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Natural Resource Stewardship and Science

Caribou Vital Sign Annual Report for the Arctic Network Inventory and Monitoring Program

September 2009-August 2011

Natural Resource Data Series NPS/ARCN/NRDS—2012/233

ON THE COVER
Caribou gathering in the Nulato Hills for the spring migration to their calving grounds, 2010.
Photograph by: Kyle Joly

Caribou Vital Sign Annual Report for the Arctic Network Inventory and Monitoring Program

September 2009-August 2011

Natural Resource Report NPS/ARCN/NRDS—2012/233

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The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado publishes a range of reports that address natural resource topics of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available from the Arctic Inventory and Monitoring Network's Caribou Vital Signs webpage (http://science.nature.nps.gov/im/units/arcn/index.cfm?rq=12&vsid=19) under the 'Documents' tab and the Natural Resource Publications Management website (http://www.nature.nps.gov/publications/nrpm/).

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Abstract/Executive Summary

Caribou (*Rangifer tarandus*) are an integral part of the ecological and cultural fabric of northwest Alaska. The Western Arctic Herd (WAH) caribou roam over this entire region, including all 5 Arctic Network Inventory and Monitoring Program (ARCN) National Park Units. Conservation of healthy caribou populations are specifically mentioned within the enabling legislation (Alaska National Interested Lands Conservation Act or ANILCA) of three of these Parks and is of critical concern of subsistence hunters within this region. Caribou are, by far, the most abundant large mammal in northwest Alaska and are famous for their long-distance migrations and large population oscillations. For these reasons, ARCN chose WAH caribou as a Vital Sign.

This report documents the monitoring results of this Vital Sign during its initial (September 2009 – August 2010) and second year (September 2010 – August 2011) of implementation. Future installations of this report should be limited to the results of a single year. Periodic syntheses of these data will be performed and reported on as appropriate. National Park Service (NPS) monitoring of the WAH is done in conjunction and cooperation with the Alaska Department of Fish and Game (ADFG), US Fish and Wildlife Service (FWS) – Selawik Refuge, and Bureau of Land Management (BLM) – Central Yukon Field Office. NPS-sponsored monitoring of the herd relies heavily on the use of Global Positioning System (GPS) radiotelemetry collars that are capable of transmitting location data to a satellite. Given the extremely remote area that the WAH inhabits, this system provides the most efficient and accurate means to track individual caribou. These data are being utilized to monitor the timing and location of migrations, as well as seasonal distributions of WAH caribou. Monitoring phenology of movement is perhaps the simplest means to track the influence of climate change, natural perturbations, development, and other potential impacts on a species.

This report also documents the NPS's commitment and involvement with the WAH Working Group. The group is comprised of important stakeholders including representatives for rural villages, sport hunters, conservationists, hunting guides, hunting transporters, and reindeer herders. In addition, all of the agencies charged with managing the WAH, including the ADFG, NPS, FWS and BLM, serve as advisors to the group. Information gathered by the Caribou Vital Sign are intended to supplement and complement existing data streams gather by the other cooperating agencies and will be of vital importance in future management decisions.

Acknowledgments

I thank Scott Miller, Regan Sarwas, Cody Priest, and Angie Southwould for comprehensive technical database and GIS assistance that made this report possible. Jim Lawler, Brad Shults, Jim Dau, Steve Fancy and others helped shape the Caribou Vital Sign protocols – the results of which are the contents of this report. I thank Jim Lawler and Dave Gustine for reviewing drafts that improved this paper.

List of Acronyms

ADFG – Alaska Department of Fish and Game

ARCN – Arctic Inventory and Monitoring Network

BELA – Bering Land Bridge National Preserve

BLM – Bureau of Land Management

CAKR – Cape Krusenstern National Monument

FWS – Fish and Wildlife Service

GAAR – Gates of the Arctic National Park and Preserve

KOVA – Kobuk Valley National Park

NOAT – Noatak National Preserve

WAH – Western Arctic Herd

Introduction

This report is the first in a series of annual reports documenting the monitoring of Western Arctic Herd (WAH). Caribou (*Rangifer tarandus*) were chosen to be a Vital Sign of the Arctic Inventory and Monitoring Network (ARCN) because they: (1) are an extremely important subsistence species that occur in all park units (Gates of the Arctic Park and Preserve (GAAR); Noatak National Preserve (NOAT); Cape Krusenstern National Monument (CAKR), Kobuk Valley National Park (KOVA) and Bering Land Bridge National Preserve (BELA)) within ARCN; (2) are specifically identified in the enabling legislation (Alaska National Interest Lands Claim Act (ANILCA)) of GAAR, KOVA and NOAT to be managed for natural and healthy populations; (3) directly impact reindeer and reindeer herders in BELA; (4) are considered good indicators of the condition of park ecosystems because they consume lichens and fungi (which derive their nutrients from the atmosphere and thus are sensitive to pollutants) making them good bio-indicators of environmental toxins; (5) are of great importance to park visitors because of the unique opportunities to view caribou in Alaskan parks; (6) are an example of an ever rarer natural phenomenon of a functioning migration of a large land mammal; (7) are integral part of the ecology and social fabric of northwest Alaska; and (8) can be compared with national and international datasets for caribou herds and ecology across the Arctic region.

