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Comparing direct and indirect methods to estimate detection rates and site use of a cryptic semi-aquatic carnivore

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ABSTRACT

Monitoring animal populations can be challenging, particularly when working with species that are cryptic, rare, or occur at low densities. The northern river otter (*Lontra canadensis*) is a cryptic, semi-aquatic carnivore that has been intensively studied in recent decades, yet much of what is known about its ecology is a result of studies that have employed indirect methods of detection and monitoring. These indirect methods, such as latrine or other sign surveys, have been the primary approach used for studying distribution, abundance, and habitat use of otters, with minimal representation of direct methods. In this study, we compared direct (camera traps) and indirect (scat count surveys) methods of evaluating detection probabilities and site use patterns of otters at latrines. We found that the direct method produced a significantly greater monthly detection probability than the indirect method and that camera surveys resulted in fewer occurrences of false negatives than scat surveys. However, the number of scats deposited at a site was positively correlated with number of visits by otters at a site (Tau-b = 0.675). Thus, while cameras outperformed scat counts in terms of detection, the two methods were comparable in determining intensity of site use. We conclude that, depending on the parameter of interest, scat counts may be an acceptable surrogate for more direct methods of monitoring otters and other cryptic species. We caution, however, that in the absence of comparative methodological data, direct methods such as camera trapping should be preferred when making inferences about animal distribution, abundance, or habitat use.

1. Introduction

Monitoring animal populations is a critical, yet challenging component of conservation and management programs. Some species are relatively easy to detect and monitor, however, detecting and monitoring species that are cryptic (e.g., many carnivores) can be challenging. In addition, many species of carnivores occur at relatively low densities/abundance, creating even more difficult circumstances for monitoring activity and demographics (Kelly et al., 2008; Linkie and Ridout, 2011; Vine et al., 2009). In spite of these obstacles, biologists and managers are often tasked with developing reliable techniques that provide meaningful estimates of ecological metrics such as presence/absence, abundance, and habitat use (O'Connell et al., 2006).

Carnivore monitoring has traditionally relied on indirect indices to measure or evaluate presence or activity, with limited use of direct approaches (Conner et al., 1983; Palomares et al., 1998; Travaini et al., 1996). Such is the case for the northern river otter (*Lontra canadensis*, hereafter "otter"), a cryptic, semi-aquatic carnivore found throughout North America. The most common indirect approach used to study otter ecology is to survey for otter sign such as latrine sites or tracks (Crowley et al., 2012; Jeffress et al., 2011; Melquist and Hornocker, 1983). More recently, remote cameras have become a feasible, direct alternative for monitoring river otter activity at dens or latrine sites (Lerone et al., 2015; Leuchtenberger et al., 2014; Olson et al., 2008). However, few studies have used remote cameras and even fewer have conducted both scat and camera surveys (Guter et al., 2008; Lerone et al., 2015; Olson et al., 2008; Stevens and Serfass, 2008). Given the historic prevalence of

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indirect methods used to estimate population metrics and habitat use of otters, there is a lack of comparative information between indirect and direct methods, particularly for the northern river otter.

Where scat surveys and remote cameras have been simultaneously used to monitor northern river and Eurasian otters there are mixed results regarding the accuracy and reliability between these two methods (Guter et al., 2008; Lerone et al., 2015; Olson et al., 2008; Stevens and Serfass, 2008). In three out of four of these studies, investigators reported either poor performance by cameras or frequent malfunctions rendering cameras unreliable; thus, scat surveys provided a more accurate representation of otter site use (Lerone et al., 2015; Olson et al., 2008; Stevens and Serfass, 2008). However, studies that reported deficiencies of remote cameras either used early model cameras, “low-end” cameras (e.g., Cuddeback Attack, Bushnell Trophy Cam HD, Bolymedia Scoutguard SG560D, as defined by Rovero et al., 2013), and/or only a few cameras (Lerone et al., 2015; Olson et al., 2008; Stevens and Serfass, 2008). Recent advances in camera technology have minimized failures that plagued earlier models and improved overall reliability (O’Connell et al., 2011). Furthermore, there is evidence that high-end cameras outperform low-end cameras by capturing more species more often (Hughson et al., 2010; Kelly and Holub, 2008). Because of low sample size, use of low-end cameras, and recent technological advances, past investigations may not be representative of the current reliability of remote cameras. In the absence of comparative studies between scat surveys and modern, high-end cameras, it is difficult to conclude that one method is more or less accurate or reliable than the other.

