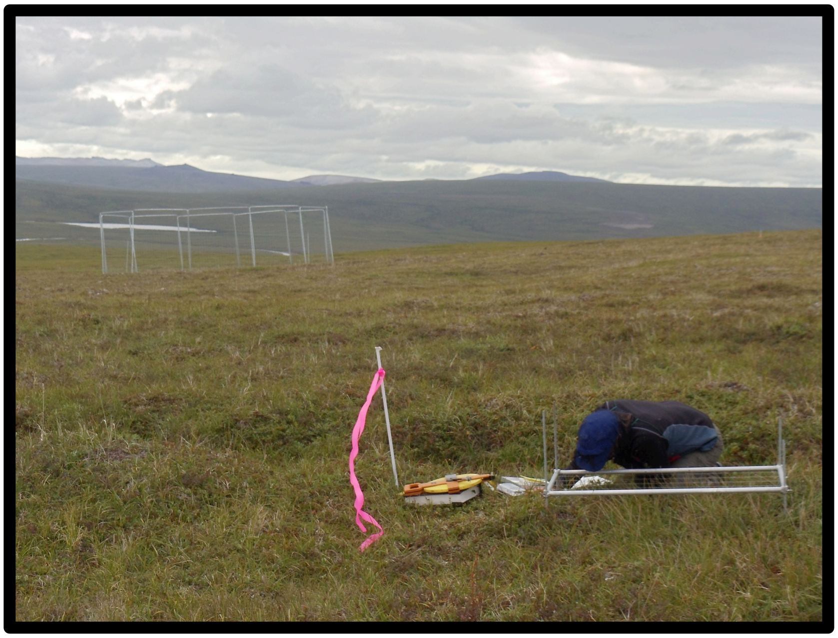
Collaborative Monitoring of Seward Peninsula, Alaska Reindeer (*Rangifer tarandus tarandus*) Grazing Lands

A Monitoring Protocol
By
Kara Ellen Moore



Reindeer Research Program

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By
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RECOMMENDED: Karin L. Sommer
Richard Thompson
Claudia Ihl

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Advisory Committee Chair

Department Head

APPROVED:

Dean, School of Natural Resources and Agricultural Sciences

Date

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OPUS

Presented to the Faculty
of the University of Alaska, Fairbanks

in Partial Fulfillment of the Requirement
for the Degree of

MASTERS OF NATURAL RESOURCES MANAGEMENT AND GEOGRAPHY

By
Kara Ellen Moore, B.S.

Fairbanks, Alaska

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List of Acronyms and Abbreviations

Alaska Department of Natural Resources…..…DNR

All-Terrain Vehicle…………………………….ATV

Bureau of Indian Affairs…………….….………BIA

Bureau of Land Management………………..…BLM

Code of Federal Regulations…………………..…CFR

Geographic Information Systems……..……….GIS

Lichen Utilization Cover Class……………….LUCC

Memorandum of Understanding………………MOU

National Parks Service……………..……..…….NPS

Natural Resource Conservation Service………NRCS

Reindeer Research Program……………..…….RRP

United States Department of Agriculture…….USDA

University of Alaska Fairbanks…………,..……UAF

Western Arctic Caribou Herd……………..…WACH

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1.0 Introduction

This project was a collaborative effort between agencies and stakeholders to develop a joint strategy in monitoring the status and use of reindeer grazing lands on the Seward Peninsula, Alaska. Implementing a uniform, scientifically sound monitoring program across landownership boundaries will provide managers and producers the data to oversee land use practices on a landscape, rather than a regional, scale. This collaborative collection and sharing of data will facilitate interagency and stakeholder communication and promote common management strategies across the entire reindeer grazing system. In turn, working together will save time and resources by eliminating duplicative efforts and expanding the knowledge base among agencies. Effective monitoring programs also show when management programs are successful, or are an early warning to herders and range managers when management is not successful (Elzinga et al. 1998).

Monitoring the status and use of range resources is important for sustainable use and the conservation of U.S. rangelands, and Congress mandates monitoring livestock grazing impacts on public federal lands. Through the Endangered Species Act, Federal Land Policy and Management Act, and National Environmental Policy Act (Elzinga et al. 1998), public land managers are mandated to inventory resources and monitor the public rangelands use. Previous inventory protocols and management strategies have produced mixed success. West (2003) concluded, “Lack of consistent and comparable monitoring procedures within and between the federal, management, advisory, and regulatory agencies has made it impossible to conclude reliably what the overall condition and trends in conditions of our public rangelands are."

Alaska's rangelands are unique (Finstad 2008) consisting of tundra and arctic vegetation (Jefferies et al. 1992). Protocols developed for typical contiguous U.S. grazing lands are likely not well suited to monitoring tundra range condition. The objective of this project was to develop a standard collaborative range monitoring protocol for the unique tundra grazing lands of the Seward Peninsula that was acceptable to all landowners, managers and stakeholders.

Rangifer species, particularly reindeer, have been the dominant grazers on the Seward Peninsula for the last 100 years. Reindeer have been grazing on the Seward Peninsula for over 120 years (Stern et al. 1980); caribou have been in the area periodically for hundreds of years (Koutsky 1981). Ungulate grazing has varying effects on vegetation communities, depending on grazing intensity, duration, ecotype and weather (Holechek et al. 2010). Traditional range succession models assume in absence of grazing, succession towards climax is a steady process. Grazing pressure then shifts the range condition away from climax (Westoby et al. 1989). However "vegetation changes in response to grazing have often been found to be not continuous, not reversible, or not consistent (Westoby et al. 1989)." Plant community changes in response to sustained heavy grazing generally show the more palatable plants decrease and are replaced with plants that are lower in palatability, productivity, and more poisonous. Moderate grazing generally results in a stable vegetation community or an increase in palatable plants. While the plant community generally responds to light grazing with an increase in palatable plants, and a decrease in unpalatable plants, there are further factors that affect the successional trend such as moisture and temperature (Holecheck 2010). Moderate grazing effects on forage plants have included stimulated vegetative growth, increased size of remaining seeds, and an overall increase in plant fitness (McNaughton 1982).

Climate change, fire and ungulate grazing are causing a shift in the arctic tundra vegetation (Joly et al. 2009). One study reported a decline in lichen biomass throughout much of the Arctic, with lichen-dominated plant communities transitioning toward more vascular plants (Joly et al. 2009). Exclosures can be helpful in identifying changes to the vegetation community influenced by ungulate grazing, or by the changes caused by climate change (Holechek 2010). A comprehensive monitoring program across range landowners will provide the early warning and identify the causes of landscape-scale vegetation community changes. Monitoring data will allow land and wildlife managers, as well as reindeer herders, to develop adaptive range management strategies to mitigate vegetation changes of rangelands.

This joint project aims to explore the relationship between grazing, climate change, and plant community composition. A comprehensive landscape monitoring program will provide feedback for reindeer herders, range managers, and land managers to make more informed decisions when setting stocking densities, making grazing management plans, and permitting activities on lichen-dominated sites.

1.1 History of Alaska's Reindeer Industry

Heightened hunting efficiency after the introduction of firearms to Alaska likely promoted the depletion of a number of the traditional subsistence animals (Ray 1975), which included: bowhead, gray, and beluga whales; Pacific walrus; bearded, spotted, and ringed seals; salmon, whitefish, blackfish, waterfowl, and caribou (Ellanna and Sherrod 2004). Sheldon Jackson, a missionary on the Seward Peninsula, envisioned reindeer herding as a solution to the apparent widespread hunger and poverty in the area. Jackson lobbied the federal government to sponsor the purchase and introduction of reindeer to Alaska. Domestic reindeer, *Rangifer tarandus tarandus,* were first introduced to the Seward Peninsula at Port Clarence on July 4, 1892 (Jackson 1893). The goal was to initiate reindeer herding on the Seward Peninsula to alleviate apparent food supply shortages for Alaska Natives (Simon 1998). Jackson also planned to use reindeer herding to assimilate Alaska Natives into the modern world (Ellanna and Sherrod 2004).

