades National Park in South Florida. As they became an increasingly popular exotic pet, the snakes were imported from Southeast Asia to the United States in great numbers (Willson et al. 2011). It is unclear whether they were purposefully released into the wild by people who did not want them as a pet or if they escaped captivity. Although the U.S. Department of the Interior banned the importation of the snakes in 2012, years of breeding in the wild with plenty of food and shelter for them to thrive allowed the Burmese python population to explode. The exact number of the snakes in the Everglades cannot be determined due to the fact that they are not easy to find. Scientists estimate their population to be in the tens to hundreds of thousands (Willson et al. 2011).

What is known is that the pythons are a major threat to the native wildlife in the Everglades, causing a decline in mammal and bird populations. Studies have shown that before the year 2000, nocturnal mammals could be regularly observed at night and in great numbers; however, road surveys from 2003-2011 revealed that the number of observed raccoons, bobcats, opossums, and rabbits dropped 90% or more since the pythons became established in the Everglades (Dorcas et al. 2012). With Burmese pythons being near the top of the food chain, stress on prey animals threatens to cause an imbalance in the food chain where the Burmese python population may grow but the overall prey population may become scarce. The greatest concern is that these dramatic decreases in prey animal populations may include at-risk species. Vulnerable or endangered species that live in the

Everglades are at a greater risk of extinction now due to the high estimated numbers of the snakes.

For example, the stomach contents of eighty-five snakes captured in the Everglades over a five year period. Twenty-five different bird species were found, four of which are threatened in Florida, and one that is protected as an endangered species under the Endangered Species Act. The birds were discovered after examining the intestinal tracts of Burmese pythons. Many ground-dwelling birds were the found inside the snakes because they are the most vulnerable to attacks. Birds from the Rallidae group were consumed the most. The fact that several at-risk bird species where discovered further exacerbates the concern for their conservation. Because the pythons are a newer predator, it is possible that the birds are unfamiliar with the dangers of the snakes and great numbers of them are being consumed as a result (Dove et al. 2011). Species in need of conservation already have smaller populations and can be challenging to find, so as their populations continue to decrease it will be even more difficult to know with accuracy just how much they are suffering.

Apart from the threat to at-risk species, another concern about the Burmese python's ever-growing presence in the Everglades is that they could potentially damage the environment. American alligators (*Alligator mississippiensis*) are abundant in the Everglades and they directly compete with the snakes for food. Each of the two species will feed on the other. Similar to the Burmese python, alligators feed on any animal they come in contact with and they will choose their prey according to size. If the snake is larger than the alligator, the alligator will likely become the prey, and vice versa. Because alligator

populations are high in the Everglades, becoming snake food is not the whole issue. The greatest concern that pertains to alligator populations is the fact that they are considered a keystone species because they are ecosystem engineers—or, a species that physically modifies and maintains the environment in which it lives. They alter the landscape in the Everglades by creating “alligator holes.” The alligators form these by displacing mud from holes in the limestone bedrock in the marshes, usually by digging with their feet and snout. These holes fill up with water during the rainy season and retain it when the warmer weather causes much of the water in the Everglades to dry. Various species of animals frequently visit the holes—which create a wetland area—for food, water, and as a habitat for them to live in and around (Connors 2015). Alligator holes are home to aquatic organisms that, without the holes, would die during the dry season. The alligators in the area will also feed on the visiting prey. If the Burmese python population and subsequent feeding on alligators were to increase to the point that alligator populations suffer, alligator holes would become increasingly scarce and many species of wildlife would suffer a loss of food, water, and habitat.

A 2007 study estimated the monetary costs of Burmese pythons preying on various species of wildlife, both threatened/endangered and non-threatened/endangered (Smith et al. 2007). A system was created that considered the probability of success (a python consumes its prey), the prey species type, and the monetary value of that species. United States Fish and Wildlife Service endangered species were valued at \$25,000, and Florida Fish and Wildlife Service threatened species at \$500. More common species that often fall prey to pythons were valued at various lower prices. The results showed that the cost is roughly \$83,892 for one snake per year. The value of lost wildlife would reach staggering

amounts of money per year when accounting for the massive predicted population size of Burmese pythons. Assuming there are a minimum of ten thousand pythons in the Everglades, the total value of wildlife would be \$838,920,000 in one year.

