FINAL REPORT

REMOVING BURMESE PYTHONS FROM LANDS MANAGED BY THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Prepared by:

Frank J. Mazzotti, Matthew L. Brien and Michael S. Cherkiss
Department of Wildlife Ecology and Conservation
Fort Lauderdale Research and Education Center
University of Florida
3205 College Avenue
Fort Lauderdale, FL 33314

And

Skip Snow
U.S. National Park Service
Everglades National Park
400l SR 9336
Homestead, FL 33034

Prepared for South Florida Water Management District

2007

REMOVING BURMESE PYTHONS FROM LANDS MANAGED BY THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Introduction

The Burmese python (*Python molurus bivittatus*), a native to Southeast Asia, can reach lengths greater than twenty feet (Wall 1921; Pope 1961). This python is a long lived (15 – 25 years) behavioral, habitat, and dietary generalist, capable of producing large clutches of eggs (8 – 107) (Lederer 1956; Branch and Erasmus 1984). Observations of pythons exist primarily from three locations in Everglades National Park (ENP): (1) along Main Park Road in the saline and freshwater glades, and mangroves, between Pa-hay-okee and Flamingo, (2) the greater Long Pine Key area (including Hole-in-the-Donut), and (3) the greater Shark Valley area along the Tamiami Trail (including L-67 Extension.). They have also been observed repeatedly on the eastern boundary of ENP, especially in the C-111 Project Basin and along other canal levees managed by the South Florida Water Management District (SFWMD). Between 1995 and 2005, 212 Burmese pythons were captured and removed or found dead on the road. During fall (Oct/Nov) of 2005 while clearing land in the C-111 Project Basin (the Frog Pond) at least 22 pythons were killed by farm machinery and at least seven more were encountered by the SFWMD while mowing retention area levees. Undocumented reports for this same time period suggest an additional 17 – 20 pythons may have been hit and killed by farm machinery. In recent years (2003 – 2005) individuals of all size classes have been seen with increasing regularity in and around ENP and on lands managed by SFWMD along the park's eastern boundary. Measured total length for snakes recovered ranged from two feet to over 15 feet, including five hatchling-sized animals recovered in the summer of 2004, and two hatchlings captured in 2005.

As do other non-native aquatic species, *P. m. bivittatus* present a potential threat to successful ecological restoration of the greater Everglades (NRC 2005) and to management of existing resources. This species is now established and breeding in south Florida. *P. m. bivittatus* has the potential to occupy the entire footprint of CERP and all canal levees managed by the SFWMD. Proposed management and control actions must include research strategies and further evaluation of removal methods for pythons. In July of 2005, an Invasive Snake/Reptile Management and Response Workshop was convened. Workshop participants came from all over the continental US and Pacific Islands, representing experience with invasive reptile management from around the world. Based on this collective experience, participants recommended strategic actions, with python control a very high priority. Initially the highest priority item identified for python control was radio tracking to determine movements, habitat use and the efficacy of using pythons to find other pythons. Radio telemetry has proven an effective method for determining habitat use and extent and timing of movements of snakes (Reinert 1993); and radio-telemetry of individual snakes has been useful in finding aggregations of anacondas (Rivas 2001). This approach has also proven successful in ENP where four *P. m. bivittatus* were radio-tracked between December 2005 and March 2006. Telemetered snakes moved away from road edges where they had been captured and into areas with

abundant elevated areas (tree islands and rock outcrops). Significantly, the four telemetered snakes led to 15 additional untagged pythons, 12 of which were captured and removed. Most important all four telemetered snakes were recovered and removed from the wild.

Objectives

Objectives of this project were:

1. To assess the feasibility of using radio telemetry to find and remove pythons
2. To examine movements and habitat use by pythons through radio telemetry