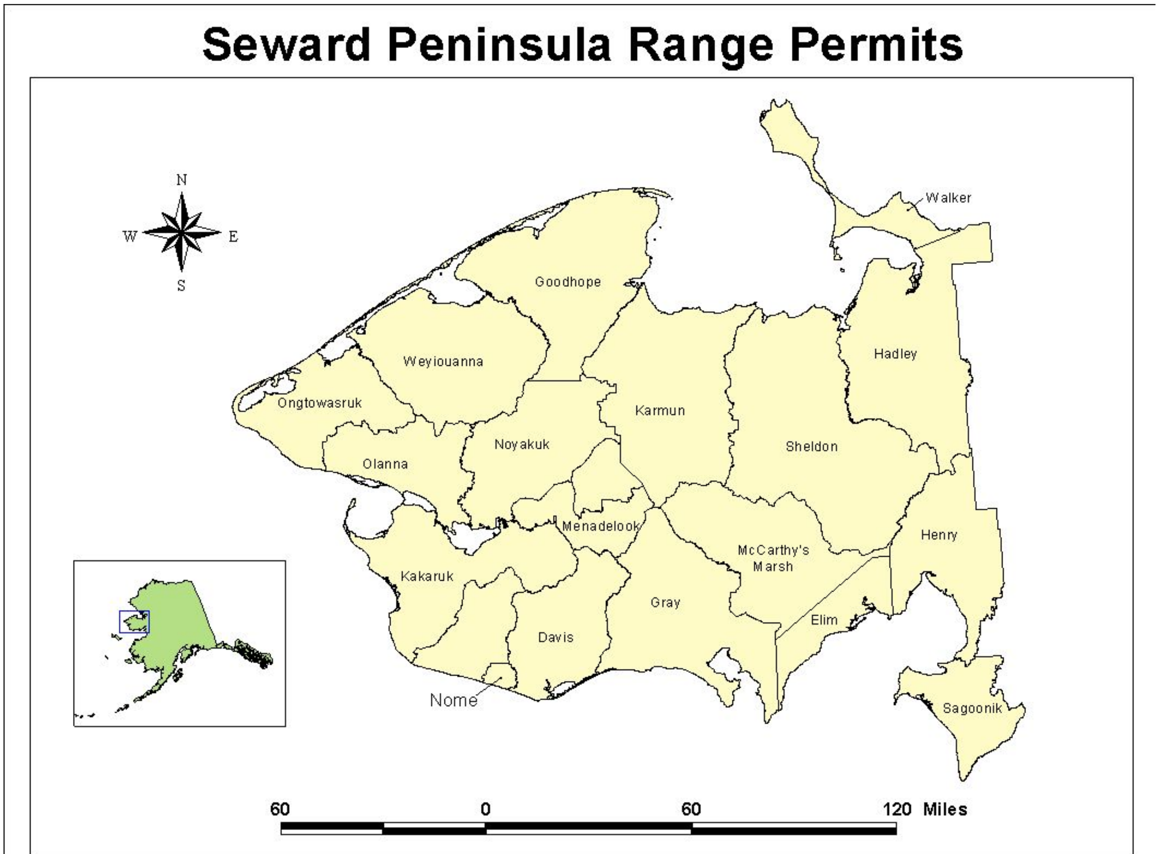
Jackson initiated an apprenticeship program for Alaska Natives where imported Sami reindeer herders were set up as mentors. Apprentices were awarded reindeer for each year they participated in the program. In reality, Alaska Natives had a difficult time actually obtaining their own reindeer through Jackson's program as the conditions of apprenticeship changed from year to year and many non-natives also owned reindeer herds (Stern et al. 1980). Native herders were forced to compete with Sami herders from Europe and after 1914 the Lomen family (Stern et al. 1980).

The Lomens were a family from Seattle who originally came to the Seward Peninsula for the gold rush, then later developed a reindeer meat industry. The Lomens were accused of unfairly competing with the Native herders for several reasons. The major reasons included the Lomens taking range lands customarily belonging to Native herders, and unfair range rules and practices including marking all mavericks at handlings to the Lomen herds. A final reason was the behavior of the Lomens at Native herd handlings, where they marked a disproportionate number of maverick reindeer to the Lomen herds (Stern et al. 1980). The Lomens also brought to the industry the capital and knowledge to develop successful marketing and shipping of reindeer to outside markets. In response to the industry domination by non-Native Alaskans, the 1937 the Reindeer Industry Act was passed (Stern et al. 1980), restricting reindeer ownership to Alaska Natives (25 United States Code §500-500n; PL 75-413).

Since reindeer introduction to Alaska, reindeer populations have varied dramatically. In the 1930s and 1940s, the reindeer population on the Seward Peninsula was over 130,000 (Stern et al. 1980), and by 2007 only 15,000 reindeer remained on the Peninsula (USDA 2008). Lichens were overgrazed in the 1930s and 1940s (Stern et al. 1980) and are slow to recover once depleted (Kumpula et al. 2000; Pegau 1968; Jefferies et al. 1992). In 1968, the State of Alaska, Bureau of Indian Affairs (BIA), and BLM reached a cooperative agreement for the BLM to take over supervision of the ranges (Stern et al. 1980). In the 1960s the BLM issued reindeer grazing permits and began monitoring rangelands through range utilization checks and established recommended stocking densities (Stern et al. 1980). By the 1990s, 17 grazing permits had been issued and many herds were growing and profitable (Carlson 2005).

Reindeer herders now are responsible for obtaining grazing authorizations for their grazing allotments from the appropriate land management agency, which permits under separate authorities, as follows; BLM (43 CFR §4300, 1996), Department of Natural Resources (DNR) (ADNR, 2008), or National Parks Service (NPS) (36 CFR § 1.6, 1986). The landowner agencies and the Natural Resource Conservation Service (NRCS) formed a memorandum of understanding (MOU) dividing primary permitting administration, with each agency adjudicating a portion of the permits. All grazing permits contain stipulations that require both a grazing management plan, and range condition monitoring. The NRCS works with herders to develop grazing management plans and assess range condition (BLM et al. 2010). Figure 1 below displays the individual range allotments.

Figure 1: Range Allotments



(Reindeer Research Program 2011)

Management changes implemented in the 1980s and 1990s included a prescribed 5 to 7 year rotational grazing system (Swanson and Colville 1999). During this management regime, some of the lichen stocks increased from earlier overgrazing (Swanson and Colville 1999) which may have initiated a landscape-changing event. The Western Arctic Caribou Herd (WACH; *Rangifer tarandus grantii*) also swelled to approximately 490,000 animals during the 1980s and 1990s (Dau 2005) and likely overgrazed lichen stocks on traditional winter ranges. The relative abundance of lichen on the Seward Peninsula may have influenced the migration pattern of the WACH. WACH migrations began extending westward onto the Seward Peninsula during the fall of 1997 (Finstad and Prichard 2000). At this point many reindeer commingled and outmigrated with the caribou (Finstad and Prichard 2000). The WACH migration progressed further west each year across reindeer allotments until 2000, when only a few reindeer herds remained intact on the west coast (Finstad et al. 2006).

Currently, reindeer herders are using new technologies, such as satellite telemetry, Geographic Information Systems (GIS), and enclosures and supplemental feeding to keep the remainder of their herds (Oleson 2005, Finstad et al. 2006). However land and range managers are concerned about the impacts of intensive grazing by caribou on the lichen ranges of the Seward Peninsula (Dau 2005).

1.2 Grazing Monitoring Importance

Historically, many herders used to practice intensive herding where they stayed with and moved their herd daily (Simon 1998). Few roads intersect the large remote range allotments. Year round access to allotments is difficult and/or expensive because they can only be reached in summer by helicopter, boat, and/or long all terrain vehicle (ATV) trips or in winter by snowmobile. Additionally, herders have many competing duties for their time, maintaining other jobs and responsibilities (Oleson 2005), and check on their reindeer only when off-time, weather and snow conditions allow for travel (Rattenbury et al. 2009). Herd movements and thus, grazing patterns are now influenced less by human intervention, but more by pressure from predators, insect avoidance, and forage searches.