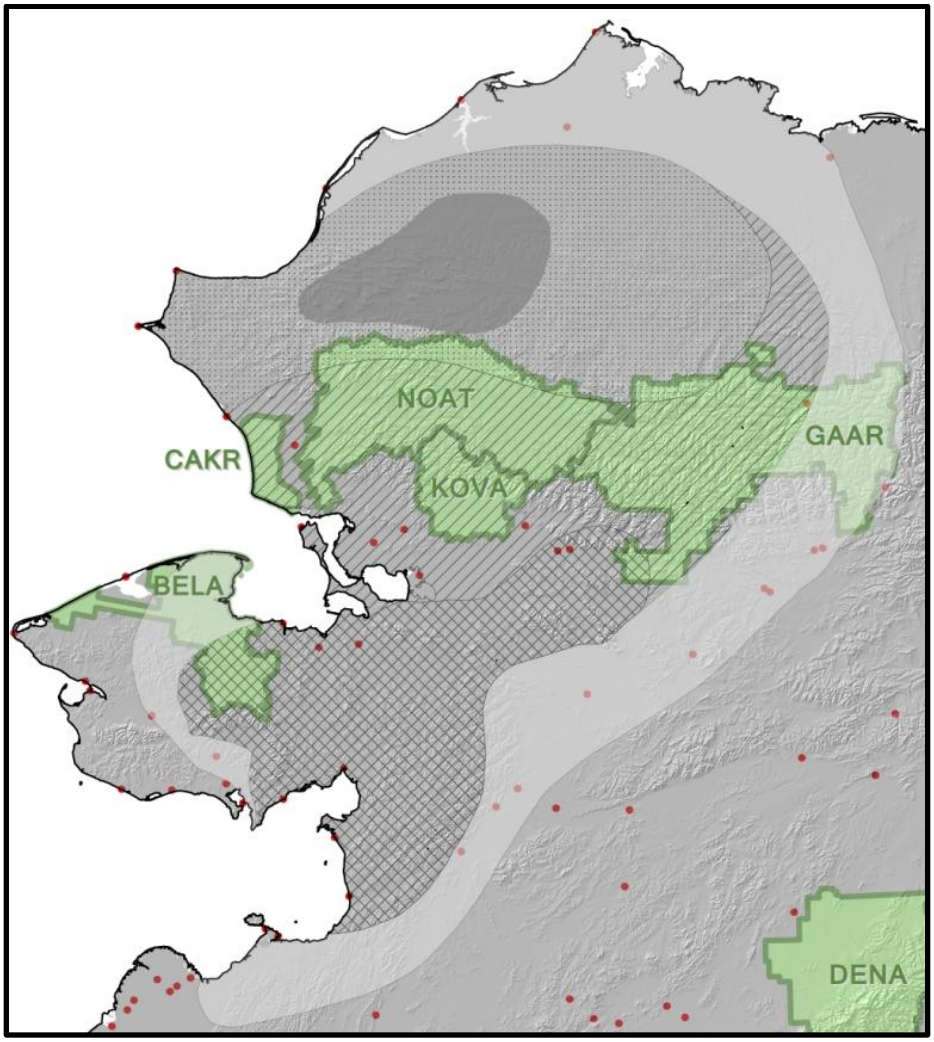
Of the various Arctic caribou herds, only the WAH regularly utilizes all 5 ARCN park units (Figure 1). WAH caribou are of great importance to people from both consumptive and non-consumptive viewpoints, and to the ecosystem as a whole. At an estimated population size of over 490,000 animals in 2003 (Dau 2007), the WAH is a significant ecological force in northwest Alaska and is the largest caribou herd in the state. The most recent estimates (348,000 caribou in 2009; J. Dau, *personal communication*) have shown the herd to be reduced from the 2003 population peak. The WAH has a substantial cultural impact in that the heritage and traditions of Native Alaskans in approximately 40 subsistence-based communities in the region have been shaped by the availability of these caribou (Western Arctic Herd Working Group 2003). The availability of WAH also affects the economics of this region. The presence and relative abundance of WAH caribou have substantial impacts on the populations of wolves, bears, and wolverines in the area. Caribou are good integrators of regional environmental conditions in northwestern Alaska because of their migratory nature. Caribou may have substantial effects on plant and lichen communities and by extension wildlife communities, either directly through browsing and grazing, or indirectly through biogeochemical cycling. While the primary objectives of monitoring will be to track the distribution and migrations of caribou, a variety of ancillary data will be obtained in the monitoring process that are likely to have great value for wildlife management, research, and evaluating long-term changes in the WAH.

This report documents the results of ARCN caribou monitoring for the initial (September 2009 – August 2010) and second (September 2010 – August 2011) year of the program. Development of the caribou monitoring protocols, which contain the detailed methodology employed to achieve the results presented here, took precedence over getting the first annual report out on schedule. Future editions should contain updated results from just a single year. Periodic syntheses of these data will be performed and reported on as appropriate.

Measurable Objectives – Core Program

- Capture and radio collar WAH caribou to maintain a sample size of 30-40 GPS collars.
- Obtain frequent (>2/day) location data via GPS-satellite telemetry.
- Membership, attendance and activity on the WAH Working Group Technical Committee.
- Attendance and involvement at WAH Working Group meetings.
- Obtain herd and environmental conditions data by radio tracking in October and April.
- Define seasonal ranges (calving, insect relief, summer, winter).
- Define migratory corridors.
- Detect changes in range distribution over time.
- Detect changes in adult survivorship over time.
- Detect changes in migration routes and movement phenology over time.
- Detect changes in the location and timing of calving (using GPS data).

Figure 1. Study area and the range of the Western Arctic Herd. Range data courtesy of the Alaska Department of Fish and Game. Dark gray delineates calving area, stippled summer range, hatched migratory areas, cross-hatched core winter range and light gray is outer range. The red dots indicate villages and towns.



Methods

The methods outlined here are provided to give the reader a sense of the methods and analyses that were conducted to monitor the WAH. Detailed methodologies used to develop this report can be found in the ARCN Caribou Vital Sign Protocol (http://science.nature.nps.gov/im/units/arcn/index.cfm?rq=12&vsid=19).

Collar deployments

All collars are deployed at Onion Portage, KOVA, in early to mid-September. Caribou are captured by hand using motorboats to intercept animals as they swim across the Kobuk River. Collars were only deployed on adult (> 2 years old) female caribou. Captures are conducted in conjunction and cooperation with the ADFG, FWS and BLM. Every collar is equipped with GPS technology that can transmit position data to satellites that can regularly be downloaded in an office setting. Collars are programmed to collect locations every 8 hours throughout the year (i.e., 1095 relocations per caribou per {non-leap} year).

Year One Survivorship

Survivorship reported here merely represents how many caribou that were collared in September remained alive through the end of the monitoring year (i.e., the following August). The number that survived plus the number that died and the number that had collar failures will equal 100%. A robust analysis of survivorship of all collared individuals (i.e., including caribou collars with Position Tracking Terminals (PTT) or Very High Frequency (VHF) –only capabilities), which take into account the duration the individual has been collared and sample size, is anticipated to be provided by the ADFG in their Survey and Inventory reports.

Seasonal Range Use

Both 50% and 95% utilization distribution kernels (Worton 1989) were developed using ArcGIS and new tools developed by the NPS. Kernels were developed for annual (September 1-August 31), calving (May 25-June 14), insect relief (June 15-July 14), late-summer (July 15-August 31) and winter (December 1 – March 31). Kernels were created for individual caribou each season and then compiled so that individuals, regardless of the number of relocations per individual, were weighted evenly. All collars were deployed at one location (Onion Portage, KOVA). As a result, their distribution throughout the first winter was not considered representative of the entire herd. Following calving (8 months later), the collared caribou were considered mixed with the herd in general based on the distribution of collars deployed in previous years (Joly pers. obs.). Range use and distribution analyses only considered collared caribou that were mixed.

Distribution and movements

The GPS radiocollar data was used to determine what percentage of GPS-collared caribou were found in each Arctic Network Park unit during summer (June, July and August), fall (September, October and November), winter (December, January, February and March) and spring (April and

May). ArcGIS was used to determine distances and velocities between successive GPS relocations.

Migration Phenology

ArcGIS was used to analyze the GPS data to determine when individual caribou crossed the Selawik, Kobuk and Noatak on their northward ("spring"; typically between April 1- June 15, due to late arriving cows) and southward ("fall"; typically September 1-November 30) migrations. The percentage of GPS-collared caribou that crossed each specified river, and the average date they crossed were calculated. A histogram of the longitudes at which the collared caribou crossed the Noatak River heading southward was developed as a visual aid to understand the geographic distribution of the fall migration. Categories of longitudes are based on equal numbers of river miles rather than equal distribution of longitudes to account for the primarily north-south direction of the river at its mouth.

Migration Routes

The minimum distance, and date for which that occurred, of individual GPS-collared caribou to the towns of Noatak, Shungnak and Selawik, during the spring (April 1-May 31) and fall migrations (September 1-November 30), were calculated using ArcGIS.

Population Modelling

Although not part of the annual monitoring of the Caribou Vital Sign, ARCN was able to support the development of a preliminary population model of the WAH. Methods are detailed in the project's final report (Prichard 2009).

