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BRIEF COMMUNICATION

Customizing a rangefinder for community-based wildlife conservation initiatives

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Abstract Population size of many threatened and endangered species is relatively unknown because estimating animal abundance in remote parts of the world, without access to aircraft for surveying vast areas, is a scientific challenge with few proposed solutions. One option is to enlist local community members and train them in data collection for large line transect or point count surveys, but financial and sometimes technological constraints prevent access to the necessary equipment and training for accurately quantifying distance measurements. Such measurements are paramount for generating reliable estimates of animal density. This problem was overcome in a survey of Asiatic wild ass (*Equus hemionus*) in the Great Gobi B Strictly Protected Area, Mongolia, by converting an inexpensive optical sporting rangefinder into a species-specific rangefinder with visual-based categorical labels. Accuracy trials concluded 96.86% of 350 distance measures matched those from a laser rangefinder. This simple customized optic subsequently allowed for a large group of minimally-trained observers to simultaneously record quantitative measures of distance, despite language, education, and skill differences among the diverse group. The large community-based effort actively engaged local residents in species conservation by including them as the foundation for collecting scientific data.

Keywords Abundance · Asiatic wild ass · *Equus hemionus* · Khulan · Density · Distance sampling · Line transect · Mongolia · Point count

Introduction

Estimating abundance of wildlife is one of the most important tasks for biologists and conservation practitioners, yet it is often a daunting challenge. Despite the established and constantly improving set of techniques for estimating large animal abundance (see Williams et al. 2002), some major obstacles persist: species of concern often occupy vast

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areas of land with few points of human access, availability of technology and aircraft are often limited or absent, and fewer professional and fiscal resources are usually available than are needed to conduct thorough surveys. Consequently, abundance of many large animal species around the world is unknown or poorly estimated and the resulting conservation plans are not well-informed.

An array of statistical sampling techniques for estimating animal abundance are relatively well understood, such as double sampling, mark-resight (batch-marked animals), mark-recapture (uniquely marked and identifiable animals), sightability bias correction models, and distance sampling (Barker 2008), but the methods themselves do not address the logistical challenges of collecting data in the field. This is exemplified in the problem of estimating Asiatic wild ass (*Equus hemionus*) abundance across the roughly 9,000 km^2 area of the Great Gobi B Strictly Protected Area, Mongolia. Animals are distributed across the entire area, aircraft are generally unavailable, and access is limited to a few dirt tracks in the park (Kaczensky et al. 2008).

To address this set of logistical problems, 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 area. Data were collected simultaneously at regular intervals by a large team of enlisted community members with training and guidance from researchers and park staff. The success of this combined technique relied on accurate distance measurements to estimate population density. This project required 50 observers who could reliably perform the survey and accurately measure the distance from observation points to animals, without the use of cost-prohibitive laser rangefinders or complicated technology. Here, I discuss a simple solution for capturing reliable distance measures of large animals with a customized optical rangefinder that is inexpensive and easy to use for professional and lay observers.

Methods

To conduct the Asiatic wild ass survey, a team of four organizers relied on 24 local pastoralists, seven park staff, three park rangers from a nearby reserve, and 12 visiting university students and instructors to collect observation data. Pairs of observers shared equipment, and thus 25 complete sets of equipment were needed to implement the survey, making expensive technology impractical. Standardizing distance measurements was one of the greatest challenges under this constraint.

I developed 25 species-specific optical rangefinders with simple categorical labels to achieve these measurements. To do this, I disassembled 25 Sonocaddie™ monocular 8× optical rangefinders (Golf Range Finder Model 17070, Dennco, NH, USA) and removed the clear 11.4 mm plate that was inscribed with a visual scale of distance for the sport of golf (Fig. 1A). This was accomplished by first removing the single screw and wristband component (Fig. 1B) and then subsequently sliding the rubber armor (Fig. 1C) off of the rangefinders. Two lateral posterior screws (Fig. 1D) were loosened on each unit in order to remove the ocular. On the anterior end of the ocular sits a single 12.3 mm threaded ring (Fig. 1E), which holds the inscribed plate in place. This was removed using a large flathead screwdriver and the inscribed plate was released.

Once disassembled, a revised scale (Fig. 2), imaged on 35 mm transparency, was trimmed to approximately 11 mm diameter and inserted (emulsion to posterior) in the space where the factory inscribed plate was removed. The threaded ring was re-inserted and tightened until it held the transparency firmly. The ocular was then reattached to the

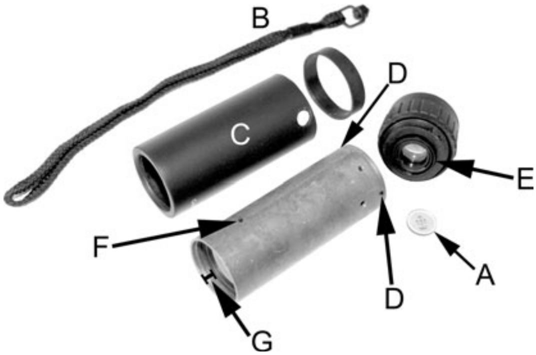

Fig. 1 A partially disassembled Sonocaddie™ optical rangefinder (Model 17070, Dennco, NH, USA), showing elements and access points for customization; *A* image scale plate, *B* wrist strap, *C* exterior armour, *D* lateral posterior screws for removing ocular, *E* threaded ring assembly for removing image scale plate, *F* anterior focal length adjustment screw, *G* adjusted focal length of anterior lense