Current herd management practices have resulted in uneven utilization of the range (Swanson and Barker 1992). Many potential foraging areas receive little use, while heavily-utilized areas may be over-grazed and need recovery time (Karin Sonnen NRCS, personal communication). A standard comprehensive monitoring program is needed to evaluate range utilization and to develop adaptive and sustainable herding practices.

2.0 Ecological Effect of Grazing Reindeer

Northern plant communities respond to a diversity of environmental changes (Shaver and Kummerow 1992). Plant community composition changes with grazing intensity, duration, ecological site type, and weather (Holechek et al. 2010). Light to moderate grazing by reindeer can stimulate and increase vascular plant and lichen growth (Gaare 1997; Pegua 1968). Moderate to heavy grazing by reindeer can result in significantly less lichen and dwarf shrubs (Vare et al. 1996; Stark et al. 2000), more mosses (Staaland 1993), and grasses in the vegetation community (Olofsson 2001; Olofsson et al. 2004; Olofsson 2006).

In a vascular plant community in North Scandinavia, reindeer grazing did not affect overall biodiversity but favored the growth of rare plants (Olofsson & Oksanen 2005). In the coastal meadows of Norway, grazing by reindeer favored growth of grass species while decreasing the ratio of herbaceous plants (Eilertsen et al. 2002). Olofsson (2006) found that reindeer grazing in a dwarf shrub community resulted in a shift to a graminoid-dominated community. Other studies by Olofsson have also shown heavy summer grazing by reindeer changes the vegetation from dwarf shrub dominated to graminoid dominated, while moderate grazing by reindeer in the same ecotype allow dwarf shrubs to dominate (Olofsson 2001; Olofsson et al. 2004). An effective range monitoring program on the Seward Peninsula will provide an early warning of vegetation community changes occurring in time to make management changes to prevent a reduction in grazing capacity.

2.1 Conservation of Lichen Stocks

The abundance of high quality vascular vegetation on the Seward Peninsula is likely not limiting, as demonstrated by the relatively high growth and body weight of Seward Peninsula reindeer (Finstad and Prichard 2000). Abundant and high quality forage species such as *Salix spp*, *Carex spp*, and flowers of *Eriophorum vaginatum* grow in spring and summer when reindeer are replenishing body stores and lactating (Cebrian 2005; Finstad 2008). However reindeer range capacity is typically based on the slow growing lichen that is the primary forage of reindeer and caribou during the winter months (Gaare 1986, 357; Pegua 1968; Swanson and Barker 1992). On the Seward Peninsula BLM and NRCS use estimates of available lichen stocks on winter range to set recommended stocking densities as in many Rangifer grazing systems (Reimers 1997).

Lichens particularly should be monitored for signs of utilization, because they are the species most sensitive to Rangifer grazing (Gaare 1986, Swanson et al. 1985). Lichen cover declined by more than 50 percent in a study on the Seward Peninsula between 1981 and 2005 when the WACH population increased and appeared on the Seward Peninsula (Joly et al. 2007). Palatable lichen species are often replaced with less palatable species if overgrazed (Oksanen 1978). Reindeer grazing and trampling can drive vegetation communities towards a type dominated by small dwarf shrubs, bare soil, and less palatable lichens (Den Herder et al. 2003).

While lichens are commonly determined as the main forage of reindeer in winter, Seward Peninsula reindeer have a considerable proportion (average 30%) of moss, evergreen sedges, and shrubs in their winter diet (Finstad 2008). The relatively high body weights of reindeer (Finstad and Prichard 2000) and a significant proportion of non-lichen species in the winter diet suggests that lichen may be less of a limiter for range capacity on the Seward Peninsula than for other Rangife*r* grazing systems. This again highlights the importance of a standard, comprehensive monitoring program because commonly used key range condition indicators (lichen utilization) used for other reindeer grazing systems may not be the appropriate indicators for the Seward Peninsula grazing system.

Reindeer need a high protein/mineral diet provided by consuming willows, sedges, and forbs during the spring and summer to support growth of tissue, organs, antlers, and hair. (Finstad 2008). Insect harassment can influence summer foraging dynamics by driving reindeer to upland areas where they trample and eat the lichen that should be saved for winter (Skogland 1984). The Sami herders of Norway intensively manage their herds to ensure reindeer do not move into lichen habitat during summer months, and ranges in Norway have more lichen biomass than Finland, which has depleted lichens from summer grazing and trampling (Forbes et al. 2006). With intensive herd management, limiting reindeer to lowland and riparian areas throughout the summer, and conserving upland lichen areas for winter, stocking densities and animal productivity could be increased.

2.2 Climate Change and Lichens

Climate change causes many different changes in atmospheric and environmental factors that affect lichen biomass (Joly et al. 2009). Atmospheric drying slows lichen growth by limiting the moisture in the air, which reduces available nutrients for uptake by the lichen. The lichen life cycle and growth is different from vascular plants. Lichens are dormant when dry, and metabolically active and growing only when moist. The thallus will photosynthesize only if water content, sunlight, and temperature are within bio-thresholds (Sveinbjornsson 1990). Joly et al. (2009) considered the effects of climate change on lichens, "summer warming and drying, with increased evaporative loss, would lead to decreased growth rates in lichens if there was not an increase in precipitation." Ecosystem changes such as lichen population fluctuations need to be further examined on the Seward Peninsula. A range monitoring program utilizing exclosures in both grazed and ungrazed areas will help differentiate vegetation community changes occurring as a result of grazing, or climate change.

3.0 Justification For Reindeer Range Monitoring With Use of Exclosures

Maintaining rangeland health is critical for a successful reindeer industry, to prevent land degradation and to meet agency mandates. The Seward Peninsula reindeer ranges consist of mostly public lands, BLM, DNR and NPS. Federal land management agencies are mandated by law to ensure that livestock grazing does not degrade the public lands or exclude other uses. A long-term, landscape-level monitoring project with standard methods is necessary to examine changes to plant communities over time from grazing and climate change. Current information on lichen and vascular plant recovery after heavy grazing and ecological site changes is necessary for proper herd management and resource protection.

There were previous installations of grazing exclosures on the Seward Peninsula with limited success because their design and construction were not compatible with permafrost or the extreme frost jacking action of cold northern soils. We have designed a "floating" exclosure that has never been used on tundra. Also, we wish to apply a new technology in vegetation monitoring to the tundra ecosystem; high-resolution photography. Because these new technologies have not been proven in Alaskan tundra we will conduct a pilot project to field test the exclosure design and high resolution photography and interpretive software.

The BLM funded the purchase of material to construct 24 to 26 "floating" exclosures. The basic design will consist of three-by-three meter panels clamped together to construct a 12-sided exclosure unit. As part of the pilot program, in 2011 the exclosure materials were shipped to Nome and materials staged for the field test of six exclosures. The RRP transported the materials to all sites during winter by snowmobile to eliminate expensive helicopter time and to minimize transportation surface disturbance. Transportation methods for monitoring will include helicopter, boat, and ATV. The RRP will construct additional exclosure units contingent upon future funding. To meet the needs of landowners, other agencies, and reindeer herders we will develop and implement a reindeer range monitoring protocol using exclosures and long-term vegetation monitoring with the following objectives.

4.0 Range Monitoring Objectives

I. What is the rate of recovery for lichen and vascular plants after heavy grazing? Measure the recovery rate for heavily grazed lichens and vascular plants for 30 years by restricting grazing within exclosures, areas fenced to keep grazing animals out. We will use changes in percent cover of vascular plants and changes in percent cover and biomass of lichens within exclosures to estimate recovery. Sites will be selected on heavily grazed areas. Agencies and herders will use this information to inform future management strategies pertaining to range management for reindeer.