Diet Analyses

For the two years of monitoring summarized in this report, ARCN analyzed feces to determine caribou diet. These analyses were conducted by Washington State University's Wildlife Habitat and Nutrition Laboratory in Pullman, WA. The lab performed 25 views for 4 slides per sample (100 view per sample) at the 'Level B' intensity - Forage Class and Major forage plants level >5% in diet (usually 6-12 major plants plus forage classes identified). Diet composition was corrected for varying digestabilities of different forage categories (e.g., shrubs versus lichens) using methods outlined by Boertje (1981) and Gustine et al. (2011).

Results

Collar deployments

During a two year period, over 50 collars were deployed which gather nearly 88,000 GPS locations (Table 1). The 39 collars in the initial year was a one-time effort to attain the desired sample size (~40). It is expected that about 10 collars will have to be deployed annually to keep up this sample size due to mortalities and the short life-span of GPS collars (3-4 years). Approximately 65 % of collared cows appeared to have a calf at heel.

Year One Survivorship

Approximately 80% of the 39 caribou collared in September 2009 survived through August 2010 (Table 1). Caribou collared the following year managed to survive their first post-capture year at a higher rate (~ 87%; Table 1). One collar appeared to fail due to mechanical issues. For the first 2 years of monitoring, there are total of 71 datasets that contain a complete years' worth of locations.

Table 1. Collar deployment overview. Number and survivorship of GPS-satellite collars deployed on adult (>2 year old) female caribou at Onion Portage, Kobuk Valley National Park, number of collared caribou that appeared to be accompanied by a calf, and approximate number of GPS locations acquired. Captures were conducted in September at the beginning of the monitoring year (September – August).

Monitoring Year	Collars Deployed	Survived 1st Year	Died	Collar Failures	With Calf (% ± 95% CI)	Active Collars at end of year	GPS Locations
2009-2010	39	31 (79.5 ± 13.26%)	7 (17.9 ± 12.6%)	1 (2.6 %)	25 (64.1 ± 15.8%)	31	39,086
2010-2011	15	13 (86.7 ± 19.5%)	2 (13.3 ± 19.5%)	0 (0.0 %)	10 (66.7 ± 27.0%)	40	48,892
Total	54				35 (64.8 ± 13.2%)		87,978

Seasonal Range Use

The 50% and 95% utilization distributions (kernels) are depicted for the following seasons: 2010 annual range (Figure 2; only for caribou collared in 2009), calving grounds for 2010 (Figure 3a) and 2011 (Figure 3b), insect relief areas for 2010 (Figure 4a) and 2011 (Figure 4b), summer range for 2010 (Figure 5a) and 2011 (Figure 5b), and 2010-2011 winter range (Figure 6; only for caribou collared in 2009). All ARCN Park units were utilized by collared WAH caribou except CAKR. Collared caribou were primarily north on Park units during calving and northwest during insect relief periods. GAAR and NOAT, and to a lesser extent KOVA, were used during the late summer. Both BELA and GAAR were utilized during the winter. Areas of GAAR, including the Kobuk Preserve portion (southwest corner of the Park) were identified as core annual, late summer (2010, 2011) and winter ranges (2010-2011). A small portion of NOAT was identified as part of the 2010 core insect relief area as well.

Figure 2. Annual (September 1, 2010 – August 31, 2011) range use of Western Arctic Herd caribou. Light orange depicts the 95% kernel (125739 km2) and dark orange the 50% kernel (4599 km2). Green hatched areas are Park units. Sample size = 26.

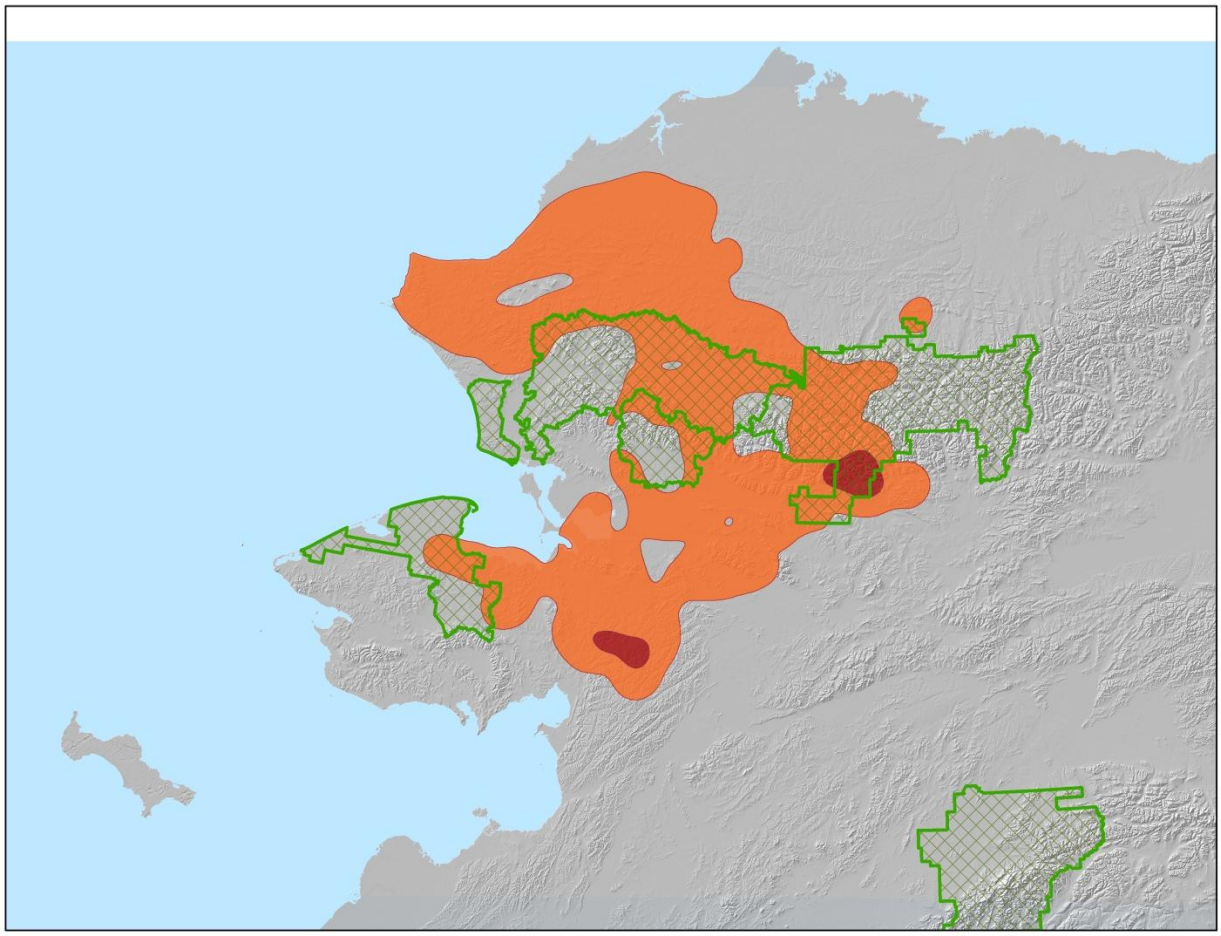
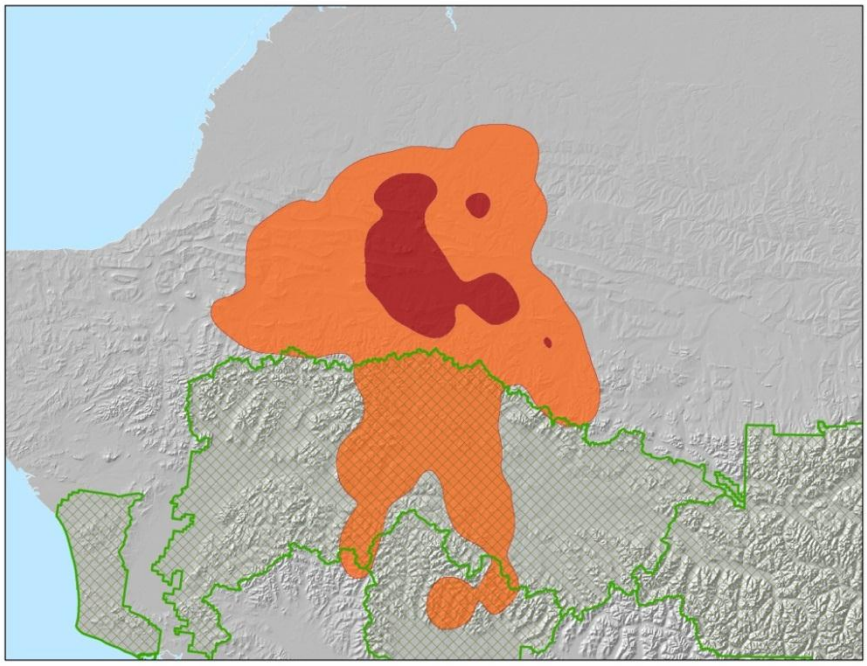