Methods

Using animals secured through ENP control efforts, such as trapping and hand capture, four adult pythons were outfitted with vhf beacon radio transmitters and released in the SFWMD managed S-332D Retention area (figures 1-4). Two transmitters were implanted in each python as backup in the event that one failed. Transmitters were implanted intraperitoneally (Reinert and Cundall 1982; Weatherhead and Anderka 1984; Hardy and Greene 1999; 2000). Temperature sensors were incorporated into the transmitter package to investigate thermal requirements of the pythons and the effects of thermal behavior on microhabitat selection. Pythons were tracked daily for the first two weeks in order to monitor the health of each individual and account for any long distance movements. Tracking was then reduced to twice a week if pythons were not recorded moving out of the general area. The majority of tracking involved triangulation for locating the position of each python. This required going to three separate locations, marking each point through GPS, and taking a compass bearing on the signal of the transmitter. Triangulation was primarily used in place of observers approaching snakes to visually get a location, thereby reducing observer influence on python movements and behavior. Each python was also visually located once every two weeks in an attempt to find other pythons and to check the status of each individual. Aerial tracking was used as necessary to follow pythons. All python locations were recorded on fine scale maps and by GPS receiver. Locations of pythons were managed by relational database and a GIS program. Habitats associated with locations were determined through GIS mapping and inspection of locations. Roads within the S-332D Retention area were driven periodically in an attempt to locate and remove other pythons.

Results

Initially, two male pythons (python 1 at 3.14m and python 3 at 3.51m) were tracked in the S-332D Retention area on the ground from 29th March 2006 through 25th May 2006 (Figures 1 and 2). During this time, both males made small scale movements, with python 1 moving an average of 76.94m/day and python 3 an average of 57.63m/day. The greatest detected movement for python 1 was 519.52m over two days, while python 3 moved 674.69m over two days. Both pythons were often located on tree island hammocks and within dense vegetation associated with berms and disturbed fields. After

remaining in the vicinity of the release site for 40 days, python 3 moved 1.6km north to a small tree island/hammock surrounded by farmland (8th May 2006) and remained there for the rest of this tracking period. On 19th May 2006, large areas of matted down grass directly beside rodent trails were observed in the farm field behind this hammock. Trails consistent with that of a large snake were also found leading between the hammock and the field. Night and day time tracking between 19th May and 23rd May indicated that python 3 spent the day on the tree hammock while moving out into the adjacent field at night. Both pythons were observed on a few occasions with obvious stomach bulges indicating recent meals.

At the end of May, pythons 1 and 3 were recovered, re-implanted with new transmitters and released in the same area along with two female adult pythons (python 5 at 4.62m and python 6 at 2.8m) that had been captured and implanted. Ground tracking of pythons 1, 3, 5, and 6 in the S-332D Retention area began 1st June 2006. Python 6 was gravid when captured and laid a clutch of 14 unviable eggs at her release site on 17th June 2006. Python 6 was then tracked through 30th June 2006 when she was removed due to complications with transmitters. Python 6 made very few movements, remaining within the release site for the entire tracking period (Figure 4, Table 1). Pythons 1, 3, and 5 made few, large scale movements up until July 2006, when all three moved a long distance out of the Retention area (Table 1). Python 1 moved on 7th July, python 5 on 14th July, and python 3 on 20th July (Figures 1-3). Despite extensive ground searching within the Retention area these three pythons could not be located and tracking by fixed wing plane commenced 28th July 2006. These long distance movements coincided with heavy rains that produced surface water in the Retention area.

Python 3 was located in ENP, 8.74km NW of last recorded location in the S-332D Retention area by fixed wing plane on 1st August 2006 (Figure 1). Pythons 1 and 5 were located in ENP on 3rd August 2006. Python 1 was 16.17km NNW of last recorded location, while python 5 was 6.66km west of last recorded location (Figures 1 and 3). All three pythons made long distance movements in the direction of their original capture location. Based on surface water level models produced by ENP staff, pythons 3 and 5 both actively avoided dry land, seeking out areas with surface water to return to original areas of capture. This often involved traveling longer distances around areas without surface water (Figures 2 and 3). After just under one month (7th July – 11th August 2006), python 1 returned over 23km to the area in which it was originally captured at the L-67 Extension levee (Figure 1). Here it remained until removal on 29th January 2007. Python 3 traveled 31.9km in just over a month (20th July – 25th August 2006) and came within 9km of the area it was originally captured (L-67 Extension levee). It then moved a further 25.37km north into Big Cypress National Preserve (BCNP) before ending up near the Seminole Indian Reserve where it remained until 17th November 2006 (Figure 2). Due to concern from the Seminole Indians regarding the close proximity of this python to homes, python 3 was relocated to L-67 Extension levee on 20th November 2006. It remained in this area until 8th January 2007 when it was removed due to injuries received from a gunshot wound. Python 5 returned 34.70km to its original area of capture near Pa-hay-okee after 75 days (25th September 2006) (Figure 3). Python 5 remained in this area for the rest of the study (29th January 2007), making very few, if any long distance movements after 25th October 2006. Rates of movement and distances traveled for each of the three pythons can be seen in Table 1. Road cruising within the retention area

occurred throughout this tracking period, resulting in one python, a male approx. 3m long, being captured on a freshly mowed berm at night.