II. How does the lichen and vascular plant community change over time when grazing is restricted?

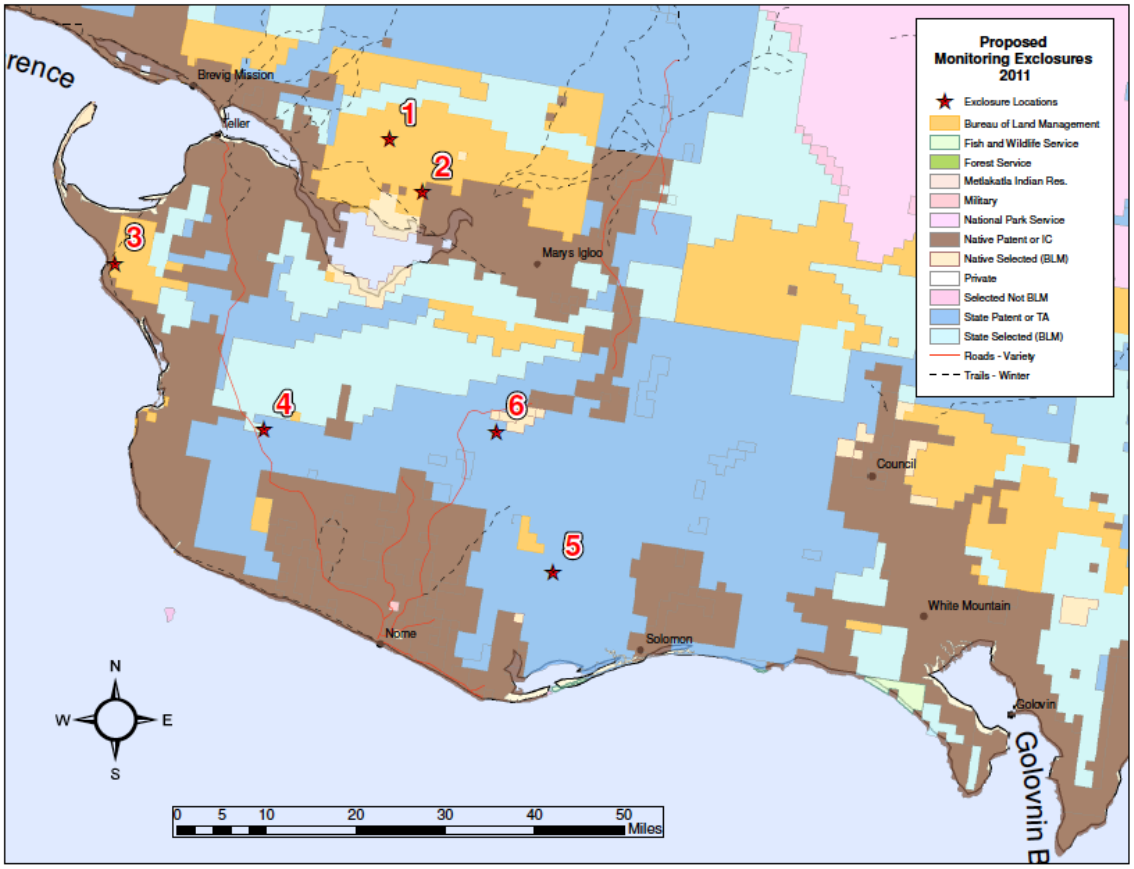
III. How is the lichen and vascular plant community impacted with continued grazing? The effects of continued grazing on heavily grazed sites will be monitored with changes in percent cover of vegetation and lichen on plots outside of the exclosure.

IV. How is the lichen and vascular plant community changing due to variables other than grazing such as climate change? We will examine non-grazing vascular plant community changes by comparing changes in percent cover and biomass of lichens and changes in percent cover of vascular plants within exclosures at sites with little or no previous grazing effects. These “control” exclosures will be placed on sites with the same ecological sites as the “treatment” exclosures.

5.0 Monitoring Protocol

Monitoring personnel will record all vascular plants and lichens to determine changes in plant community structure. Monitoring personnel will perform lichen utilization assessments by examining *Rangifer* preferred lichen species including: *Cladina rangerferina, C. arbuscula, C. mitis, C. stellaris, C. stygia,* (Pegua 1968), *Cladonia gracilis, C. uncialis, Cetraria cucullata, C. islandica, C. laevigata, C. nivalis* (Joly et al. 2009). Three or four exclosures will be established for each ecological site type. Ecological sites are a classification for mapping vegetation based on potential annual vascular plant production, potential lichen biomass, soil classification, climate and landscape position (Swanson and Knapman 2001). Three replicates are necessary for data analysis. The sample design is described in Appendix 1. Figure 2 on the following page displays the locations of the pilot study exclosures.

Figure 2: Locations of Pilot Study Exclosures Installed by Land Ownership



Courtesy of BLM, 2011.

Both lichen and vascular plants will be monitored with percent cover measurements. Monitoring personnel will determine percent cover with both high resolution photographs analyzed with U. S. Department of Agriculture (USDA) SamplePoint software, and by performing manual point counts with a point frame. Percent cover determinations will be used to estimate vegetation recovery and changes in community composition. Monitoring personnel will perform the manual point count monitoring with a 0.5-by 1-meter point frame strung with monofilament across both axes that intersect 50 times. The frame contains two layers of monofilament. Monitoring personnel will record the species directly under the crosshairs. All dead plant tissue will be recorded as litter. A full description of methods and monitoring instructions are attached in Appendix 1: Monitoring Protocol.

SamplePoint Software is free and can be downloaded from the USDA web page: http://www.ars.usda.gov/services/software/software.htm. Booth et al. (2006) found that monitoring accuracy with high resolution photos and interpretation with SamplePoint software had comparable accuracy with the most accurate field methods. Minimal training is needed to master the program, while saving time over traditional methods.

5.1 Use of Satellite Imagery

Agencies desiring to augment the photo monitoring and biomass data have the option of using satellite imagery.

6.0 Project Methods

6.1 Agency Collaboration

I initially designed and implemented a survey to cover the major details of the monitoring program. The initial survey is attached as Appendix 3. I sent the survey to all the interested and involved agencies in January of 2010 and collected their responses for the next two months. I synthesized the responses into a basic monitoring protocol and sent the plan out for comments in June of 2010. I collected comments for the next month, then edited the monitoring protocol to mitigate agency concerns and maintain the study objectives. In March of 2011 I sent a second revised version of the monitoring protocol to agency collaborators for comment, and received comments over the next month. I formulated the final monitoring protocol by working with statistician Julie McIntyre at UAF to ensure the study design was valid, contained sufficient replication for data analysis, and the study objectives were met.

Major challenges included both the competing agency agendas and BLM's changing objectives. I based the final monitoring protocols on requirements for data integrity and the study questions. I included agency comments as much as possible. It wasn't possible to accommodate all agency comments and suggestions into the monitoring protocol. Where there were conflicts I weighed the options and chose the option that would:

1. Maintain study objectives and provide for data integrity and statistical power.
2. Be feasible both financially and logistically over the long term of the study.

6.2 Monitoring Locations

The RRP will install control exclosures on all ranges with treatment exclosures. All permitting necessary for the installation of the first six sites was completed. The RRP and BLM will complete and submit permitting applications for the remaining sites. The initial six sites for the pilot study are listed on the following page in Table 1.

Table 1: Pilot Study Site Information

Site #	Range & ID	Latitude	Longitude	LUCC	Ecotype	Ownership
1	Davis D8	64°52'9.34"N	165° 6'53.62"W	5	43- Low Shrub	State DNR
2	Davis DC8	64°39'39.64"N	164° 49'0.15"W	5	41-Shrub meadow/61 Lichen Meadow	State DNR
3	Noyakuk N2	65°18' 21.492"N	165°42' 40.03"W	2	71- Dryas Limestone Slope	BLM
4	Noyakuk N8	65°13'52.41"N	165°33'0.09"W	4	60- Lichen (Tussock Tundra)	BLM
5	Lee K2	65°1' 39.648"N	166°39' 32.44" W	5	63- Lichen Sedge (Coastal Tundra)	BLM
6	Lee K8	64°48'30.19"N	165° 59'2.82"W	5	70- lichen granitic slope	State DNR

6.3 Pilot Study Results

BLM provided funds for the RRP to hire two interns to construct the exclosures. Four of the six pilot study exclosures were constructed in summer 2011. All of the exclosures' material packages were missing materials once delivered to the sites. The RRP interns were not able to return to one site on the Noyakuk range, and one site on the Davis range with the additional materials needed to finish the construction in time for monitoring. The RRP will finish the two remaining exclosures in the summer of 2012. The RRP performed the vegetation monitoring for the four constructed exclosure sites in late July 2011. The monitoring took two to five hours for two people per site to complete, depending on the diversity of the vegetation. This time estimate included both assembling the photo frame, photo taking, and the point count monitoring. The photo documentation portion takes about one hour with an experienced camera operator. The RRP is developing a detailed manual describing procedures to take the photos, one over-exposed, one-underexposed, and one regular photo of each site.

