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A collaborative approach for estimating terrestrial wildlife abundance

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ABSTRACT

Accurately estimating abundance of wildlife is critical for establishing effective conservation and management strategies. Aerial methodologies for estimating abundance are common in developed countries, but they are often impractical for remote areas of developing countries where many of the world's endangered and threatened fauna exist. The alternative terrestrial methodologies can be constrained by limitations on access, technology, and human resources, and have rarely been comprehensively conducted for large terrestrial mammals at landscape scales. We attempted to overcome these problems by incorporating local peoples into a simultaneous point count of Asiatic wild ass (*Equus hemionus*) and goitered gazelle (*Gazella subgutturosa*) across the Great Gobi B Strictly Protected Area, Mongolia. Paired observers collected abundance and covariate metrics at 50 observation points and we estimated population sizes using distance sampling theory, but also assessed individual observer error to examine potential bias introduced by the large number of minimally trained observers. We estimated 5671 (95% CI = 3611–8907) wild asses and 5909 (95% CI = 3762–9279) gazelle inhabited the 11,027 km^2 study area at the time of our survey and found that the methodology developed was robust at absorbing the logistical challenges and wide range of observer abilities. This initiative serves as a functional model for estimating terrestrial wildlife abundance while integrating local people into scientific and conservation projects. This, in turn, creates vested interest in conservation by the people who are most influential in, and most affected by, the outcomes.

1. Introduction

Estimating abundance is one of the most important prerequisites for the conservation and management of wildlife because it defines the need and scope of human action. Aerial surveys are often used to sample large mammal populations and generate statistical estimates of abundance (Caughley, 1977; Melville et al., 2008). While managers and practitioners in developed countries often have access to aircraft and technology to help accomplish this task, many of the world's endangered and threatened fauna exist in remote areas of developing countries where terrestrial access, technology, aircraft availability, and skilled human resources are extremely limited. Attempts at surveying wildlife abundance in such areas may be further complicated by the effects of low density on estimators (Barnes, 2002). Wildlife can thus decline rapidly without detection and the needed conservation actions may be implemented too late, if at all (Karanth et al., 2003).

Statistical sampling techniques have been used to estimate animal abundance for decades (Schwarz and Seber, 1999; Williams et al., 2002). The most developed, and best understood, methods include variations of double sampling, mark-resight (batch-marked animals), mark-recapture (uniquely-marked animals), sightability bias correction models, and distance sampling (Barker, 2008). Recently, researchers have begun to combine these techniques to create synergistically more effective methods (Laake et al., 2008; Lubow and Ransom, 2009), but even in light of such statistical advances the logistical problem of surveying remote areas with constrained resources has not been well-addressed.

Estimating Asiatic wild ass (*Equus hemionus*) and goitered gazelle (*Gazella subgutturosa*) abundance across the vast expanse of the Great Gobi B Strictly Protected Area (SPA), Mongolia, exemplifies this problem. Animals are distributed across the entire area, reliable aircraft are unavailable, and access is limited in the park (Kaczensky et al., 2008). Asiatic wild ass are now listed as endangered (IUCN, 2010) and anecdotal and scientific evidence suggest that abundance has declined globally by more than 50% over the past two decades. The Gobi region has long been a stronghold for the wild ass, though the species has disappeared from the vast

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majority of its historic range (Feh et al., 2001; Reading et al., 2001; Kaczensky et al., 2011). Goitered gazelles are classified as a vulnerable species by IUCN (2010) and while little is known about current populations, it is believed that their numbers are declining and Mongolia may contain the majority of the global population (Reading et al., 1999). Well-informed abundance estimates are needed to direct conservation plans and prompt action for the remaining populations of both species.

Conservation of species such as Asiatic wild ass and goitered gazelle can be challenging, even when protected areas are designated. Indigenous peoples often rely heavily on ecosystem services, and when national parks and protected areas exclude participation of adjacent indigenous communities from resource management decisions, conservation efforts may be undermined (McNeely et al., 1990; Adams et al., 2004; Corbera et al., 2007). Land use between native wildlife and pastoralists overlaps across most of Mongolia. Interviews of pastoral families in the Gobi region indicated that while some people regularly utilize wild asses for food and others consider them only as competition with livestock, many are interested in pursuit of conservation efforts (Kaczensky et al., 2006). We embraced this perspective to develop a community-based initiative for estimating wildlife abundance in the Great Gobi B SPA using a large-scale simultaneous point count across the entire area, and subsequently modeled the count data to generate estimates of abundance. This initiative illustrates a functional model for integrating local people into scientific and conservation projects by bringing them into protected areas, incorporating them directly into the science, and exposing them first-hand to the value of resource conservation. This collaboration in turn can create vested interest in conservation by the people who are most influential in, and most affected by, the outcomes (Danielsen et al., 2008; Reed, 2008).

