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Evaluating the impacts of wildland fires on caribou in interior Alaska

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Caribou are found throughout the boreal forests of interior Alaska, a region subject to chronic and expansive wildland fires. Fruticose lichens, if available, constitute the majority of the winter diet of caribou throughout their range and are common in mature boreal forests but largely absent from early successional seres. Fire, the dominant ecological driving force, increases vegetative diversity and productivity across the landscape but may reduce caribou winter forage availability for decades. Increasingly, wildland fire regimes are influenced by humans seeking to reduce fire hazards or mitigate the effects of years of fire suppression. Consequently, biologists have debated the importance of forage lichens to the dynamics of caribou populations and land managers questioned the importance of fire regime to wintering caribou. To better understand the impacts of wildland fire on caribou, we are simultaneously investigating relationships between fire history, caribou movements, forage lichen availability and caribou nutritional performance on winter range.

The Nelchina Caribou Herd (NCH) provides an excellent research opportunity to investigate the effects of wildland fires on interior herds. Scientists have been studying this important herd for over 50 years and it has been the focus of numerous, recent research projects which provide extensive background information. Moreover, for the past ten years the majority of the herd has migrated northeast out of the Nelchina Basin, over the Alaska Range (Figure 1) in the fall to overwinter in the Ladue and Dennison Fork river drainages north of the Alaska Highway. The current winter range consists of

gently rolling, continuous and expansive stands of black spruce. Wildland fire has left a complex mosaic in this otherwise relatively homogeneous landscape. There are frequent and extensive wildland fires in the herd's current winter range, which provides for an exceptional framework to evaluate the relationships between stand-age and forage lichen abundance. Additionally, because use of this area by the NCH is relatively recent, the region provides the opportunity to evaluate selection for lichen abundance driven by wildland fire.

The herd historically over-wintered in the boreal forest in the heart of the Nelchina Basin, a region practically devoid of fires for the past 50 years. Assuming that wildland fire is detrimental to lichen abundance, it seems paradoxical that the herd has shifted its winter range north of the Alaska Range. Obviously, factors other than age of stand influence selection of winter range. Grazing or trampling by caribou, competition from other species, or interactions of those factors may inhibit lichen abundance. Indeed, instead of limiting lichen abundance, under certain circumstances, fire may be requisite for recovery of over-grazed or over-mature range. Comparison of the historic and current ranges provides a unique framework to evaluate these hypotheses.

Caribou present significant challenges for evaluating resource selection. The herd, which consists of approximately 30,000 individuals, calves in the eastern foothills of the Talkeetna Mountains. Large aggregations form during the summer, splinter and dissipate throughout the Nelchina Basin prior to the fall migration. The current winter range is located over 150 miles to the northeast of the calving grounds (Figure 1). Extensive, frequent and unpredictable movements, as well as highly variable degrees of aggregation result in problematic estimation of both used and available resources. The large geographic extent of the herd's range (approximately 69,000 km²) and the various spatial scales that resource selection could operate add to the complexity and necessitate the use of a combination of methods to collect and analyze data.

We are investigating habitat selection at 3 spatial scales. At the broadest scale, we are comparing fire history, lichen abundance and caribou distribution between the herd's historic and current winter range. In addition, we will compare these ranges to secondary wintering areas and summer range. Within the current winter range (intermediate scale) we are evaluating resource selection in relation to recent (less than

50 years old) wildland fires. At the finest scale, we will be analyzing the role of lichen abundance for selection of specific feeding sites.

It is often noted that selection for a resource does not necessarily indicate that availability of that resource affects the fitness of individuals or the dynamics of populations. In the case of fire-caribou relationships, the most likely consequence of fire-caused scarcity of forage lichens is poor overwinter nutritional performance. Consequently, we are evaluating the overwinter nutritional performance of both free-ranging and captive caribou on various ranges. These indices will be related to resource selection patterns in order to determine if differential habitat use reveals quantifiable changes in body weight, a key index of reproductive potential. The study is in its third of 5 years and some preliminary results are available.