The pilot study indicates monitoring can be accomplished in a full day per site for sites accessed by ATV and on foot. When accessed by helicopter, two sites could be completed in a day. The point count monitoring with a frame is the most time consuming portion of monitoring. If monitoring personnel are completing only photo monitoring, the time on site should be approximately one hour. The two sites on the Noyakuk range, and DC 8 on the Davis Range will take two days to monitor if accessed by ground, because of the distance travelled by boat and/or ATV to access these sites.

The exclosure at site K2 on the west coast of the peninsula is a major attractant for perching by birds. This should be considered as an unexpected confounding variable for the data because of the unknown quantity of additional nutrients added to the site by the birds.

The RRP designed a password-accessed site for the point count data entry, and for cataloging the photos. This information will be available to all agency personnel that need it at http://reindeer.salrm.uaf.edu/exclosures/. The data entry for the point counts takes a few hours per site. The RRP camera and collapsible camera stand will be available for the use of BLM, NRCS, or NPS employees who will assist in monitoring activities.

7.0 Intended Data Analysis Approach

SamplePoint software includes data analysis and statistical analysis methods in the software. Data will be analyzed with the SamplePoint software or other software at agency discretion.

8.0 Responsible Parties

8.1 Stakeholder Contributions

The RRP will setup, construct, and complete the baseline monitoring for the initial six exclosures that comprise the pilot study. All future interval monitoring will be coordinated and performed based on available funding.

8.2 Monitoring Responsibility

Both the BLM and NRCS will assist with monitoring, when possible. The NPS may be able to help with monitoring if their exclosure project is implemented.

8.3 Maintenance Responsibility

The RRP and BLM will be jointly responsible for the maintenance of the exclosures. The NRCS may help with maintenance when on site for monitoring purposes. The RRP, BLM, and NRCS will all perform maintenance on an as needed basis. Agency personnel will identify maintenance needs when on site for vegetation monitoring.

8.4 Agency Contributions

The BLM and NRCS are both able to contribute helicopter time for monitoring, BLM particularly for those exclosures that will be on BLM lands. The NPS may be able to cooperate on monitoring with their own exclosures on NPS lands if their project is implemented. The NPS may allow plots according to this protocol within their exclosures, and cooperate by data sharing.

8.5 Funding

The BLM provided funding for exclosure material and for some labor costs of construction. The RRP has provided logistical support by providing storage and staging areas, transportation of material to sites and labor for transportation and exclosure construction. All future construction of exclosures and monitoring will be coordinated and performed based on available funding.

9.0 Data Storage and Access

The RRP will handle data management and storage. The RRP will perform photo interpretation and species logging for the baseline pilot study of the initial six exclosures. After the initial setup, the agency personnel taking the photos will be responsible for the photo interpretation. Data will be available for anyone that needs it at http://reindeer.salrm.uaf.edu/exclosure.

10.0 Management Implications

Herders and resource managers will use the project results for range management decisions, such as setting stocking densities, determining key indicator species, and determining optimal seasonal range distribution of reindeer. The data on recovery time for forage species will be used for recommending rotational grazing periods. This study will also provide resource managers, researchers, and herders alike with insights on potential changes to the tundra from climate change that will influence future herd and resource management decisions such as fire management strategies, and wildlife management changes based on changing habitat.

Although the exclosures are constructed to exclude all large grazers, and hares, they cannot exclude microtine rodents or voles, and insects. The herbivorous insect groups thought to be dominant in the arctic are lepidopterans (moths and butterflies) and herbivorous hymenopterans (sawflies, wasps, bees and ants), with population sizes varying widely. Populations of these insects are thought to be lower at high latitudes, and where the climate is severe and vegetation diversity low (Jefferies et al. 1992). The extent and effects of insect herbivory on Seward Peninsula plant communities is currently unknown, however must be considered as this type of grazing cannot be excluded.

11.0 Conclusion

11.1 Final Comments

This study will provide valuable information for reindeer herders, range managers, and land managers on the Seward Peninsula. It may also provide valuable insights into the ecological changes on the tundra from climate change and grazing. This study requires a long-term commitment amongst the partners for substantial time, financial resources, and labor for monitoring, data entry, and interpretation, as well as maintenance and construction of the exclosures. The collaborators should remember this study will provide valuable information for range management, but only if the partners perform the monitoring, and input and interpret the data and photos. The BLM needs to commit not just financial resources, but also to assist in the monitoring, data entry, and interpretation. The RRP has performed the collaboration and coordination to design the study, constructed the exclosures, and implemented the pilot study. However, the RRP is just one partner in the study; other agency personnel will also need to make monitoring the exclosures a priority for the project to work.

11.2 Recommendations

To ensure long term commitment to the project an MOU should be developed amongst the involved agencies. The MOU should detail agency's intended contributions, including financial contributions, helicopter time, monitoring time, and data entry and interpretation. The MOU should also address data ownership and authorship of project results in technical reports and peer reviewed journals. Other contributing agencies shall be listed as additional contributing authors. The MOU intent should be to detail and agree on the contributions and responsibilities for each agency to ensure a long term commitment to the project.

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APPENDIX 1

SEWARD PENINSULA REINDEER GRAZING
MONITORING PROTOCOL

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December 2011

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Preface

This appendix contains the necessary instructions for collecting vegetation and lichen percent cover at each monitoring site, and details about the exclosure construction. Table 1 below summarizes the three types of measuring of foliar cover at the monitoring sites both within and outside the exclosures.

Table 1: Site Measuring Details

Monitoring Type	Details	Frequency
Sample Point Photos	Three high resolution photos taken of each plot, one at normal exposure, one overexposed, and one underexposed.	Initially and every five years
Point Counts with Frame	50 points recorded at each plot with frame. Line up the monofilament crosshairs and record the species or if litter, record "litter."	Initially and every ten years
Lichen Biomass Estimation	For each lichen recorded as a "hit" with the point frame, record species, and measure and record height of live biomass in mm with a metal rod.	Initially and every ten years, in conjunction with point counts with frame

1.0 Detailed Instructions for Completing Vegetation Monitoring

All transects start from a permanent, white, fiberglass stake set in the center of the exclosure. All plots are permanently marked with two white, fiberglass stakes. The transect bearings were completed using a declination of 14 degrees.

1.1 Percent Cover Using Photography and Interpretive Software: SamplePoint

Assemble the aluminum camera mounting frame. Locate the first plot and carefully place the frame over the square meter plot with the two fiberglass marking stakes inside the frame touching the bottom two corners. Do not step inside the plot. On a white notecard use a black marker to write the date, transect, plot, and site ID. Place the card in the lower left corner of the frame. Calibrate the camera and take the photos according to the SamplePoint photo monitoring instructions. Carry the frame to the second plot, and repeat the process with a new white notecard noting the new plot, and transect ID. Repeat. Be sure not to step in any of the plot areas. Table 2 below details the transects, bearings, distances and plot IDs.

