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Appendix 1: Error calculations for GPS collars around the Satara rest camp, Kruger National Park.

Craig .J. Tambling

Introduction

The accuracy of Global Positioning System (GPS) data increased following the removal of Selective Availability by the United States Military on the 1st of May 2000. As a result GPS data no longer required differential correction (Dussault et al. 2001) to produce accurate location data, and uses of GPS data increased considerably. Despite this increased precision of GPS data, several studies have shown that fix accuracy of GPS collars decreases in areas with increased vegetation cover (Di Orio et al. 2003, Lewis et al. 2007) and influence of vegetation should be factored into the initial planning of projects employing GPS data.

A recent application to come out of GPS collar advances is the ability to locate large predator kill sites from GPS data signatures. However, considering that many large predators will use vegetation cover to assist in hunting success (Funston et al. 2001, Hopcraft et al. 2005), the reduction of GPS accuracy in dense habitats may play a role in the ability of researchers to detect kills when ground truthing kill site prediction models. Ground truthing of kill site prediction models requires that an area around the GPS positions be investigated, and this area will be dependent on the GPS errors associated with different vegetation structures (Sand et al. 2005, Knopff et al. 2009).

In this appendix I test the accuracy of the GPS collars used in the study in order to determine the distance for cluster delineation as well as the search area at each GPS cluster, where a GPS cluster is defined as ≥ 2 consecutive GPS positions within a prescribed distance that greater than the maximum GPS error.

Methods and Materials

During April 2005, three GPS collars (Hawk105 units, African Wildlife Tracking ^{cc}, Pretoria, South Africa) were tested for accuracy in three habitat types in the Satara region (31.77° E, 24.39° S) of the Kruger National Park (KNP). Three GPS collars were placed in three different habitat types and allowed to acquire GPS fixes for 48 hours. The three habitat types portrayed vastly different vegetation structures and are classified as open (no obstructions above the collar), mixed (approximately 50% of the sky was obscured by vegetation) and dense (almost 100% of the sky was obscured by vegetation). Fix success was calculated for each collar as the percentage of acquired fixes out of a possible 48 attempted fixes to ascertain if any of the three vegetation structures significantly reduced GPS fix success. At each collar position the actual GPS position was recorded on a handheld Garmin E-Trax Vista (Garmin ©) with an accuracy reading of 4m. For each fix obtained at each of the collar positions the distance between the observed fix and the GPS recorded fix was calculated and differences in observed error were tested between habitat structures using an ANOVA, with Tukey Post Hoc tests used to assess what combinations of habitat structures lead to observed differences (Zar 1996).

Results

Both open and mixed habitat structures obtained 100% of fixes attempted, while the collar in the dense vegetation structure obtained 98% (47/48) of attempted GPS fixes. GPS error differed between the three habitat structures ($F_{2,140} = 9.176, p < 0.005$) with significant differences found between the open and riverine habitat structures ($p < 0.05$) and the mixed and riverine habitat structures ($p \ll 0.005$). Riverine habitat structure had the largest average error (19.2m) for the

two days (Fig. 1) and surprisingly the mixed habitat had the smallest (7.8m), but this was not statistically smaller than the error for the open (11.7m) habitat structure ($p = 0.326$). Maximum error for each habitat structure was 78.4m, 35.7m and 82.6m for open, mixed and dense habitat structures respectively.

Discussion

The results obtained during the GPS collar testing phase, albeit with a small sample size over a short period of time, are similar to published findings that show that dense vegetation reduced fix success and GPS accuracy. As expected, the greatest GPS error (82.6m) occurred under the densest vegetation cover. For the remainder of the project I assume that this maximum observed error represents the greatest displacement between consecutive GPS positions that is not the result of the collared individual moving. Therefore, any displacement of $<100\text{m}$ is assumed to represent the collared individual remaining in the same location, and any displacement of $>100\text{m}$ is assumed to represent movement of the collared animal and GPS clusters are defined as ≥ 2 consecutive GPS positions within 100m of the previous GPS position. If however, the displacement distance of the collar is $>100\text{m}$ as a result of GPS error and the collared individual however remains in the same position, the following displacement will be of a similar distance and the GPS position will again be near the originating point and the total length of time of the cluster will not be affected. The distance of 100m less than or equal to other studies employing a ground truthing search procedure (200m - Anderson & Lindzey 2003, 100 and 200m - Sand et al. 2005, 190m - Franke et al. 2006, 200m - Webb et al. 2008, 200m - Knopff et al. 2009)

Average error for all three vegetation was <25m for all habitat structures, and this is consistent with tests of GPS collars in Boreal forests (Di Orio et al. 2003). Using the observed average error of less <25m we set our search area or the remainder of the project to a radius of 25m around the initial GPS position at the GPS cluster. This central point for the search radius was shifted to a new GPS location if the subsequent GPS location fell outside the initial 25m radius.

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Figure 1. Average GPS error observed over 48 hours for each of the GPS collars placed in a different habitat structure in the Satara region of the Kruger National Park (KNP), South Africa.