## **Management**

Approximately \$120 billion is spent in the United States on invasive species management every year (Pimentel et al. 2004). Everglades restoration efforts are made more difficult by the Burmese python issue since they pose a major threat to wildlife, including ecosystem engineers. Agencies such as the Florida Fish and Wildlife Conservation Commission have helped to remove thousands of snakes from the National Park, but with such a large population, there has been little impact. Organized “snake hunts” have been established to encourage public assistance in snake removal. In 2013, the Florida Fish and Wildlife Conservation Commission partnered with the Fish and Wildlife Foundation of Florida to create the month-long “Python Challenge” (US Army Corps of Engineers 2013). It allowed members of the public over the age of 18 to hunt pythons and compete for cash prizes. A total of 68 snakes were removed at the end of the month. A second Python Challenge is scheduled in 2016 in hopes of attracting more participants (Fish and Wildlife Foundation of Florida 2013).

The capture of Burmese pythons is a challenging task. A field experiment was designed that was used to capture Burmese pythons in the Everglades. The primary goal was to see if the traps proved to be an effective tool in capturing the snakes, ultimately generating a new management strategy for the invasive population. Sixty traps of several slightly different designs were baited with live rats and monitored from the beginning of

August to mid-November. Although there were various other animals found in the traps (all which were subsequently released nearby), only three Burmese pythons were caught (Reed et al. 2011). There were other factors that may have interfered with the number of captured snakes such as the large numbers of prey species in the area to begin with as well as the python's tendency to be ambush predators instead of foragers. Waiting for the prey to come to them is the natural behavior of the snakes, so it is possible that the traps simply did not attract them. The experiment sheds light on the difficulties with creating management tools for Burmese pythons.

Apart from catching and removing snakes from the Everglades, several other ideas to deal with the issue have been considered and/or implemented. Some scientists have wanted to use the biological control method, which uses a virus or parasite that attacks a species to lower the population, but they fear it could potentially backfire and harm other species in the sensitive environment (Barratt et al. 2010). Due to difficulties in locating the snakes, the Invasive Species Management Branch (ISM) has used scent dogs to detect snakes as well as "thermal energy remote sensing by an Unmanned Aerial Vehicle (UAV)" (US Army Corps of Engineers 2013). In addition, python identification and safety training are given to Corps employees so that they can remove snakes they find. The Nature Conservancy created a Burmese python management group called "Python Patrol," which is now controlled by the Florida Fish and Wildlife Service. The group trains responders to identify, locate, and humanely and safely capture the snakes for removal from the Everglades National Park (The Nature Conservancy 2015). Captured snakes are tagged and relocated to a facility for research or training. Currently, there is no guaranteed way to manage the Burmese python problem in the Everglades.

Public safety is a common concern for visitors to the Everglades. Burmese python attacks on humans outside of the Everglades have been reported in the past, so a study of python attacks over ten years was compiled. The five total incidences were recorded as unprovoked attacks in which biologists were wading through flooded areas. None of the attacks suggested that the pythons were attempting to prey on the biologists because they did not strike and then constrict, as they do when bringing down prey (Reed et al. 2014). It is possible that the pythons mistook the biologists for prey, releasing them when they realized they were not. Because no one visiting the Everglades National Park has been recorded being bitten (out of the million plus visitors the park has annually), it is very unlikely that Burmese pythons pose a significant threat to human safety.

### **Potential Range Expansion**

Many people are desperate to get the numbers under control because they fear that the snakes may start occupying habitats further inland and along the southern coast of the United States. The potential for them to wreak havoc on ecosystems is debated, but it is still a major concern because there are many areas along the southern coast that the snakes may be able to thrive in. Various studies suggest that for the time being, the pythons do not have a large success rate in places where the climate differs significantly from that of Florida's Everglades (Dorcas et al. 2011, Avery et al. 2010, Mazzotti et al. 2011, & Jacobson et al. 2012).

