



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

September 2022–August 2023

Natural Resource Report NPS/ARC/NRR—2023/2612



ON THE COVER

Winter-killed caribou in spring, south of Gates of the Arctic National Park and Preserve, Alaska.

NPS / KYLE JOLY

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Executive Summary

Caribou (*Rangifer tarandus*) are an integral part of the ecological and cultural fabric of northwest Alaska. Western Arctic Herd (WAH) caribou roam over this entire region, including all 5 Arctic Network (ARCN) Inventory and Monitoring Program's National Park units. Conservation of healthy caribou populations is specifically mentioned within the enabling legislation (Alaska National Interested Lands Conservation Act or ANILCA) for 3 of these park units and is of importance to subsistence hunters. 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, the ARCN parks chose WAH caribou as a Vital Sign for long-term monitoring.

This report documents the monitoring results of this Vital Sign during its 14th year (September 2022–August 2023) of implementation. Results from the previous years of monitoring are also included for ease of comparison. 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). Thanks to a 2015 data sharing agreement, the report includes data funded by the ADFG dating back to September 2013. That particular year was chosen as it represents when the ADFG started deploying a substantial number of GPS collars on an 8-hour relocation schedule.

Monitoring of the herd relies heavily on the use of Global Positioning System (GPS) radio telemetry 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 utilized to monitor the timing and location of migrations, as well as seasonal distributions of WAH caribou. Monitoring movement and the phenology of movement is perhaps the simplest means to track the influences of climate change, natural perturbations, development, and other potential impacts on a species—an analysis of which is outside the scope of this current report.

This report also documents the NPS commitment and involvement with the WAH Working Group. The group is composed of important stakeholders including representatives for rural villages, sport hunters, conservationists, hunting guides, hunting transporters, and reindeer herders. In addition, all the agencies charged with managing the WAH, including the ADFG, NPS, US Fish and Wildlife Service (FWS) and Bureau of Land Management (BLM), serve as advisors to the group. Information gathered by the Caribou Vital Sign monitoring program are intended to supplement and complement existing data streams gathered by the other cooperating agencies and will be important in future management decisions.

Acknowledgments

The ADFG, BLM, FWS, and students of the regional high schools helped with collar deployments over the years. We thank the NPS GIS Team for the comprehensive technical database and GIS assistance that made this report possible over the past 14 years. Monitoring a herd that ranges over a vast and remote landscape provides numerous challenges, and we thank ADFG biologists Alex Hansen, Christie Osburn, Brennan Watson, and others for their continued assistance and collaboration. We thank Tim Fullman, Alex Hansen, and Eric Wald for reviewing drafts that improved this report.

List of Acronyms

ADFG:Alaska Department of Fish and Game

ANILCA: Alaska National Interest Lands Conservation Act

ARCN:Arctic Network Inventory and Monitoring Program

BELA:Bering Land Bridge National Preserve

BLM:Bureau of Land Management

CAKR:Cape Krusenstern National Monument

FWS:US Fish and Wildlife Service

GAAR:Gates of the Arctic National Park and Preserve

KOVA:Kobuk Valley National Park

NOAT:Noatak National Preserve

NPS:National Park Service

WAH:Western Arctic Herd

Introduction

This report is the latest in a series of annual reports documenting long-term monitoring of the Western Arctic Herd (WAH). Caribou (*Rangifer tarandus*) were chosen to be a Vital Sign of the National Park Service's (NPS) Arctic Network (ARCN) Inventory and Monitoring Program because they: (1) are an extremely important subsistence species that occur within all ARCN park units (Gates of the Arctic National 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)); (2) are specifically identified in the enabling legislation (Alaska National Interest Lands Conservation 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 opportunities to view caribou in Alaskan parks; (6) are an example of the ever more rare natural phenomenon of long-distance migration of a large land mammal; (7) are an integral part of the ecology and social fabric of northwest Alaska; and, (8) can be compared with national and international caribou datasets across the Arctic region to gain insight into the ecology of the WAH or Arctic ecology in general.

Of the 4 Alaska Arctic caribou herds, only the WAH regularly utilizes all 5 ARCN park units (Figure 1). WAH caribou are of great importance to people for both consumptive and non-consumptive purposes, 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. The herd rather steadily declined from its 2003 apex to 152,000 in 2023 (Alex Hansen, *personal communication*, 2022). Federal and state wildlife management agencies are currently considering more robust measures to help slow or reverse this 20-year decline, including reducing harvest bag limits for bulls but especially for cows. The heritage and traditions of Alaska Natives in approximately 40 subsistence-based communities in the region have been shaped by the availability of WAH caribou (Western Arctic Herd Working Group 2019). The availability of the WAH also affects the economy 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 indicators 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 to wildlife communities, either directly through browsing and grazing, or indirectly through biogeochemical cycling. While the primary objectives of this monitoring are to track the distribution and migrations of caribou, a variety of ancillary data (e.g., survival) are obtained in the monitoring process that are likely to have great value for park and wildlife management, ungulate research, and evaluating long-term changes in the WAH.

This report documents the results of ARCN caribou monitoring for the 14th year (September 2022–August 2023) of the program. The caribou monitoring protocols contain the detailed methodology

employed to obtain the results presented here (Joly et al. 2012). Periodic syntheses of these data will be performed and reported on as appropriate.

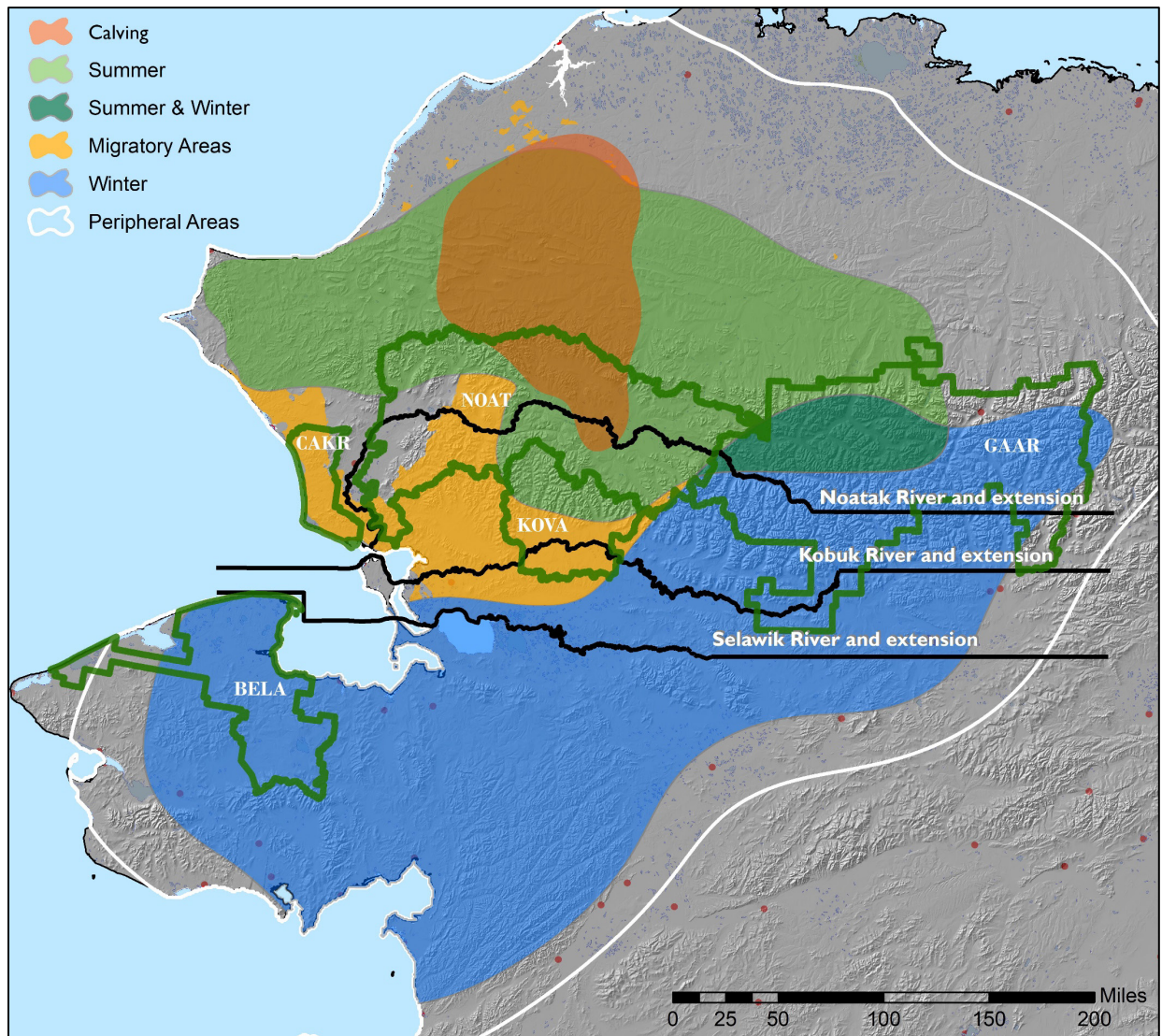


Figure 1. Study area and the range of the Western Arctic Herd. Generalized range data courtesy of the Alaska Department of Fish and Game. The red dots indicate villages and towns. Black lines depict key rivers. These rivers have been artificially extended to the east to help track the timing of caribou migratory movements. Green polygons are NPS units.

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 condition data by radio tracking.
- Define seasonal ranges (i.e., 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).

Methods

The methods outlined here are provided to give the reader a brief summary 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 (Joly et al. 2012, available at <https://www.nps.gov/im/arcn/caribou.htm>).

Collar Deployments

For decades, all WAH collars had been deployed at Onion Portage, KOVA, from early September to early October. Caribou were captured by hand using motorboats to intercept animals as they swam across the Kobuk River. However, in recent years there has been both a reduction and delay of fall migration in the WAH and because of this, only a combined total of 7 collars were deployed at Onion Portage in 2017 and 2018. As a result, collars have been deployed using net gun techniques in spring beginning in 2019 and annually since 2021. Both river and net gun captures used protocols approved by a State of Alaska and NPS Institutional Animal Care and Use Committees (IACUC). NPS collars were only deployed on adult (> 2 years old) female caribou. Capture operations are led by the ADFG, in conjunction and cooperation with the NPS. 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 at least every 8 hours throughout the year (i.e., 1095 relocations per caribou per {non-leap} year for the 8-hour interval). For collars collecting relocations more frequently than every 8 hours, the data were subsampled to 8 hours for this report to provide consistency among individuals.

Year One Survivorship

Survivorship reported here merely represents how many caribou that were collared in this reporting period (i.e., September 2022–August 2023) remained alive through the end of the monitoring year (i.e., August 2023). The number that survived plus the number that died will equal 100% (i.e., collar malfunctions are not included). Survivorship of collars deployed in the spring, via netting, is not directly comparable to the survivorship of collars deployed in the fall, using motorboats, due to differences in the time until the end of the monitoring year.

