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McCarthys Marsh Caribou Winter Range Transects: Vegetative Changes from 1997 to 2006

Kyle Joly and Randi R. Jandt

Alaska

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Cover Photo

Tundra near Transect 3 and the 1977 Wagon Wheel burn with the Bendeleben Mountains in the background. BLM photo by the author.

Author

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INTRODUCTION

The Bureau of Land Management (BLM) began studies of the winter range of the Western Arctic Caribou Herd (WACH) in 1981. Twenty permanent vegetation transects were deployed within the Buckland River valley on the northeastern side of the Seward Peninsula. Additional sites added in 1996 and 1997 included eight located in and around the McCarthys Marsh area of the southcentral region of the Seward Peninsula (Table 1 and Figure 1). All relocatable transects (two transects deployed in 1981 were not found again) were monitored during 1981, the mid-1990s, and again in 2005 and 2006. Jandt et al. (2008) compared all paired burn and unburned transects, while Joly et al. (2007) compared the vegetative changes over the three time periods in the Buckland Valley region. This report presents the changes in vegetation within the McCarthys Marsh area between 1997 and 2006 detected using these permanent transects. Two of the eight transects had paired burned transects, and these results will be presented here to retain a central location for McCarthys Marsh data even though these data previously were reported by Jandt et al. (2008).

The WACH numbered 490,000 caribou (*Rangifer tarandus*) as of 2003 (Dau 2005). Lichens are the primary winter forage for caribou. Lichen cover has been declining in the Buckland Valley, which is within the herd's core winter range, since 1981 (Joly et al. 2007). In 1997 the BLM chose McCarthys Marsh, an area outside the range of the WACH until the mid-1990s, as a site for deploying new transects primarily to document the rate and magnitude of caribou disturbance in a recently invaded range that had high initial lichen cover. It was assumed that once the caribou had "discovered" this relatively pristine winter range, they would heavily utilize it. However, groups of caribou used the area only sporadically between 1996 and 2006, although as many as 10,000 animals were observed on occasion. Serendipitously, lower than expected use did not render the monitoring valueless. Changes in vegetation on these transects also helped shed light on the effects of lighter grazing pressure, climate change, wildfire, and the interactions of these factors (Joly and Jandt 2007), illustrating how monitoring efforts may yield unexpected, yet important, findings.

METHODS

Permanent vegetation transects were deployed in the McCarthys Marsh and Death Valley area in 1997 at eight sites. Two of these sites had an additional transect located within a nearby burned area so as to

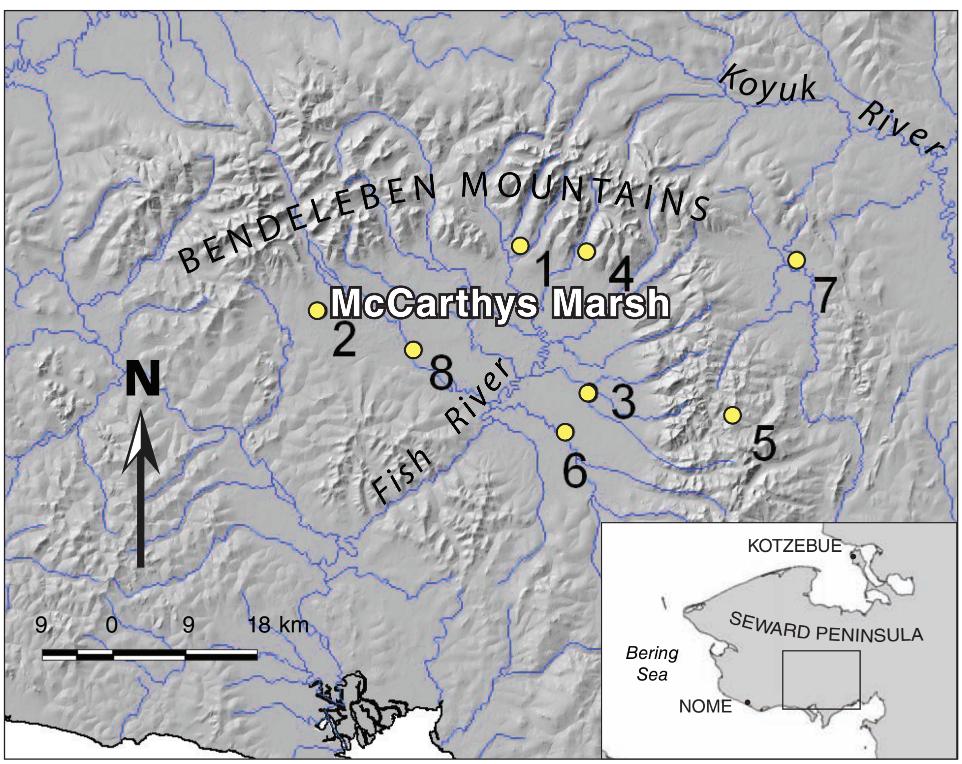

Figure 1. Locations of permanent vegetation transects in the McCarthys Marsh region of the Seward Peninsula, Alaska. For transect names and coordinates, see Table 1.