DISCUSSION

The 2006 tracking of pythons on SFWMD lands was remarkable in that all three remaining telemetered pythons (1, 3 and 5) made relatively rapid, long distance movements out of the Retention area where they had been relocated, and back to their original area of capture. The magnitude and rate of these movements appear to be unparalleled in many other studies of python and snake species (Fitch and Shirer 1971; Slip and Shine 1988; Madsen and Shine 1996; Rivas 1999; Fearn et al. 2005). This large-scale movement and apparent ability to 'home' has not been documented in *P. m. bivittatus* to any extent in previous studies. One study (Goodyear 1994), undertaken in disturbed land in Hong Kong, documented the movements of a displaced female *P. m. bivittatus* (2.7m) through radio telemetry. It was proposed that she had returned to her home range after a few days, a distance of 170m. In the pilot radio telemetry study of *P. m. bivittatus* in ENP (2005-2006), displaced individuals made few large scale movements with no obvious attempts to return to original place of capture. Instead, movements appeared to be associated with breeding, with males seeking out females. Maximum distances traveled by pythons in ENP were between 449.2m and 1.28km, similar to distances traveled by pythons relocated to SFWMD lands (388.92m – 1.53km). However, once the pythons left SFWMD lands, maximum distances traveled were between 4.7km and 6.75km in only a few days.

Tracking of pythons on SFWMD lands coincided with the end of the known breeding season (Dec-March) for *P. molurus* in their home range (Wall 1921; Bhatt and Choudhury 1993). Through observations, the breeding season for *P. m. bivittatus* in ENP also appears similar (Snow pers comm.). Individuals in the Retention area did not appear to be engaged in mating with other pythons, and with the onset of heavy rains and surface water in July began heading back toward their original capture locations. As a semi aquatic, heavy bodied snake, the onset of surface waters facilitated the rapid long distance movements required by *P. m. bivittatus* to 'home' in this study. In fact, these pythons actively avoided dry land in their attempt to return home, remaining in areas with surface water the whole time. Given that the Retention area has abundant rodents, it appears prey was not a motivating factor in the movements of these pythons. The large amount of energy required to undertake such movements suggest that, as with a number of other snake species (Slip and Shine 1988; Madsen and Shine 1996; Rivas 1999; Fearn et al. 2005), *P. m. bivittatus* that are wild born and established in south Florida probably display a high degree of site fidelity. Therefore, these long distance movements are considered atypical and a result of displacement.

The dispersal capabilities demonstrated by relocated *P. m. bivittatus* in this study raise several issues for python management. Essentially, captive released, displaced or juvenile pythons searching for a suitable home range have the potential to colonize almost any area in south Florida. It appears that higher water levels encourage and expedite movements, though exactly how dispersal is affected by other factors such as habitat type, higher elevations, age, size, sex, and time of year remains unknown. For

example, males of many polygynous snake species tend to travel more widely in search of females during the breeding season (Madsen and Shine 1996; Rivas 1999). Of particular concern is the spread of pythons into biologically vulnerable areas such as the Florida Keys, which contain several federally endangered or threatened species. The many creeks and canals separating the Keys from the mainland could possibly facilitate movement by pythons. With increasing number of pythons sighted or recovered along the 18 mile stretch leading to the Keys, there is a real potential for this invasion to occur. Given the ability of *P. m. bivittatus* to disperse long distances, it is important for management to determine which factors affect movement and therefore the overall nature of python dispersal.