Methods

Research Team

The U. S. Geological Survey's Alaska Science Center (ASC) and the Alaska Department of Fish and Game (ADFG) developed a cooperative research project to investigate a suite of questions that will help elucidate the role of wildland fire in caribou ecology. Personnel from the Alaska Fire Service (AFS), Bureau of Land Management, Fish and Wildlife Service, National Park Service, and University of Alaska – Fairbanks have assisted the ASC in this research. Funding for this project was secured from the National Interagency Fire Center, ASC and ADFG.

Resource Selection

We captured caribou by darting them from helicopters in the spring and fall during each year of the study. Approximately 100 caribou were fitted with either traditional VHF or GPS radiocollars. The GPS collars, programmed to obtain locations every 7 hours, were equipped with VHF beacons as well. Monthly aerial surveys were used to collect data on caribou movements and distribution. We downloaded GPS data from the collars every six months during capture operations.

We used monthly aerial radio-telemetry data collected by the ADFG in the early 1980's to determine caribou use patterns on the historic winter range, which enabled us to compare broad scale patterns of selection. Forage lichen biomass, as determined from ground surveys, was then correlated to percent coverage of lichens as determined from digital aerial videography. Digital videography was employed to obtain coverage data from a large number of used and random plots throughout the NCH's range. This allowed us to analyze broad scale patterns of selection (historic versus current winter range).

To analyze resource selection at an intermediate scale we used our telemetry data to delineate the current winter range of the NCH. Data assembled by AFS on fire perimeters dating back to 1950 was then incorporated into a Geographic Information System (GIS). Using this data, we calculated the proportion of area burned in the last 50 years. By comparing caribou distribution to wildland fire history in the region, we have been able to determine if the caribou select for or avoid these younger stands in the herd's current winter range.

To evaluate resource selection at the finest scale, vegetation plots were located at sites that were used by caribou, as determined from the relocation data. These data were compared to data from sites randomly distributed throughout the current winter range. Lichen biomass, stand age and a suite of other characteristics were determined at each of the plots. We subcategorized lichen biomass into primary and secondary caribou forage lichens, as well other less preferred lichens. Based on other studies, we initially considered *Cladina amaurocraea*, *C. arbuscula*, *C. mitis*, *C. rangiferina*, and *C. stellaris* primary forage lichens and *Cetraria cucullata*, *C. islandica*, *C. laevigata*, *C. nivalis*, *Cladonia gracilis*, *Bryoria* spp., and *Parmelia* spp. to be of secondary importance.

Nutritional Performance

Free-ranging caribou had numerous morphometric measurements taken at the time of each capture, as well as being fitted with radiocollars. By measuring body weight at 4, 10, and 16 months of age (Figure 2), we obtained weight change over each caribou's first winter and first summer relatively free of maternal influence. This information will then be related to the individuals' use of habitat and distribution relative to other caribou.

Evaluating the nutritional performance of free-ranging caribou is problematic in that range use is confounded by the myriad of factors that influence the movements of caribou. To evaluate the affect of lichen abundance on nutritional performance under more controlled circumstances, we conducted *in situ* feeding trials with hand-raised animals. Several NCH caribou calves were captured at 1 day of age and reared in captivity. During the following 2 winters, the calves were brought to enclosures on the herd's historic and current winter ranges. After a 7-day acclimation period, we determined activity budgets, diets, and weight changes during one-week feeding trials. We conducted these trials on 1 hectare enclosures with lichen coverage ranging from 0-56%.

Results and Discussion

Approximately 40 4-month-old calves and 12 16-month-old yearlings were captured each fall, along with 20 adults that received GPS collars. All the calves and GPS collared cows that survived the winter were captured again in the spring and following fall. Over 800 VHF and 12,000 GPS relocations were collected in the current winter range during the first 2 winters of the project. GPS units successfully determined locations on over 80% of attempts.

Broad Scale Selection

The majority of the radio-collared caribou (~85%) utilized the current winter range, which encompassed approximately 10,000 km². During the first 2 winters since the commencement of this project, not a single captured caribou was located in the historic winter range within the Nelchina Basin. By comparison, a previous ADFG radio-telemetry study consisting of over 2,500 locations of NCH caribou between 1980 and 1985 clearly identified the Nelchina Basin area as the primary winter range. Evaluation of lichen availability on the historic range is not yet complete but it appears that, despite a paucity of recent fires, lichen is less abundant on the historic range than on the current winter range. However, lichen biomass is high within a series of wildlife exclosures constructed on the historic range in the 1950s, suggesting that grazing and trampling by caribou during the non-winter months keeps lichen abundance low.