Table 1. Coordinates of transects (NAD 83 datum).

#	Transect name	Latitude (N)	Longitude (W)
1	Wagon Wheel Airstrip	65°10.875'	163°04.718'
2	Upper Pargon	65°04.588'	163°35.392'
3B	1977 Wagon Wheel Burn	65°01.713'	162°50.602'
3UB	1977 Wagon Wheel Unburned	65°01.545'	162°50.577'
4	Lava Creek	65°11.096'	162°53.968'
5	Darby Mountains	65°01.374'	162°27.266'
6	Etehepuk	64°58.789'	162°53.406'
7	Death Valley	65°12.410'	162°20.295'
8B	1972 Pargon Burn	65°02.910'	163°19.494'
8UB	1972 Pargon Unburned	65°02.895'	163°19.419'

create paired burned and unburned transects. All transects were read in 1997 and in 2006. A 1-m x 0.5-m sampling frame (see Figure 2) was placed along the 50-m transect at 4-m intervals (12 total). Each frame was divided into 0.1-m x 0.1-m sections to develop 50 point-intercept locations. Species was determined for each intercept. The first "hit" for each intercept was used to determine percent cover. While multiple "hits" were recorded through the canopy, these data were not part of this analysis. Only the first hit was recorded for the Buckland transects (Joly et al. 2007). Percent cover was then calculated for the entire transect for each of the following vegetative classes: lichens, graminoids, shrubs, mosses, forbs, and non-vegetated. The lichen class was further subdivided into primary, secondary, and non-forage lichens based on published literature and the authors' field experience (see Joly et al. 2007). T-tests were employed for dependent samples to statistically compare differences in vegetative cover between 1997 and 2006. Repeat photography was also used to document changes in vegetative cover.

Figure 2. Researcher quantifying vegetation cover at the Death Valley transect using the sampling frame.

RESULTS

Unburned Transects: 1997 versus 2006

The relative 54.0% decline in lichen cover over the last decade was significant (T = - 7.89, df = 7, P < 0.001). Similarly, primary lichens suffered a 57.5 % relative decline, which was also significant (T = - 5.59, df = 7, P < 0.001). The large decline in lichen cover was offset by increases in graminoids, shrubs, and forbs. Graminoid cover more than doubled during the study, which was significant (T = 3.64, df = 7, P = 0.008). Shrub cover significantly increased by a relative 30.0 % (T = 3.80, df = 7, P = 0.007). The relative 63.0 % increase forb cover was also significant (T = 2.96, df = 7, P = 0.021). The changes in cover for both moss (P = 0.123) and non-vegetated (P = 0.628) were not significant. Changes in absolute percent coverage are depicted in Figure 3.

Paired Transects: Burned versus Unburned

The data comparing the two paired burned and unburned transects is presented in Figure 4. Wildland fires burned these areas in 1972 and 1977, so the burns were 34 and 29 years old at the time of the last (2006) reading. Although the absolute percent coverages vary between the two decades, the relative patterns of vegetative cover between burned and unburned transects are very similar.

