Wildlife Society Bulletin 38(2):366–369; 2014; DOI: 10.1002/wsb.413

*Original Article*

# Assessing Risks to Humans from Invasive Burmese Pythons in Everglades National Park, Florida, USA

**ROBERT N. REED,**[1] *United States Geological Survey, Fort Collins Science Center, 2150 Centre Avenue, Building C, Fort Collins, CO 80526, USA*
**RAY W. SNOW,** *National Park Service, Everglades National Park, 40001 State Road 9336, Homestead, FL 33034, USA*

**ABSTRACT** Invasive Burmese pythons (*Python molurus bivittatus*) are now established across a large area of southern Florida, USA, including all of Everglades National Park (NP). The presence of these large-bodied snakes in the continental United States has attracted intense media attention, including regular reference to the possibility of these snakes preying on humans. Over the course of a decade (2003–2012), we solicited reports of apparently unprovoked strikes directed at humans in Everglades NP. We summarize the circumstances surrounding each of the 5 reported incidents, which occurred between 2006 and 2012. All strikes were directed toward biologists moving through flooded wetlands; 2 strikes resulted in minor injury and none resulted in constriction. We consider most of these strikes to be cases of "mistaken identity," in which the python initiated a strike at a potential prey item but aborted its predatory behavior prior to constriction and ingestion. No strikes are known to have been directed at park visitors despite visitation rates averaging over one million per year during this period. We conclude that while risks to humans should not be completely discounted, the relative risk of a human being killed by a python in Everglades NP appears to be extremely low.
Published 2014. This article is a U.S. Government work and is in the public domain in the USA.

**KEY WORDS** Burmese pythons, Everglades, Florida, human–wildlife interactions, invasive species, *Python molurus bivittatus*.

Invasive Burmese pythons (*Python molurus bivittatus*) in southern Florida, USA, have attracted intense media and popular interest in recent years (Rotella et al. 2010). Introduced to Florida several decades ago as a result of the international pet trade, the pythons have expanded their range to include all of Everglades National Park (Everglades NP) and surrounding areas, and have been implicated in the regional decline of native mammals (Snow et al. 2007, Willson et al. 2011, Dorcas et al. 2012). These snakes attain very large sizes and are capable of ingesting prey to the size of deer and alligators, resulting in striking visual images that are attractive to journalists and the public at large. Snakes evoke strong reactions in humans, perhaps because of the co-existence of snakes and primates as predators and prey over evolutionary time (Isbell 2006, Headland and Greene 2011). As is the case with sharks (Neff and Hueter 2013), media coverage of pythons in Florida is often distorted as it passes through the filter of human emotions. Among the most sensationalized aspects of the python invasion of Florida is the risk that these snakes pose to humans. It is true that free-ranging pythons have bitten a number of people in southern Florida, but nearly all of these were defensive bites resulting from attempts to capture a python. We consider such bites to be provoked by humans intentionally interacting with the snake, and as such they are not indicative of the likelihood that pythons will direct predatory behaviors toward humans.

Received: 3 April 2013; Accepted: 18 October 2013
Published: 27 February 2014

[1]*E-mail: reedr@usgs.gov*

## STUDY AREA

Everglades National Park is located in southern Florida, spanning the southern tip of the Florida Peninsula and most of Florida Bay. Established in 1947, and later expanded, the now 1,509,000-acre (610670.63-ha) park lies in portions of 3 counties: Miami-Dade, Monroe, and Collier. The park contains both temperate and tropical plant communities and marine and estuarine environments. Its vast subtropical upland and marine ecosystems include freshwater marshes, tropical hardwood hammocks, rock pinelands, sawgrass (*Cladium jamaicense*) prairies, and extensive mangrove (genera *Rhizophora*, *Avicennia*, and *Laguncularia*) forests. Everglades National Park protects an unparalleled landscape of seasonally inundated, fire-adapted, low and often very dense vegetation that provides important habitat for rich bird life and numerous rare and endangered species such as the manatee (*Trichechus manatus latirostris*), American crocodile (*Crocodylus acutus*), and the elusive Florida panther (*Felis concolor coryi*). The park is the only place in the United States designated as a World Heritage Site, an International Biosphere Reserve, and a Wetland of International Importance. Although elevation only ranges from 0 to 8 feet (0–2.438 m) above sea level, much of the park is largely inaccessible to the casual visitor.