Furthermore, inter-specific competition and shading (primarily by mosses) in concert with grazing and trampling may inhibit lichen growth and recovery. Subsequently, we have established new enclosures and “seeded” lichen fragments on a variety of burned and unburned substrates to evaluate these hypotheses.

Intermediate Scale Selection

While less than 1% of that historic winter range has known to have burned in the last 50 years, AFS records indicate that recent wildland fires cover more than 20% of the current winter range. More than 85% of these fires have occurred in the last 15 years. Fires that are over 30 years old account for only about 10% of the total number of burns, but nearly 40% of the total area (Figure 3). Vegetation plots examined within the current winter range support the fire scar data, revealing that few stands are over 200 years old and sites between 60 and 100 years of age are the most common.

Less than 6% of the relocations, both VHF and GPS, in the current winter range fell within mapped fire perimeters during the winters of 1999-2000 and 2000-2001. Given that over 20% of the range has burned within the last 50 years, caribou used these areas proportionately less than their availability. There were also indications that when caribou were relocated in fires that they were near the perimeter or did not stay for long periods (Figure 4). Moreover, we are investigating the possibility that some locations of caribou within mapped fire perimeters may actually constitute use of unmapped islands of unburned habitat within the fire perimeter.

Fine Scale Selection

Selection against using recent burns and for lichen-rich older stands was also readily apparent at the finest scale. A comparison of stand-ages of 120 used and 120 random sites revealed that caribou used 80- year-old and older stands more than expected and used stands younger than 80 years less than expected within the current winter range. Forage lichen biomass was greatest in 80-220 year-old stands but virtually absent from stands less than 60 years old. Some lichens, such as *C. rangiferina*, were not detected in substantial quantities in stands that were younger than 150 years old. Forage lichen coverage was much greater at caribou locations (30%) than at random sites (10%). This

translated into significantly greater primary and secondary forage lichen biomass at caribou locations versus random locations as lichen coverage was strongly correlated with lichen biomass. Mean primary forage lichen biomass at caribou locations was more than double the biomass at random locations. Because some random sites may have been within stands selected for by caribou, the difference between used and random locations is only a conservative estimate of the potential differences between used and unused habitat.

Nutritional Performance

Changes in overwinter body measurements of free-ranging caribou were noted each year. Calves, on average, lost about 5% of their total weight over the winter (Table 1.) During this period however, skeletal growth did occur. Metatarsus and mandible lengths were both, on average, approximately 2 cm longer at the end of winter than before it. Cows lost on average over 10% of their body weight the first winter, but only 5% during the second. Some individuals actually gained weight over the winter.

Table 1. Mean (n, sd) weights of caribou from the 1998, 1999, 2000 and 2001 cohorts.

Cohort	4 months	10 months	16 months
1998	51.0 (7, 3.8)	51.5 (7, 4.6)	75.8 (22, 11.9)
1999	51.7 (35, 4.7)	48.7 (23, 3.9)	74.8 (21, 8.4)
2000	53.5 (37, 6.6)	52.5 (26, 4.6)	83.0 (19, 5.2)
2001	58.5 (40, 5.9)	54.8 (33, 4.9)	N/A

Analysis of individual and cohort performance of free-ranging radio-collared caribou in relation to habitat use has just begun. However, captive caribou grazing on the historic winter range spent more time ruminating, which infers lower habitat quality, than when they were on the current winter range. The captive caribou resorted to changing their diet to include poor forage such Labrador tea (*Ledum* spp.) when on the historic winter range. The results of grazing captive caribou on different plots with varying levels of lichen abundance are still pending but should provide specific data on the abundance of lichen required for caribou to maintain their body weight over winter.

