Resource Selection Functions: Mapping Habitats and Predicting Population Dynamics of Sensitive Arctic Wildlife

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Key Words: resource selection models, habitat-based population viability analysis, barren-ground caribou, *Rangifer tarandus groenlandicus*, gray wolf, *Canis lupus*, grizzly bear, *Ursus arctos*, *Ursus arctos horribilis*[1], wolverine, *Gulo gulo*, Northwest Territories, Nunavut

Extended Abstract: Cumulative effects are an important but challenging component of the environmental assessment process. The success of cumulative effects analyses is often limited by (1) difficulties in defining the extent and incremental impacts of temporally and spatially separated projects, (2) a lack of large-scale strategic guidance, and (3) the availability of only a few standardized methods. We developed a set of quantitative tools, collectively known as a habitat-based population viability analysis, which can assist land managers and resource planners in conducting broad-scale environmental assessments.

Habitat-based population viability analyses are statistical models that incorporate the deterministic changes associated with habitat alteration and longer-term, less predictable stochastic (random) fluctuations in population demographics and environment. The approach has a number of advantages, including the following:

- It provides spatially explicit input and output
- It is quantitative, and thus, provides measures of precision and uncertainty
- It is based on well-established statistical and ecological theory
- It is general enough to accommodate a wide range of valued ecosystem components

We developed a habitat-based population viability analysis for sensitive and valued wildlife of the Canadian central Arctic. Recent discoveries of diamondiferous kimberlite deposits across the Northwest Territories and Nunavut have led to unprecedented levels of mineral exploration and development. The cumulative effects of such activities and others (recreation, oil and gas development, road development, etc.) are now an issue of concern for regulatory agencies, conservationists, wildlife managers, and First Nations. Regional planning initiatives are being

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[1]NatureServe Explorer (version 4.0, July 2004) lists *Ursus arctos* as the brown bear, and *Ursus arctos horribilis* as the grizzly bear.

developed to guide and monitor the rate of industrial development, but few tools are in place to quantify current and future effects.

As the first step in meeting some of the information needs of regional planning initiatives, we generated resource selection models that statistically related the observed distribution of radio-collared barren-ground caribou (*Rangifer tarandus groenlandicus*), gray wolves (*Canis lupus*), grizzly bears (*Ursus arctos*), and wolverines (*Gulo gulo*) to vegetation, interspecific interactions, and human disturbance features. Across all models, mines and other major developments had the largest negative effect on species distribution, followed by exploration activities, and outfitter camps; however, our models did not suggest strong avoidance by all radio-collared individuals during all seasons to each disturbance type. We used a geographic information system to extrapolate each seasonal resource selection model to the study area, and then performed risk assessments to quantify the loss of high quality habitats for each species as a function of modeled resource selection function coefficients and hypothetical zones of influence and accompanying disturbance coefficients. Modeled coefficients were estimated from the observed movements of collared animals, and hypothetical zones of influence and disturbance coefficients were taken from the scientific literature. In general, human disturbances had the largest negative influence on the availability of grizzly bear and wolf habitats, followed by caribou and wolverine habitats. The largest seasonal effect was recorded for caribou, where model coefficients suggested a 37% reduction in high quality, and an 84% increase in low quality habitats during the post-calving season.

The demographic implications of a reduction in the quality and area of habitats should also be an important consideration during a cumulative effects assessment. We used PATCH, a spatially explicit population viability analysis model, to relate resource selection, animal movements, and disturbance effects to predicted long-term population dynamics. Data limitations and life history considerations constrained application of the population viability analysis to grizzly bear and wolverine populations. Habitat losses associated with present and future scenarios of disturbance resulted in a reduction in the total number of animals of each species. The stochastic population viability analysis model suggested that grizzly bears were more susceptible to extirpation than wolverines. For both species, simulated inter-year variation in environmental quality had a large influence on population dynamics. Deterministic changes in habitat availability and quality resulting from human disturbance should be considered in conjunction with less predictable environmental processes.

Our findings were based on a relatively small sample of animals extrapolated to a large study area with few disturbance effects. Future increases in industrial development across the central Arctic or a different sample of animals could result in markedly different disturbance effects. We recommend further monitoring of sensitive Arctic wildlife at a number of observational scales.