



Estimating Brown Bear Abundance and Occupancy in the NPS Arctic Network

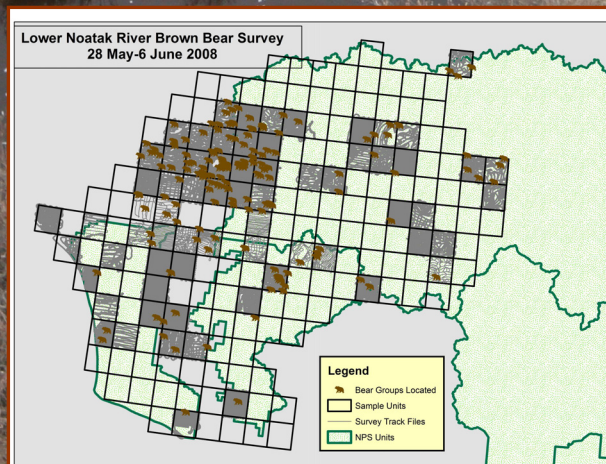


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ABSTRACT: Managing brown bear populations presents biological, cultural, and legal challenges for park managers. Baseline ecological data area lacking for brown bear populations in the Arctic Monitoring Network (ARCN) [Bering Land Bridge National Preserve (BELA); Cape Krusenstern National Monument (CAKR); Gates of the Arctic National Park (GAAR); Kobuk Valley National Park (KOVA); Noatak National Preserve (NOAT)] despite increasing harvest, viewing demands from the public and increasing negative bear-human interactions. The purpose of this project is to develop a population monitoring protocol that has statistical validity, is cost-effective, and can be implemented across the network. To develop this technique and associated protocol, we have completed 4 brown bear abundance/occupancy aerial surveys since 2005 in 3 of 4 proposed survey areas with the ARCN park units. During 28 May-6 June 2008, an aerial, direct-count survey was completed in a 20,772 km² area of the lower Noatak River drainage that includes all lands within CAKR and the western portion of NOAT. We employed a stratified, simple random sample design with double-sampling to estimate the abundance of brown bears and to determine brown bear occupancy. During 233 hrs of aerial surveys, we surveyed 68 sample units (i.e., 37% of sample units) and double-sampled 44% of completed sample units. Protocol development will be completed and fully implemented during 2009.

BACKGROUND: Brown Bears (*Ursus arctos*) are good indicators of long-term habitat change within park ecosystems because they are a long-lived species, require large quantities of resources from their habitat, and populations have the potential to respond to long-term changes in resource conditions. These animals play important ecological roles as top predators influencing population dynamics of other species including moose and caribou. Brown bears are specifically mentioned in the enabling legislation for BELA, KOVA, NOAT and GAAR. Brown bears may be harvested by subsistence users throughout the ARCN parks whereas sport hunters are restricted to hunting in preserve units. Two 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). A potential logistical and financial limitation of this approach is that a radio-collared 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 is of limited application for large study areas where annual monitoring is of interest. Distance sampling with line transects is the second most recent 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 (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. 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 a single year in areas with low densities of bears (i.e., ARCN).



Brown bear groups located within sample units and associated flight lines. Sample units that are dark were double-sampled. The high number of bears in the northwest portion of the study area corresponds to the area around the Red Dog Lead/Zinc Mine where all units were sampled. Duplicate observations have not been removed, so the map is not a representation of bear density, but of presence/absence within each unit surveyed.

OUR APPROACH: Occupancy--We consider the viability of using occupancy sampling and modeling (MacKenzie et al. 2006) for monitoring brown bears in ARCN park units. 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 abundance estimation 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 the areas for presence or absence of the species. Sampled sites are visited at least twice by independent observers usually within the same day 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). Occupancy probability for brown bears may be more useful than abundance to observe long-term changes in distribution related to ecological changes or human developments. Abundance--The resulting occupancy data also may be used to estimate abundance. Occupancy requires a minimum of 2 surveys, and the advantage to repeated sampling is the ability to correct the resulting abundance estimate for visibility bias. Visibility bias is simply the bias introduced because of the proportion of animals that are not observed. We applied a stratified, simple random sampling design with 4 strata (i.e., mountains, hills, valleys, and the 1987 Red Dog Mine census area) and used the double-sampling data to estimate visibility bias.

FIELD METHODS: We stratified our survey area using physiographic GIS data into 3 strata (mountains, hills, valleys), and for the 2008 survey only, we created a 4th stratum to duplicate an area that was surveyed in 1987 prior to the construction of the world's largest lead/zinc mine. The Red Dog Mine has now operated for over 15 years, so we censused the units in this stratum to obtain a comparable estimate of brown bear abundance to the 1987 estimate. Sample units are geographically referenced rectangles (i.e., 6 min latitude by 14 min longitude) and averaged 111 km² (43 mi²). The determining factor for sample unit size was the feasibility of each aircraft to survey 2 units/day within the constraint of 6-8 hrs of flight time. Sample units were chosen randomly, and sample effort was allocated proportionally to each stratum. We used tandem-seat aircraft with a pilot and observer to systematically search sample units by either flying contours in mountainous terrain or by evenly spaced transects on flat terrain to locate bear groups. We flew at altitudes between 100 m and 300 m depending upon terrain and wind conditions and at speeds <80 knots. For each bear group located, we record group composition, the location with a GPS, and used a high-quality digital camera to photograph the bear(s). Each day, we attempted to resample each sample unit with a second aircraft team. Only units double-sampled can be used in the occupancy model, but all units sampled may be used in abundance estimation. Since bears are not marked, photographs are necessary to determine the bear groups that are seen by each team individually and those bears seen by both observation teams. With these data, we can calculate visibility bias for each survey without actually marking animals and correct the abundance estimate for visibility bias and its associated variance.

DISCUSSION: The 2008 survey yielded the most complete field data of the 4 surveys, but data analyses are incomplete. The sampling and double-sampling effort exceeded our expectations so we are hopeful to obtain a relatively precise occupancy probability and abundance estimate. We observed a minimum of 193 total bears of which 126 were ≥ 2 years old. Our current effort is to finish data analyses and complete the vital sign monitoring protocol this year. We believe this survey method may be the most cost effective and least intrusive method to monitor brown bears in ARCN given the large landscape of the network (i.e. 19 million acres or 25% of the land area of the NPS) and other important park values such as wilderness.



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