Seasonal Range Use

Both 50% and 95% utilization distribution kernels (Worton 1989) were produced using ArcGIS and ArcGIS tools developed by the NPS (see Joly et al. 2012). Kernels were developed for the year (September 1–August 31) and for the following seasons: winter (December 1–March 31), calving period (May 28–June 14), insect relief (June 15–July 14), and late-summer (July 15–August 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 (i.e., normalized to a common scale). Results from every year of monitoring are also included for ease of comparison. The Least Squares Cross Validation (LSCV) smoothing parameter (Worton 1989) was utilized for all kernels (Joly et al. 2012). In fall, all collars were deployed at Onion Portage in KOVA, while in spring, collar deployments were via net gunning and clustered in areas relatively near aviation bases. As a result, their initial distribution was not considered representative of the entire herd. At calving,

the collared caribou were considered mixed with the herd based on the distribution of collars deployed in previous years (Prichard et al. 2023). Range use and distribution analyses only considered collared caribou that were mixed with the rest of the herd. For example, data from caribou collared in the fall of 2019 or spring of 2020 would not be used to develop kernels until the 2021 calving season.

Distribution and Movements

The GPS radiocollar data were used to determine what percentage of GPS-collared caribou were found in each ARCN 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. Annual distance moved was the sum of the distances 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 Rivers on their northward (“spring”; typically, between April 1–June 15) 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.

Migration Routes

A histogram of the longitudes at which the collared caribou crossed the Noatak River (the first major river crossed) 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. The minimum distance, and its date of occurrence, between individual GPS-collared caribou and the villages of Noatak, Shungnak and Selawik, and Onion Portage, were calculated using ArcGIS for spring (April 1–May 31) and fall migrations (September 1–November 30).

Results

Collar Deployments

With continued late migrations and relatively few caribou crossing the Kobuk River in fall, we again relied upon net gunning to deploy collars. A record high of 56 GPS collars were deployed via net gunning in the upper Kobuk River drainage from March 29th through April 4th, 2023, 15 of which were video-equipped collars. Since the inception of this project, over 900,000 GPS locations have been gathered at an 8-hour interval (Table 1). It is expected that about 12–15 NPS collars will need to be deployed annually to maintain an adequate sample size due to mortalities and the lifespan of GPS collars (~8 years). We do not collect calf-at-heel data during spring captures.

Table 1. Collar deployment overview. Number and survivorship (%) of GPS-satellite collars deployed on adult (>2 years old) female caribou, number of collared caribou that appeared to be accompanied by a calf, and number of GPS locations acquired at an 8-hour interval. The percentage of caribou that survived plus those that died will equal 100% (i.e., percent failures not included). Data on calf presence in not collected during spring net gunning (i.e., reported as Not Available (NA)).

Monitoring Years	Deployment Season	Collars Deployed	Survived 1 st Year (%)	Died 1 st Year (%)	Collar Failures 1 st Year(%)	With Calf (%)	# Collars W/ Complete Year of Data	Total GPS Locations
2022–2023	Spring	56	40 (72.7%)	15 (27.3 %)	1 (1.8 %)	NA	65	103,094
2021–2022	Spring	33	32 (100 %)	0 (0 %)	1 (3.0 %)	NA	56	90,619
2020–2021	Spring	48	38 (79.2 %)	10 (20.8 %)	0 (0.0 %)	NA	51	79,517
2019–2020	Fall	42	35 (85.4 %)	6 (14.6 %)	1 (2.4 %)	18 (42.9 %)	70	79,161
2018–2019	Combined	33	–	–	–	–	32	52,044
2018–2019 ^a	Spring	30	18 (90.0 %)	2 (10.0 %)	10 (33%)	6 (20 %)	–	–
2018–2019 ^a	Fall	3	3 (100 %)	0 (0%)	0 (0.0 %)	2 (66.7 %)	–	–
2017–2018	Fall	4	3 (75.0 %)	1 (25.0 %)	0 (0.0 %)	3 (75.0 %)	52	63,277
2016–2017	Fall	25	22 (88.0 %)	3 (12.0 %)	0 (0.0 %)	19 (76.0 %)	77	86,651
2015–2016	Fall	38	35 (92.1 %)	3 (7.9 %)	0 (0.0 %)	28 (73.7 %)	79	76,284
2014–2015	Fall	35	28 (80.0 %)	7 (20.0 %)	0 (0.0 %)	24 (68.6 %)	52	62,076
2013–2014	Fall	25	19 (76.0 %)	6 (24.0 %)	0 (0.0 %)	11 (44.0 %)	46	55,971
2012–2013	Fall	12	8 (66.7 %)	4 (33.3 %)	0 (0.0 %)	7 (58.3 %)	34	42,965
2011–2012	Fall	14	10 (76.9 %)	3 (23.1 %)	1 (7.1 %)	10 (71.4 %)	36	46,706
2010–2011	Fall	15	13 (86.7 %)	2 (13.3 %)	0 (0.0 %)	10 (66.7 %)	39	48,892
2009–2010	Fall	39	31 (81.6 %)	7 (18.4 %)	1 (2.6 %)	25 (64.1 %)	31	39,086
Total	n/a	419	–	–	–	157 (62.3 %)	720	926,343

^a Indicates row containing a partial year's worth of data.

Year One Survivorship

Survival of the caribou collared in spring 2023 through the end of August was 72.7%; the lowest ever reported for spring captures and the second lowest annual survival report ever reported for spring or fall captures (Table 1). Spring capture cohorts only have to survive 5 months to reach the end of the reporting year, as opposed to 12 months for fall captures, thus, one would expect survival of spring capture cohorts to be greater than those of fall capture cohorts. Therefore, it is likely that the annual survival rate for collared caribou was the lowest ever reported here. For the past 14 years of monitoring, there are over 700 datasets that contain a complete year of locations.

Seasonal Range Use

The 50% and 95% utilization distributions (kernels) are depicted for the annual range (Table 2; Figure 2 and Figure 3), winter range (Table 3; Figure 4 and Figure 5), calving grounds (Table 4; Figure 6 and Figure 7), insect relief areas (Table 5; Figure 8 and Figure 9), and late-summer range (Table 6; Figure 10 and 11). For each figure, part ‘a’ represents the utilization distribution for the 2022-2023 (annual, winter) or 2023 (calving, insect relief, late-summer) season and part ‘b’ represents the utilization distribution for caribou collared from 2009–2022 (however, most caribou collared before 2019 had died or dropped their collars prior to the end of the reporting year and were not used). The 50% kernels are also referred to as “core areas”. GAAR, KOVA, and NOAT were utilized by collared WAH caribou during this reporting period, but BELA and CAKR were not. Due to heavy use of the central Brooks Range, the annual distribution was most similar to 2020-2021 and 2017-2018. The core area was primarily in the central Brooks Range, where much of the herd wintered. The 2022–2023 winter distribution covered the greatest amount of area for any winter monitored. This was due to the herd diffusely wintering in 3 different areas: the Brooks Range, the upper Kobuk River, and the west-central North Slope. During calving, collared caribou were primarily north of park units and in the general calving grounds. The calving distribution extended farther south compared to a typical spring and was similar to a number of other years with late spring migrations. This was driven by caribou that wintered in the Kobuk River area arriving late to the calving area; caribou that wintered in the central Brooks Range were not similarly delayed. The 2023 insect relief area was generally consistent with past years, but the core area was a little further southwest and closer to the coast than most years. Also, the insect relief area did not extend as far eastward in the latter part of this time period compared to previous years. Caribou distribution during late-summer was broadly dispersed across the western portion of North Slope and Brooks Range, relatively similar to previous years but not ranging as far east as the herd did from 2010-2017.

Table 2. Annual range areas of Western Arctic Herd caribou (95% and 50% kernels for September 1–August 31).

Years	Sample Size	95% kernel area (km ²)	50% kernel area (km ²)
2022–2023	65	100510	6419
2021–2022	51	32118	1081
2020–2021	51	102321	4468
2019–2020	37	174149	16045
2018–2019	32	129884	5523
2017–2018	52	129123	5758
2016–2017	55	100312	2493
2015–2016	44	101094	6387
2014–2015	22	48860	3375
2013–2014	25	46678	1618
2012–2013	34	72778	2169
2011–2012	36	125906	4374
2010–2011	26	136415	6058

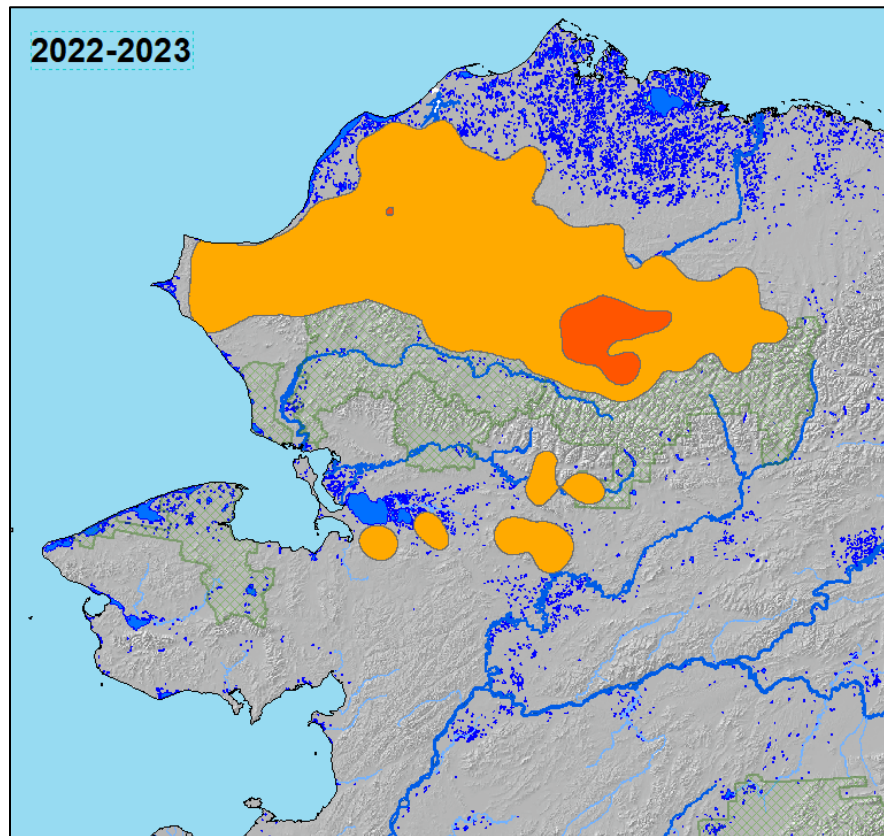


Figure 2. 2022–2023 annual (September 1–August 31) range use of Western Arctic Herd caribou. Light orange depicts the 95% kernel and dark orange the 50% kernel. Green hatched areas are NPS units.