The results of this project will be applied to develop a radio telemetry program as part of a comprehensive, science-based control and containment program designed to reduce the number of pythons in south Florida, and therefore their impact on the ecosystem and probability that people will encounter them. For example, natural history information such as social interactions, movements and habitat use can be used to determine how to design and deploy control measures such as traps and to develop recommendations for habitat modification (e.g. clearing or mowing vegetation) and ecosystem restoration (e.g. removal of levees and re-establishment of hydrological patterns). However, the semi aquatic nature of *P. m. bivittatus* and ability to disperse suggests that restoration of natural water flow through the Everglades may potentially benefit this species.

The unique dispersal capabilities of *P. m. bivittatus* and affiliation with water indicate that effective management of the rapidly expanding python population in south Florida requires cooperation and involvement of all land managers and relevant agencies. Rapid movements of python 3 across land owned or managed by SFWMD, ENP, BCNP, and Seminole, is a clear example of this need for broad scale involvement. However, for any future containment programs to succeed it is crucial that the release of captive pythons in south Florida be dramatically reduced if not eliminated.

Literature Cited:

Bhatt, K. and B. C. Choudhury. 1993. The diel activity pattern of Indian python (*Python molurus molurus linn.*) at Keoladeo National Park, Bharatpur, Rajasthan. J. Bombay Nat. Hist. Soc. 90: 395-403.

Branch, W. R. and H. Erasmus. 1984. Captive breeding of pythons in South Africa, including details of an interspecific hybrid (*Python sebae natalensis* x *Python molurus bivittatus*). Journal of the Herpetological Association of Africa 1984(30):1-10.

Fearn, S., Schwarzkopf, L., and R. Shine. 2005. Giant snakes in tropical forests: a field study of the Australian scrub python, *Morelia kinghorni*. Wildlife Research 32: 193-201.

Fitch, H. S. and H. W. Shirer. 1971. A radiotelemetric study of spatial relationships in some common snakes. Copeia 1971(1): 118-128.

Goodyear, N. C. 1994. *Python molurus bivittatus* (Burmese Python). Movements. Herpetol. Rev. 25:71-72.

Hardy, D. L., Sr. and H. W. Greene. 1999. Surgery on rattlesnakes in the field for the implantation of transmitters. Sonoran Herpetologist 12:25-27.

Hardy, D. L., Sr. and H. W. Greene. 2000. Inhalation anaesthesia of rattlesnakes in the field for processing and transmitter implantation. Sonoran Herpetologist 13:110-114.

Lederer, G. 1956. Fortpflanzungsbiologie und Entwicklung von *Python molurus molurus* (Linné) und *Python molurus bivittatus* (Kühl). Die Aquarien- Und Terrarien-Zeitschrift 9:243-248.

Madsen, T. and R. Shine. 1996. Seasonal migration of predators and prey: Pythons and rats in tropical Australia. Ecology 77: 149-156.

National Research Council. 2005. Re-engineering storage in the Everglades: risks and opportunities. National Academies Press. Washington. DC.

Pope, C. H. 1961. The giant snakes. Alfred A. Knopf, New York.

Reinert, H. K. 1993. Habitat selection in snakes. Pages 201-240 *in* R. A. Seigel and J. T. Collins, editors. Snakes: ecology and behavior. McGraw-Hill, New York.

Reinert, H. K. and D. Cundall. 1982. An improved surgical implantation method for radiotracking snakes. Copeia 1982:702-705.

Rivas, J. A. 1999. The life history of the Green anaconda (*Eunectes marinus*): with emphasis on its reproductive biology. PhD dissertation. University of Tennessee. Pp13-30.

Rivas, J. A. 2001. Feasibility and efficiency of transmitter force-feeding in studying the reproductive biology of large snakes. Herpetological Natural History 8(1): 93-95.

Slip, D. J. and R. Shine. 1988. Habitat use, movements and activity patterns of free-ranging diamond pythons, *Morelia s. spilota* (Serpentes: Boidae): a radiotelemetric study. Australian Wildlife Research 15: 515-531.

Wall, F. 1921. Ophidia taprobanica or the snakes of Ceylon. Govt. Printer, Colombo.

Weatherhead, P. J. and F. W. Anderka. 1984. An improved radio transmitter and implantation technique for snakes. J. Herpetol. 18:264-269.

Table 1. Total distances traveled and rates of movement for pythons within the S332 Retention area and after leaving the Retention area. * Only includes movements after 1 June 2006. ^ Does not include movements after second relocation to L-67 Extension (17th November 2006).