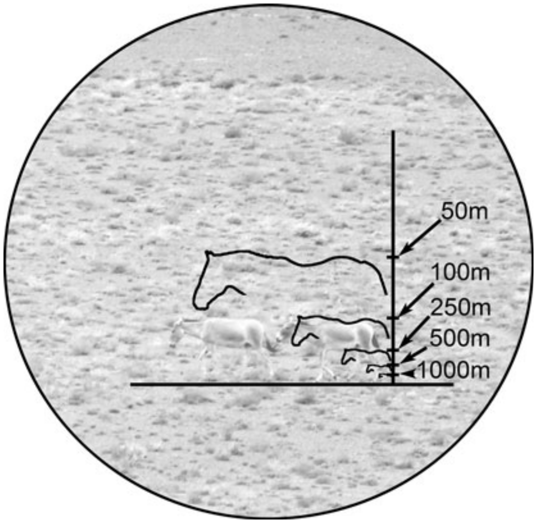

Fig. 2 Simulated view through a customized optical rangefinder showing measurement of the distance from observer to Asiatic wild ass (*Equus hemionus*) as between 100 and 250 m. Photograph and scale overlay are from a 2010 Asiatic wild ass survey in the Great Gobi B Strictly Protected Area, Mongolia

unit and secured by tightening the lateral posterior screws (Fig. 1D). Depth of the transparency material was considerably less than that of the inscribed plate removed, and thus the focal range for each rangefinder also required adjustment. This was accomplished by loosening the single anterior lateral screw (Fig. 1F) until the anterior-most lens was mobile. The lens was pushed toward the posterior until the anterior edge of the lens was approximately 4.0 mm from the anterior edge of the entire unit (Fig. 1G), and then the screw was tightened firmly. Lastly, the rubber armour was replaced over the unit and the wristband was reattached.

The species-specific insert was calibrated using a Leica Rangemaster 1200 Scan laser rangefinder (Leica, Solms, Germany) to measure exact distances to a domestic horse (*Equus caballus*) of similar height as an Asiatic wild ass (should height ranges 110–130 cm (Groves 2002)). A silhouette was drawn to match the species of interest and this was digitized, copied, and scaled using layers in Adobe® Photoshop® CS3version 10.0.1 (Adobe Systems, Inc., San Jose, CA, USA). Once editing was completed, the digital file was imaged to 35 mm transparencies.

I assessed accuracy of the customized rangefinder using 14 different observers (seven male, seven female) to categorize the distance between each observer and domestic horses in blind trials. Observers were given verbal instruction on how to use the rangefinder, shown an example (Fig. 2), and allowed to take one reading at 100–249 m with confirmation and feedback from the instructor. Afterwards, each observer collected 25 measurements (five in each distance category) from random points in random order. I compared these data to simultaneous readings from the laser rangefinder, as operated by the proctor. Mid-sized domestic horses roaming in large pastures along the Front Range of northern Colorado, USA, were observed for these measures. I analyzed these data with mixed-effects logistic regression using the lme4 package of R version 2.12.1 (The R Foundation for Statistical Computing 2010). Observer identity was used as a random effect on the model intercept and observer gender, age, experience using optical devices to view wildlife, experience collecting scientific data, and experience using a rangefinder were evaluated as fixed effects.

Results

The resulting product of this conversion was a species-specific monocular rangefinder, whereby an observer could look through the device at an Asiatic wild ass, align the base of the scale with the feet of the animal, and read the distance that equated with the height of an animal's back (Fig. 2). The rangefinder was limited to a maximum distance category of 1,000–2,500 m due to the magnification capabilities of the original tool. The manufacturer's scale only provided a maximum distance of 200 m, but this limitation was due to the minimum height category on the scale provided: the true limitation of the monocular was its intrinsic magnification. An Asiatic wild ass was large enough to detect reliably with this tool at the 1,000 m range and diminished to an immeasurable small size at about 2,500 m. The total cost per finished unit at the time of this project was less than US$ 12.00.

The accuracy trials resulted in 350 observations (70 per distance category) of domestic horses in pasture at distances ranging 51–1193 m. Five observers had experience conducting or participating in scientific studies and nine had no such experience. Eight observers had used binoculars, spotting scopes, or other optical equipment to regularly view wildlife, and four had used some form of rangefinder previous to these trials. There were no significant relationships between gender, age, or experience in relation to accuracy of observations (gender, $z = 0.87$, $P = 0.38$; age, $z = 0.37$, $P = 0.71$; science experience, $z = 1.09$, $P = 0.28$; optics use, $z = -0.29$, $P = 0.78$; rangefinder use, $z = -0.60$, $P = 0.55$). The distance categories of 50–99 m, 100–249 m, and >1,000 m were perfectly correlated to distances measured by the laser rangefinder. Erroneous measures in the distance categories of 250–499 m and 500–999 m were positively biased with all incorrectly categorized distances being read as the next farthest category and none being estimated as a closer category (Fig. 3). Five of 70 observations (7.14%) were classified as 500–999 m when the laser rangefinder indicated the correct category was 250–499 m and six of 70 observations (8.57%) were classified as >1,000 m when the laser rangefinder indicated the correct category was 500–999 m. Actual distance of the incorrectly categorized points ranged from 9 to 89 m closer than the minimum of the 500–999 m observed category and from 9 to 159 m closer than the minimum of the >1,000 m observed category.