Comparing monthly precipitation and temperature from various locations near the Burmese python's native South Asian range and plotting it against areas in the United

States that were similar, researchers have produced a general idea of where the snakes could potentially expand by the year 2100 (Rodda et al. 2009). For today's climate, some studies claim that Burmese pythons can theoretically live along the coasts and throughout most of the southern states (Figure 1) (USGS 2012 & Rodda et al 2009). By 2100, the suitable climate could potentially allow pythons to invade further inland and through several states in the Midwest (Rodda et al. 2009). It was previously thought that salt water could not support Burmese pythons for extended periods of time, so islands off the coast of Florida would be safe from the snakes; however, the United States Geological Survey conducted experiments refuting that belief (USGS 2012). Even though the pythons are freshwater snakes, researchers conducted studies where juvenile snakes were kept in salt water over a period of weeks and months to assess their tolerance. The results showed that they could live in salt water for several months at a young age. The researchers believe that an adult python could potentially survive longer, so there is a fairly good chance that the snakes could invade other habitats that are suitable (U.S. Geological Survey 2012).

Although there is evidence that the snakes may be able to expand their range in the future, some recent experiments suggest the opposite (Avery et al. 2010, Dorcas et al. 2011, & Jacobson et al. 2012). The Burmese python's ability to survive in South Carolina was studied to answer the question of whether they can expand their range throughout the southern United States. The test subjects were transported from southern Florida to South Carolina, where the temperatures in the winter months are lower. The snakes were monitored to see how well they adapted to the new environment. Most of the snakes died from exposure to the cold when they did not look for shelter, and the rest died when the temperature dropped to abnormally low levels (Dorcas et al. 2011). Even though they all

died, they did survive for longer than expected in temperatures lower than they were accustomed to. This begs the question of whether the issue was with the experiment. It is possible that the pythons did not seek shelter when the temperature dropped because they had not learned this behavior before. They were taken out of an environment that they were accustomed to and perhaps did not know how to survive in a different environment. Given time, the pythons may be able to learn the correct behaviors to survive in colder temperatures, which would affect their range expansion.

Two similar studies in which the pythons were not taken out of Florida yielded similar results (Avery et al. 2010 & Mazzotti et al. 2011). Captive Burmese pythons in north-central Florida were monitored during cold weather. Nearly all of the snakes died during the study even though they were provided with shelter and heat. Since the experiment was conducted within the natural environment of the snakes, it is unlikely that wild snakes would be able to survive in areas outside of Florida where the temperatures in the winter months drop to lower levels than what the pythons are used to (Avery et al. 2010). This idea is reinforced by the second study in which pythons in southern Florida were monitored during record-low temperatures in early January to see if they were able to survive. Most of them died from the cold, supporting the idea that Burmese pythons can only survive within a certain temperature range (Mazzotti et al. 2011).

This evidence casts more doubt on whether the snakes could expand their range. Cold weather affects the pythons both physically and behaviorally. As the temperature drops, digestion either slows greatly or stops (Jacobson et al. 2012). Activity levels also greatly diminish, and eventually snakes will succumb to the weather conditions.

Physiologically, it seems that Burmese pythons cannot survive the lower winter temperatures that are common along the southern United States. Behaviorally, the pythons do not possess the appropriate knowledge/skills to survive because many of them do not seek shelter and/or try to bask in sunlight instead.

## **Conclusions**

Regardless of where in the United States the Burmese python may eventually dwell, the fact remains that the invasive species is alive and well in the Everglades. The damage will only continue to get worse if management strategies are not in place. Many of Florida's commonly seen wildlife may become endangered, and those species that are already endangered may cease to exist. However, researchers and officials are actively looking for new ways to control the problem and save both the wildlife and the ecosystem. As more awareness about the issue spreads, the chances of finding a strategy that works are good.

