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ABSTRACT: The invasive Burmese python is a large constrictor snake that is now well established in south Florida. This invasive predator could have major detrimental impacts to native wildlife populations and is a perceived threat to human health and safety. Finding and removing this elusive predator in vast Everglades habitats of wet sawgrass prairies with interspersed hardwood hammocks poses many challenges for biologists and land managers in south Florida, and no single solution is likely to prevail. In ongoing research, we are exploring opportunities to improve detection of this cryptic species using such diverse approaches as environmental DNA, trained detector dogs, and thermal infrared imagery. In this paper we update the status of these efforts. Other research, using captive pythons in outdoor pens at our facility in Gainesville, has resulted in the development of a newly-patented live trap that is specific to large snakes. We are currently testing and evaluating techniques to complement this new trap design for effective python removal in concert with improved detection tools.

KEY WORDS: Burmese python, eDNA, Everglades, Florida, infrared detector, live trap, *Python bivittatus*, refugia, unmanned aerial system

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INTRODUCTION

The Burmese python (*Python bivittatus*) has quickly become the highest profile reptile of the many invasive reptiles in Florida. Due to its large adult size that may exceed 5 m and the range of food items at risk to be eaten, it has received considerable media attention. The species has been breeding in the wild in south Florida for over a quarter-century (Meshaka et al. 2000). Its invasion pathway in south Florida has been largely attributed to (illegal) pet releases, although the highly destructive Hurricane Andrew in 1992 may also have released many from captive breeding and holding facilities (Snow et al. 2007b, Bilger 2009). The ecological impacts from this large invasive predator are yet to be fully understood, but Burmese pythons in south Florida are already known to consume a wide variety of native wildlife, including endangered species (Greene et al. 2007, Snow et al. 2007a, Dove et al. 2011). Pythons also evoke strong emotional reactions due to the perceived threat that these snakes pose to humans, despite the fact that the actual risk to humans appears to be very low (Reed and Snow 2014).

The ecological impacts of Burmese pythons underscore the importance of developing practical methods and techniques for reducing the python population and ameliorating the impacts. To that end, NWRC biologists and colleagues have investigated a number of potentially promising options for detecting and capturing pythons in south Florida. In this paper we review these efforts and examine the prospects for large scale field applications.

DETECTING BURMESE PYTHONS

No one knows how many Burmese pythons exist in south Florida. More than 1,900 pythons have been removed since 2000 (http://www.nps.gov/ever/ nature science/burmesepythonresearch.htm). Popular estimates of the total python population in south Florida exceed 100,000 (Lee 2014), but such estimates are no more than guesses. A large part of the problem in determining how many pythons exist in Florida is the difficulty in detecting them. Despite their large size, Burmese pythons are very cryptic and blend well into the natural habitats of south Florida, including many natural and man-made wetlands. Almost all of the animals removed are found on canal levees or roads, which only represent a small fraction of the Greater Everglades ecosystem. Detecting pythons in the rest of the Everglades requires a set of different methods.

Environmental DNA

Organisms are constantly sloughing cells containing DNA into their surrounding environment. Recently, the ability to detect this genetic material, known as environmental DNA (eDNA), has been shown to be possible for several aquatic vertebrates (Ficetola et al. 2008, Goldberg et al. 2011). This prompted us to investigate the application of eDNA to Burmese pythons, which are closely associated with water and otherwise very difficult to detect. The resulting study culminated in development and publication of a methodology for detecting python eDNA in water (Piaggio et al. 2014). This represents a significant advance in our ability to monitor the current extent of the python range and to detect incipient invasive populations before the animals are actually observed or encountered through standard visual searching. The eDNA method is also applicable to eradication efforts to verify that no animals remain in the area, and to detect any that reinvade. We are currently applying this method to surveys in south Florida by sampling water from canals where University of Florida personnel are regularly surveying the adjacent levees for invasive species. When the water samples are analyzed, we will be able to compare the visual survey method to the eDNA method, as well as compare eDNA findings between survey sites.