	Python 1		**Python 3**		**Python 5**		**Python 6**
	Retention area*	**After Retention area**	**Retention area***	**After Retention area^**	**Retention area**	**After Retention area**	**Retention area**
Total distance	2974.6m	78193.97m	3044.6m	69829.7m	4305.14m	56032.3m	1211.89m
Average Rate of movement	80.38m/day	385.19m/day	60.89m/day	581.91m/day	97.84m/day	285.88m/day	40.4m/day
Greatest rate of movement	388.92m/day	6183.65m/ 2 days	1527.52m/ 7 days	4701.43m/ 2 days	963.3/ 2 days	6752.82/ 3 days	439.93m/ 2 days

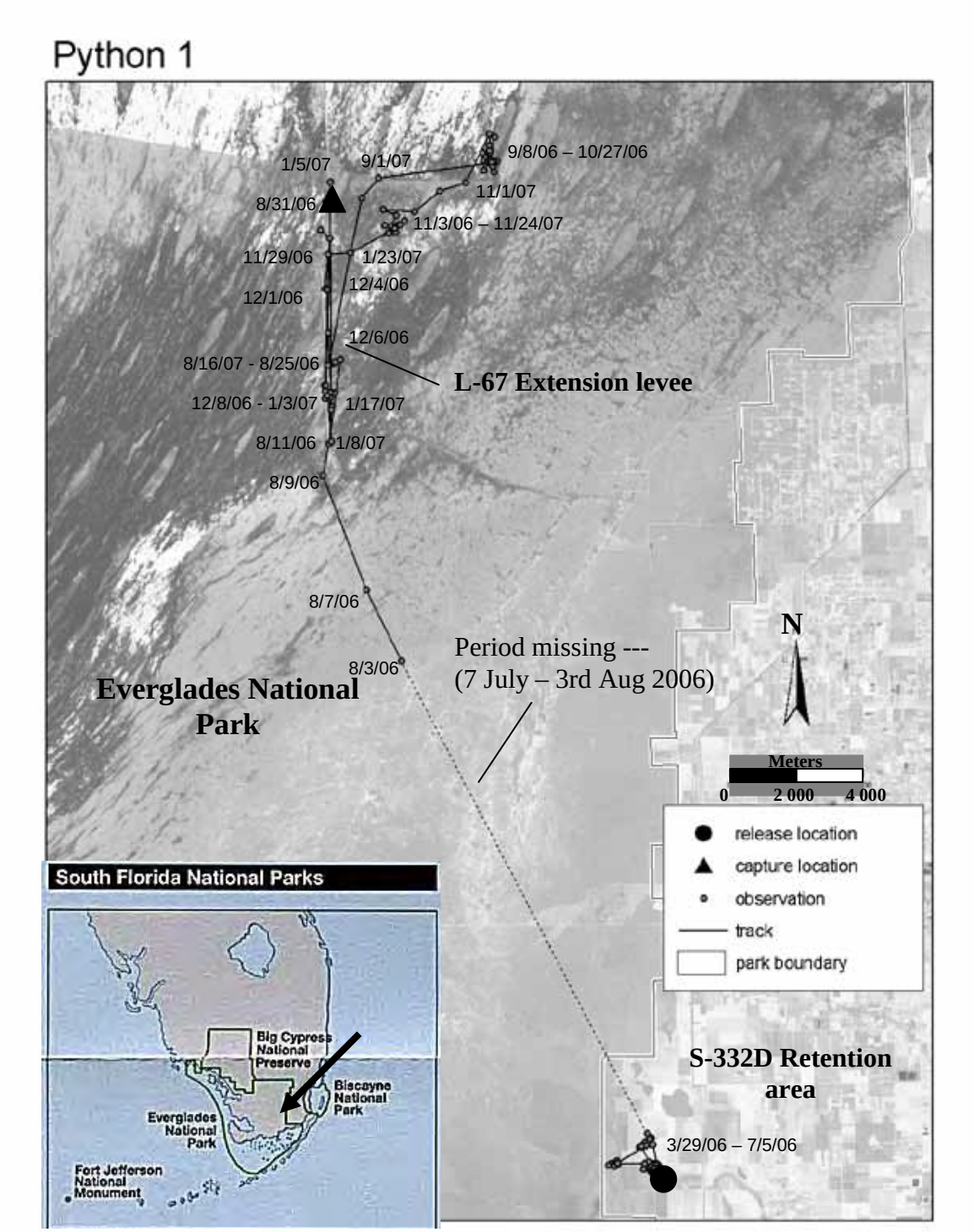

Figure 1. Movements of python 1 (male 3.14m) between 1st June 2006 and 29th January 2007 displayed on map provided by Everglades National Park.