Figure 3. Calving (May 25-June 14) area use of Western Arctic Herd caribou. A) 2010. B) 2011. Light orange depicts the 95% kernel (27242 km2 and 15390 km2, respectively) and dark orange the 50% kernel (3866 km2 and 2142 km2, respectively). Green hatched areas are Park units. These kernels include all (both parturient and non-parturient) GPS-collared cows.

A) 2010. Sample size = 32.



B) 2011. Sample size = 40.

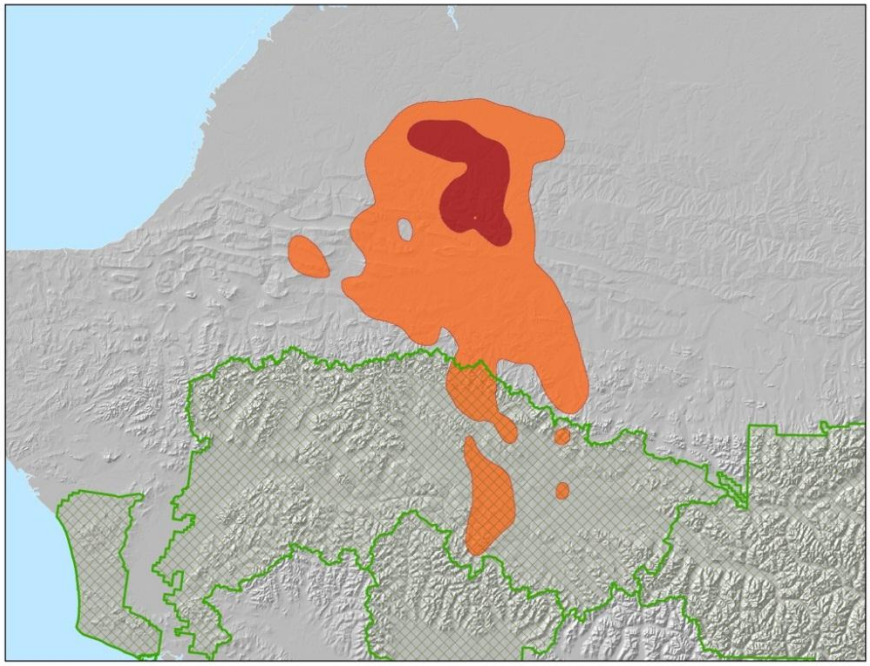
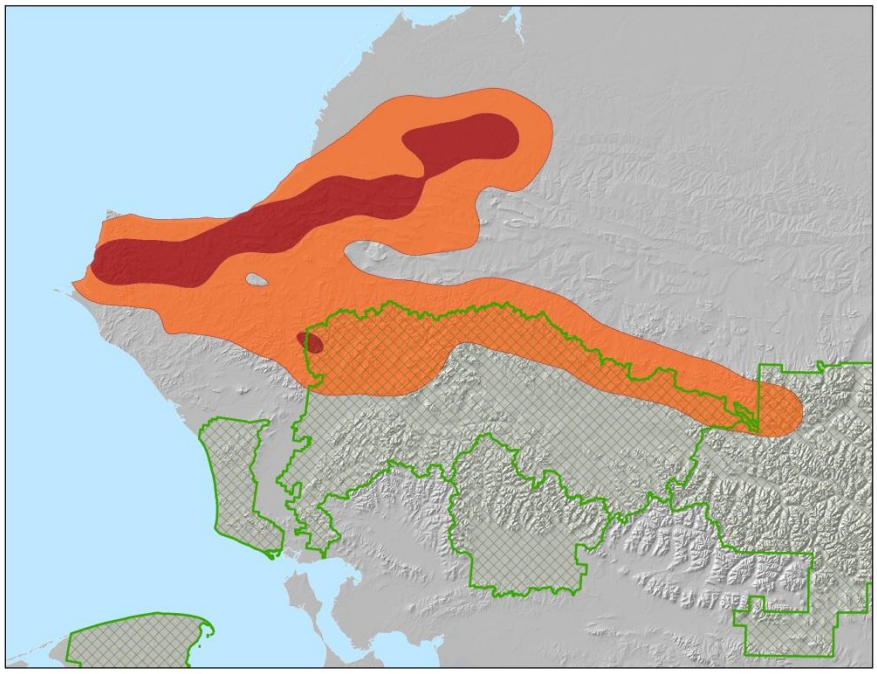


Figure 4. Insect relief (June 15-July 14) area use of Western Arctic Herd caribou. A) 2010. B) 2011. Light orange depicts the 95% kernel (41021 km2 and 20365 km2, respectively) and dark orange the 50% kernel (8416 km2 and 2391 km2, respectively). Green hatched areas are Park units.

A) 2010. Sample size = 32.



B) 2011. Sample size = 39.