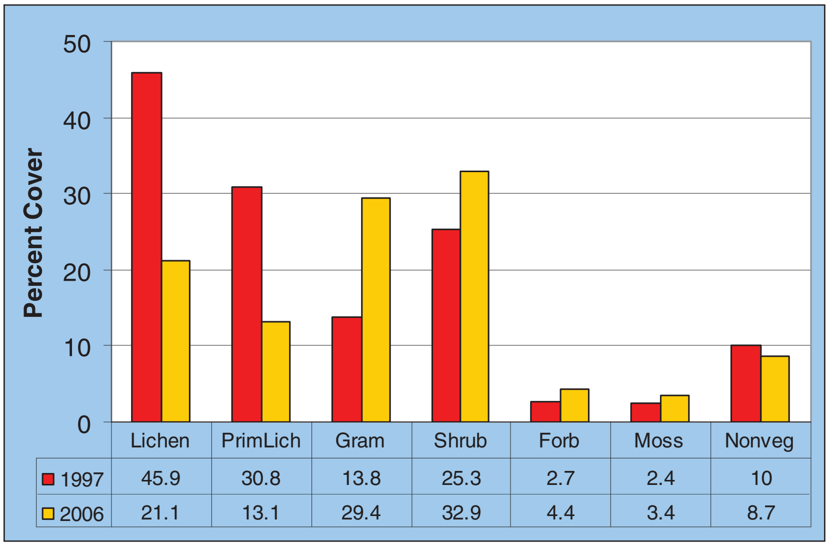

Figure 3. Changes in percent cover of different vegetative classes from 1997 to 2006 on eight permanent transects in the McCarthys Marsh area of the Seward Peninsula, Alaska. “PrimLich” represents cover of primary caribou forage lichens—a subcategory of all lichens.

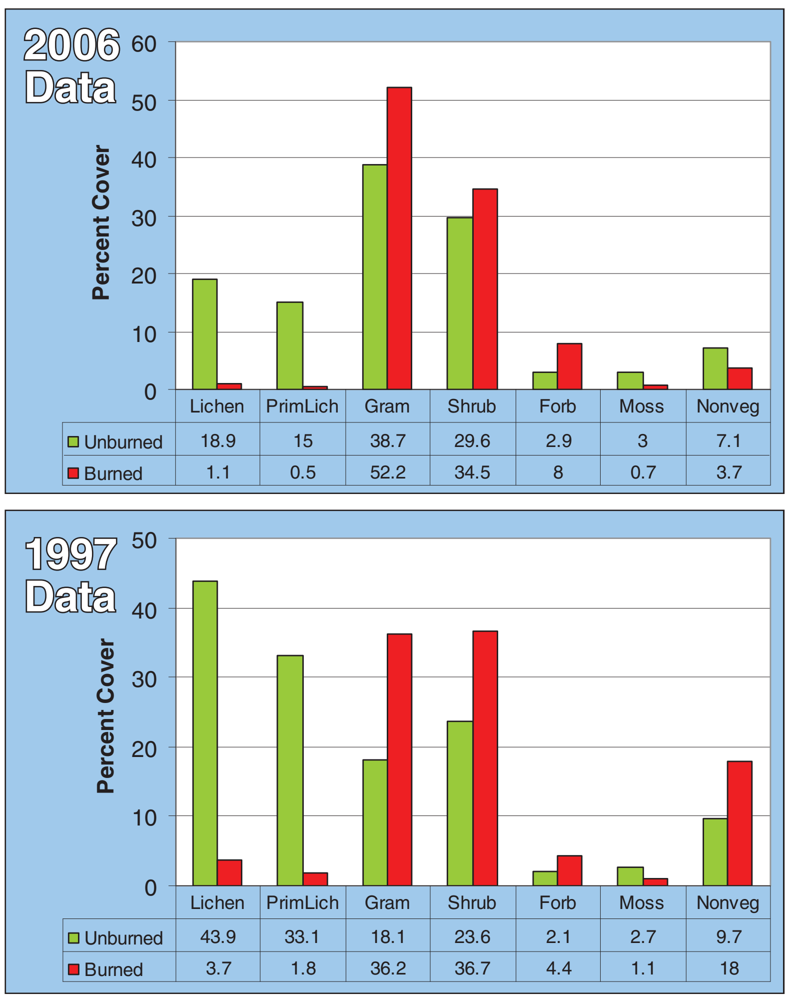

Figure 4. Observed differences in percent cover of different vegetative classes between paired burned and unburned transects. Sampling was conducted in 1997 and 2006 on two permanent transects in the McCarthys Marsh area of the Seward Peninsula, Alaska. “PrimLich” represents cover of primary caribou forage lichens—a subcategory of all lichens.

Repeat Photography: Lava Creek and Death Valley

Photos taken at the same place on the east side of Lava Creek show obvious signs of substantial increases in shrub cover (Figure 5). The bright ground cover in the 1997 photo is replaced by low evergreen shrubs in the 2006 photo. Also, the extent of alder (*Alnus* spp.) clusters is much greater in the 2006 photo than in the 1997 photo. Notice the large boulder in the middle of the 1997 photo that is almost totally obscured in 2006. Also note size increases in individual shrubs and expansion of shrub cover extent.