Table 2: Transect Chart

Transect	Bearing	Inside Plot & ID	Outside Plot & ID
1	333°	2 m, Plot 1	34 m, Plot 5
2	307°	4 m, Plot 2	59 m, Plot 6
3	201°	2 m, Plot 3	27 m, Plot 7
4	73°	3 m, Plot 4	90 m, Plot 8

1.2 Percent Cover Using Point Counts With Frame

Take the monitoring frame out of the box, assemble the bolts into the corners of the frames using the wing nuts to tighten. Check that all of the monofilament strings are in the correct grooves. All of the monofilament pieces should intersect at 90 degree angles. You will have a grid with 50 monofilament intersections, or "crosshairs" to use. Position the frame at the first plot with the inside bolt legs of the frame touching the two white fiberglass marking stakes. Use the wing nuts to adjust the height of the frame above the vegetation. Record all the plot details on the monitoring sheet, including plot, transect, site, date, monitoring personnel, etc. Starting at the lower left corner of the frame, look at the first "crosshair," lining up the two layers of monofilament and record the plant under the crosshairs on the monitoring sheet. When the crosshairs are over lichen, follow the lichen biomass estimation instructions below. If the point is bare ground, or any type of dead plant matter, record as "litter." Continue through the first 10 points in the first, bottom row, recording each species that is a hit, or litter. Continue to the other rows and repeat the process. Then move the frame to the second plot and repeat. Be sure not to step in any of the plot areas.

1.3 Lichen Biomass Estimation

If a lichen is recorded the height must also be recorded for later estimation of biomass. Wet the lichen first, then insert a metal rod next to the lichen, above the litter and humus layer. Hold the rod perpendicular to the sample frame, and measure the height to the nearest millimeter. Record the height in the "height" box next to the plant identification box on your data monitoring sheet. The data monitoring sheet is displayed below as Figure 1.

Figure 1: Data Monitoring Sheet

Seward Peninsula Reindeer Range Cover-Point Intercept Species Sampling

Location: Range site lat/long treatment/control

Date: Observer(s)

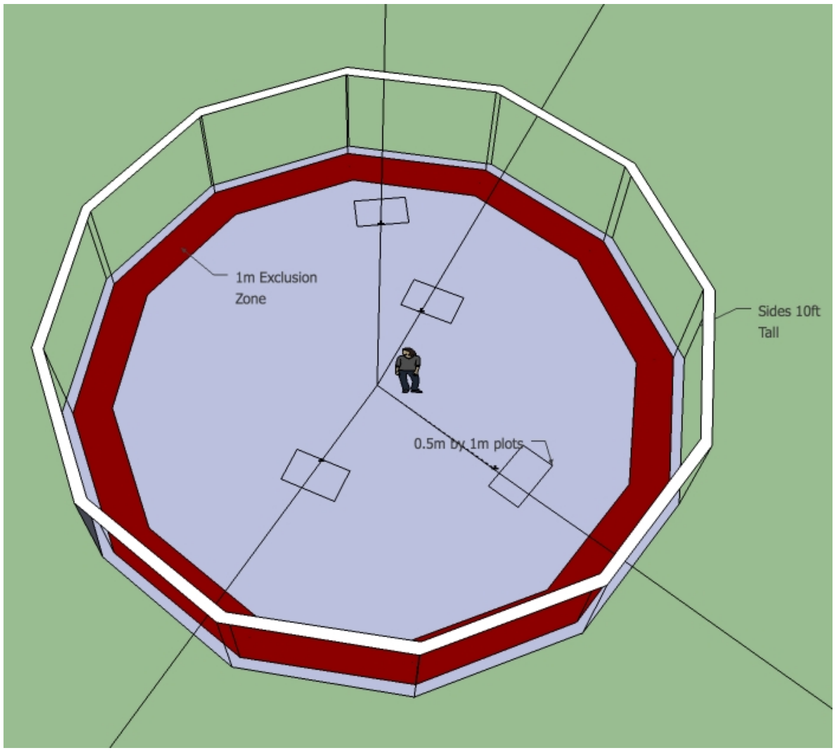
Transect # bearing ° inside/outside distance to quadrant

Point	Genus-species	*Sp.* code	Height	Comments	Point	Genus-species	*Sp.* code	Height	Comments
1					26				
2					27				
3					28				
4					29				
5					30				
6					31				
7					32				
8					33				
9					34				
10					35				
11					36				
12					37				
13					38				
14					39				
15					40				
16					41				
17					42				
18					43				
19					44				
20					45				
21					46				
22					47				
23					48				
24					49				
25					50				

2.0 Sample Design

The RRP assigned the eight plots for each exclosure in permanent locations. Plot locations were generated using random bearings in degrees and random distances from exclosure centers. White fiberglass stakes showing approximately four inches above ground, driven into the ground approximately 12 inches, permanently mark the plot corners. There are two plots along each of the four transects; one plot inside the exclosure and one plot outside the exclosure. A one meter area adjacent to the fencing was excluded from possible plot space due to additional precipitation and zinc leachate effects. Figure 2 below displays plot and transect layout within the exclosures. Detailed diagrams follow in Appendix 2.

Figure 2: Exclosure Shape and Layout



The sample design is described in detail below.

a. Sample population: lichen and vascular plants

b. Sample unit: Exclosures, 24 to 26 planned

c. Sample unit size and shape: Dodecagon, 12 sided polygon with three meter sides

d. Sample unit positioning:

1.) By ecological site. Each ecological site type should have three or four replicates:

a. Lichen Meadow (Mountain) (ecological site ID 61)/ Shrub Meadow (ecological site ID 41)
b. Dryas Limestone Slope (ecological site ID 71)
c. Lichen (Tussock Tundra) (ecological site ID 60)
d. Low Shrub (ecological site ID 43)

e. Lichen Sedge (Coastal Tundra) (ecological site ID 63)

f. Lichen Granitic Slope (Alpine) (ecological site ID 70)

2.) NRCS Lichen Utilization Cover Class (LUCC)

a. Exclosures placed on zero through two (control), and five (treatment). The LUCC is a measure of lichen usage and disturbance and includes an estimated recovery period in years. Class zero is classified as no lichen usage. Class one is characterized as trace lichen usage, less than five percent lichen cover is disturbed or dislodged with no recovery period necessary. Class two is characterized as slight lichen usage, five to 25 percent of lichen cover is disturbed or dislodged with a two to four year recovery. Class five is characterized as heavy, with 76 to 100 percent of the lichen cover disturbed or dislodged, adequate lichen remaining for regeneration, and a recovery period of 12 to 15 years (Swanson and Knapman 2001).

3.) By landowner; only on federal BLM or state DNR managed lands.

4.) By range allotment; Lee, Noyakuk, Davis, and possibly Olanna. These ranges have active herds, which is necessary for a study that requires continued grazing.

5.) By LUCC for treatment and control. 14 <u>treatment</u> sites on NRCS LUCC five. 14 <u>control</u> sites on NRCS LUCC two, one, or zero.

e. Sample unit: Permanent, 30 years or more

Sample units to be sampled: 24 to 26

4.0 Exclosure Size

The exclosures are designed to minimize snow drifting, maintenance requirements and wall length while increasing stability and sturdiness, as shown in Figure 1.

- Each section of the exclosure is 3.35 meters wide and 2.5 meters high.
- One meter along all fence panels will be excluded from plot space due to additional moisture from snow drifting and zinc leachate from fencing.
- A 12-sided exclosure (dodecagon) provides for:
  - Area of 125.65 square meters
  - Radius of 6.25 meters

5.0 Exclosure Construction

The RRP constructed the first four exclosures in 2011 on a case-by-case basis, as follows; locations are listed in Table 2.

- Materials were transported to site by snowmachine.
- Exclosures were constructed of panels held together by butterfly clamps and galvanized high tensile wire.
- The exclosures have no permanent foundation. The free floating exclosure is anchored to stakes to ensure it stays in place.
- Wire mesh spacing is 12-by-12 centimeters and smaller at the bottom; adequate to keep out grazing animals including muskox, caribou, reindeer, and hares.
- The top of the fence panels will have reflectors attached to be visible for snowmachines.

- A small pilot study was completed in 2011 with the first four exclosures. A pilot study is necessary to determine if the time to implement monitoring strategy is feasible, and to discover any design discrepancies.

6.0 Designated Walking Paths

Vegetation trampling will be prevented by designating permanent walking paths. A one-meter periphery inside of each exclosure will be designated for walking. Vegetation trampling from construction necessitated the exclusion of the eight meters adjacent to the exterior of the exclosure from possible plot placement. Monitoring personnel will only walk outside of the walkway when necessary to access the plots, and only after they use a water sprayer to saturate all vegetation. The RRP has permanently marked all plots with fiberglass stakes. No trampling will occur within the plot areas. Plots and transects outside the exclosures are also permanent and well marked with two white fiberglass stakes each, and pink flagging tape to prevent trampling.