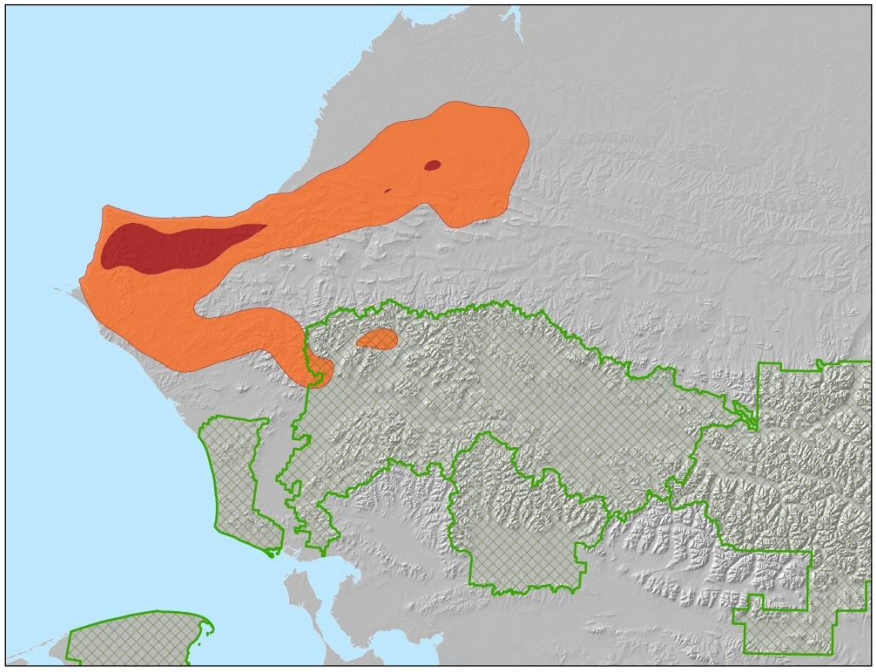
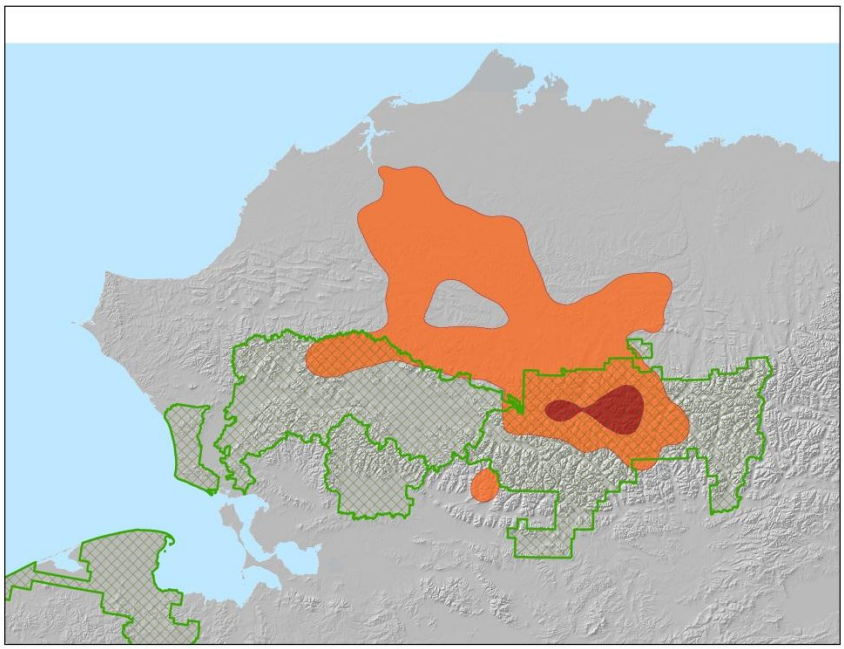


Figure 5. Late-summer (July 15-August 31) range use of Western Arctic Herd caribou. A) 2010. B) 2011. Light orange depicts the 95% kernel (53249 km^2 and 102088 km^2, respectively) and dark orange the 50% kernel (2730 km^2 and 18914 km^2, respectively). Green hatched areas are Park units.

A) 2010. Sample size = 30.



B) 2011. Sample size = 39.

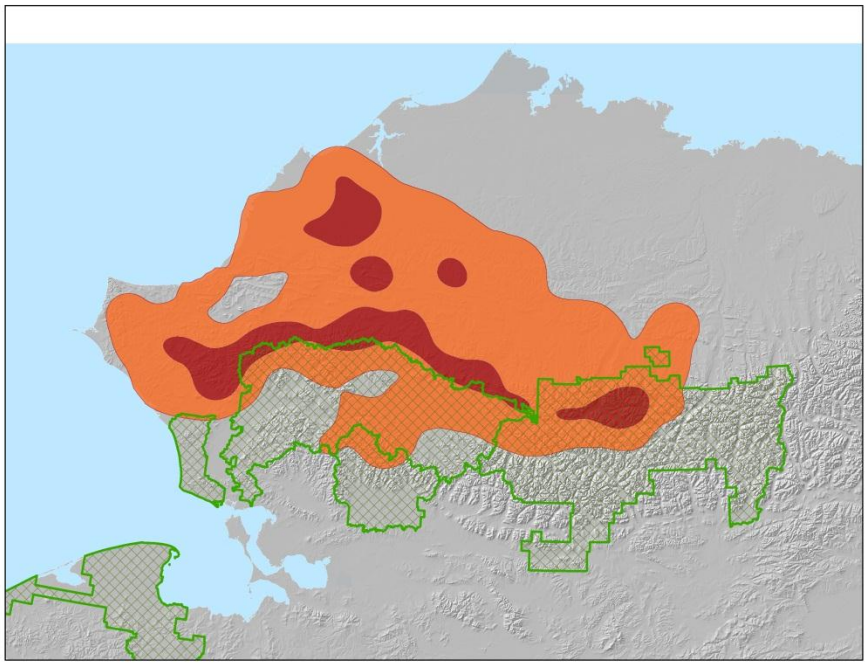
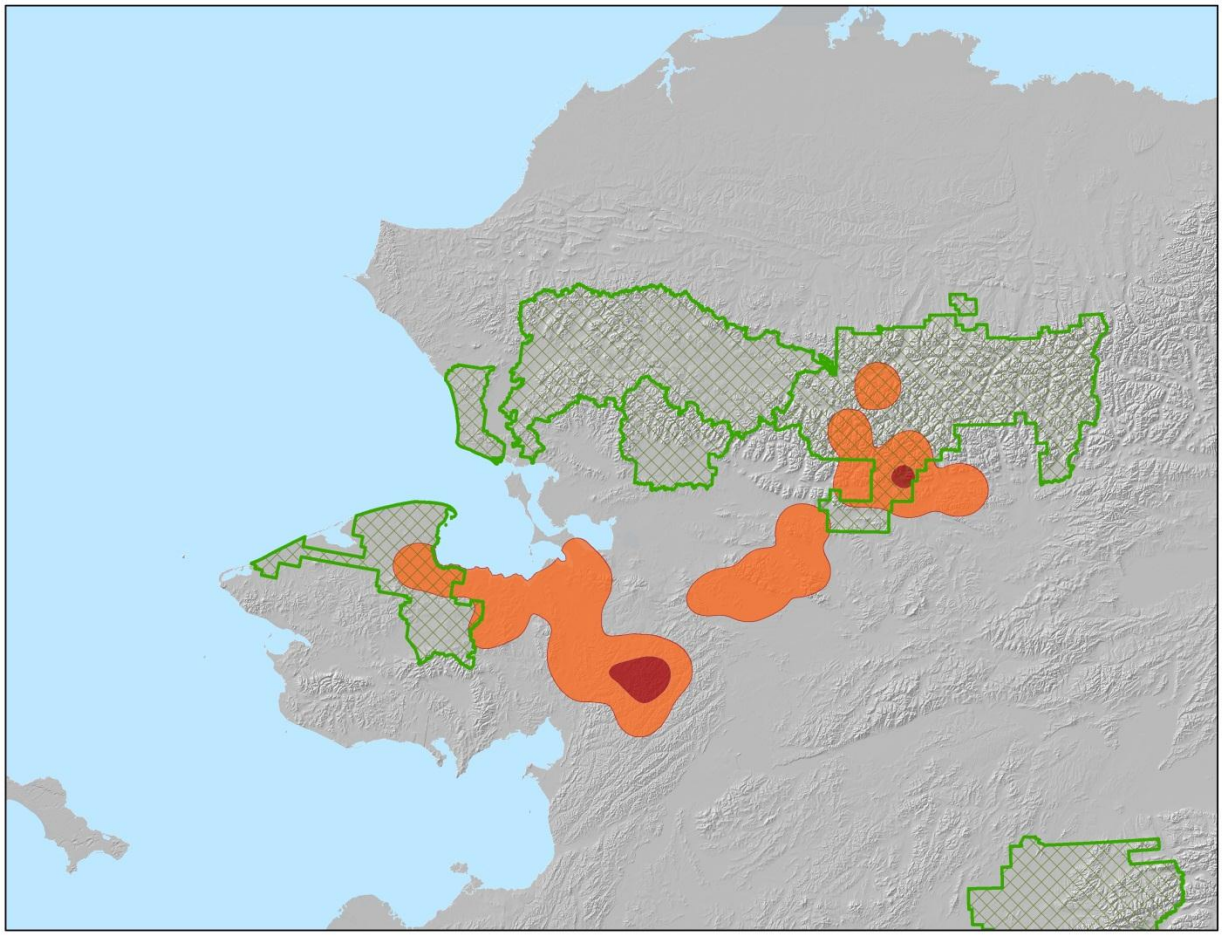