2. Study area

The Great Gobi B SPA consists of 9265 km^2 desert and steppe biomes and our study area incorporated an additional 1762 km^2 of adjacent lands where wild asses have been known to roam (Feh et al., 2001; Kaczensky et al., 2008, 2011). Plains dominate the east and rolling hills populate the west. Elevations range from 1000 to 2840 m above sea level, with the Altai Mountains forming a northern boundary to the park and several mountain ranges forming the southern border with China. Desert environments are dominated by saxaul (*Haloxylon ammodendron*), which in places can be large enough to obscure views of asses or gazelles from observers. Steppe environments are dominated by Poaceae such as *Stipa* spp. and *Ptilagrostis* spp. Sympatric indigenous ungulates in this ecosystem are wild horse (*Equus ferus przewalskii*) on the plains, and argali (*Ovis ammon*), and Siberian ibex (*Capra sibirica*) in the mountains.

3. Methods

3.1. Field methodology

A combination of mark-resight and distance sampling techniques, similar to that described by Kissling and Garton (2006), was employed at observation points across the entire study area. We conducted this simultaneous point count using pairs of observers at 25 observation points in the eastern half of the park on 5–6 August, 2010, and then relocated the teams to count from an additional 25 observation points in the western half of the park on 7–8 August, 2010 (Fig. 1). The team was comprised of 4 organizers (2 Mongolian, 1 American, 1 Austrian), 24 local pastoralists, 7 park staff, 3 park rangers from nearby Shargen Gobi Saiga Reserve, and 12 university students and instructors (9 Mongolian, 3 German). Everyone was trained in equipment use and data collection protocols in the days preceding the survey. This training involved a classroom overview of survey history, project design, and data collection by the organizers, followed by a day of field practice where observers used compasses and rangefinders to measure targets at known distances. For field deployment, each pair of observers was equipped with a watch, binoculars, a customized optical rangefinder (see Ransom, 2011), standard map compass, pencils, and datasheets, as well as food and water.

Each observer at each point was instructed to collect data independently, with the first observer conducting a complete 360° survey and then passing the equipment to the second observer who subsequently conducted another complete 360° survey. Observers were instructed not to share datasheets or communicate between observations. Surveys from all points were conducted simultaneously at 20:00 h, after which observers slept at their observation points and then conducted surveys again at 07:00, 09:00, 11:00, 13:00, and 15:00 h for a total of 6 complete surveys at each point. All observers rendezvoused at a central point upon completion of the eastern 25 points to provision and review data collection efforts, and then were re-deployed to the remaining 25 observation points in the west.

Data collected at each observation included time, species, number of adults, number of offspring, vegetation type (shrub or open), behavior (laying, standing, running), discrete distance category (0–100 m, 101–500 m, 501–1000 m, 1001–2000 m, 2001–5000 m, 5001–7000 m), and compass bearing. Because discernment of adults versus offspring was inconsistent at long distances, we used only total count of individuals for analyses. Rangefinder capability was limited to 2500 m and the farthest distance categories were visually estimated. A single compass bearing was recorded at the center of small groups or a range of bearings was recorded for the endpoints of large dispersed groups. Covariate data for sun effect was calculated a posteriori as described in Ransom (2012) using data consisting of time of observation, compass bearing, observation latitude and longitude, and solar position information from the National Oceanic and Atmospheric Administration solar calculator (http://www.srrb.noaa.gov/highlights/sunrise/sunrise.html, accessed August 24, 2010).

3.2. Geographic information system (GIS) data

Observation points were chosen using a stratified random sample by overlaying a 15 km by 15 km grid across the study area and randomly selecting one elevated point in each cell. This allowed us to maximize the field of view and we defined the maximum viewing distance as 7000 m. The visible area from each observation point was calculated using the surface analysis option "viewshed" of the Spatial Analyst extension in ArcGIS 9.3 (Environmental Systems Research Institute, Redlands, California, USA). We used a digital elevation model (DEM) at 90 m spatial resolution obtained from the Shuttle Radar Topography Mission tiles for Mongolia and northern China (http://glcf.umiacs.umd.edu) for these analyses.

We anticipated that delimiting high and low density wild ass areas within the study area would decrease the encounter rate variance attributed to gregarious behavior; therefore, we attempted to stratify wild ass data by modeling habitat selection as a function of elevation, slope, vegetation type, distance from water, and normalized difference vegetation index (NDVI). We used linear regression to model these effects for detected groups and 1000 random points (within the visible radius of the 50 observation points). A group was defined as one or more animals in close proximity to each another. Elevation, slope, and distance from water for each location were calculated using the GIS data. Main vegetation types were classified from satellite imagery by von Wherden et al. (2006). NDVI data was derived from a Moderate