Conclusions

The NCH's winter range is in the boreal forests of east-central Alaska where wildland fire is a key ecological factor increasing vegetative diversity and productivity. Wildland fires destroy lichen mats in the region, with replacement of primary caribou forage species taking more than 50 years. Our data strongly reinforce the tenet that lichen abundance is related to stand age. These results imply that fire regime can have strong influences on lichen abundance. Moreover, factors influencing fire frequency such as prescribed fire, fire suppression, or climate change likely influence the availability of winter range for caribou, which avoid recently (within the past 50 years) burned areas. By limiting our analysis to only older stands, it was revealed that caribou were specifically selecting for lichen abundance rather than some physical characteristic inherent in older stands. If forage lichen abundance affects winter weight loss, the frequency, distribution and size of wildland fires may play a significant role in increasing vulnerability to predators, delaying maturity and reducing productivity of caribou. These consequences could directly be detrimental to the fitness of individuals and populations of caribou.

This project will continue through FY2004. Remaining tasks include determining the over-winter nutritional performance of the 2002 cohort relative to habitat use. In addition, over the summer of 2002 and 2003, we intend to complete aerial-videographic evaluations of lichen abundance at caribou locations on outlying and historic winter range and at locations of GPS collared individuals. Concurrent with these activities, we intend to analyze data and produce manuscripts of results.

