Protocol Development Summary

Protocol: Brown Bear (*Ursus arctos*) Population Monitoring and Distribution

Parks Where Protocol will be Implemented: Bering Land Bridge National Preserve (BELA), Cape Krusenstern National Monument (CAKR), Noatak National Preserve (NOAT), and Gates of the Arctic National Park and Preserve (GAAR).

Justification/Issues being addressed:
Two statistical techniques have been predominantly used for monitoring bears in Alaska. The first approach uses capture-mark-recapture (CMR) techniques to estimate abundance and density of bears (Miller et al. 1997). This CMR approach has been used widely across Alaska and has been used for both black (*Ursus americanus*) and brown bears (*U. arctos*). The analytical techniques used for estimation are based on well developed theory (Pollock et al. 1990). A potential logistical and financial limitation of this approach is that a radio-marked sample of bears must be established and maintained to estimate probability of detecting bears, to monitor movements of bears between the marking and observation period, and ultimately to estimate abundance and density of bears. Therefore, this technique may be of limited application for large study areas where annual monitoring is of interest.

Distance sampling with line transects is the second most common and rigorous method used to estimate bear density (Quang and Becker 1996). During line transect sampling, a transect is traversed and animals are observed at varying distances. The observation distances are used to model the probability of detecting animals at varying distances from the transect (i.e., detection function) with the assumption that detection of individuals on the line is perfect. This detection function is in turn used to correct raw counts of animals for detection probability and to estimate density. The assumption of perfect detection on the line has been relaxed for aerial surveys because individuals can not be observed directly beneath the aircraft (i.e., on the transect). Aerial line transect methods have been further modified for bear surveys to allow the use of covariates (e.g., habitat type) related to sightability of individual animals (Quang and Becker 1996), application in mountainous terrain where distance from lines varies with relief (Quang and Becker 1999), and the use of ancillary data (double count data from 2 observers) to further relax the assumption of perfect detection on the transect. Like CMR techniques, line-transects have been successfully applied for bear surveys in several areas around Alaska (Becker 2003), and the sampling and analytical components of this approach are based on sound theory (Borchers et al. 2002). However, sample size needs may not be met in areas with low densities of bears and independence among observers using the double count procedure has been questioned. Therefore, an alternative technique may be useful to monitor bear populations in some areas of Alaska.

The purpose of this project is to develop and implement a population monitoring protocol that has statistical validity, is cost-effective, and can be implemented across the network. Managing brown bear populations presents biological, cultural, and legal challenges for park managers. Baseline ecological data are lacking for brown bear populations in ARCN despite increasing harvest and viewing demands from the public. Brown bear abundance may be a parameter that can be estimated across the network if a logistically simpler, statistically rigorous, and cost effective estimator of brown bear abundance can be developed and implemented often (i.e., every 3-5 years in each sampling area). This technique will rely more on direct, aerial observation of bears during one sampling period which could make it more cost-effective than the current line-transect technique used in Alaska which is more expensive and requires multiple years of effort to obtain one estimate.

Specific Monitoring Questions and Objectives to be Addressed by the Protocol:
Some of the specific monitoring questions that will be addressed by this protocol include:

- What is the population of brown bears in each sample area and ARCN?
- What is the distribution of brown bears in ARCN parks and how is it changing?
- How do populations and distribution of brown bears vary in relation to human presence and/or human development?

Basic Approach:

Statistical Methodology-Occupancy/Distribution

We consider the viability of using occupancy sampling and modeling (MacKenzie et al. 2006) for monitoring brown bear populations in ARCN. Occupancy models are used to estimate the probability of occupancy of sampling units within the larger study area. These models were selected for this species and area because the previously mentioned techniques were likely not viable due to logistical, financial, or statistical restrictions. Occupancy sampling is conducted by visiting a sample of sites within a larger study area and observing or capturing individual animals, or finding animal sign that confirms presence (e.g., tracks). Sites with no evidence of presence are also recorded. Sampled sites are visited at least twice by independent observers usually within a time period short enough to restrict the probability of births, deaths, immigration, and emigration in sites during the sampling period. From these data, models are used to estimate the probability of detecting presence given a site is occupied and detection probability is used to correct raw observations of presence to estimate occupancy probability; the proportion of sites within the larger study area that are occupied (MacKenzie et al. 2006), thus avoiding bias caused by false absences. Estimates of occupancy are calculated with R statistical programs (R-project 2006).

Although the concept of presence/absence sampling has been around for some time, occupancy or presence/absence modeling has gained attention in recent years because some species in some situations can not easily be sampled and modeled using techniques commonly used for more abundant or easily observed species. More importantly, recent developments have provided a more rigorous framework for modeling occupancy and avoiding simplified and unrealistic assumptions about perfect detection of presence (MacKenzie et al. 2006). Occupancy may be considered a surrogate of abundance, particularly for territorial species where the size of the sampling unit is roughly equivalent to the territory size. Others view occupancy probability as the appropriate parameter for monitoring programs (Manley et al. 2004) and occupancy modeling is currently being used for monitoring avian, mammalian, and amphibian species (MacKenzie et al. 2006).

Statistical Methodology-Abundance Estimation

Double-count data are currently analyzed using a stratified, simple random sample estimator originally developed for estimating the abundance of moose (Gasaway et al. 1986). Garshelis and McLellan (2006) provide necessary advice and caution on the extension of occupancy to abundance. However, additional estimators may be more appropriate for these data especially the estimator developed by Royle and Nichols (2003). An appropriate abundance estimator will be chosen prior to implementation in 2009.

Principal Investigators and NPS Lead:

Protocol development will be accomplished through a cooperative agreement with the University of Alaska Fairbanks (UAF) for Occupancy modeling. Abundance estimation will be developed with UAF and a contract with VerHoef Statistical Consulting. Principal Investigator will be Brad Shults (NPS).

Development Schedule, Budget, and Expected Interim Products:

The P.I.'s will produce a draft protocol ready for external peer review by December 1, 2008. After peer review, revision and approval, we hope to fully implement the protocol in Spring 2009. We have budgeted $60,000 for protocol implementation in FY08.

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