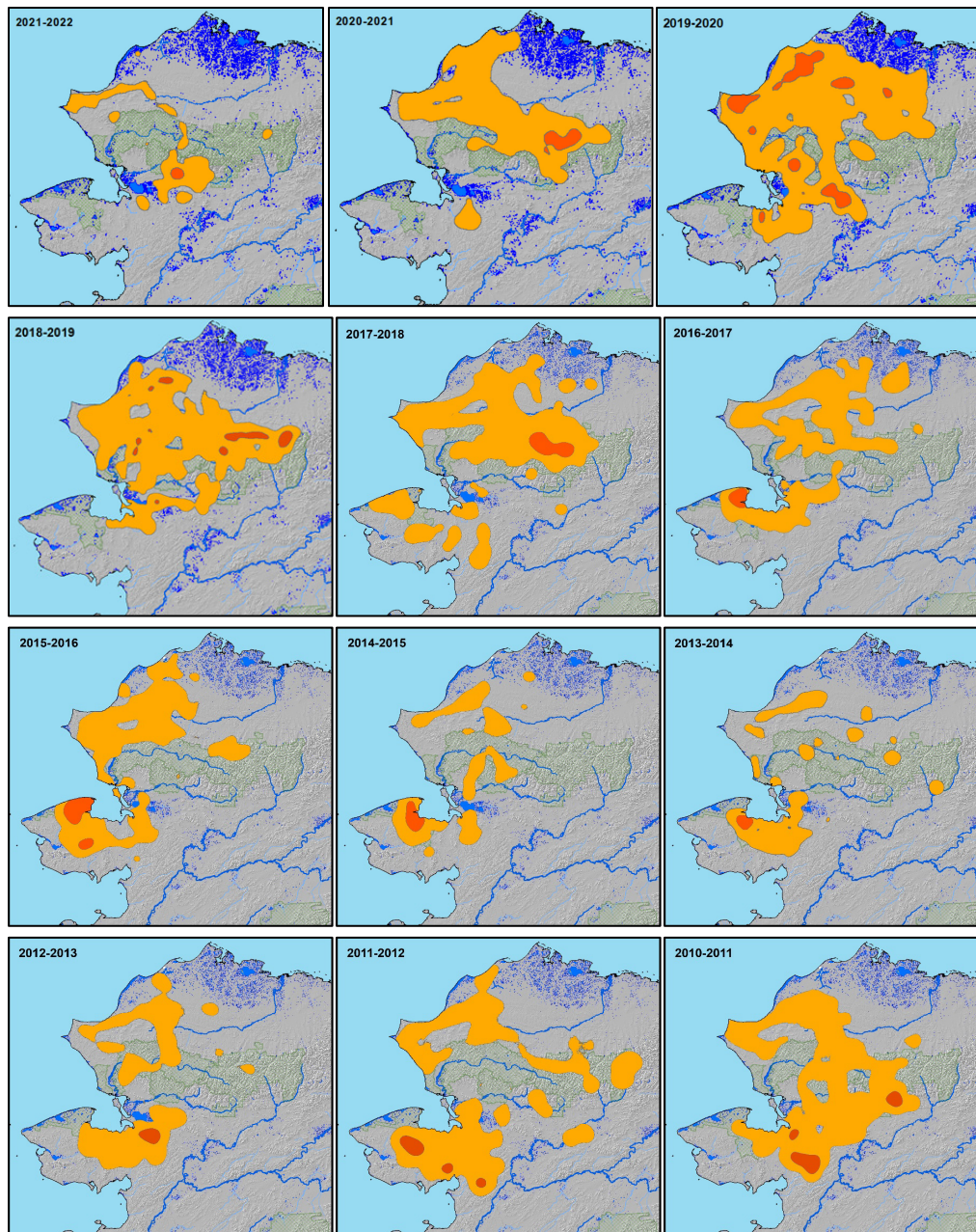


Figure 3. 2010–2022 annual (September 1–August 31) range use of Western Arctic Herd caribou. Light orange depicts the 95% kernel and dark orange the 50% kernel. Green hatched areas are NPS units.

Table 3. Winter range areas of Western Arctic Herd caribou (95% and 50% kernels for December 1–March 31).

Years	Sample Size	95% kernel area (km ²)	50% kernel area (km ²)
2022–2023	76	21316	334
2021–2022	68	1913	82
2020–2021	58	5002	23
2019–2020	40	11757	274
2018–2019	40	8191	84
2017–2018	63	9814	67
2016–2017	67	10321	538
2015–2016	48	6210	151
2014–2015	36	5386	133
2013–2014	35	4338	105
2012–2013	30	5801	131
2011–2012	40	3933	86
2010–2011	27	9170	274

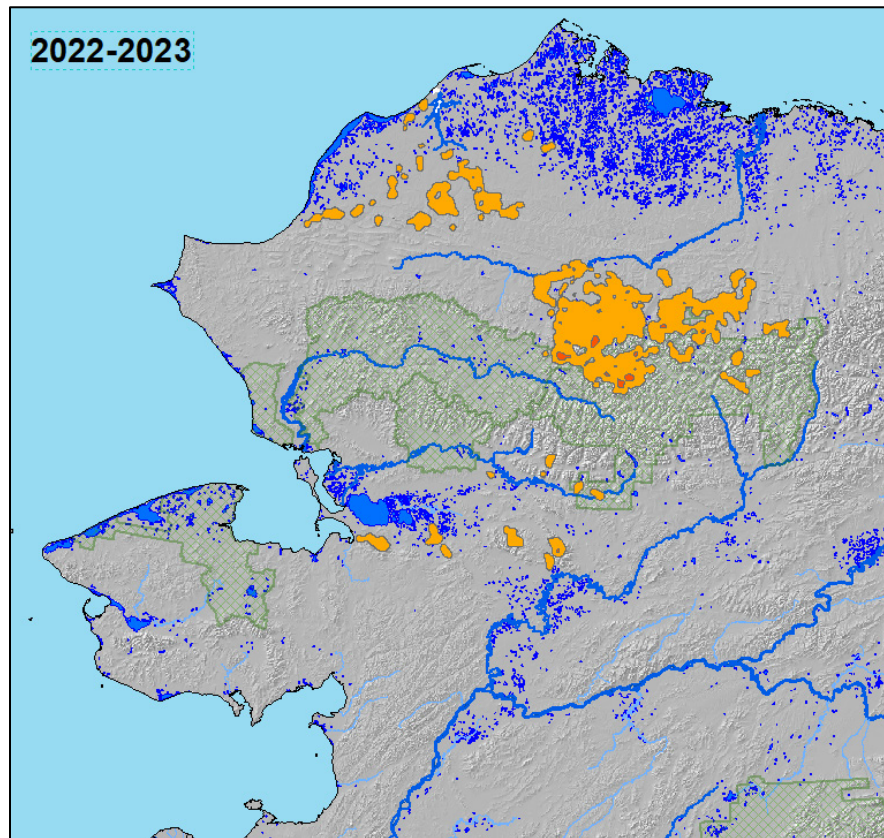


Figure 4. 2022–2023 winter (December 1–March 31) range use of Western Arctic Herd caribou. Light orange depicts the 95% kernel and dark orange the 50% kernel. Green hatched areas are Park units.

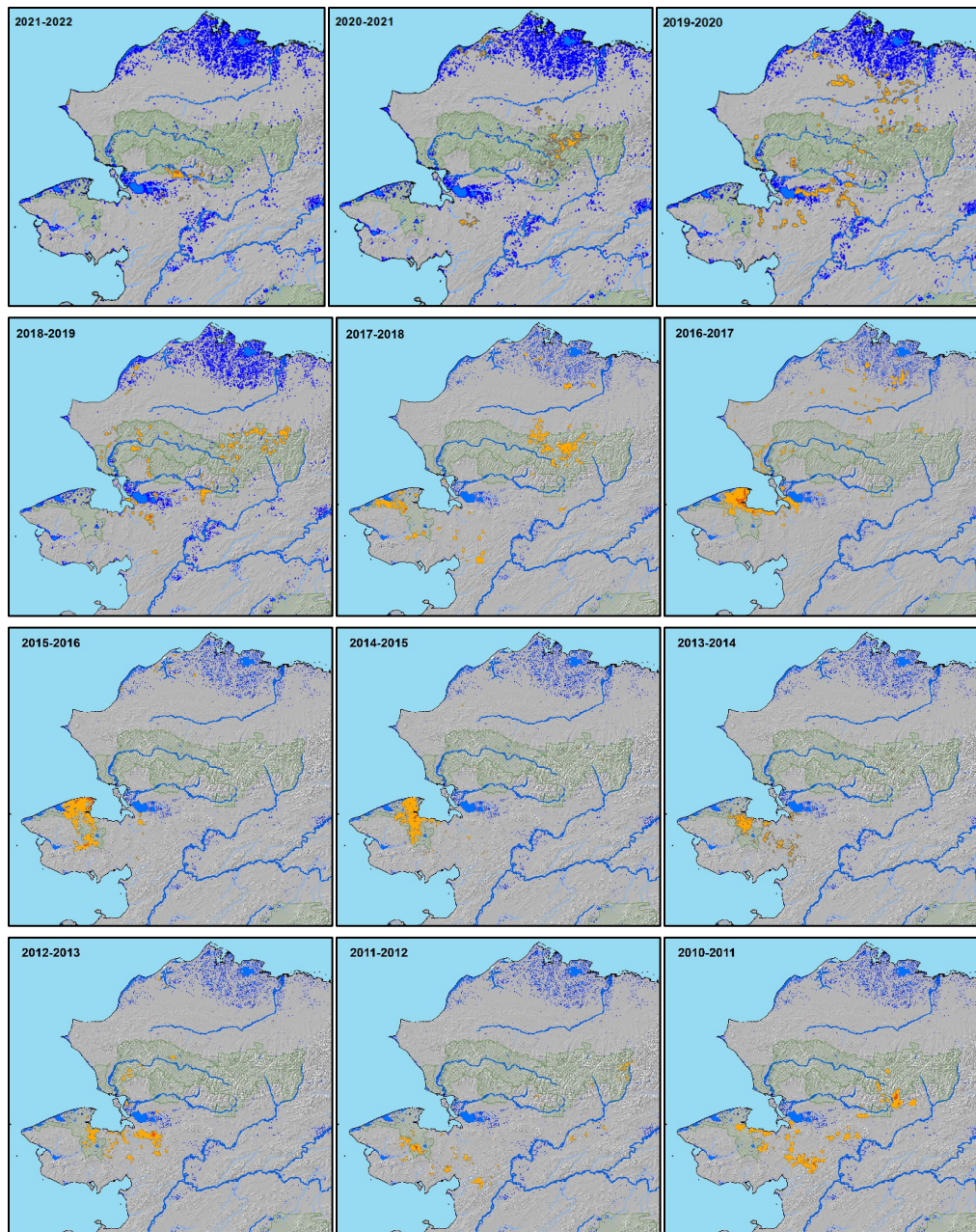


Figure 5. 2010–2022 winter (December 1–March 31) range use of Western Arctic Herd caribou. Light orange depicts the 95% kernel and dark orange the 50% kernel. Green hatched areas are Park units.

