International Polar Year Project: Effects of Climate Change, Glacial Retreat, and Snowfield Loss on Wild Sheep Habitat, Nutrition, and Population Distributions in Polar and High Mountain Ecosystems in Alaska, Far Eastern Russia and Central Asia: A Comparative Study

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Abstract: The purpose of this study is to determine the effect of glacial and snowfield retreat on wild sheep habitat in selected study areas of Alaska, far-eastern Russia, and central Asia. We hypothesize that climatic changes are altering the traditional habitat for high-mountain large mammals, particularly wild sheep. Wild sheep are sensitive to environmental change and may be an indicator species regarding the effects of climate change in arctic and high mountain ecosystems. With predicted warming temperatures, the cold season is expected to shrink and may decline in severity, requiring herbivores to expend less energy to survive. For individual years, however, climatic extremes in arctic and alpine ecosystems could result in either shortened or lengthened vegetation growing seasons during which herbivores procure most of the extra nutrients needed for reproduction and the storage of fat for the next winter. For most herbivores, a longer forage growing season would be expected to increase total uptake of nutrients whereas a shortened growing season would reduce intake. In the case of wild sheep, which do not hibernate and are active throughout the cold season, the predicted outcome is less clear and higher population carrying capacities might be predicted for either or both of these simple hypothetical seasonal changes. For this study, wild sheep habitat is characterized using several types of remotely-sensed data. Landsat satellite imagery is being used to identify and map changes in glacial and snowfield extent and landscape change within the study area. Changes in snow and ice extent and distribution due to melting may impact the health and nutritional value of wild sheep forage in the study through increased release of water and trapped nutrients due to melting. Data resident in the Global Land Ice Measurements from Space (GLIMS) database will be used to fill in data gaps of snow and ice distribution. Historical aerial photography, topographic maps, and historical reports will be used for additional interpretation and to provide information on snow and ice distribution prior to unavailability of satellite data. MODIS satellite imagery is used to track phenology. Phenology integrates information on vegetation, species, and climate as reflected in the timing, intensity, and duration of greenness. Quickbird imagery is being used to capture vegetation pattern and structure, which allows mapping of generalized

vegetation types, including woody vs. non-woody vegetation. Various phenological, spatial and structural metrics will be derived from these data and summarized for the study area to define and characterize distinctive landscapes. In addition, wild sheep feces are being collected and analyzed for nutrient value, digestibility, and vegetation species composition. Analysis of remotely-sensed data will be coupled with fecal analysis to attach a measure of nutritional value, digestibility (stress), and forage species composition and change with respect to wild sheep. Collection of subsequently remotely-sensed data will then be used to map these landscapes through time, monitoring any changes in their extent and distribution. This permits evaluation of the overall quality of the habitat for wild sheep based on the inferred nutritional value of each landscape type, and provides a means to monitor habitat quality through time. Long term monitoring and analysis of changes in glacial and permanent snowfield extent may result in phenological changes in wild sheep habitat. These methods may provide long term monitoring tools for wildlife managers, and also be applied in similar environments in widely dispersed wild sheep habitat.

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