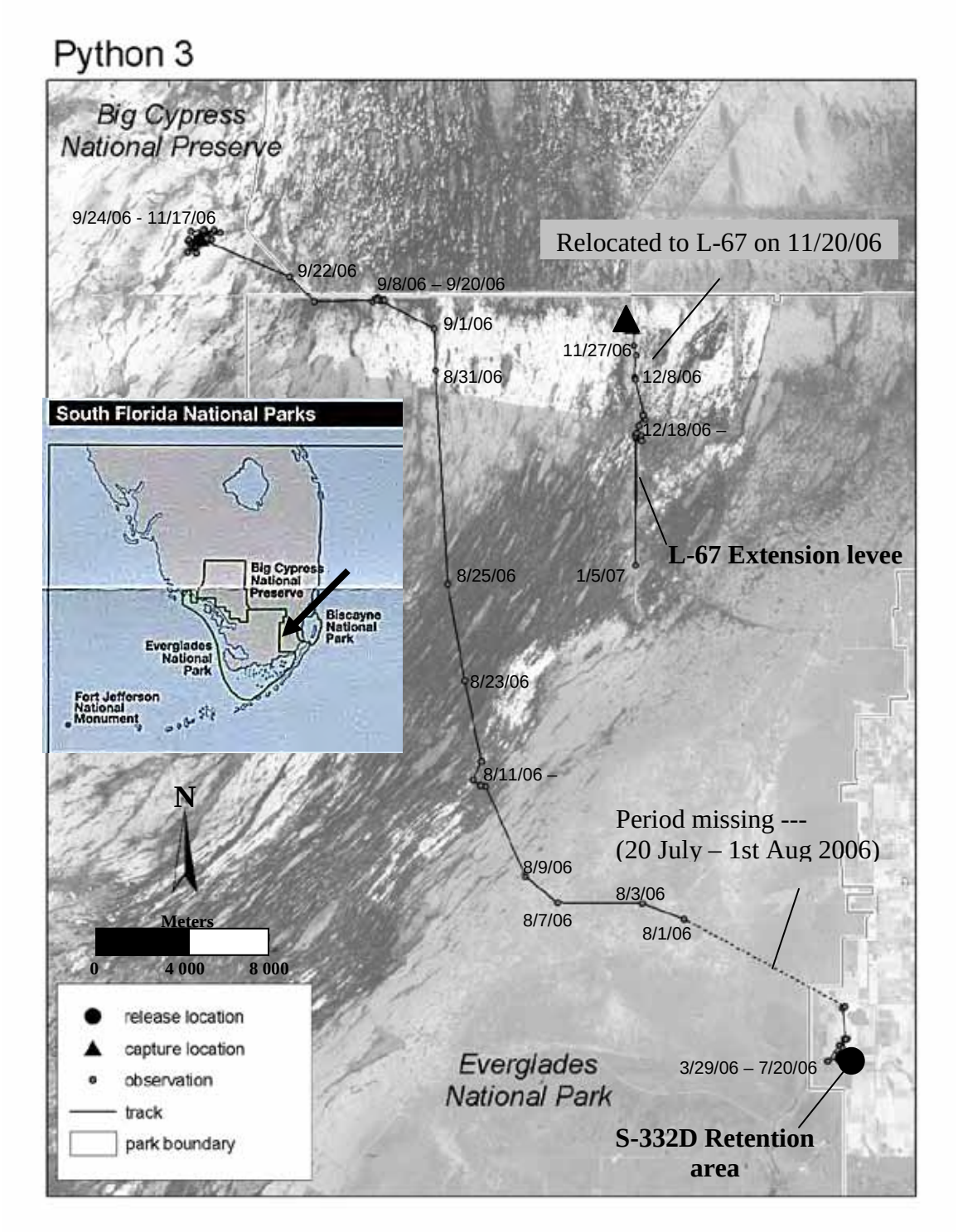

Figure 2. Movements of python 3 (male 3.51m) between 1st June 2006 and 8th January 2007 when it was removed due to a gunshot wound displayed on map provided by Everglades National Park.