## METHODS

Over the past decade, we solicited reports of interactions between pythons and humans in and around Everglades NP. In this paper we report and evaluate 5 incidents involving apparently unprovoked strikes directed at humans by free-ranging Burmese pythons in Everglades NP. At the time each incident was reported, we requested that the primary observer write a full description of the location, environmental conditions, personnel involved, and all observed python behaviors. We then condensed these reports to the salient details reported below and asked the original observer to confirm that our condensation was factually correct and not missing any important details. Pythons were captured by observers after 2 of the observed strikes, and data on body size, condition, etc., for these snakes resulted from necropsies performed later by the second author.

## RESULTS

### Incident 1

On 7 July 2006 at about 0930 hours, 2 biologists were walking through a freshwater prairie short-hydroperiod marsh in Everglades NP (approximate location UTM 17R 528944, 2806804) characterized by a mix of grasses, with vegetation cover estimated at 30%. The area was flooded to a depth of 15–20 cm. Weather conditions were described as warm, humid, and thinly overcast, with light and variable winds. They were traveling single-file, separated by 2–3 m. As the lead biologist (male, 76 kg, 188 cm) brushed by a clump of grass, the trailing biologist observed a python emerge from the grass and strike at the lead biologist's calf. The snake's open jaws came up short of his leg by 10–15 cm. The python retracted and was found tightly coiled in the clump of grass, at which point it was captured. The python was an immature female (212.5 cm total length, 186.5 cm snout-to-vent length [SVL], 4.366 kg), and necropsy revealed an empty stomach and the remains of a pied-billed grebe (*Podilymbus podiceps*) in the lower intestinal tract. Overall, the snake appeared to be healthy and in good condition.

### Incident 2

On 10 October 2006 at about 1115 hours, 2 biologists were walking between 2 vegetation monitoring sites in Everglades NP (approximate location UTM 17R 529382, 2806419) in a vegetation community characterized by native wetland grass species and scattered willow (*Salix* spp.) heads. The area was flooded to 30-cm to 35-cm water depth. Ambient temperature was estimated at 29–32° C, with partly cloudy, humid, and still conditions. While walking, the lead biologist (female, 162 cm, 63 kg) felt teeth on her skin through her pants on the back of her leg just above the knee. Turning, she observed a submerged python moving between plants and partly underneath a periphyton mat. She was certain she had not stepped on the snake, though she was in close proximity. The trailing biologist was 2–3 m behind and did not witness the snake strike. Later examination revealed that the biologist's skin was not broken. The biologists captured the python, which was an immature male (218 cm total length, 189 cm SVL, 4.034 kg) with a fat mass of 180 g. The python appeared healthy, although it was fairly thin. The stomach and lower gastro-intestinal tract were empty.

### Incident 3

On 7 November 2007 at about 1430 hours, 2 biologists were attempting to locate a Burmese python surgically implanted with a radiotransmitter in Everglades NP (approximate location UTM 17R 520419, 2800341). Weather conditions were clear and sunny with a temperature of approximately 24–27° C and little to no wind. The python being radiotracked was a female (362 cm total length, 323 cm SVL, 21.64 kg). The lead biologist (male, approx. 182 cm, approx. 75 kg) unknowingly passed the python, which was submerged in approximately 45 cm of water in an area with dense aquatic vegetation. The trailing biologist was 2–3 m behind, and was struck just below the knee by the python as he passed it. The python did not attempt to coil after the bite, but did not let go. Within 2 seconds of being bitten, the victim grabbed the entire upper jaw of the python (resulting in punctures to his fingers) and pulled it from his leg. Both biologists immediately exited the area to tend to the injury, such that subsequent behavior of the python was not observed. Multiple punctures were visible on the leg from maxillary and pterygoid teeth on the upper jaw, as well as from the lower jaw. Injuries were minor and recovery was complete.