7.0 Measurement Timing

Monitoring timing is critical and must be performed at the same point in the growing season every time for meaningful data comparison.

- Time of Year: Monitoring personnel will perform monitoring during second half of July.

- Phenology: The second half of July is near peak growth for vascular plants and before senescence.

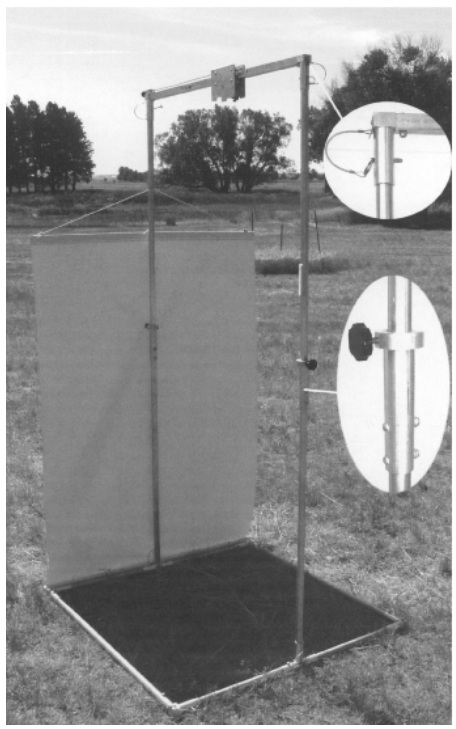
8.0 Measuring Frequency and Type

The type and frequency of measuring includes photo documentation and interpretation with SamplePoint software, in conjunction with NRCS LUCC assessment monitoring initially and every five years. The RRP constructed a sample frame for taking the plot photos from a consistent height and aspect according to the protocol in the USDA Sample Point software tutorial. The frame is constructed of aluminum with a one-meter by one-meter frame base, and camera mount two meters above the base.

Monitoring personnel will estimate percent cover with the USDA Sample Point software. Percent cover will be used to estimate vegetation recovery and changes in community composition. Software is free and can be downloaded from the USDA web page: http://www.ars.usda.gov/services/software/software.htm. The software requires three photos of each plot; one overexposed, one normal and one underexposed. Agency personnel will determine percent cover by merging the photos and identifying the species within the software. Sample Point software use will eliminate bias from different personnel over the 30 years of monitoring.

The RRP has purchased Canon Eos Rebel T3i. The camera uses a 18-55 mm lens, takes photos in RAW (nadir) format and later is converted to tagged image file format (TIFF) or Bitmap (BMP). Photos will be taken two meters from the ground in a one by one meter wide aluminum frame shown in Figure 3 below. Monitoring personnel will place labels for each photo containing Date, Transect Number, Plot Number, and Site ID on a rectangle of paper in the bottom left corner of the vegetation plots. The software techniques are described in detail in the Sample Point Tutorial document.

Figure 3: Aluminum Camera Stand (Booth et al. 2004)



Monitoring personnel will estimate lichen biomass with methods described in Moen et al. (2007) initially and every 10 years thereafter. After wetting the lichen and allowing it to soften, a blunt metal rod will be inserted into the lichen, above the litter and humus layer. The rod will be held perpendicular to the sample frame and lichen height measured to the nearest millimeter. Biomass is estimated with the following formula; lichen volume =

(percent cover)x(plot area cm)x(lichen height cm). This method was validated with destructive biomass sampling and had similar results (Moen et al. 2007).

Monitoring personnel will perform cover estimates with a 0.5 by 1.0 meter frame with a two-layer monofilament grid with 50 points to calculate cover. Personnel will record all species under the crosshairs as a hit. This data will augment the SamplePoint data and provide additional information for interested agencies. These cover estimates will be performed initially and every 10 years thereafter, or at the request and funding of an agency.

9.0 BLM Invasive Species Management Best Management Practices

All vehicles, transport equipment used in access, construction, maintenance and operations of the project must be thoroughly cleaned prior to moving equipment and gear across or onto BLM managed lands. Washing and/or brushing equipment and gear to remove material that can contain weed seeds or other propagates helps to ensure equipment that is being transported across or onto BLM managed lands are weed and weed-seed free. High pressure washing is recommended to treat the insides of bumpers, wheel wells, undercarriages, inside belly plates, excavating blades, buckets, tracks, rollers, drills, buckets, shovels, any digging tools, etc., to remove potential weeds, seeds, and soil carrying weed propagules, and vegetative material. All gear, clothing, tool bags and accessories must be free of all plant debris, mud, and materials that can be the source of non-native invasive plants and pathogens.

Site reclamation must be implemented as soon as possible after construction using the original organic layer. This organic layer is to be removed and set aside upon initial site disturbance, and replaced on disturbed areas in lieu of revegetation with non-local materials.