The photo-point pair from Death Valley shows obvious signs of substantial increases in graminoid cover (Figure 6). This area was used by a large group of caribou and lichens were mined out. There are damaged tussocks (bright spots), but low-lying moss (orange areas) is still visible in 1997. Nine years later, the site is a field of vigorous tussocks. Ankle-deep tussocks are now knee-high, and the moss is no longer visible. This area did not burn.

DISCUSSION

Results from the McCarthys Marsh permanent transect data agree with, and reinforce, other research (Jandt et al. 2008, Joly et al. 2007) that has documented the large and rapid changes occurring in tundra ecosystems within the range of the WACH in northwest Alaska. Lichen cover has declined significantly in the McCarthys Marsh area, with declines in primary caribou forage species leading the way. Grazing and trampling were likely the primary factors contributing to this very rapid decline. However, it is remarkable that such significant changes were documented with limited caribou use occurring in only about 4 of the 9 years between monitoring efforts. Graminoid (grass and sedge) cover has more than doubled from 1997 to 2006. Shrub cover and forb cover have also increased significantly over this period within the study area.

Figure 5. Lava Creek in 1997 (left) and 2006 (right), McCarthys Marsh area of the Seward Peninsula, Alaska.

Figure 6. Death Valley in 1997 (left) and 2006 (right), McCarthys Marsh area of the Seward Peninsula, Alaska.

Lichen cover, including specifically primary forage lichens, was much lower on burned transects than on unburned transects. There has been little recovery of lichen cover 30–35 years post-fire, with less than 2% cover in 2006. In fact, relative cover of lichen actually declined between 1997 and 2006. Lichens are highly susceptible to burns and take decades to recover, though graminoids can recover very quickly (see Figure 7; white area is dead lichens, but grasses have returned). Unlike lichens, graminoid, shrub, and forb cover were all greater in the burned transects than in the paired unburned transects. The absolute percent cover of graminoids increased markedly.

Figure 7. Quick recovery of vascular vegetation, Oregon Creek burn. White vegetation is fire-killed lichens.

On individual transects, such as Death Valley, the increase in graminoid cover was remarkable and obvious on photo-plot comparisons. We hypothesize this response to be an indirect effect of grazing; the site experiences warming due to surface albedo changes when the highly reflective, insulating lichen cover is removed. Alternatively, the marked growth response in vascular species—primarily cottongrass (*Eriophorum* spp.)—may be stimulation due to warming climate. Experimental studies (Walker et al. 2006) have documented substantial plant community shifts associated with changes in temperature and growing season—even when those changes are as small as or even smaller than those experienced on the Seward Peninsula since the 1970s. The trend of increasing graminoids was also noted in the Buckland Valley transects, where this class had the largest increases in percent cover (Joly et al. 2007). Significant changes in moss cover between the mid-1990s and 2006 were not detected on either the Buckland Valley or these McCarthys Marsh transects (Joly et al. 2007, this study). At Lava Creek the photo-pairs show substantial increases in shrub cover, which has been documented by Sturm et al. (2001) in other Arctic regions.

These results provide additional evidence that factors other than high caribou numbers and fire, such as climate warming, are affecting vegetative cover in tundra ecosystems. Lichen cover declined in unburned transects despite the fact that the WACH did not utilize the area frequently during the study period. Furthermore, relative lichen cover declined on burned transects where lichen cover was too low to attract caribou use (see Joly et al. 2007). Increased graminoid cover and shrub cover, observed on both burned and unburned transects, is a predicted effect of climate warming (Chapin et al. 1995, Sturm et al. 2001, Walker et al. 2006). Increased moss cover has been a common indicator of overgrazed ranges (Klein 1987, van der Wal 2006), but it was not noted in this study.

The McCarthys Marsh and Buckland Valley transects should continue to be monitored every 7–10 years. We recommend that additional transects be established in the Nulato Hills, a heavily utilized portion of the WACH's winter range. Additional information, especially in older age-classes, is needed to determine a reasonable recovery curve for lichens within the range of the WACH. Lastly, further investigations into the area's fire regime and the extent of potential winter range for the herd would help in the development of specific fire management recommendations to protect remaining productive, old-growth lichen communities.

ACKNOWLEDGEMENTS

Randy Meyers, who retired from the BLM in March 2007, has been an integral member of the team studying the winter range of the WACH for more than a decade. Her botanical expertise, from which the authors benefited on this and many other projects, will be missed. Also appreciated was the fieldwork assistance provided by Ann Claerbout in 2006 and Jeanie Cole in 1997.

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