Figure 6. Winter (December 1, 2010 - March 31, 2011) range use of Western Arctic Herd caribou. Light orange depicts the 95% kernel (39206 km2) and dark orange the 50% kernel (2195 km2). Green hatched areas are Park units. Sample size = 26.



Distribution and movements

Usage of the 5 ARCN Parks is detailed in Table 2. The only ARCN Park unit not utilized during the study period was CAKR. GAAR and NOAT recorded the highest percentage of use. Annual movements are summarized in Table 3. WAH caribou exhibit some of the longest migrations of any terrestrial mammal.

Table 2. Percent of Western Arctic Herd (WAH) collars within different Park units; including Bering Land Bridge National Preserve (BELA), Cape Krusenstern National Monument (CAKR), Gates of the Arctic National Park and Preserve (GAAR), Kobuk Valley National Park (KOVA), and Noatak National Preserve (NOAT). Summer is June, July and August. Fall is September, October, and November. Winter is December, January, February, and March. Spring is April and May.

Season	Sample Size	BELA	CAKR	GAAR	KOVA	NOAT
Summer 2010	30	0.0	0.0	90.0	10.0	100.0
Fall 2010	29	3.6	0.0	51.7	62.1	89.7
Winter 2010-2011	27	7.4	0.0	33.3	0.0	0.0
Summer 2011	40	0.0	0.0	37.5	10.0	65.0

Table 3. Annual distance moved by GPS-collared Western Arctic Herd caribou cows.

Monitoring Year	Sample Size	Mean Distance (SD)	Maximum Distance
2009-2010	31	3254 (237) km	3724 km
2010-2011	39	3045 (323) km	3747 km
Total	70		

Migration Phenology

The results for when and how many GPS-collared caribou crossed the Noatak, Kobuk and Selawik Rivers on their annual 'spring' and 'fall' migrations are detailed in Table 4. A histogram (Figure 7) of where caribou crossed the Noatak River provides a visual depiction of the geographic spread of the fall migration.

Table 4. Timing and prevalence of river crossing events by Western Arctic Herd caribou. Reported results are average date (standard deviation); percentage of collared cows crossing; and sample size. A). Results for generally southward 'fall' migration. B). Results for generally northward 'spring' migration. Dates are for the first crossing if the individual re-crosses. 'Spring migration' is not limited to the months of April and May as some cows cross the Noatak in early June.

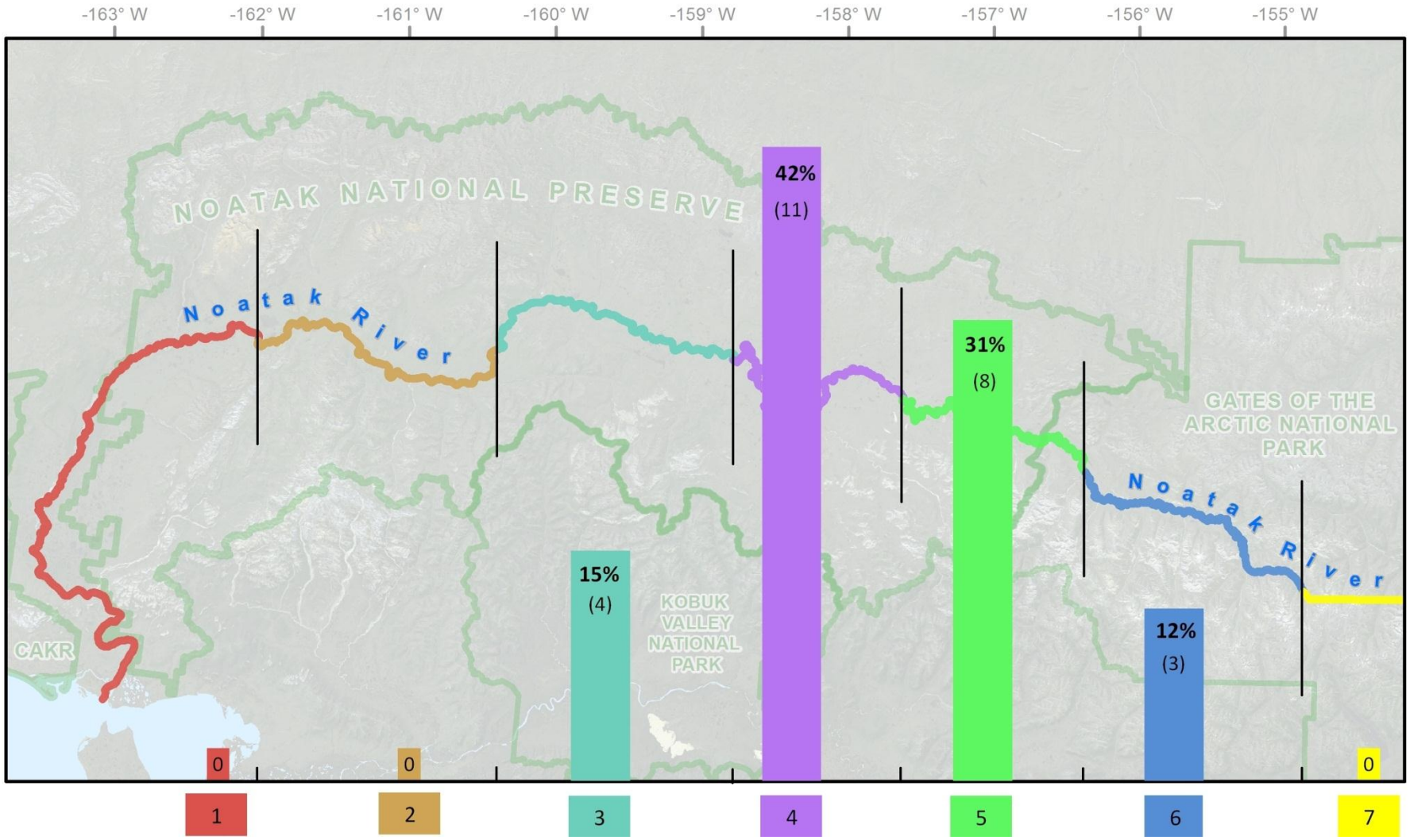
A. Fall

Year	Noatak	Kobuk	Selawik
2010	Sep 24 (16.4); 96.7%; 30	Oct 12 (17.6); 76.7%; 30	Oct 24 (11.7); 62.1%; 29