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APPENDIX 2

DETAILED EXCLOSURE DIAGRAMS

Diagram 1: Exclosure Aerial View

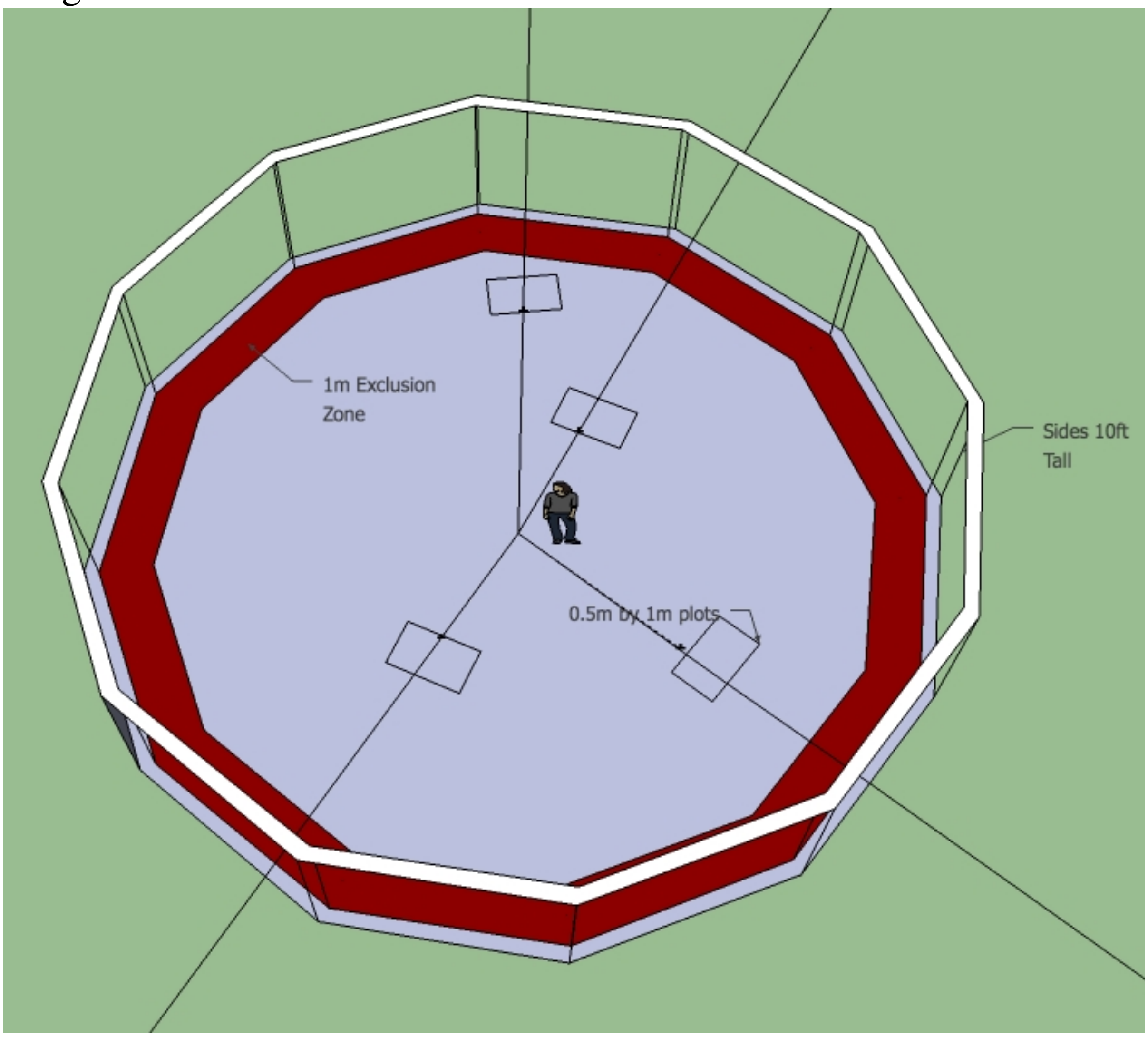


Diagram 2: Exclosure Side View

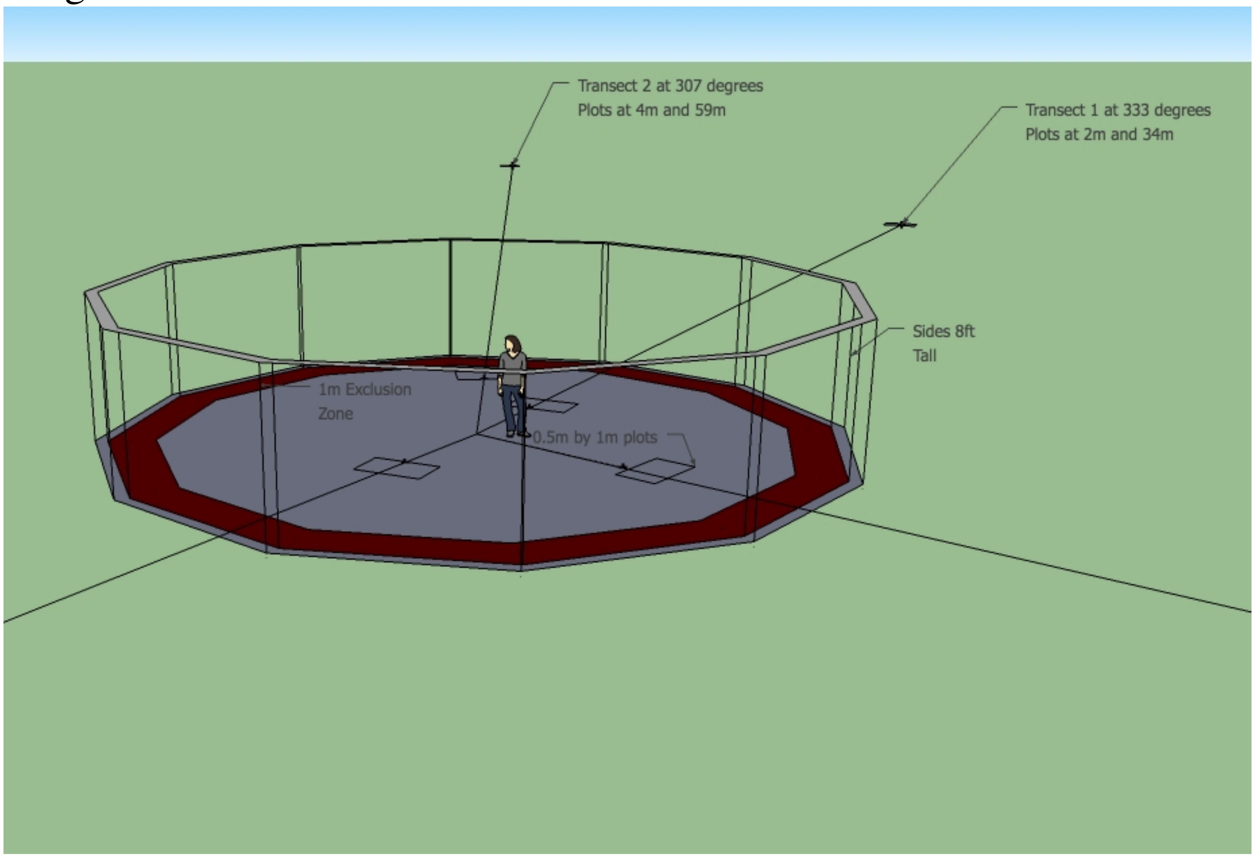
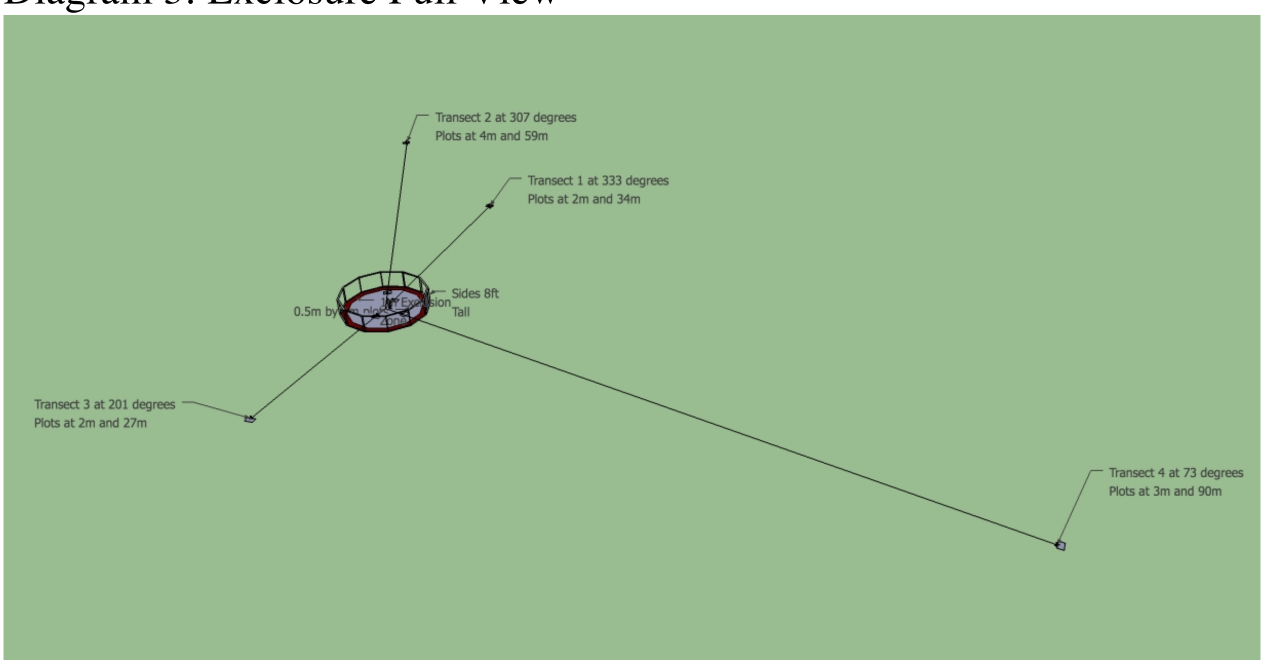


Diagram 3: Exclosure Full View



APPENDIX 3

INITIAL SURVEY

Seward Peninsula Reindeer Range Monitoring Program Survey

The Reindeer Research Program (RRP) will purchase a minimum of 24 10'x10' panels that will be clamped together as 6 separate 10'x10'x10' exclosure units. The RRP will ship exclosure materials to Nome. The RRP will transport and install the exclosures to sites on a case by case basis; dependent upon location and logistics.

Monitoring Setup:
Is installing six exclosures enough?

Are the exclosures the right size, should they be smaller or larger?

How should the exclosures be distributed; by landownership, reindeer herd boundaries, topographical features, or by a combination of these factors?

Where should the exclosures be installed?

How often should the exclosures be monitored?

Stakeholder Contributions:
Can your agency contribute to monitoring either directly or indirectly?

Can your agency contribute through services such as helicopter time or funding? If so how often?

Who will be responsible for the maintenance of the exclosures?

Monitoring Protocol:
Should both lichen and vascular plants be monitored?

What plant monitoring protocol should be used?

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