Innovative Methods for Estimating Densities and Detection Probabilities of Secretive Reptiles Including Invasive Constrictors and Rare Upland Snakes

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Background:

Accurate estimates of population density are a critical component of effective wildlife conservation and management. However, many snake species are so secretive that their density cannot be determined using traditional methods such as capture-mark-recapture. Thus, the status of most snake populations remains completely unknown, presenting a substantial obstacle to wildlife inventory or management plans and impeding effective management of these species on DoD lands. Here we develop a novel technique for estimating density of secretive snakes that combines behavioral observations of snake road crossing speed, systematic road survey data, and simulations of spatial movement patterns derived from radiotelemetry, without relying on mark-recapture. We demonstrate this approach through case studies of the imperiled southern hognose snake (*Heterodon simus*) in the North Carolina Sandhills and the invasive Burmese python (*Python molurus bivittatus*) in Everglades National Park, Florida.

Objective:

1) Develop a method to simulate snake movements to calculate detection probabilities during systematic road surveys
2) Use this method to estimate densities of southern hognose snakes and Burmese pythons.

Summary of Approach:

Our density estimation approach combines behavioral observations of snake road crossing speed, effort-corrected road survey data, and simulation-based modeling of spatial movement to estimate population densities. We used previously collected radiotelemetric data to quantify movement metrics (frequency, distance, and direction of movement in relation to home range center and roads). These data were then used to parameterize individual-based movement models in a biased correlated random walk framework to estimate the frequency with which individual snakes cross roads. Next, information on survey vehicle speed and snake crossing speed were used to determine the probability of detecting a snake, given that it crossed the road transect during a survey. We then used the resulting relationships between observation frequency and density to infer density from large databases of systematic road survey data for our focal species. Finally, we simulated models to assess sensitivity of our density estimates to uncertainty in parameter values and model assumptions.

Benefit:

Our research enhances strategic planning and management of DoD's natural resources by developing a novel framework for obtaining heretofore unavailable information (density) critical to management of species of conservation concern. Specifically, we develop a standardized, verified tool, applicable to many species, regions, and installations to ultimately assist with resource management and reduce or avoid training restrictions. Further, our case studies benefit the individual missions of military installations by providing baseline density information for our focal species, the southern hognose snake and Burmese python. This information will aid resource managers at bases tasked with conserving southern hognose snakes, or preventing establishment, spread, and impacts of invasive pythons.

Accomplishments:

We have developed a novel technique for estimating density of secretive snakes using road survey and spatial movement data, without needing to recapture individuals. We describe this method, through the first case study of the southern hognose snake, in a manuscript that has been submitted for publication in a scientific journal, and are following up with a manuscript reporting python density that is near submission. In addition to describing the method, these manuscripts provide the first density estimates for either of our focal species. We find that southern hognose exist at relatively low densities (0.17 per ha), raising concern that this species may not only have declined in geographic range but may also occur at relatively low densities and/or be declining in their strongholds, such as the North Carolina Sandhills. Our estimates of python density (1.5 – 5 per km2) provide baseline information that is critical for management of this harmful invader. Our results suggest that current control measures are insufficient to curb population growth and spread of pythons in South Florida, but highlight strong variation in python density over time. Overall, our method enhances our ability to study and manage many secretive snake species that are most effectively samples using road surveys.

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