B. Spring

Year	Noatak	Kobuk	Selawik
2011	May 18 (11.8); 96.3%; 27	May 15 (5.8); 70.4%, 27	May 9 (5.8); 55.5%; 27

Figure 7. Distribution of caribou crossing the Noatak River, fall 2010. This histogram depicts where collared female caribou crossed the Noatak River, generally from north to south, on their fall migration. Relative percentages (and the absolute number) of caribou are provided. The river is divided into seven color-coded segments which are displayed in the background. The middle five segments are 100 river kilometers long, while the westernmost is 200 km and the easternmost runs as far as east caribou migrate.



Migration Routes

The results for when and the minimum distance GPS-collared caribou were to the villages of Noatak, Shungnak and Selawik on their annual 'spring' and 'fall' migrations are detailed in Table 5. Onion Portage, which has been used as a Kobuk River crossing by caribou for more than 10,000 years, is utilized both on the fall and spring migrations.

Table 5. Minimum distance and date that collared Western Arctic Herd caribou passed northwest Arctic villages of Noatak, Shungnak, and Selawik, and the historical caribou river crossing location of Onion Portage, KOVA. Reported results are distance in kilometers (standard deviation); average date (standard deviation); and sample size. A). Results for generally southward fall (September, October, November) migration. B) Results for generally northward spring (April and May) migration.

A) Fall

Year	Noatak	Shungnak	Selawik	Onion Portage
2010	176.8 (54.2); Oct 7 (17.6); 29	36.6 (37.3); Oct 8 (15.5); 29	86.1 (53.1); Oct 20 (12.7); 29	32.6 (32.7); Oct 3 (14.6); 29

B) Spring

Year	Noatak	Shungnak	Selawik	Onion Portage
2011	202.3 (40.7); May 20 (9.8); 27	74.5 (46.7); May 9 (12.0); 27	110.3 (97.4); May 12 (7.78); 27	64.8 (60.3); May 15 (8.2); 27

Western Arctic Herd Working Group

Several NPS employees, including ARCN's Caribou Vital Sign Monitoring Lead, attended and presented information at both the December 2009 and December 2010 meetings. The Caribou Vital Sign lead acted as the NPS's representative on the Technical Committee and contributed to the 'Caribou Trails' newsletters and revisions to the 2003 Management Plan. NPS contributed financially to support these meetings.

Population Modeling

The results of the population modeling effort are detailed in that projects final report (Prichard 2009). One of the most critical findings was that "harvest levels and percentage of cows harvested can greatly impact population trajectory" (Prichard 2009). The modeling effort suggests that more caribou can be harvested, with less impact on herd growth, if the percentage of females taken is reduced. A copy of this report can be found at ARCN's Caribou Vital Sign webpage, located at http://science.nature.nps.gov/im/units/arcn/index.cfm?rq=12&vsid=19.

Diet Analyses

Lichens constituted nearly 60% or more of the diet of caribou in fall and spring (Table 6). One individual utilized over 90% in its diet. Use of graminoids was low (< 5%), except in the location that had the lowest usage of lichens where it was ~ 9% of the diet. Mosses also constituted a larger portion of the diet at this location. Mushrooms constituted > 10% of the diet during the fall of 2010. This result was supported by visual inspection of the rumen (stomach) during several necropsies that were performed by the ADFG during that year. The locations of sites mentioned in Table 6 are listed in Table 7.

Table 6. Diet composition of Western Arctic Herd caribou derived from microhistology of feces that was corrected for digestibility. Results are the percentage of that class of vegetation (and its standard deviation, SD). The 'Graminoid' category includes grasses and sedges. The 'Forbs' category includes *Equisetum* spp. The 'Misc.' category includes seeds, spruce (*Picea* spp.), needles and other miscellaneous vegetative items. The samples are from individuals of unknown sex and age. 'N' indicates sample size. A) Results from fall (September) samples. B) Results from spring (March-April) samples.

a) Fall Diet Composition

Site-Year	N	Lichens	Shrubs	Graminoids	Forbs	Moss	Mushrooms	Misc.
KOVA 2010	25	67.1 (5.7)	8.1 (3.8)	3.7 (1.5)	4.3 (3.3)	5.8 (1.8)	11.1 (5.8)	0.0 (0.0)

b) Spring Diet Composition

Site-Year	N	Lichens	Shrubs	Graminoids	Forbs	Moss	Mushrooms	Misc.
Wheeler 2011	4	84.1 (5.7)	6.2 (1.6)	4.8 (1.5)	4.3 (3.9)	2.8 (1.1)	1.9 (2.2)	0.0 (0.0)
Wrench 2011	15	59.2 (16.2)	17.6 (7.7)	9.3 (4.9)	1.7 (1.6)	11.9 (10.3)	0.0 (0.0)	0.0 (0.0)

Table 7. Site locations of fecal collections used for diet composition analyses.

Site	Latitude	Longitude
KOVA (Onion Portage all years)	67.1057	-158.2701
Wheeler 2011	66.3039	-156.9235
Wrench 2011	65.9714	-159.5931

New Products Completed Prior to the End of Reporting Period

Most of the products can be found on ARCN's Caribou Vital Sign webpage, which is located at http://science.nature.nps.gov/im/units/arcn/index.cfm?rq=12&vsid=19, under the "Documents" tab.

Technical Reports

Joly, K. 2011. Winter range studies of the Western Arctic Caribou Herd, northwest Alaska. University of Alaska Fairbanks Ph. D. dissertation. Fairbanks, Alaska. 221 pp.

Prichard, A. K. 2009. Development of a preliminary population model of the Western Arctic Caribou Herd. Final Report. ABR, Inc. Fairbanks, Alaska. 14 pp.

Scientific Journal Articles

Joly, K. and D. R. Klein. 2011.Complexity of caribou population dynamics in a changing climate. Alaska Park Science 10 (1): 26-31.

Joly, K. 2011. Modeling influences on winter distribution of caribou in northwestern Alaska through use of satellite telemetry. Rangifer Special Issue 19: 75-85.

Collins, W. B., B. W. Dale, L. G. Adams, D. McElwain, and K. Joly. 2011. Fire, grazing history, lichen abundance, and winter distribution of caribou in Alaska's taiga. Journal of Wildlife Management 75 (2): 369-377.

Joly, K., D. R. Klein, D. L. Verbyla, T. S. Rupp and F. S. Chapin III. 2011. Linkages between large-scale climate patterns and the dynamics of Alaska caribou populations. Ecography 34 (2): 345-352.

Joly, K., F. S. Chapin III, and D. R. Klein. 2010. Winter habitat selection by caribou in relation to lichen abundance, wildfires, grazing and landscape characteristics in northwest Alaska. Écoscience 17 (3): 321-333.