Table 4. Calving period areas of the Western Arctic Herd (95% and 50% kernels for May 28–June 14).

Year	Sample Size	95% kernel area (km ²)	50% kernel area (km ²)
2023	109	17613	714
2022	101	13660	460
2021	78	8654	505
2020	70	14370	651
2019	58	4712	355
2018	54	9996	375
2017	84	7511	364
2016	82	6790	806
2015	54	5127	193
2014	56	4514	111
2013	40	21870	749
2012	38	31219	2118
2011	42	11429	291
2010	33	18362	707

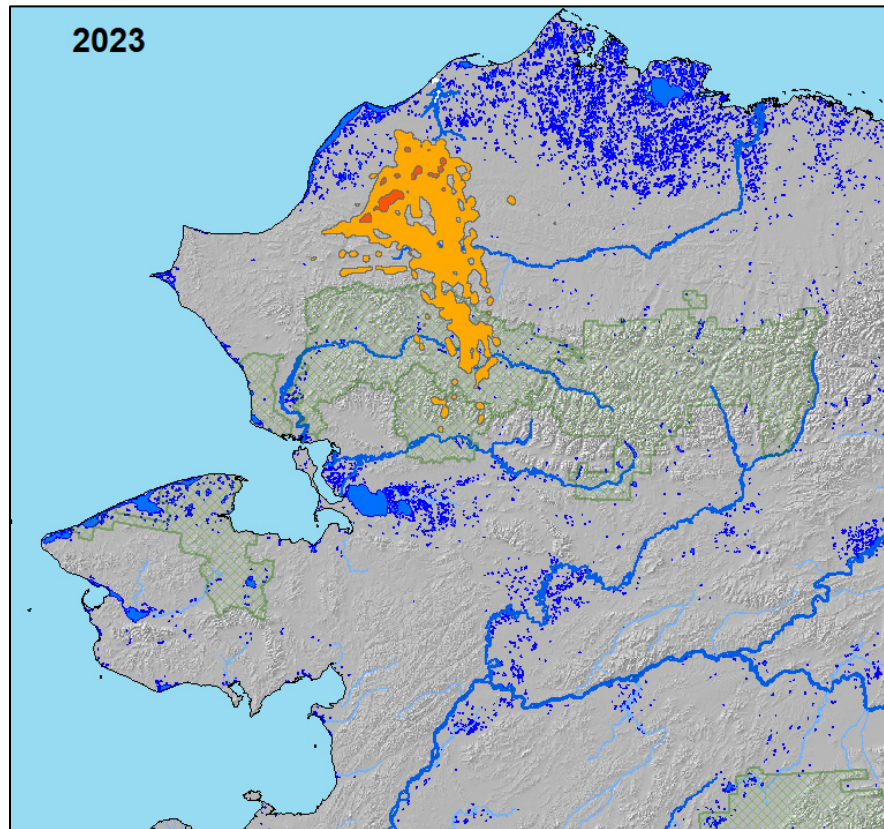


Figure 6. 2023 calving period (May 28–June 14) area use by Western Arctic Herd caribou. Light orange depicts the 95% kernel and dark orange the 50% kernel. Green hatched areas are Park units. These kernels include all (both parturient and non-parturient) GPS-collared cows.

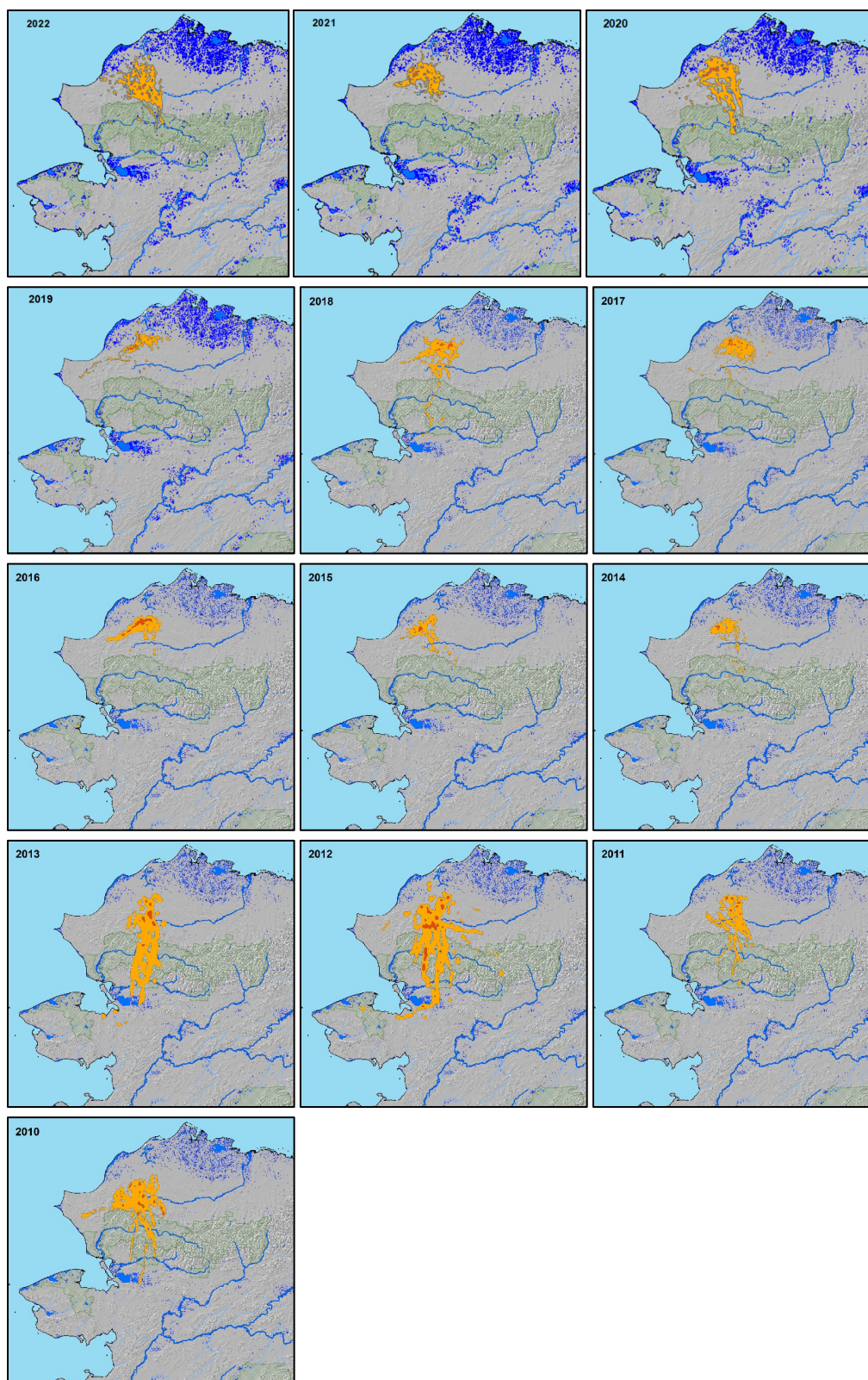


Figure 7. 2010–2022 calving period (May 28–June 14) area use by Western Arctic Herd caribou. Light orange depicts the 95% kernel and dark orange the 50% kernel. Green hatched areas are Park units. These kernels include all (both parturient and non-parturient) GPS-collared cows.

Table 5. Insect relief areas of Western Arctic Herd caribou (95% and 50% kernels for June 15–July 14).

Year	Sample Size	95% kernel area (km ²)	50% kernel area (km ²)
2023	107	18644	3566
2022	98	18256	3241
2021	77	19924	3616
2020	70	16457	1938
2019	57	19746	3465
2018	54	22787	6033
2017	80	25874	4858
2016	82	24722	7190
2015	52	20537	3834
2014	47	17214	4226
2013	36	22043	3688
2012	38	24476	5505
2011	40	20734	2737
2010	33	31142	3468

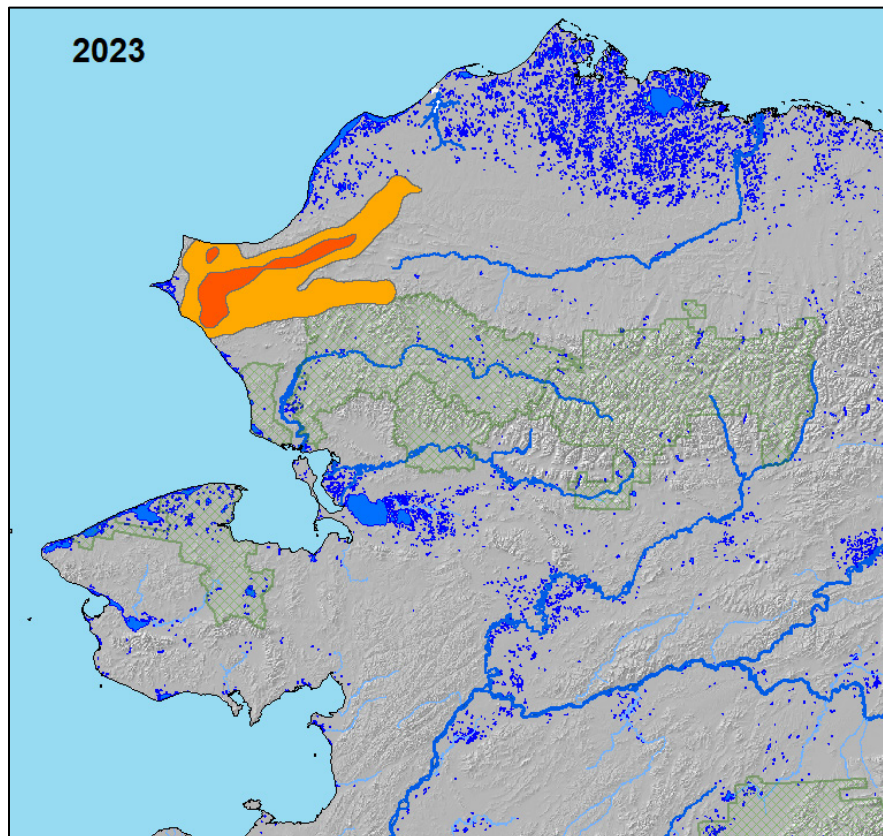


Figure 8. 2023 insect relief (June 15–July 14) area use of Western Arctic Herd caribou. Light orange depicts the 95% kernel and dark orange the 50% kernel. Green hatched areas are Park units.

