REPTILES & AMPHIBIANS

Annual Reproduction and Reproductive Frequency of Burmese Pythons (*Python bivittatus*) in Southwestern Florida, USA

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Burmese Pythons (*Python bivittatus* Kuhl 1820) are large snakes capable of killing and consuming large prey, some even greater than their own body size, which enables them to grow to large sizes and produce large numbers of eggs (Bartoszek et al. 2018). Burmese Pythons are generally thought to be "capital breeders," consuming large quantities during a designated feeding season, before using the stockpiled fat reserves to sustain themselves during breeding, oviposition, and incubation of their clutch (Shine 2003). This reproductive strategy supposedly costs breeding females by substantially impacting body condition, leading to a reduction in reproductive frequency (Bonnet et al. 1998). The cost of a reproductive season may be 35–40% of total body mass (Bartoszek and Easterling, unpubl. data), leading to an assumption that these snakes reproduce at low frequencies (Bull and Shine 1979).

Despite being a well-documented invasive species established in southern Florida, little is known about the reproductive frequency of Burmese Pythons in their invaded range (Krysko et al. 2008; Reed and Rodda 2009; Guzy et al. 2023). According to data from > 4,000 necropsies of field-collected snakes in Florida, 36% of all females may not reproduce each year, suggesting that introduced pythons living in the wild follow a biennial or even triennial rhythm (Currylow et al. 2022). In their native range of southeastern Asia, python farmers report that the females can breed annually if they are able to reach breeding condition (i.e., have sufficient fat reserves) (Natusch and Lyons 2014). We herein report three instances of consecutive annual reproduction of wild Burmese Pythons in southwestern Florida, including a female that reproduced in six of seven seasons.

As part of a spatial-use research and removal program, we radio-tracked 20 adult female Burmese Pythons from 28 January 2013 through 30 Jun 2024. Methods for python tracking and captures are provided by Bartoszek et al. (2021). Individual pythons were captured in an area of about 38,850 ha of public and privately owned lands adjacent to Naples, Florida, USA. Releases were staggered as individuals to be tracked were captured (latest release was 13 March 2020). Of the 20 released individuals, 15 were tracked through at least one annual reproductive cycle (Table 1).

On 22 May 2014, we tracked a telemetered female python (F06, initially released 21 April 2014; SVL = 376 cm) to a Nine-banded Armadillo (*Dasypus novemcinctus*) burrow on private land adjacent to Rookery Bay National Estuarine Research Reserve (RBNERR), where we noted that she was incubating a clutch of eggs. On 2 June 2015, we discovered F06 in a different Nine-banded Armadillo burrow with a new clutch, despite having produced a clutch during the previous reproductive cycle. The following year, F06 was extracted from the field for retransmission (19 May 2016). During surgery, the veterinarian discovered that she was once again gravid. As a result of the stress of capture, surgery, and captivity, F06 aborted her clutch of 54 eggs. These eggs likely would have been viable had we not disturbed her during the crucial period prior to incubation. During the fourth year of tracking, F06 did not produce a clutch. During the fifth year of tracking, she was observed presumptively mating, but ultimately was seriously injured by an American Alligator (*Alligator mississippiensis*) and was recovered and euthanized. Subsequent necropsy indicated that she had not laid a clutch of eggs, but instead had retained the oviductal, malformed clutch. Had she not been injured, she likely would have laid an additional clutch that year.

A second adult female python captured in RBNERR, and released on 7 March 2016 (F13; SVL = 371 cm), produced a large clutch of eggs in the Reserve during her initial tracking year (clutch size = 58). The following breeding season, she was observed mating with two telemetered males. On 27 May 2017, she was incubating eggs in a Gopher Tortoise (*Gopherus polyphemus*) burrow (Bartoszek et al. 2024). Upon extraction from this second consecutive clutch, F13 was euthanized to allow telemetered males to seek other unknown females for removal. Both F13 and F06 were larger than the average-

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Table. 1. Recorded reproductive events for radio-tracked female Burmese Pythons (*Python bivittatus*) in Collier County, Florida, USA. Female pythons producing consecutive clutches are indicated by bold type. A breeding season encapsulates the annual cycle of approximately 100 days during December into March (Currylow et al. 2022). Key: ● = breeding year, ○ = nonbreeding year, × = mortality, α = euthanized, ⌀ = lost contact.