Joly, K., T. S. Rupp, R. R. Jandt, and F. S. Chapin III. 2009. Fire in the range of the Western Arctic Caribou Herd. Alaska Park Science 8 (2):68-73.

Joly, K., R. R. Jandt, and D. R. Klein. 2009. Decrease of lichens in arctic ecosystems: role of wildfire, caribou and reindeer, competition, and climate change. Polar Research 28 (3):433-442.

Jandt, R., K. Joly, C. R. Meyers, and C. Racine. 2008. Slow recovery of lichen on burned caribou winter range in Alaska tundra: potential influences of climate warming and other disturbance factors. Arctic, Antarctic, and Alpine Research 40 (1): 89-95.

Joly, K., M. J. Cole, and R. R. Jandt. 2007. Diets of overwintering caribou, *Rangifer tarandus*, track decadal changes in arctic tundra vegetation. Canadian Field-Naturalist 121 (4): 379-383.

Joly, K., P. Bente, and J. Dau. 2007. Response of overwintering caribou to burned habitat in northwest Alaska. Arctic 60 (4): 401-410.

Joly, K., R. R. Jandt, C. R. Meyers, and M. J. Cole. 2007. Changes in vegetative cover on Western Arctic Herd winter range from 1981-2005: potential effects of grazing and climate change. Rangifer Special Issue 17: 199-207.

Presentations

Joly, K. 2011. Winter range studies of the Western Arctic Caribou Herd, northwest Alaska. University of Alaska Fairbanks Ph.D. dissertation defense, Fairbanks, Alaska.

Joly, K. and D. R. Klein. 2011. Caribou in a changing world. George Wright Society Conference, New Orleans, Louisiana.

Miller, S. D. and K. Joly. 2011. Managing and Analyzing Spatial Data from GPS-Collared Caribou Using the SQL Server 2008 Geography Data Type. George Wright Society Conference, New Orleans, Louisiana.

Joly, K. 2011. Fire effects on caribou winter range. Introduction to Fire Effects, RX-310, Alaska Fire Service, Fairbanks, Alaska.

Joly, K., S.D. Miller and R.E. Sarwas. 2010. Tools and techniques for managing and analyzing large GPS datasets. 12th North American Caribou Workshop, Winnipeg, Manitoba, Canada.

Prichard, A., K. Joly and J. Dau. 2010. Quantifying potential biases in survival and parturition estimates from telemetry data from unknown age caribou. 12th North American Caribou Workshop, Winnipeg, Manitoba, Canada.

Joly, K., F. S. Chapin III and D. R. Klein. 2010. Habitat selection by overwintering caribou relative to lichen abundance, wildfires, grazing and landscape characteristics in northwestern Alaska. 12th North American Caribou Workshop, Winnipeg, Manitoba, Canada.

Miller, S. D. and K. Joly. 2010. Bridging spatial and tabular data using MapWinGIS ActiveX Control in a Natural Resource Monitoring Database. NPS Inventory and Monitoring Program Meeting for Database managers. Fort Collins, Colorado.

Prichard, A. and K. Joly. 2010. Quantifying potential biases in demographic parameters calculated from telemetry collar data. The Wildlife Society – Alaska Chapter Meeting. Anchorage, Alaska.

Joly, K., D. R. Klein, D. L. Verbyla, T. S. Rupp and F. S. Chapin III. 2009. Linkages between large-scale climate patterns and the dynamics of arctic ungulate populations. CARMA. Vancouver, British Columbia.

Joly, K., D. R. Klein, D. L. Verbyla, T. S. Rupp and F. S. Chapin III. 2009. Linkages between large-scale climate patterns and the dynamics of arctic ungulate populations. American Society of Mammalogists Annual Meeting. Fairbanks, Alaska.

Joly, K., D. R. Klein, D. L. Verbyla, T. S. Rupp and F. S. Chapin III. 2009. Linkages between large-scale climate patterns and the dynamics of arctic ungulate populations. The Wildlife Society – Alaska Chapter Meeting. Fairbanks, Alaska.

Joly, K. 2008. Factors affecting winter distribution of caribou in northwest Alaska. 12th North American Caribou Workshop, Goose Bay-Happy Valley, Labrador, Canada.

Joly, K., T. S. Rupp, R. R. Jandt, and F.S. Chapin III. 2008. Fire in the range of the Western Arctic Caribou Herd. Park Science in the Arctic. Fairbanks, AK.

Discussion

This report is the first installation of ARCN's Caribou Vital Sign monitoring program, covering September 2009 until the end of August 2011. Subsequent annual reports will cover just a single year. GPS collars were deployed in the Western Arctic Herd for the first time during this reporting period. Thirty-nine collars were deployed in the initial year (September 2009) and an additional 15 GPS collars were deployed in 2010. Well over 80,000 relocations have been collected during the first two years of vital sign monitoring. Although inference is poor due to small sample sizes, the potentially high mortality rates of adult females (18 and 13 % in the first and second monitoring years, respectively) may be reflective of the downward trend of the herd and, thus, will require larger collar deployments in the future to keep the sample size of GPS-collared caribou around 40 animals. Range use by GPS-collared cows during 2010 was similar to range use by the herd for the past several years. WAH caribou used NOAT and GAAR more consistently than other park units, while no GPS-collared caribou have used CAKR to date. The Kobuk Preserve portion of GAAR (its southwest corner), was identified as core winter range for the winter of 2010-2011. WAH caribou display some of the longest annual migrations of any terrestrial mammal in the world. Diet analyses were consistent with other reports, highlighting the importance of lichens to the diet of WAH caribou during late winter but also during late summer and migration. While interesting migration phenology, herd distribution, and other data were collected during the study period, it will be a number of years before trends can be assessed. A large number of products and presentations were developed during the initiation of the Vital Sign; many of which are available on-line at http://science.nature.nps.gov/im/units/arcn/index.cfm?rq=12&vsid=19, under the 'Documents' tab. The protocol for the Caribou Vital Sign should be finalized during the upcoming reporting year (September 2011-August 2012).

Literature Cited

Boertje, R. D. 1981. Nutritional ecology of the Denali caribou herd. M.S. thesis, University of Alaska Fairbanks, Fairbanks, Alaska.

Dau, J. 2007. Units 21D, 22A, 22B, 22C, 22D, 22E, 23, 24 and 26A caribou management report. Pages 174-231 *in* P. Harper, editor. Caribou management report of survey and inventory activities 1 July 2004-30 June 2006. Alaska Department of Fish and Game. Project 3.0. Juneau, Alaska.

Gustine, D.D., P. S. Barboza, L. G. Adams, R. G. Farnell, and K. L. Parker. 2011. An isotopic approach to measuring nitrogen balance in caribou. *Journal of Wildlife Management* 75(1):178-188.

Prichard, A. K. 2009. Development of a preliminary population model of the Western Arctic Caribou Herd. Final Report. ABR, Inc. Fairbanks, Alaska. 14 pp.

Western Arctic Caribou Herd Working Group. 2003. Western Arctic Caribou Herd Cooperative Management Plan. 33 pp.

Worton, B.J. 1989. Kernel methods for estimating the utilization distribution in home-range studies. Ecology 70:164-168.