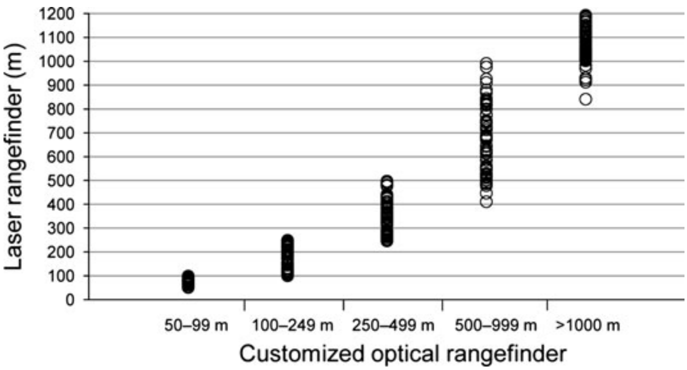

Fig. 3 Distance measures from a customized optical rangefinder and a laser rangefinder for 350 observations of domestic horses (*Equus caballus*) along the front range of northern Colorado, USA

Discussion

This simple customized rangefinder allowed 14 test subjects to correctly record 96.86% of 350 observations of horses at distances <1,200 m; subsequently, 50 observers with different language, education, and skill abilities were able to simultaneously record quantitative measures of distance in Mongolia. The important categorical variable of distance to animal groups was thus captured systematically across observation points and observers, and this allowed for an abundance survey of a large endangered mammal to be conducted using sound statistical theory and quantitative measures. In addition to the critical distance measure, the cost-effectiveness of producing this tool allowed for a large number of observers to be enlisted with only minimal training.

Since distance sampling began to develop as a common technique for estimating animal abundance, researchers and practitioners have struggled with the particular problem of accurately quantifying distance. The basic premise of distance sampling is that detection of animals decreases with increasing distance from the observer, and accurate distance measurements can provide the necessary data for modeling density (Buckland et al. 1993). Monumental improvements in technology have overcome many basic distance measurement problems with tools such as laser rangefinders, but these are not always a solution if the application is outside of budget constraints or instrument capabilities (such as distance limitations with aerial applications or use on small moving targets).

Challenging problems such as rapidly measuring distance from an observer to pelagic birds led Heinemann (1981) to develop fixed interval and continuous scale rangefinders for the specific application. Likewise, innovation to measure distance from aerial platforms has led large animal surveys to incorporate wing-strut markers on fixed-wing aircraft for assigning distance categories (Marsh and Sinclair 1989; Guenzel 1997). The use of terrestrial line transect surveys for large mammals is still quite limited (Koenen et al. 2002) and innovative tools are needed to measure distance in a variety of conditions.

The tool described here proved adequate for the case of the Asiatic wild ass survey, but it may not be so for surveys of small taxa or for animals observed at great distances. The usefulness of this tool would be greatly improved if the initial rangefinder were 10× or more magnification. Alternatively, a similar approach could be employed by inserting a visual scale into one ocular of higher-powered binoculars, though if cost-effectiveness deteriorates appreciably by using higher-powered optics, utilizing laser rangefinders may become more cost-effective and provide more precise metrics.

Errors at farther distances detected in accuracy trials of this customized rangefinder were positively biased. This could be attributed to the slight variation in size of the horses viewed, inability of observers to discern exact location of an animal's feet due to vegetation, or some interaction of these factors. All observers reported problems discerning exact foot level at greater distances, and slightly underestimating actual height of an animal will lead to the direction of error observed. All optical rangefinders are constrained by the ability of an observer to correctly identify a baseline for determining height of the subject being measured, and this problem is magnified by increasing vegetation height and decreasing animal size. This type of measurement error in practice can lead to an inflated tail of the detection function and thus bias estimates of density (Buckland et al. 1993). This bias would be quite small based on these accuracy trials, but if serious bias were to arise, the farthest distance categories could be pooled to correct for this type of measurement error. This, however, could simultaneously increase variance on the population estimate as well.

Optical rangefinders are far from new technology, but their existence for sporting use does not easily lend them for use in wildlife conservation and management. Similar optical devices to the one described here abound on the commercial market and creative customization can tailor them to wildlife application. As conservation projects become more innovative in dealing with the challenges of estimating animal abundance, tools such as this may assist in generating statistically-based estimates for species of concern. Surveys such as the Asiatic wild ass initiative also form the foundation for community-based conservation efforts by actively incorporating local residents into the science and direct management of resources.

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