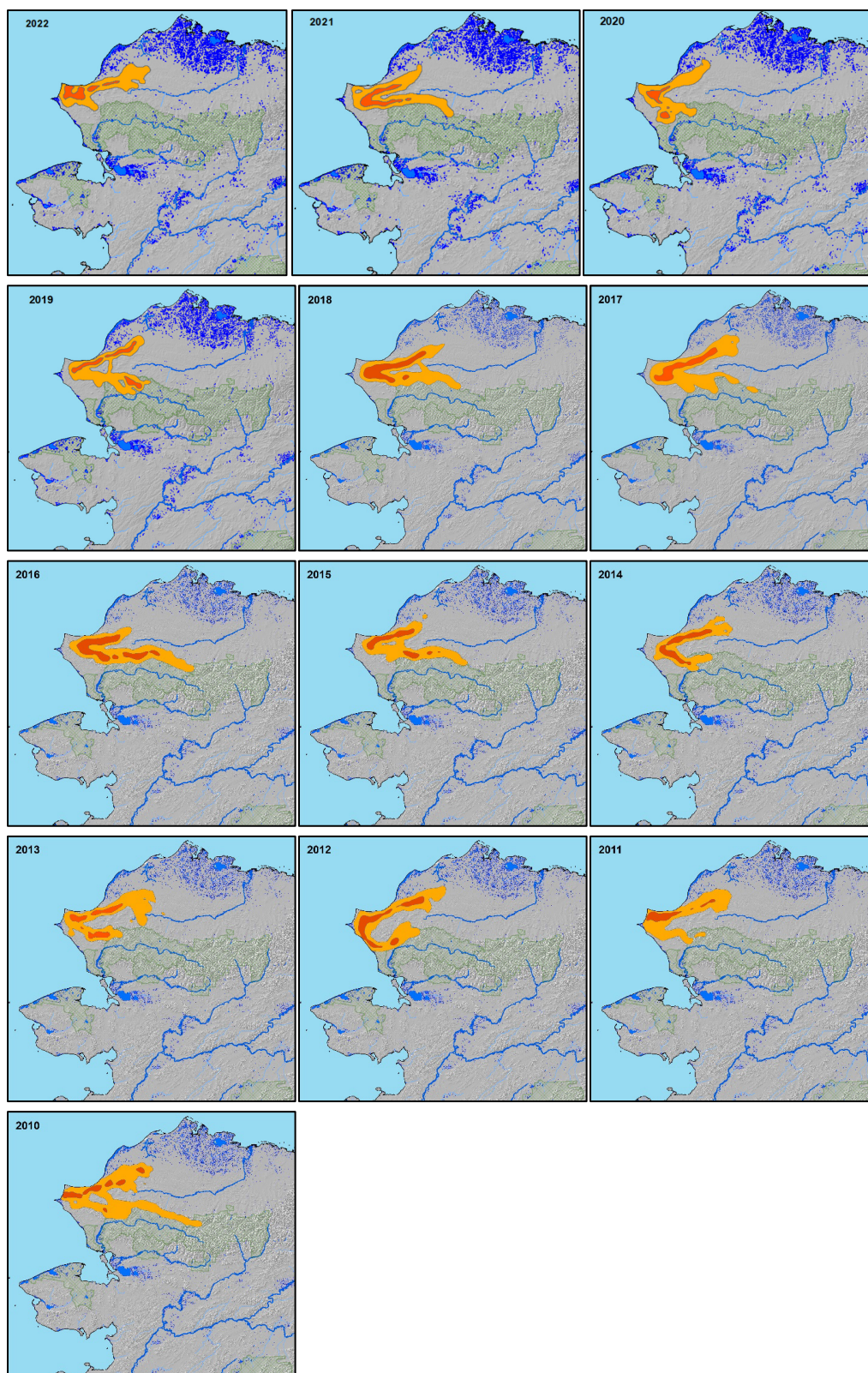


Figure 9. 2010–2022 insect relief (June 15–July 14) area use of Western Arctic Herd caribou. Light orange depicts the 95% kernel and dark orange the 50% kernel. Green hatched areas are Park units.

Table 6. Late-summer areas of Western Arctic Herd caribou late-summer (95% and 50% kernels for July 15–August 31).

Year	Sample Size	95% kernel area (km ²)	50% kernel area (km ²)
2023	106	32230	1034
2022	88	41671	2368
2021	72	46120	936
2020	68	19945	1104
2019	53	27437	243
2018	52	32126	432
2017	78	58281	4807
2016	81	47168	937
2015	51	44808	888
2014	46	53809	2687
2013	36	35253	359
2012	38	49736	2236
2011	39	64807	4373
2010	31	43859	2914

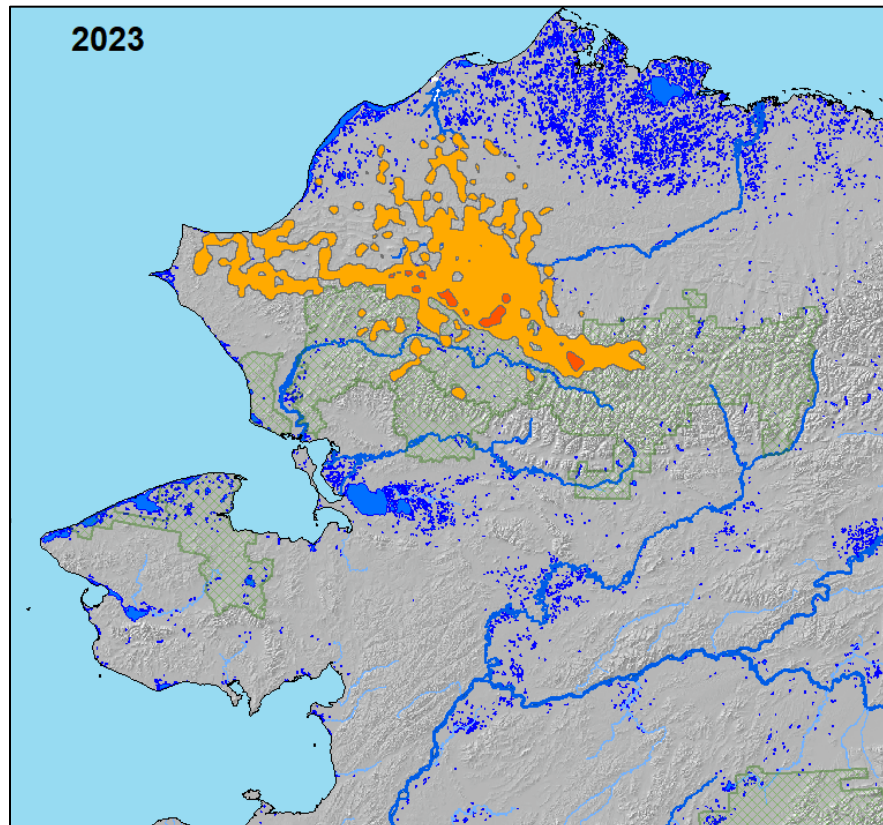


Figure 10. 2023 late-summer (July 15–August 31) range use of Western Arctic Herd caribou. Light orange depicts the 95% kernel and dark orange the 50% kernel. Green hatched areas are Park units.

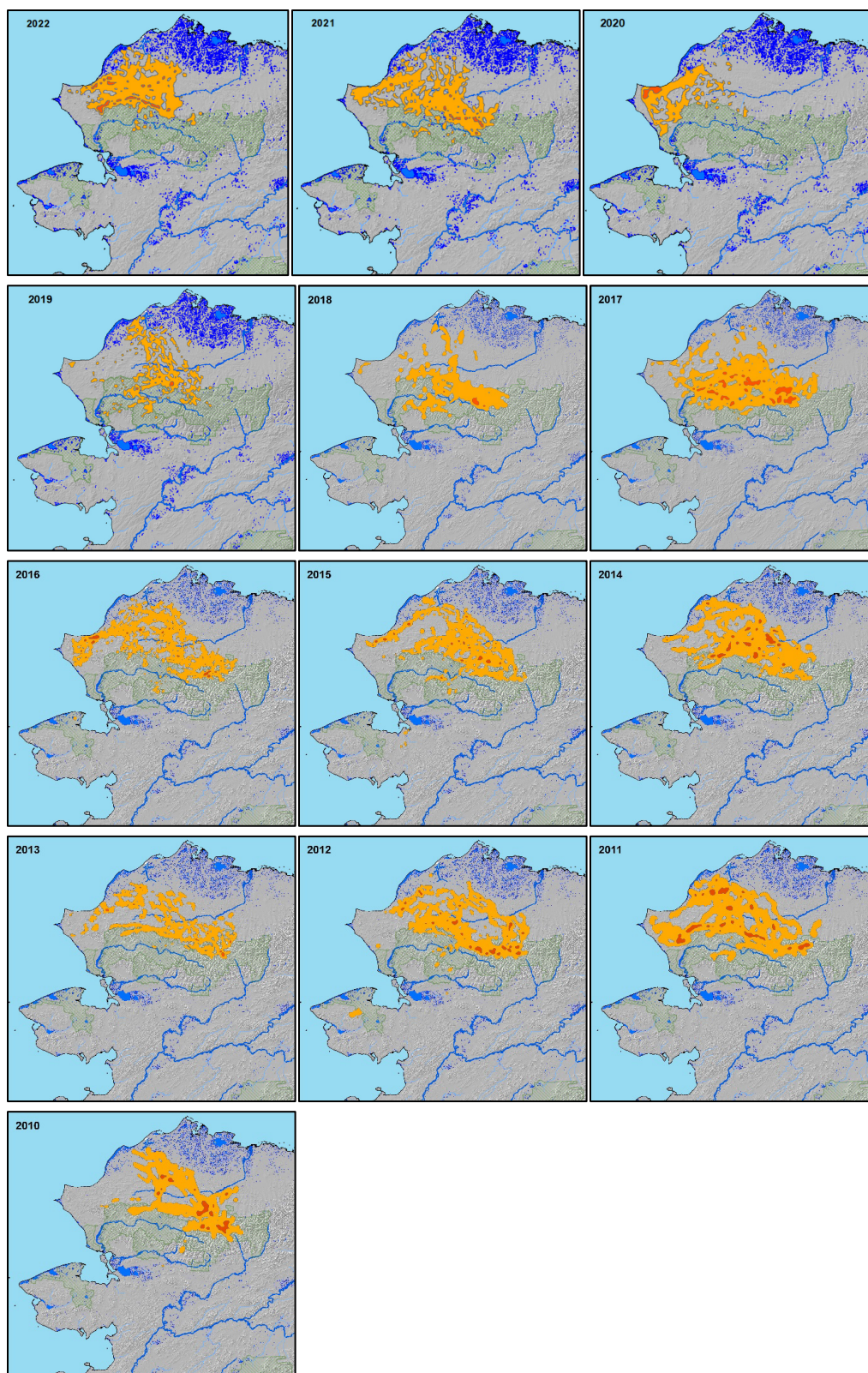


Figure 11. 2010–2022 late-summer (July 15–August 31) range use of Western Arctic Herd caribou. Light orange depicts the 95% kernel and dark orange the 50% kernel. Green hatched areas are Park units.