		Breeding Seasons Tracked						
Python ID	**Initial Year**	**Season 1**	**Season 2**	**Season 3**	**Season 4**	**Season 5**	**Season 6**	**Season 7**
F01	2013	○	○	○	●	⌀	—	—
F02	2013	●	○	⌀	—	—	—	—
F03	2013	●	×	—	—	—	—	—
F04	2014	●	○	●	α	—	—	—
F05	2014	●	○	●	α	—	—	—
F06	2014	●	●	●	○	α	—	—
F07	2015	●	α	—	—	—	—	—
F09	2015	●	α	—	—	—	—	—
F11	2015	●	○	●	α	—	—	—
F13	2016	●	●	α	—	—	—	—
F14	2016	○	●	α	—	—	—	—
F16	2019	●	○	●	●	●	●	●
F18	2020	●	○	●	×	—	—	—
F19	2020	●	○	●	α	—	—	—
F20	2020	●	○	●	α	—	—	—

sized breeding female (mean SVL = 338 cm; Bartoszek and Easterling, unpubl. data). These two observations indicated that annual reproduction was occurring more frequently than originally assumed. We hypothesized that this might be a size-specific effect in our study area and larger females capable of preying more frequently on larger animals were capable of this higher rate of reproduction (Jayne et al. 2022).

On 28 December 2018, we captured a third adult female python (F16; SVL = 261 cm) on private lands adjacent to RBNERR (Fig. 1). Since her release on 17 January 2019, F16 has produced clutches in six of seven annual reproductive cycles. During the first three breeding seasons, F16 bred in a biennial cycle. On 28 June 2021, after extraction from her second clutch, her SVL was measured at 315 cm. After reaching that size, she successfully laid clutches in five consecutive annual breeding cycles. This observation was contrary to the size-specific fecundity hypothesis, as F16 is still below average length in our study area. Instead, this seemingly correlates to findings of Shine et al. (1998), who found that smaller female Reticulated Pythons, *Malayopython reticulatus* (Schneider 1801) appear to reproduce more frequently. This could be an exhibition of flexible maternal control (Shine 2003). Python F16 remains free-ranging and we will continue to track her.

To the best of our knowledge, these are the first recorded observations of annual reproduction in Burmese Pythons in southern Florida that provide substantive evidence of potentially higher fecundity than previously realized. Factors such as prey size and availability, feeding rates, density-dependent fecundity, and genetic predisposition could affect reproductive potential, as suggested for other species of pythons (Shine and Madsen 1997; Madsen and Shine 1999). Additionally, environmental factors that impact prey availability (e.g., rainfall, climate change, invasion timeline) also could contribute

Figure 1. A female Burmese Python (*Python bivittatus*) identified as F16 incubating one of her many clutches of eggs in the Rookery Bay National Estuarine Research Reserve, Florida, USA. Photograph by Kyle Findley.

to this effect (e.g., MacDonald-Beyers and Labisky 2005; Madsen et al. 2006; Sperry and Weatherhead 2008; Catano et al. 2015), although those data are currently outside the scope of the current study. The irregular pattern of successive annual reproduction in our study suggests that clutch frequency is not fixed (Bull and Shine 1979). Our initial experimental design was based on the understanding that Burmese Pythons reproduced biennially (Reed and Rodda 2009). Consequently, tracking periods were limited to 2–3 years to observe spatial-use and behavior in reproductive and non-reproductive annual cycles. Observations of multi-annual reproduction led us to track some animals for longer periods (i.e., 4–6 years). We recommend tracking for terms greater than four years to adequately document fecundity and reproductive potential of Burmese Pythons in their invaded range.

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