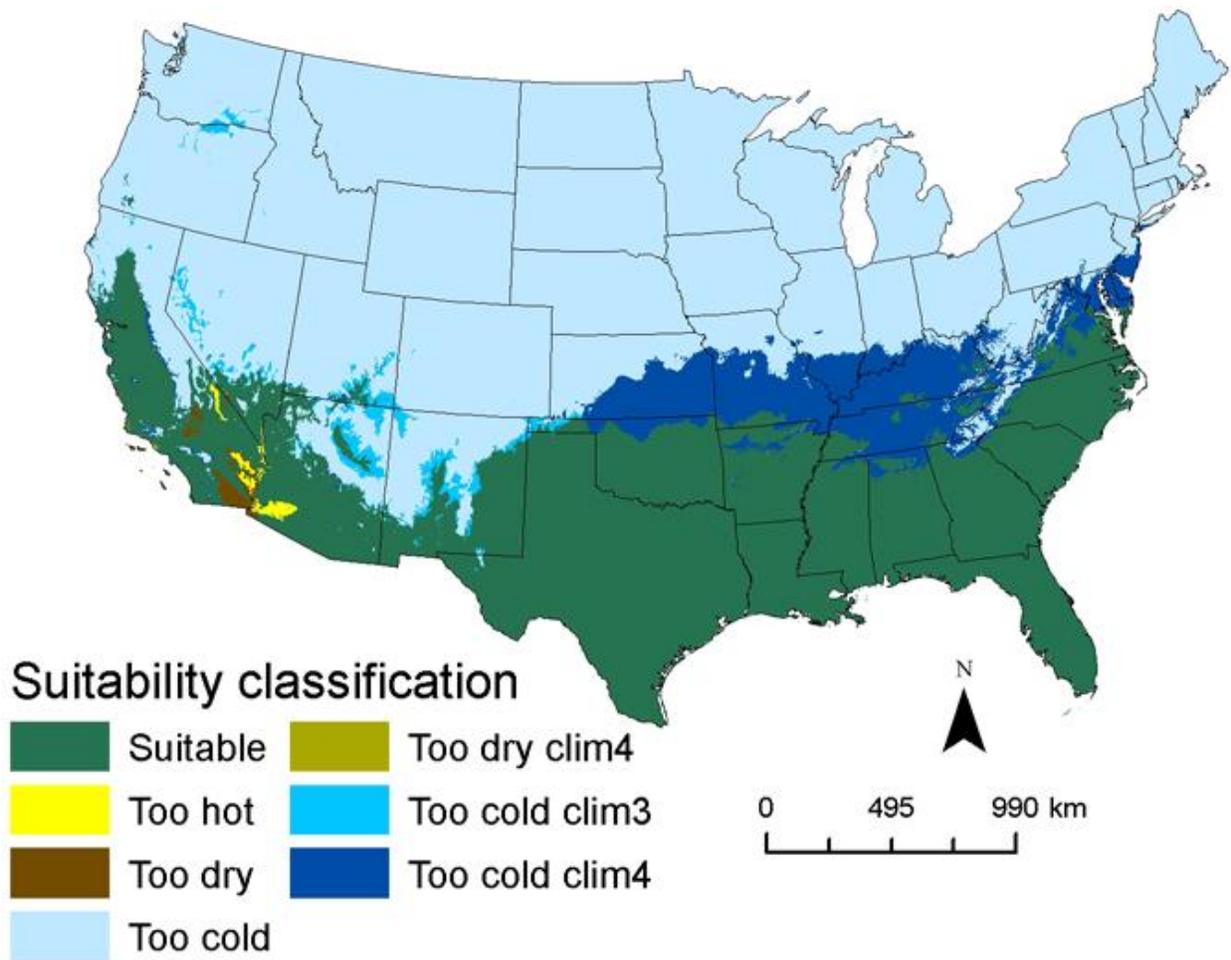


Figure 1. A map of the potential range expansion of the Burmese python by the year 2100 (Rodda et al. 2009).

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