Figure 1: Area Map

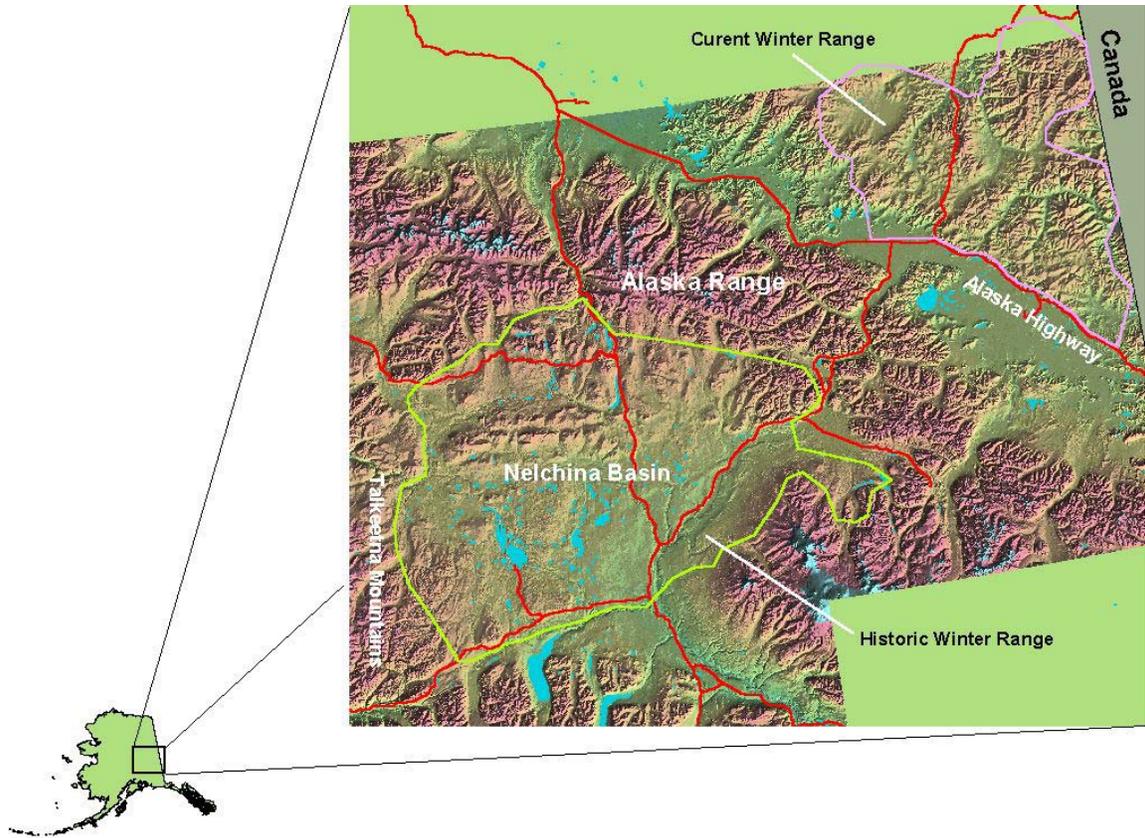


Figure 2: Caribou capture



Figure 3: Histogram of fire frequency vs. area

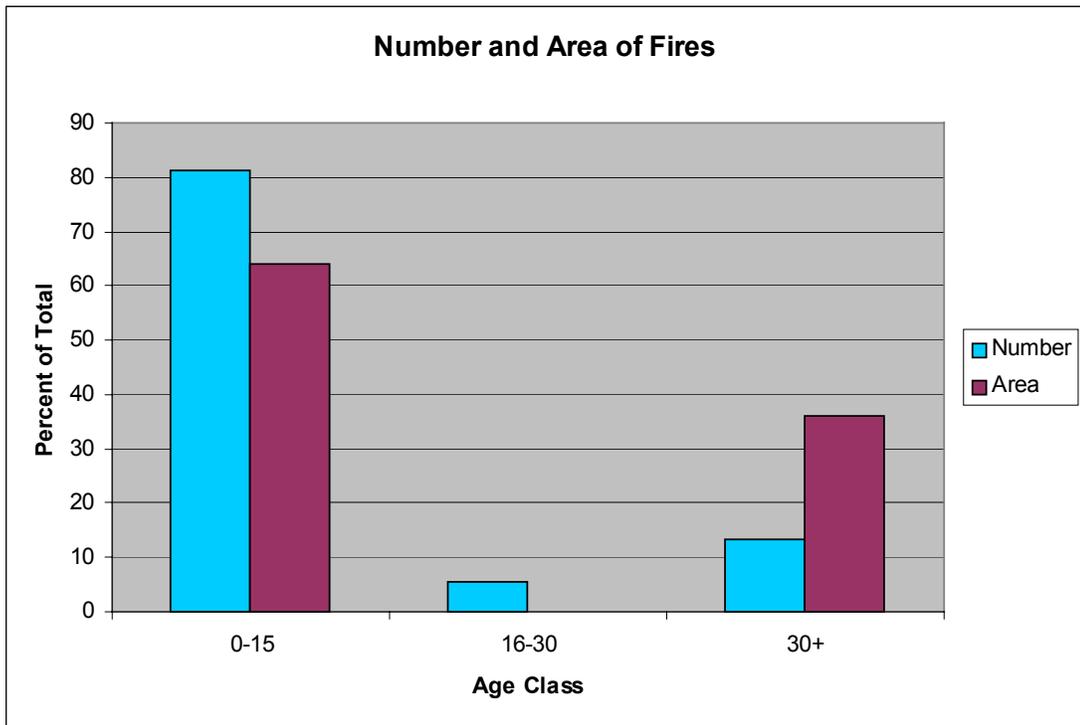
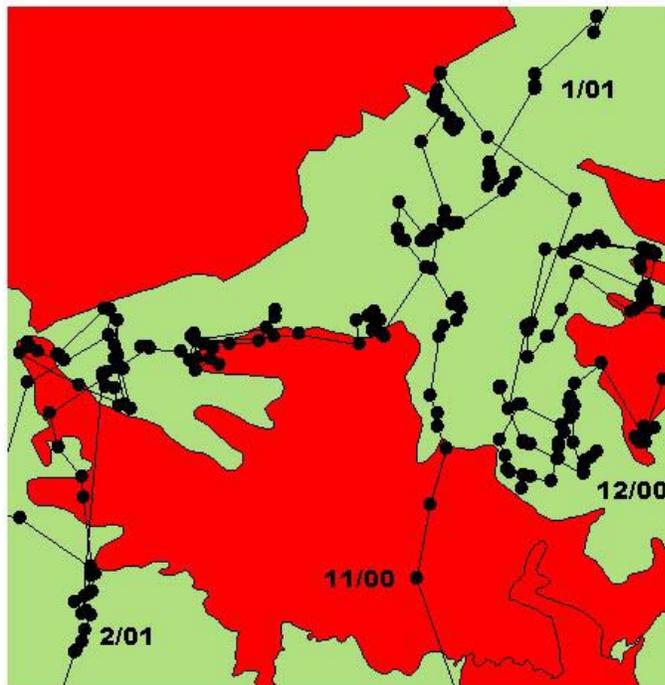


Figure 4:GPS data showing movements around fire perimeters



- Burned Area
- Unburned Area
- GPS Location