Our objective was to compare the relative performance of direct (remote cameras) and indirect (scat surveys) methods for monitoring otters at latrines. Specifically, we determined how well these methods performed in terms of estimating detection rates and measuring otter site use. We hypothesized that modern, high-end cameras would provide a more reliable estimate of both detection and site use of otters than scat surveys. We therefore predicted that the direct method would result in fewer false negatives than the indirect method, and that correlation between methods would be weak. If, however, detection rates and measures of site use were highly correlated between the two methods, then scat surveys should be considered an equally reliable method for the estimation of otter detection and site use.

2. Methods

Our study area comprised 64 km of the Provo River and its tributaries along the Wasatch Range of the Rocky Mountains in north-central Utah. This area, known as Heber Valley (40°30′26″ N, 111°26′59″ W), has an annual average temperature of 8.1 °C with a summer average of 19.2 °C and a winter average of −3.3 °C. Annual precipitation averages 41.2 cm and consists mostly of snowfall from late fall through early spring (National Oceanic and Atmospheric Administration, 2000). The study area contained 2 large reservoirs and the river itself winds through multiple towns and agricultural areas (for more details on the study area see Day et al., 2015) near Heber City, Utah.

2.1. Latrine surveys

We initially surveyed for river otter latrines by walking the length of riverbanks in our study area on two separate occasions. Once located, we identified otter scat from that of other species by its size, shape, odor, contents, and the presence of mucous (Greer, 1955). When we discovered a latrine site, we counted the number of fresh (i.e., wet, soft, pungent) otter scats. After counting scats, we recorded a GPS location and removed all scat from the site, so as not to recount old scats during future visits.

After the initial riverbank surveys, we continued to search for latrine sites from February 2010 through February 2012 by radiotelemetry of 23 translocated otters (Day et al., 2013). After we found a latrine, we removed all scat and monitored the site on a monthly basis for the next three months. If we did not find scat during subsequent visits within this three-month period, we discontinued monitoring the site. If we did find scat during the initial three months we continued to monitor the latrine site monthly for the duration of the study, regardless of how much time passed between uses.

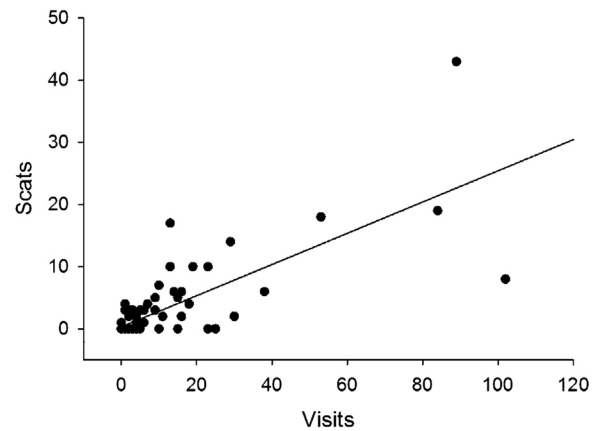

Fig. 1. Number of scats collected and visits recorded by remote cameras (Tau-*b* correlation = 0.675, $p < 0.001$) of northern river otters (*Lontra canadensis*) monthly at Provo River, Utah, 2011–12.

2.2. Remote camera sampling

After one year of monitoring latrines, we randomly selected 10 sites for sampling with remote cameras in addition to continued monitoring of scat deposition (Fig. 1). We monitored these 10 latrines for one year, from March 2011 through February 2012, for a total of 3310 trap nights. For a latrine to be eligible for camera placement, the only requirement was that we collected scat in more than one month. Monitored latrines were an average of 3379 m (±SD 3875 m) apart, and total distance between the furthest two latrine sites was 34.01 km. Following the categorization of cameras as proposed by Rovero et al. (2013), we used “high-end” infrared (no-flash) cameras (Reconyx PC900, Reconyx Inc., Holmen, WI). We placed cameras approximately 3 m from the edge of latrine sites at 0.5–1 m above the ground. We programmed cameras to the ‘high’ sensitivity level, and to record two images per capture event (spaced 1 s apart) with a quiet period of 15 s between events. We visited cameras once per month to count scats and to perform camera maintenance.

We examined each image and recorded all identifiable species present, but did not attempt to distinguish between individuals of any given species. We separated images of otters from images of all other species and extracted date and time stamps associated with each image. Using the date and time stamps, we then sorted otter images into visits. We defined two separate “visits” as two consecutive images of otters separated by at least 30 min of otter inactivity. We used 30 min to make our results comparable to other studies that used the same time interval to separate visits (e.g., Hall et al., 2013; Michalski and Peres, 2007; Stevens and Serfass, 2008). Because 30 min was an arbitrary choice, however, we also analyzed our data using 1 h intervals to define visits to see if this choice affected results. With visits delineated, we recorded the maximum