Distribution and Movements

Usage of the 5 ARCN Parks is detailed in Tables 7 and 8. For the 5th year in a row, no collared caribou migrated south to BELA. NOAT again recorded the highest percentage of use compared to other Parks in fall and summer, but not spring, which was unusual. While fall use of NOAT was greater than other parks, fall 2022 marked the lowest use of NOAT by this monitoring program. Likewise, KOVA had its lowest fall use ever reported. Migration took the bulk of the herd southeast, into the Brooks Range, rather than south of the Kobuk River. This led to both GAAR and NOAT having the 2nd greatest use in winter ever reported. All of the winter use in NOAT was tightly clustered in its northeastern-most corner. After 4 consecutive years of caribou using KOVA in winter, none did this reporting period. GAAR had the highest use of any park in spring 2023. This marks the only year other than 2021 in which spring use was greater in GAAR than NOAT. NOAT had its lowest recorded spring use ever in 2023. Summertime use of all 5 ARCN Parks were near or below to the long-term averages as caribou stayed further north. WAH caribou continued to exhibit some of the longest migrations and movements of any terrestrial mammal. The mean annual distance traveled by all collared caribou this reporting year decreased from last year and was below the long-term average (Table 9). No collared caribou interacted with the Delong Mountain Transportation System (DMTS, commonly referred to as the Red Dog Road) this reporting period.

Table 7. Percent of Western Arctic Herd (WAH) collars that entered 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). Fall (September, October, and November) and winter (December, January, February, and March). Averages are for all years.

Season	Sample Size	BELA	CAKR	GAAR	KOVA	NOAT
Fall 2022	89	0.0	0.0	27.0	14.6	32.6
Fall 2021	88	0.0	9.1	15.9	69.3	79.5
Fall 2020	70	0.0	0.0	65.7	22.9	74.3
Fall 2019	52	0.0	13.5	1.9	25.0	38.5
Fall 2018	52	0.0	17.3	40.4	32.7	73.1
Fall 2017	82	15.9	20.7	35.4	41.5	58.5
Fall 2016	77	42.9	11.7	10.4	45.4	63.6
Fall 2015	50	70.0	22.0	4.0	58.0	60.0
Fall 2014	46	82.6	8.7	19.6	50.0	71.7
Fall 2013	35	0.0	8.6	20.0	57.1	88.6
Fall 2012	38	26.3	7.9	10.5	36.8	84.2
Fall 2011	39	12.8	28.2	33.3	33.3	46.2
Fall 2010	29	3.6	0.0	51.7	62.1	89.7
Fall Average	57	19.5	11.4	25.8	42.2	66.2

Table 7 (continued). Percent of Western Arctic Herd (WAH) collars that entered 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). Fall (September, October, and November) and winter (December, January, February, and March). Averages are for all years.

Season	Sample Size	BELA	CAKR	GAAR	KOVA	NOAT
Winter 2022–2023	88	0.0	0.0	64.8	0.0	19.3
Winter 2021–2022	79	0.0	1.3	16.5	41.8	6.3
Winter 2020–2021	65	0.0	0.0	70.8	1.5	4.6
Winter 2019–2020	46	0.0	2.2	17.4	2.2	4.3
Winter 2018–2019	47	0.0	2.1	46.8	4.3	25.5
Winter 2017–2018	72	23.6	6.9	33.3	0.0	12.5
Winter 2016–2017	72	47.2	11.1	5.6	0.0	11.1
Winter 2015–2016	47	74.5	0.0	0.0	0.0	0.0
Winter 2014–2015	43	72.1	0.0	4.7	0.0	2.3
Winter 2013–2014	35	60.0	0.0	8.6	0.0	0.0
Winter 2012–2013	36	30.6	8.3	0.0	0.0	11.1
Winter 2011–2012	31	16.1	0.0	35.5	0.0	0.0
Winter 2010–2011	28	7.1	0.0	32.1	0.0	0.0
Winter Average	53	25.5	2.5	25.9	3.8	7.5

Table 8. Percent of Western Arctic Herd (WAH) collars that entered 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). Spring (April and May) and summer (June, July and August). Averages are for all years.

Season	Sample Size	BELA	CAKR	GAAR	KOVA	NOAT
Spring 2023	76	0.0	0.0	57.9	11.8	27.6
Spring 2022	73	0.0	1.4	11.0	53.4	86.3
Spring 2021	57	0.0	0.0	73.6	0.0	38.6
Spring 2020	41	0.0	2.4	17.1	22.0	43.9
Spring 2019	41	0.0	0.0	41.5	2.4	46.3
Spring 2018	62	25.8	0.0	32.3	12.9	51.6
Spring 2017	66	31.8	4.5	3.0	34.8	63.6
Spring 2016	46	76.1	0.0	0.0	19.6	84.8
Spring 2015	33	63.6	3.0	6.1	21.2	87.9
Spring 2014	35	45.7	0.0	8.6	14.3	88.6

Table 8 (continued). Percent of Western Arctic Herd (WAH) collars that entered 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). Spring (April and May) and summer (June, July and August). Averages are for all years.

Season	Sample Size	BELA	CAKR	GAAR	KOVA	NOAT
Spring 2013	30	13.3	0.0	0.0	66.7	70.0
Spring 2012	29	17.2	0.0	27.6	31.0	48.3
Spring 2011	28	3.6	0.0	35.7	42.9	82.1
Spring Average	47	21.3	0.9	24.2	25.6	63.0
Summer 2023	111	0.0	0.0	31.5	7.2	86.5
Summer 2022	102	0.0	0.0	2.9	2.9	79.4
Summer 2021	97	0.0	0.0	57.7	4.1	86.6
Summer 2020	70	0.0	14.3	0.0	0.0	60.0
Summer 2019	59	0.0	0.0	18.6	15.3	93.1
Summer 2018	55	0.0	0.0	67.3	29.1	94.5
Summer 2017	86	0.0	0.0	46.5	11.6	90.7
Summer 2016	80	1.3	0.0	36.3	10.0	96.3
Summer 2015	53	3.8	0.0	50.9	9.4	96.2
Summer 2014	57	0.0	0.0	43.9	0.0	80.7
Summer 2013	41	0.0	0.0	51.2	31.7	87.8
Summer 2012	39	2.6	0.0	59.0	20.5	92.3
Summer 2011	40	0.0	0.0	37.5	10.0	65.0
Summer 2010	30	0.0	0.0	90.0	10.0	100.0
Summer Average	65	0.6	1.0	42.4	11.6	86.4

Table 9. Annual distance (September 1–August 31) moved by GPS-collared Western Arctic Herd caribou cows. Average is for all years.

Monitoring Year	Sample Size	Mean Distance (SD)	Maximum Distance
2022–2023	65	2859 (271) km	3299 km
2021–2022	51	3039 (358) km	3833 km
2020–2021	50	2722 (322) km	3416 km
2019–2020	37	2538 (312) km	3138 km
2018–2019	32	2540 (362) km	3126 km
2017–2018	47	2854 (432) km	3820 km
2016–2017	55	2932 (523) km	3756 km
2015–2016	35	3110 (488) km	3827 km

Table 9 (continued). Annual distance (September 1–August 31) moved by GPS-collared Western Arctic Herd caribou cows. Average is for all years.

Monitoring Year	Sample Size	Mean Distance (SD)	Maximum Distance
2014–2015	22	3238 (521) km	4076 km
2013–2014	24	3392 (521) km	4404 km
2012–2013	34	3071 (304) km	3636 km
2011–2012	36	3085 (485) km	3758 km
2010–2011	39	3045 (323) km	3747 km
2009–2010	31	3254 (237) km	3724 km
Average	40	2977 (390) km	3683 km
Total	558	–	–

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 Tables 10 and 11. The timing of the fall 2022 migration was near the long-term average for all 3 rivers. However, the percentage of collared caribou crossing each river was markedly below average. For the Noatak River, the percentage crossing was a record low 27% and the percentage crossing the Kobuk (21%) and Selawik (14%) Rivers were both the 3rd lowest ever reported. For comparison, from 2010–2015, an average of 88%, 81%, and 76% of collared caribou crossed the Noatak, Kobuk, and Selawik Rivers, respectively. Overall, there is a general trend of less caribou crossing all these key rivers in fall over the last 13 years, reflecting a shift away from the southernmost winter ranges by the herd. The duration (the number of days between the average date of crossing the Noatak and Selawik Rivers) of the fall 2022 migration (32 days) was the shorter than the record longest duration of fall 2021 migration (58 days) but still longer than the long-term average (29 days). The average fall migration duration for the 7 years spanning 2010–2016 was only 18.4 days, a period when the herd had a more distinct southerly fall migration pattern. For spring migration, the timing of crossing the Selawik River was slightly earlier than the long-term average while the crossings of both the Kobuk and Noatak Rivers were the 3rd latest on record. This disparity led to the longest duration of spring migration on record (26 days). This is 9 days longer than the previous longest duration of spring migration (2019, 2022) and suggests that caribou on southern winter ranges encountered deep snow and were delayed in reaching the calving grounds to the north.

Table10. Fall migration timing and prevalence of river crossing events by Western Arctic Herd caribou. Reported results are average date (standard deviation in number of days); percentage of collared cows crossing; and sample size (N) results for generally southward 'fall' migration. Dates are for the first crossing if the individual re-crosses. Duration is the average number of days between Noatak and Selawik River crossings. Average (Avg) is for all years.

Year	Noatak River			Kobuk River			Selawik River			Duration
	Crossing Date (SD)	% Crossed	N	Crossing Date (SD)	% Crossed	N	Crossing Date (SD)	% Crossed	N	
2022	Sept 25 (20.6)	27.3%	88	Oct 12 (5.7)	20.5%	88	Oct 27 (9.2)	13.6%	88	32
2021	Sept 16 (24.2)	85.7%	84	Oct 16 (14.8)	73.2%	82	Nov 13 (12.8)	10.0%	80	58
2020	Sep 26 (23.0)	63.9%	72	Nov 3 (1.0)	5.6%	72	Nov 9 (0.6)	5.6%	72	44
2019	Sept 6 (42.7)	46.8%	47	Oct 16 (13.3)	36.2%	47	Oct 25 (14.4)	27.7%	47	49
2018	Oct 13 (28.6)	56.0%	50	Nov 3 (23.2)	20.0%	50	Nov 7 (16.1)	16.0%	50	25
2017	Sep 17 (40.0)	65.9%	82	Oct 30 (22.5)	48.1%	81	Nov 10 (18.2)	42.3%	78	54
2016	Sept 15 (21.1)	73.3%	75	Sep 24 (12.7)	58.1%	74	Oct 2 (15.4)	52.1%	73	17
2015	Sep 22 (29.5)	85.7%	49	Oct 1 (22.3)	85.4%	48	Oct 5 (21.0)	85.4%	48	13
2014	Sep 12 (19.9)	88.9%	45	Oct 1 (15.8)	84.8%	45	Oct 7 (15.6)	86.4%	44	25
2013	Sep 26 (16.9)	100%	35	Oct 7 (17.4)	91.4%	35	Oct 12 (16.4)	88.6%	35	16
2012	Oct 8 (20.8)	84.8%	33	Oct 11 (17.7)	78.8%	33	Oct 14 (18.1)	70.0%	33	6
2011	Sep 27 (37.2)	74.4%	39	Oct 13 (27.0)	71.8%	39	Oct 19 (27.4)	61.5%	39	22

Table10 (continued). Fall migration timing and prevalence of river crossing events by Western Arctic Herd caribou. Reported results are average date (standard deviation in number of days); percentage of collared cows crossing; and sample size (N) results for generally southward 'fall' migration. Dates are for the first crossing if the individual re-crosses. Duration is the average number of days between Noatak and Selawik River crossings. Average (Avg) is for all years.