Python Detection Dogs

Because of their incredible sense of smell, dogs (*Canis familiaris*) are used for a wide variety of detection purposes in wildlife management (Vice and Engeman 2000, Duggan et al. 2011, Dahlgren et al. 2012). Through an agreement with Everglades National Park and the South Florida Water Management District, the Auburn University EcoDogs program conducted a pilot study to assess whether detection dogs were an effective tool for python management efforts (Martin 2012). Personnel with the USDA Wildlife Services Program assisted with dog training at the Gainesville, FL facility and provided field support during searches in south Florida. This effort, which occurred during November 2010-April 2011, resulted in the capture of 19 pythons (Romagosa et al. 2011). The search team found that dogs (black Labradors) typically worked 5 miles/day before having to stop due to overheating. The dog search team success rate (92%) exceeded that of human search teams (64%) in controlled canal searches, and the dogs performed searches 2.5 times faster than humans (Romagosa et al. 2011). Researchers concluded that despite limitations due to heat and being restricted to levees and roads, dogs can complement current search and trapping methods.

Infrared Detectors

Heat radiated from bodies of warm-blooded wildlife is detectable via variety of infrared (IR) devices (Croon et al. 1968, Garner et al. 1995, Franke et al. 2012). This technology has yet to be applied in studies of cold-blooded animals, perhaps in part because body temperatures of snakes and lizards are similar to their surroundings and thereby would be invisible to IR detectors used for surveying warm-blooded animals. We reasoned, however, that snakes or lizards that have been basking in the sun would retain their body heat longer than the surroundings, and that late in the day they would be discernible with IR detectors. In October 2013, in collaboration with UF researchers, we tested two IR devices (RAZ® infrared camera and FLIR® Model T420) for their ability to detect Burmese pythons. We secured 4 snakes in mesh bags and placed them on grass-covered open ground at 15-m intervals, up to 60 m from the detectors. Each snake had spent the day in a refuge box equipped with a warming blanket. The snakes' initial surface body temperatures averaged 25.7°C (25.1°C to 26.8°C). We recorded images of the snakes from 1740 to 2000. As expected, snakes lost heat steadily after dark, but their surface body temperatures remained several degrees above background substrate temperatures (18.9°C versus 15.3°C). The snakes were clearly discernible until the end of the test period. Our results demonstrated that either unit can detect large snakes under these test conditions.

A potential application of this technology is as part of in an unmanned aerial system (UAS) for sustained surveys aloft. The FLIR unit we tested is too large for practical UAS deployment, but the size of the RAZ unit is appropriate. An unmanned system carrying the appropriate IR detector could survey levees and roads, and ideally transmit real-time information to response teams for retrieval of the snakes. Hand-held IR units might make ground searches for pythons more effective by increasing the detectability of this very cryptic species.

TRAPPING BURMESE PYTHONS

Developing a Live Trap for Large Snakes

Live-trapping is a standard method well known to virtually all wildlife professionals. For pythons, trap development has taken many forms (Reed et al. 2011). In almost any live-trap application, a major concern is the capture and welfare of non-target animals. Total avoidance of non-target capture might be impossible, but effective preventative measures can substantially reduce the rate of non-target captures and have economic benefits as well.

One outcome of our recent trials with captive pythons was the development of an innovative patented trap for large snakes (Humphrey 2013). The trap is specifically configured to avoid inadvertently capturing non-target animals by using 2 spring-loaded weight-sensitive trip pans. Each trip pan has an independent release mechanism so that both trip pans must be in a depressed position to spring the trap. Of the native snakes in in south Florida, only very large species such as eastern diamondback rattlesnakes (*Crotalus adamanteus*), water moccasins (*Angkistrodon piscivorous*), or eastern indigo snakes (*Drymarchon couperi*) would likely have the length and weight to depress both pressure plates simultaneously and be captured with this trap properly set. Tests with 2 water moccasins (total length140 cm and 152 cm, body mass 2.35 kg and 2.54 kg, respectively) and one yellow rat snake (*Pantherophis alleghaniensis*; 151 cm, unknown body mass) verified that these animals did not trigger the trap. Substantially reducing, if not eliminating, the risk of non-target captures implies that large-scale trap deployments are possible at greatly reduced costs. As Reed et al. (2011) observed, "…labor is typically the most expensive component of trapping budgets and fewer trap checks per unit time would greatly reduce costs associated with operational python trapping." With our new design, trap checks can be scheduled for every 2 or 3 days or even longer without endangering non-targets, thereby greatly reducing personnel costs. This in turn will increase efficiency by allowing greater numbers of traps to be operated at one time.