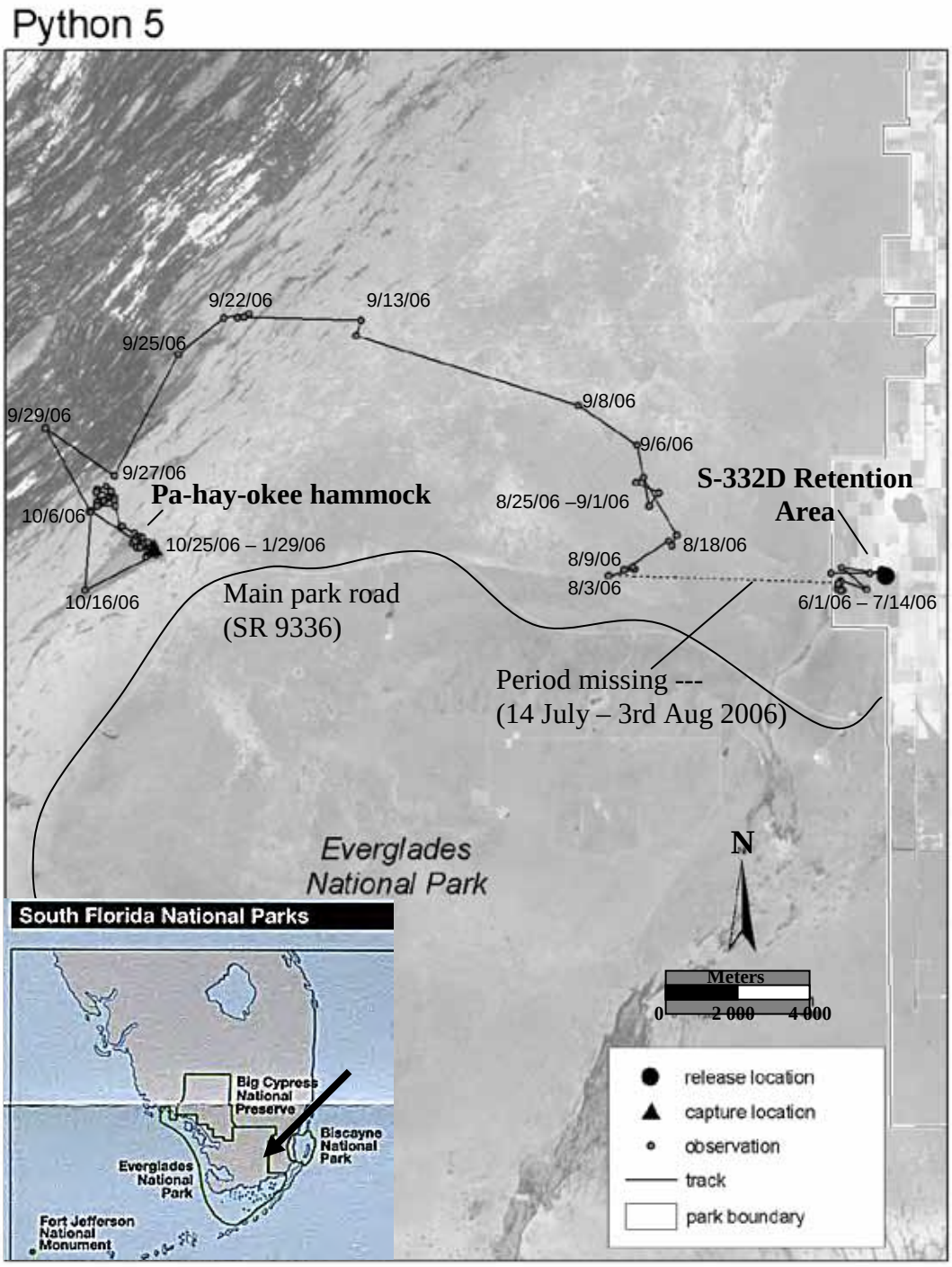

Figure 3. Movements of python 5 (female 4.62m) between 1st June 2006 and 29th January 2007 displayed on map provided by Everglades National Park.