Year	Noatak River			Kobuk River			Selawik River			Duration
	Crossing Date (SD)	% Crossed	N	Crossing Date (SD)	% Crossed	N	Crossing Date (SD)	% Crossed	N	
2010	Sep 24 (16.4)	96.7%	30	Oct 12 (17.6)	76.7%	30	Oct 24 (11.7)	62.1%	29	30
Avg	Sep 23 (26.2)	73.4%	55	Oct 14 (16.2)	58.0%	55	Oct 23 (15.1)	48.0%	54	29

Table 11. Spring migration timing and prevalence of river crossing events by Western Arctic Herd caribou. Reported results are average date (standard deviation in number of days); percentage of collared cows crossing; and sample size (N) 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. These later crossings are included in the results. Duration is the average number of days between Noatak and Selawik River crossings. Average (Avg) is for all years.

Year	Noatak River			Kobuk River			Selawik River			Duration
	Crossing Date (SD)	% Crossed	N	Crossing Date (SD)	% Crossed	N	Crossing Date (SD)	% Crossed	N	
2023	May 28 (5.3)	16.4%	67	May 18 (6.0)	13.4%	67	May 2 (14.1)	11.9%	67	26
2022	May 21 (14.3)	87.0%	69	May 8 (8.5)	54.2%	72	May 4 (7.3)	18.1%	72	17
2021	Apr 18 (27.1)	26.3%	57	May 9 (8.3)	8.8%	57	May 7 (6.7)	7.0%	57	NA
2020	May 19 (5.8)	45.9%	37	May 12 (5.3)	37.8%	37	May 3 (5.6)	27.0%	37	16
2019	May 12 (10.8)	34.1%	41	May 10 (7.4)	21.4%	42	Apr 25 (14.4)	23.3%	43	17

^a One caribou migrated south but stayed on the Seward Peninsula and did not migrate north in spring

Table 11 (continued). Spring migration timing and prevalence of river crossing events by Western Arctic Herd caribou. Reported results are average date (standard deviation in number of days); percentage of collared cows crossing; and sample size (N) 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. These later crossings are included in the results. Duration is the average number of days between Noatak and Selawik River crossings. Average (Avg) is for all years.

Year	Noatak River			Kobuk River			Selawik River			Duration
	Crossing Date (SD)	% Crossed	N	Crossing Date (SD)	% Crossed	N	Crossing Date (SD)	% Crossed	N	
2018	May 24 (7.4)	36.1%	61	May 18 (8.8)	37.7%	61	May 10 (6.8)	38.1%	63	14
2017	May 11 (4.6)	65.1%	63	May 2 (10.0)	61.9%	63	Apr 25 (5.3)	59.4%	64	16
2016	May 7 (8.4)	84.8%	46	Apr 28 (8.3)	84.8%	46	Apr 24 (8.6)	84.8% ^a	46	13
2015	May 18 (6.5)	84.4%	32	May 9 (6.2)	81.8%	33	May 3 (4.4)	82.3%	34	15
2014	May 8 (7.3)	91.2 %	34	Apr 27 (4.1)	88.2%	34	Apr 23 (3.6)	88.2%	34	15
2013	May 31 (6.2)	93.1%	29	May 26 (8.1)	79.3%	29	May 21 (10.2)	79.3%	29	10
2012	June 7 (26.7)	74.4%	43	May 29 (26.4)	69.7%	43	May 26 (27.5)	69.7% ^a	43	12
2011	May 18 (11.8)	96.3%	27	May 15 (5.8)	70.4%	27	May 9 (5.8)	55.5%	27	9
Avg	May 17 (10.9)	64.2%	47	May 12 (8.7)	54.6%	47	May 5 (9.3)	44.6%	47	15

^a One caribou migrated south but stayed on the Seward Peninsula and did not migrate north in spring.

Migration Routes

A histogram (Figure 12 and 13) of where caribou crossed the Noatak River provides a visual depiction of the geographic spread of the fall migration. Crossings of the Noatak continue to be variable. The 2022 migration was distributed very similarly to 2020 and 2021. The bulk of the caribou crossing the Noatak River did so towards the central portion of the river.

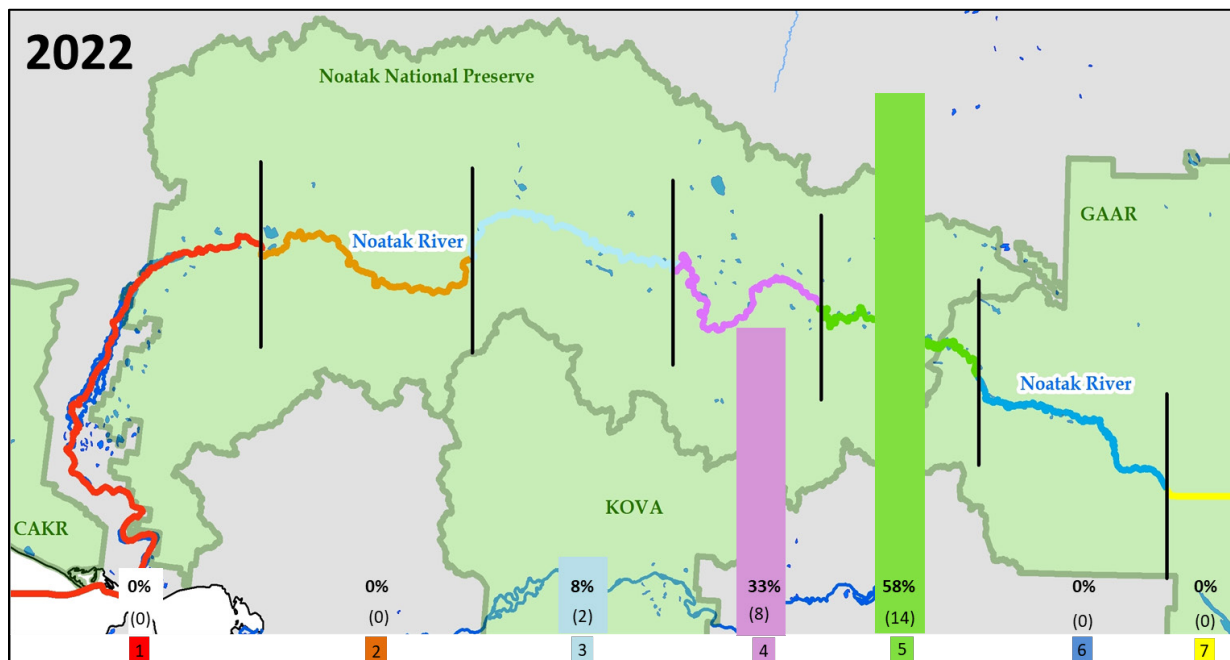


Figure 12. 2022 distribution of caribou crossing the Noatak River during fall. This histogram depicts where collared female caribou crossed the Noatak River, generally from north to south, on their fall migration. Relative percentages (top number) and absolute number (middle number) of caribou are provided. The river is divided into seven color-coded segments (labeled with numbers in the colored boxes along the bottom of the figure). The middle five segments are 100 river kilometers long, while the westernmost segment (red) is 200 km (before extending into the Chukchi Sea) and the easternmost (yellow) runs as far east as WAH caribou are known to migrate.

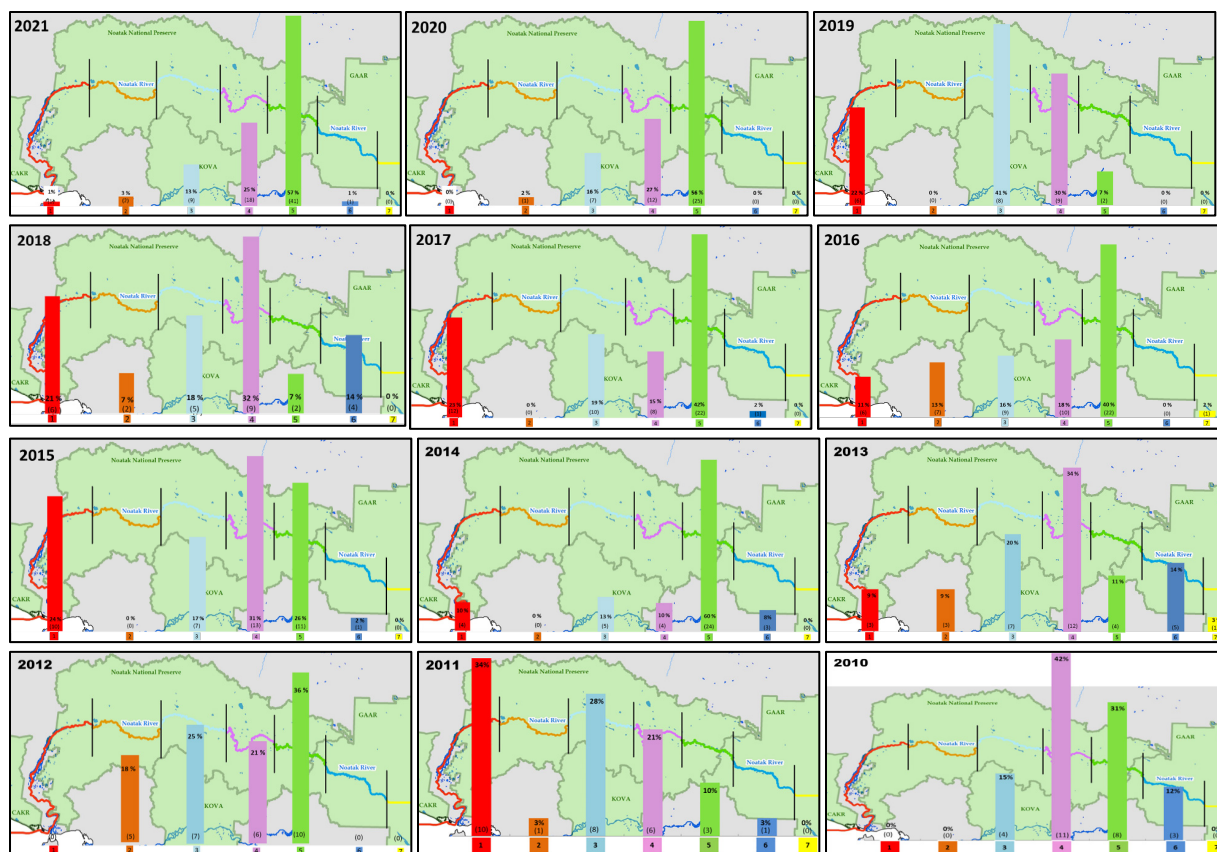


Figure 13. 2010–2021 distribution of caribou crossing the Noatak River during fall. This histogram depicts where collared female caribou crossed the Noatak River, generally from north to south, on their fall migration. Relative percentages (top number) and absolute number (middle number) of caribou are provided. The river is divided into seven (lowest number) color-coded segments which are displayed in the background. The middle five segments are 100 river kilometers long, while the westernmost segment (red) is 200 km (before extending into the Chukchi Sea) and the easternmost (yellow) runs as far east as WAH caribou are known to migrate.