Live Traps as Refugia

When a live trap is deployed, the general procedure is to provide shade to protect any animal that is captured from direct sunlight (e.g., Jojola 2007). To evaluate the possible effects of shading on python trap performance, we set up a choice test using captive pythons at our Gainesville, FL research facility. We tested 4 wild-caught pythons from south Florida sequentially in a 10 × 30 × 6-ft outdoor pen from 7 September to 4 November 2010. We provided a water pan and several large climbing branches as well as 2 python live traps, one covered with burlap and the other covered with black plastic (Figure 1). During several days of acclimation, the traps were closed. Then we set each trap and recorded the activity of the python with video cameras.

Table 1. Captive Burmese python responses to live traps covered with either burlap or black plastic, September - November 2010.

Python	Traps Set	Python Trapped	Trap Selected	Latency to Enter Trap
40	September 7	September 10	Black	3 days
	September 20	September 23	Black	3-5 days
92	October 4	October 4	Black	6 hours
	October 5	October 5	Black	18 hours
	October 6	October 7	Black	1.5 days
39	October 21	October 21	Black	3 hours
	October 25	October 25	Black	1 hour
90	October 28	Did not enter trap - Ended on 3 November		

Figure 1. Burmese python in choice test of live traps covered with black plastic (left) or burlap (right).

We ended the trial when the snake entered one of the traps. We removed the snake from the trap, and we reset them and again allowed the snake to continue to explore the pen. We recorded subsequent captures to obtain an idea of the consistency of individual snake's choices.

Three of the 4 test pythons consistently selected the trap covered with black plastic; the fourth snake never entered a trap (Table 1). Because of the small sample size, these results must be considered preliminary. However, it is undeniable that in over 26 days of testing none of the 4 test animals entered the burlap-covered trap. The burlap provided some shade, but the trap was still very well lit and perhaps to the snakes did not provide either a potential source of prey or a secure refuge. By contrast, the trap covered with black plastic was totally dark inside and we surmise that pythons considered it a safe haven.

For field application, these findings suggest that python live traps covered in black plastic could be deployed as refugia, with no need for baiting. The refugia-traps would likely attract the attention of pythons which are not necessarily seeking prey, thus expanding the potential target population. Also, without the need for a bait or lure, the trapping procedure is greatly simplified.

DISCUSSION

Controlling the invasive Burmese python population across hundreds of thousands of hectares and numerous land management jurisdictions in south Florida is a daunting task. Even though there is no magic bullet for eradicating Burmese pythons from south Florida, there are tools available that can be applied now. These include the methods we present here, as well as options such as radiotelemetry and the Judas snake technique (Harvey et al. 2008). Researchers will continue to develop more effective capture and removal techniques. In the meantime, the tools we already have should be applied with force to prevent the python population from growing and spreading any further. This requires putting dozens of people to work in the Everglades ecosystem setting and checking hundreds of traps, employing detector dogs, and surveying waterways using eDNA techniques. There is no easy way, but delaying is probably the worst course of action.

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LITERATURE CITED

Bilger, B. 2009. Swamp things. The New Yorker April 20, pp. 80-89.

Croon, G. W., D. R. McCullough, C. E. Olsen, Jr., and L. M. Queal. 1968. Infrared scanning techniques for big game censusing. J. Wildl. Manage. 36:135-140.

Dahlgren, D. K., R. D. Elmore, D. A. Smith, A. Hurt, E. B. Arnett, and J. W. Connelly. 2012. Use of dogs in wildlife research and management. Pp. 140-153 *in*: N. J. Silvy (Ed.), Wildlife Techniques Manual: Research, Vol. I. The Johns Hopkins University Press, Baltimore, MD.

Dove, C. J., R. W. Snow, M. R. Rochford, and F. J. Mazotti. 2011. Birds consumed by the invasive Burmese python (*Python molurus bivittatus*) in Everglades National Park, Florida, USA. Wilson J. Ornithol. 123:126-131.

Duggan, J. M., E. J. Heske, R. L. Schooley, A. Hurt, and A. Whitelaw. 2011. Comparing detection dog and live trapping surveys for a cryptic rodent. J. Wildl. Manage. 75: 1209-1217.

