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Estimating density of secretive terrestrial birds (Siamese Fireback) in pristine and degraded forest using camera traps and distance sampling

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ABSTRACT

Tropical Asian Galliformes are secretive and difficult to survey. Many of these species are considered "at risk" due to habitat degradation although reliable density estimates are lacking. Using camera trapping and distance sampling data collected on the Siamese Fireback (*Lophura diardi*) in northeastern Thailand, we compared density estimates for pristine and degraded lowland forest. Density was poorly estimated using distance sampling, likely due to small sample size arising from poor visibility in dense vegetation and bird's sensitivity to observers. We analysed camera trap data using both count-based and presence/absence-based methods. Those density estimates had narrower confidence intervals than those obtained using distance sampling. Estimated density was higher in dry evergreen forest (5.6 birds km^{-2}), than in old forest plantations (0.2 birds km^{-2}), perhaps because dense forest habitats provide Firebacks with more resources and refuge from predation. Our results suggest that camera trap data can be used for estimating density of cryptic terrestrial bird species inhabiting tropical forest that lack unique identification markings. However, this technique requires that the effective sampling area is known and thus requires knowledge of the animal home range size.

1. Introduction

Of the c. 300 Galliformes species found worldwide, 26% are classified as "threatened", largely due to habitat loss and degradation, hunting and human disturbance (IUCN, 2013). In tropical Asia, there are 180 species of Galliformes (Madge and McGowan, 2002) of which 21 (∼12%) are of global conservation concern (1 Critically Endangered, 4 Endangered, and 16 Vulnerable species IUCN, 2012). Despite the threats facing tropical pheasants (Phasianidae), little is known about the basic biology of most species. Moreover, many species are secretive and hard to observe, making most traditional bird survey methodology difficult to implement.

Deforestation and habitat degradation in tropical regions represents a major threat to global biodiversity (Laurance and Bierregaard, 1997; Watson et al., 2004). When deforestation occurs, the amount of habitat available of forest species is

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reduced, and the original forest is replaced by plantations or other agricultural uses (Forman, 1995). As forest fragments become smaller, they will be subjected to increased edge effects and human pressure, resulting in habitat degradation (Watson et al., 2001; Beier et al., 2002). Animals occupying degraded forests may face reduced food resources and refuges, and in some cases increased pressure from invasive species (Schwitzer et al., 2011). Consequently, species must respond to changes in dietary composition and diversity, group size and adult sex ratio, and population density (Schwitzer et al., 2011). For birds, studies have suggested that tropical plantations and modified forests can support a variety of taxa including many forest specialists, especially in close proximity to natural forest, and sometimes at higher abundance and richness than in primary habitat (Barlow et al., 2007; Greenberg et al., 1997). In contrast, some studies have argued that the value of such plantations has been overstated (Barlow et al., 2007) and that benefits may only be temporary (Mintra and Sheldon, 1993). Thus, understanding the responses of species to habitat, especially in changes of abundance and density to heavily modified habitat can help to design habitat management and to make strategies for species conservation.

Animal abundance provides the most critical information for defining the status of a species and thus for conservation assessments and practical wildlife management (Conroy and Carroll, 2001). A large number of techniques exist for assessing population abundance and density, including quadrant or plot sampling techniques (Jaeger and Inger, 1994), distance sampling (Thomas et al., 2012; Buckland et al., 2001), photographic mark-recapture methods (Karanth and Nichols, 2002; Karanth et al., 2004), repeated presence–absence surveys (Royle and Nichols, 2003) and repeat count surveys (Royle, 2004). However, each of these techniques makes assumptions that can be difficult to meet for cryptic terrestrial birds such as some Galliformes. Distance sampling requires that the surveyed species should be detected by visual or auditory means (Thomas et al., 2012; Buckland et al., 2001). Applying distance sampling to survey some Galliformes has been previously discouraged, because of the increased probability of not detecting animals on the transect line owing to their cryptic behavior and the possibility that they may be able move quietly away from their initial location before detection (Winarni et al., 2005). Photographic mark-recapture is based on the identification of individuals using unique markings (Karanth and Nichols, 2002). Repeated presence–absence and repeated count survey (Royle, 2004) could provide an alternative method to estimate abundance where identification of individuals in not required. For example, the model described in Royle (2004) has been used to estimate occurrence and abundance of Great Argus Pheasant (*Argus argusianus*) using camera-trap data (O'Brien and Kinnaird, 2008), however, the results indicated a population trend but the accuracy of those estimates were not tested. Moreover, O'Brien and Kinnaird (2008) did not attempt to estimate density as the method is not considered rigorous using camera-trap data.

In northeastern Thailand, Siamese Fireback (*Lophura diardi*) is relatively abundant in some protected areas where it is found predominantly in lowland and foothill forest habitats (<800 m elevation) of mainland Southeast Asia but seams to also tolerate considerable degradation of their forest habitat, such as moderate logging and cultivated field in small clearing (BirdLife International, 2012) and forest regeneration through plantations of *Eucalyptus* and *Acacia* (Suwanrat, 2013). This makes the species an excellent candidate species for quantitatively investigating the effect of habitat degradation on pheasants while testing the efficacy of various survey techniques that could be applied to tropical Asian Galliformes, a group which currently lack a practical field survey method for population estimation due to their secretive behavior (non-calling birds, and inhabiting dense tropical forest).

In this work we focus on a resident Siamese Fireback population in Sakaerat Biosphere Reserve (northeastern Thailand) inhabiting both dry evergreen forest and areas reforested with *Acacia* and *Eucalyptus*. We start by estimating the abundance and density of the species in both habitats (undisturbed dry evergreen forest and disturbed forest plantation) using camera trapping and distance sampling data. Second we assess the different methods by comparing our camera trap and distance sampling derived estimates of abundance and density to estimates based on spot mapping (also known as territory mapping) of radio-tagged Siamese Firebacks. Assuming that spot mapping can be considered closest to "true density", the method/model that provides density estimates closest to those values, with narrow confidence interval can be considered an appropriate approach for estimating Siamese Fireback density.

2. Materials and methods

2.1. Study area

The study was conducted at Sakaerat Environmental Research Station (SERS; Fig. 1), classified as a UNESCO biosphere reserve since 1967. The reserve, covering 78.09 km^2, is located in northeastern Thailand (14° 30′N, 101° 55′E) on the edge of Thailand's Korat Plateau at an elevation of 280–762 m. SERS has two major natural forest types: dry evergreen forest (46.82 km^2) and dipterocarp forest (14.51 km^2), and two large patches of more than 20 year old forest plantation of mixed acacia (*Acacia spp.*) and eucalyptus (*Eucalyptus spp.*, 14.46 km^2), and several small patches of bamboo forest (1.12 km^2), grassland (0.93 km^2) and the office and operational building (0.25 km^2) (Thailand Institute of Science and Technology, 2012a). Average annual precipitation is 1071 mm with a dry season from November to April (average monthly rainfall of 210 mm) and a wet season from May to October (average monthly rainfall of 860 mm). Average annual temperature is 26.1 °C (ranging from a low monthly average of 19.3 to a high of 32.8 °C) and the average relative humidity is 82.2% (monthly range of 74%–87%) (Thailand Institute of Science and Technology, 2012b).