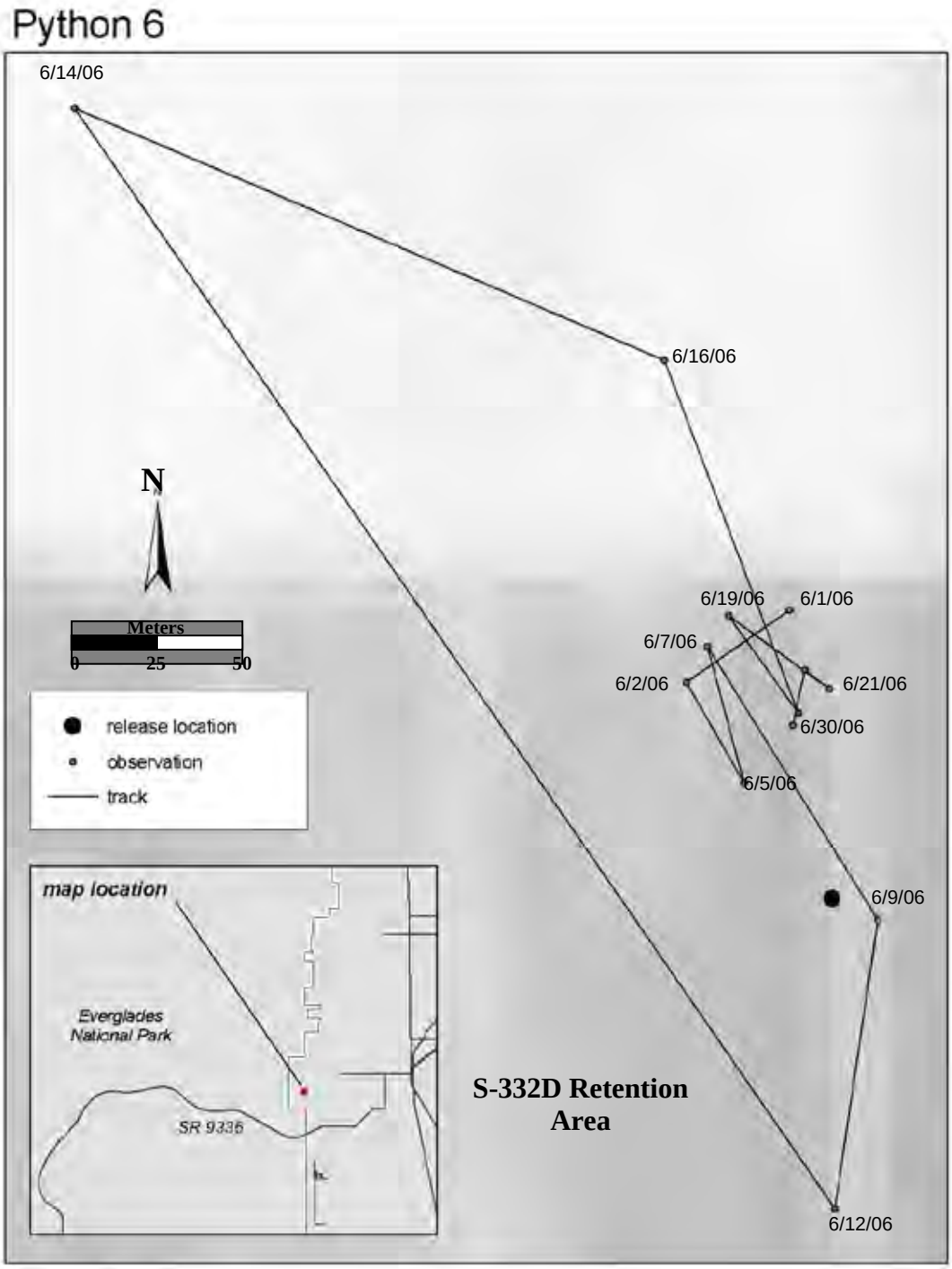

Figure 4. Movements of python 6 (female 2.8m) between 1st June 2006 and 30th June 2006 when it was removed due to complications with transmitters displayed on map provided by Everglades National Park.