Ficetola, G. F., C. Miaud, F. Pompanon, and P. Taberlet. 2008. Species detection using environmental DNA from water samples. Biol. Letters 4:423-425.

Franke, U., B. Goll, U. Hohmann, and M. Heurich. 2012. Aerial ungulate surveys with a combination of infrared and high-resolution natural colour images. Anim. Biodiv. Conserv. 35:285-293.

Garner, D. L., H. B. Underwood, and W. F. Porter. 1995. Use of modern infrared thermography for wildlife population surveys. Envir. Manage. 19:233-238.

Goldberg, C. S., D. S. Pilliod, R. S. Arkle, and L. P. Waits. 2011. Molecular detection of vertebrates in stream water: A demonstration using Rocky Mountain tailed frogs and Idaho giant salamanders. PLoS ONE 6(7): e22746.

Greene, D. U., J. M. Potts, J. G. Duquesnel, and R. W. Snow. 2007. Geographic distribution: *Python molurus bivittatus* (Burmese python). Herpetol. Rev. 38:355.

Harvey, R. G., M. L. Brien, M. S. Cherkiss, M. Dorcas, M. Rochford, R. W. Snow, and F. J. Mazzotti. 2008. Burmese pythons in south Florida: Scientific support for invasive species management. Doc. WEC242, Wildlife Ecology and Conservation Dept., Florida Coop. Extension Service, Institute of Food and Agric. Sciences, University of Florida.

Humphrey, J. S. 2013. Trapping method and apparatus. U.S. Patent 8,407,931 B1.

Jojola, S. 2007. Live-trapping, transportation to research facility, handling, and processing of *Rattus* spp. Standard Operating Procedure FP 031.00. USDA National Wildlife Research Center, Fort Collins, CO.

Lee, J. 2014. Burmese python killed in Florida Everglades. USA Today Network. Available online.

Martin, C. 2012. A giant battle: Auburn canines help in search for Everglades' pythons. Available online.

Meshaka, W. E. Jr., W. F. Loftus, and T. Steiner. 2000. The herpetofauna of Everglades National Park. Florida Sci. 63: 84-103.

Piaggio, A. J., R. M. Engeman, M. W. Hopken, J. S. Humphrey, K. L. Keacher, W. E. Bruce, and M. L. Avery. 2014. Detecting an elusive invasive species: A diagnostic PCR to detect Burmese python in Florida waters and an assessment of persistence of environmental DNA. Molec. Ecol. Res. 14:374-380.

Reed, R. N., and R. W. Snow. 2014. Assessing risks to humans from invasive Burmese pythons in Everglades National Park, Florida, USA. Wildl. Soc. Bull. 38:366-369.

Reed, R. N., K. M. Hart, G. H. Rodda, F. J. Mazzotti, R. W. Snow, M. Cherkiss, R. Rozar, and S. Goetz. 2011. A field test of attractant traps for invasive Burmese pythons (*Python molurus bivittatus*) in southern Florida. Wildl. Res. 38:114-121.

Romagosa, C. M., T. D. Steury, M. A. Miller, C. Guyer, B. Rogers, T. C. Angle, and R. L. Gillette. 2011. Assessment of detection dogs as a potential tool for python detection efforts. Unpubl. report, Auburn University, Auburn, AL. 10 pp.

Snow, R. W., M. L. Brien, M. S. Cherkiss, L. Wilkins, and F. J. Mazzotti. 2007a. Dietary habits of the Burmese python, *Python molurus bivittatus*, in Everglades National Park, FL. Herpetol. Bull. 101:5-7.

Snow, R. W., K. L. Krysko, K. M. Enge, L. Oberhofer, A. Walker-Bradley, and L. Wilkins. 2007b. Introduced populations of *Boa constrictor* (Boidae) and *Python molurus bivittatus* (Pythonidae) in southern Florida. Pp. 416-438 *in*: R. W. Henderson and R. Powell (Eds.), The Biology of Boas and Pythons. Eagle Mountain Publishing, Eagle Mountain, UT.

Vice, D. S., and R. M. Engeman. 2000. Brown tree snake discoveries during detector dog inspections following Supertyphoon Paka. Micronesica 33(1/2):105-110.