### Incident 4

On 19 October 2011 at 1022 hours, 3 biologists were walking along a flooded levee along the eastern boundary of Everglades NP (location UTM 17R 542743, 2822029). The levee was densely vegetated and covered with approximately 25 cm of water. Rain was falling at the time, it was a windy day and ambient temperature was approximately 23° C. As the lead biologist (female, 170 cm, 68 kg) passed a thicket of willow (*Salix caroliniana*) and Burma reed (*Neyraudia reynaudiana*), the second biologist observed a python strike at her calf from beneath a floating mat of dead vegetation. The strike missed and the python immediately retracted into the water. The lead biologist was unaware that the strike had occurred until alerted by the second biologist, who estimated the head to be approximately 13 cm long and 8 cm wide. He estimated that <50 cm of the python was extended during the strike. He searched for the python after the strike but could not locate it.

### Incident 5

On 29 January 2012 at roughly 1130 hours, 3 biologists along with a colleague and his daughter were radiotracking a male Burmese python (252 cm total length, 220.5 cm SVL, 6.0 kg) surgically implanted with a radiotransmitter. Weather conditions that day were overcast with an approximate temperature of 21° C. The terrain was freshwater marsh with 30–60 cm of standing water in most areas, dense saw grass cover, and a thick layer of surface periphyton. The tracking group walked in a single file with the 3 biologists in front and approximately 4 m separating these biologists from the rest of the group. The lead biologist was struck on the left ankle by a python as he passed a saw grass patch to his left. The biologists used the telemetry receiver to confirm that the strike was from the python being radiotracked; the snake

subsequently moved away from the group while staying submerged. The injury sustained was minor with small puncture wounds visible from both the upper and lower jaw.

## DISCUSSION

Other than the 5 incidents described above, we are unaware of any strikes directed at humans by free-ranging Burmese pythons since they became established in southern Florida (probably >25 yr ago; Willson et al. 2011). The Burmese python is such a high-profile invader that any serious attacks or hospitalizations would have attracted media coverage, and so we are confident that we did not miss any notable unprovoked attacks. None of the strikes resulted in serious injury. In none of these incidents were the snakes intentionally provoked into striking, and indeed none of the snakes had been detected by a human prior to the strike.

Worldwide, attacks on humans by free-ranging giant constrictors are rare and often clouded by misinformation and exaggeration (Murphy and Henderson 1997, Reed and Rodda 2009). Recently, however, it was reported that in the Philippines, 26% of adult males in a group of hunter-gatherers had been attacked by reticulated pythons (*Malayopython reticulatus*) and 6 fatal attacks had occurred over a 40-year period (Headland and Greene 2011). Reticulated pythons numerically dominate reported attacks on humans by free-ranging snakes, and occasionally succeed in ingesting humans (Murphy and Henderson 1997, Bellosa et al. 2007). Despite having a large native range that overlaps in many areas with that of reticulated pythons, free-ranging Burmese pythons are very rarely implicated in attacks on humans. We have identified only a single credible report of a human fatality due to a free-ranging Burmese python, the death of an infant in Hong Kong about a century ago (Wall 1921; Hong Kong is north of the distribution of reticulated pythons). Indeed, although Burmese pythons eat a wide range of prey items in both native and invaded ranges (Snow et al. 2007, Reed and Rodda 2009, Dove et al. 2011), we can find only 2 reliable accounts of predation on non-human primates of any species by Indian or Burmese pythons (Channer 1895, Khamcha and Sukumal 2009).

At least 16 humans were killed by large constricting snakes in the United States between 1978 and 2009 (Humane Society of the United States 2012), which appears to exceed the number of fatalities in the rest of the world during this period. This is ironic considering none of the giant constrictors are native to the United States. At least 7 human fatalities in the United States are attributed to captive Burmese pythons, divided roughly evenly between snakes that killed adults during handling and/or entry into a cage and unconfined or escaped snakes that killed children in the same dwelling where the snake was housed. Most of the latter involved snakes attacking sleeping children, suggesting predatory motivations. There are no known human fatalities from free-ranging giant constrictor snakes in the United States, despite several reports of unprovoked strikes or bites from captives that had escaped from houses or other buildings.

Possible motivations for the Everglades python incidents reported above include defensive strikes against a potential antagonist and strikes associated with feeding behavior. Of these, we consider defensive strikes to be the less probable motivation. In our experience, pythons rely on crypsis and evasion as their primary means of minimizing interactions with humans and other potential predators. Defensive bites are typically observed only when the human is attempting to capture or kill a python (authors, personal observation). All of the strikes reported above were directed toward humans from the side or the rear, rather than from in front as would be expected if the python perceived the human as an advancing threat. Among 4 of the incidents, the ratios of "prey" mass (body mass of person at whom strike was directed) to "predator" mass (python) were 17.4:1, 15.6:1, approximately 3.5:1, and 14.4:1, respectively. The python involved in the October 2011 incident was not captured. Nonetheless, relationships established from previous necropsies between head width, total length, and mass of pythons suggest that a python with a head width of approximately 8 cm would typically be about 5 m total length and that snakes of this length weigh 55–65 kg, on average (authors, unpublished data). This would result in a prey-to-predator ratio of approximately 1.1:1, although this should be considered a very rough estimate because it was based on a brief glimpse of the python's head. Although pythons can consume prey items that occasionally exceed their own body mass (Greene 1997), the pythons in 4 of these incidents would not have been able to consume an adult human. The snake involved in the 2011 incident may have been much larger, yet the strike did not result in contact with a human. Aborting strikes prior to contact suggests that pythons may be able to assess the size of a potential prey item in mid-strike and react accordingly. Because humans were far too large for most of the snakes to ingest, because some of the strikes were aborted before making contact, and because none resulted in constriction attempts, we tentatively suggest that these were cases of "mistaken identity" (Murphy and Henderson 1997:137); in this scenario, the python initiates a predatory strike toward a potential prey item in response to a visual or thermal cue, but recognizes the unsuitability of the prey item during the strike and halts the predatory sequence.

Over the past decade (2003–2012), Everglades NP has recorded an average of 1,019,942 visitors/year (National Park Service 2013*b*). Many visitors travel along hiking and canoe trails in areas where pythons have been observed or captured, and yet none of the reported incidents involved a park visitor. During this timeframe, >2,000 free-ranging Burmese pythons have been removed from southern Florida (National Park Service 2013*a*, Wildlife Foundation of Florida 2013), and low individual detection probabilities for pythons (Reed and Rodda 2009) imply that removed pythons represent a very small proportion of the population. This suggests that risks to park visitors on either a per-visitor or per-python basis are exceedingly low. Instead, all strikes were directed at biologists moving through undeveloped areas of the park. Incidents 1 and 2 occurred in an area subject to intense ecological restoration efforts over the past decade. A

minimum of 1,200 person-hours of biological monitoring fieldwork were devoted to the area starting in 2003 (J. Taylor, Everglades National Park, personal communication), plus hundreds of additional labor hours per year for treating exotic vegetation. Conservatively, this effort sums to 15,000 hours, or >7 person-years of field effort in densely vegetated and seasonally flooded vegetation communities—the risk of python attack thus appears to be low even for those people regularly moving through python-occupied areas.

All 5 incidents occurred in flooded vegetation communities. Possibly predatory attacks on biologists by green anacondas (*Eunectes murinus*) in flooded environments in Venezuela were also reported by Rívas (1999). As humans wade through shallow water, they produce ripples that move ahead of them, and these pressure waves may be detectable to a motionless snake in ambush posture. We speculate that detecting these changes in water pressure may alert a python that an animal is approaching, perhaps priming it to strike immediately when a potential prey item is detected by visual or thermal cues.

We conclude that the risk of a human being killed as a result of a predatory attack by a free-ranging Burmese python is very low in any given year, and is vanishingly low as compared with other sources of human mortality in Florida. Although low, the risk is not non-existent. Available evidence from captive snakes suggests that even those strikes that result from cases of mistaken identity or defensive behavior may still result in constriction, which can prove fatal to humans when a large python and/or a small human is involved.

## ACKNOWLEDGMENTS

We thank H. W. Greene, R. W. Henderson, J. C. Murphy, and F. J. Mazzotti for comments on a previous version of this manuscript. B. Greeves, Z. Fratto, N. O'Hare, M. Rochford, T. Selby, L. Serra, and B. Smith contributed information on human–python incidents and reviewed our summaries of these incidents. Funding for our research on Burmese pythons has been provided by Everglades National Park, the U.S. Geological Survey (USGS) Greater Everglades Priority Ecosystem Science program, and the Invasive Species Program of the USGS Ecosystems Mission Area.

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*Associate Editor: Gorman.*