The timing and distance of GPS-collared caribou came the closest to the villages of Noatak, Shungnak and Selawik, as well as Onion Portage, on their annual ‘spring’ and ‘fall’ migrations are detailed in Tables 13 and Table 14. Onion Portage, which has been used as a Kobuk River crossing by caribou for more than 10,000 years, is frequently utilized both during the fall and spring migrations (Anderson 1968). The fall 2022 minimum distance to Noatak was the 2nd farthest ever reported, with animals staying further north and east than in most years. The timing was the 2nd earliest caribou came closest to Noatak. In stark contrast to the previous year, when the distances to Shungnak, Selawik, and Onion Portage were some the shortest ever reported, the distance in fall 2022 were record longest for Selawik and Onion Portage and 2nd longest for Shungnak. It was the 2nd latest ever that caribou came their closest to Shungnak and latest ever for Onion Portage, but earlier than the long-term average for Selawik. The minimum distances in spring from all featured locations were greater than the long-term averages. The spring timing was mixed.

Table 12. Fall season minimum distance and date that collared Western Arctic Herd caribou passed the northwest Arctic villages of Noatak, Shungnak, and Selawik, and the historical caribou river crossing location of Onion Portage, KOVA. Reported results are average minimum distance in kilometers (standard deviation); average date of the minimum distance (standard deviation); and sample size. Results are for generally southward, fall (September–November) migration. Average is for all years.

Year	N	Noatak		Shungnak		Selawik		Onion Portage	
		Distance (SD)	Date (SD)	Distance (SD)	Date (SD)	Distance (SD)	Date (SD)	Distance (SD)	Date (SD)
2022	88	166.7 (59.5)	Sep 13 (13.7)	159.7 (85.8)	Nov 6 (24.8)	219.3 (88.6)	Oct 11 (29.4)	151.7 (84.5)	Nov 3 (27.3)
2021	73	144.2 (67.6)	Oct 4 (19.5)	60.1 (90.6)	Nov 9 (16.6)	90.0 (83.5)	Oct 26 (16.2)	54.5 (79.5)	Oct 19 (18.2)
2020	65	118.0 (54.4)	Sept 11 (17.8)	148.8 (101.9)	Oct 11 (20.8)	181.6 (85.0)	Oct 10 (21.7)	126.4 (92.9)	Oct 7 (16.2)
2019	46	155.5 (92.6)	Sept 27 (21.5)	169.1 (101.9)	Nov 4 (23.7)	178.4 (132.6)	Oct 16 (27.5)	145.2 (108.5)	Oct 24 (27.7)
2018	46	116.0 (85.1)	Oct 6 (27.2)	142.7 (73.0)	Oct 25 (31.9)	135.1 (82.7)	Oct 17 (34.4)	117.0 (65.1)	Oct 17 (32.8)
2017	69	135.9 (103.9)	Oct 5 (31.6)	138.6 (81.0)	Oct 30 (27.6)	138.9 (94.7)	Oct 25 (32.0)	115.5 (81.0)	Oct 27 (29.9)
2016	73	137.5 (88.3)	Oct 21 (33.4)	139.9 (100.6)	Oct 7 (28.5)	123.8 (107.5)	Oct 8 (23.6)	110.2 (97.4)	Oct 4 (26.6)
2015	49	132.7 (64.3)	Oct 23 (30.0)	132.0 (103.9)	Oct 3 (26.8)	86.3 (88.3)	Oct 6 (24.0)	93.2 (101.8)	Oct 2 (26.0)
2014	46	165.8 (76.5)	Oct 16 (26.9)	80.1 (88.2)	Oct 7 (23.6)	96.4 (95.7)	Oct 8 (18.8)	62.8 (87.6)	Oct 1 (22.5)
2013	35	146.8 (69.7)	Oct 14 (25.9)	83.8 (53.2)	Oct 11 (19.1)	63.9 (59.3)	Oct 15 (17.1)	60.4 (52.4)	Oct 9 (20.0)
2012	34	155.0 (61.1)	Oct 22 (31.7)	78.1 (87.1)	Oct 16 (19.9)	81.6 (49.9)	Oct 24 (20.0)	58.5 (71.6)	Oct 13 (19.8)
2011	39	123.8 (83.6)	Sep 30 (28.1)	140.0 (106.5)	Oct 19 (27.1)	118.4 (117.7)	Oct 12 (29.4)	122.8 (96.9)	Oct 14 (27.0)

Table 12 (continued). Fall season minimum distance and date that collared Western Arctic Herd caribou passed the northwest Arctic villages of Noatak, Shungnak, and Selawik, and the historical caribou river crossing location of Onion Portage, KOVA. Reported results are average minimum distance in kilometers (standard deviation); average date of the minimum distance (standard deviation); and sample size. Results are for generally southward, fall (September–November) migration. Average is for all years.

Year	N	Noatak		Shungnak		Selawik		Onion Portage	
		Distance (SD)	Date (SD)	Distance (SD)	Date (SD)	Distance (SD)	Date (SD)	Distance (SD)	Date (SD)
2010	29	176.8 (54.2)	Oct 7 (17.6)	36.6 (37.3)	Oct 8 (15.5)	86.1 (53.1)	Oct 20 (12.7)	32.6 (32.7)	Oct 3 (14.6)
Average	53	144.2 (73.9)	Oct 6 (25.0)	116.1 (85.5)	Oct 19 (23.5)	123.1 (87.6)	Oct 15 (23.6)	96.2 (80.9)	Oct 13 (23.7)

Table 13. Spring season minimum distance and date that collared Western Arctic Herd caribou passed the northwest Arctic villages of Noatak, Shungnak, and Selawik, and the historical caribou river crossing location of Onion Portage, KOVA. Reported results are average minimum distance in kilometers (standard deviation); average date of the minimum distance (standard deviation); and sample size. Results are for generally northward, spring (April and May) migration. Average is for all years.

Year	N	Noatak		Shungnak		Selawik		Onion Portage	
		Distance (SD)	Date (SD)	Distance (SD)	Date (SD)	Distance (SD)	Date (SD)	Distance (SD)	Date (SD)
2023	67	205.3 (28.2)	May 19 (11.1)	164.7 (84.3)	Apr 30 (13.5)	221.7 (72.4)	May 8 (9.5)	150.1 (76.1)	May 6 (12.0)
2022	63	182.3 (50.7)	May 20 (13.2)	80.2 (96.0)	Apr 26 (17.9)	127.5 (77.4)	May 2 (15.6)	63.1 (86.6)	May 6 (14.5)
2021	57	222.1 (58.2)	May 17 (11.5)	181.7 (84.0)	May 1 (15.3)	238.8 (84.9)	May 7 (13.2)	172.3 (72.6)	May 5 (13.5)
2020	37	203.9 (87.3)	May 18 (11.8)	177.4 (105.0)	April 29 (18.5)	190.5 (133.0)	May 5 (16.1)	152.0 (106.8)	May 5 (17.4)
2019	36	167.2 (65.7)	May 6 (18.1)	173.1 (63.4)	Apr 23 (15.6)	184.3 (89.1)	Apr 28 (16.4)	149.6 (57.4)	Apr 27 (14.9)
2018	53	189.0 (78.2)	May 21 (6.7)	149.8 (54.6)	May 4 (17.9)	149.9 (122.9)	May 8 (12.9)	131.0 (60.6)	May 7 (15.8)

Table 13 (continued). Spring season minimum distance and date that collared Western Arctic Herd caribou passed the northwest Arctic villages of Noatak, Shungnak, and Selawik, and the historical caribou river crossing location of Onion Portage, KOVA. Reported results are average minimum distance in kilometers (standard deviation); average date of the minimum distance (standard deviation); and sample size. Results are for generally northward, spring (April and May) migration. Average is for all years.

Year	N	Noatak		Shungnak		Selawik		Onion Portage	
		Distance (SD)	Date (SD)	Distance (SD)	Date (SD)	Distance (SD)	Date (SD)	Distance (SD)	Date (SD)
2017	61	167.8 (97.2)	Apr 30 (17.6)	164.2 (103.3)	May 1 (16.5)	126.4 (145.1)	Apr 28 (16.5)	129.5 (107.6)	May 5 (15.2)
2016	46	103.6 (78.0)	May 5 (9.6)	180.7 (68.1)	May 1 (12.7)	82.6 (107.8)	Apr 29 (12.7)	136.9 (71.2)	May 2 (12.4)
2015	37	124.4 (69.6)	May 9 (13.7)	162.9 (71.7)	May 5 (13.6)	69.5 (104.0)	May 2 (13.4)	120.7 (77.5)	May 7 (14.0)
2014	35	117.1 (81.1)	May 5 (8.5)	143.1 (28.7)	Apr 27 (7.8)	53.2 (85.5)	Apr 26 (8.3)	102.6 (45.9)	Apr 29 (7.4)
2013	30	138.5 (52.4)	May 23 (14.1)	123.9 (57.5)	May 18 (17.2)	58.3 (68.9)	May 11 (20.0)	79.4 (57.0)	May 19 (17.5)
2012	29	178.2 (97.2)	May 26 (7.7)	142.1 (69.4)	May 22 (10.3)	117.0 (116.7)	May 22 (9.8)	117.0 (72.5)	May 23 (10.3)
2011	27	202.3 (40.7)	May 20 (9.8)	74.5 (46.7)	May 9 (12.0)	110.3 (97.4)	May 12 (7.78)	64.8 (60.3)	May 15 (8.2)
Average	44	169.4 (68.0)	May 14 (11.8)	147.6 (71.7)	May 3 (14.5)	133.1 (100.4)	May 5 (13.2)	120.7 (73.2)	May 7 (13.3)

Western Arctic Herd Working Group

Several NPS employees, including ARCN's Caribou Vital Sign Monitoring Lead, attended and presented information at the December 2022 meeting, which was held in person after 2 years of teleconferences due to COVID-19 safety protocols. The Caribou Vital Sign lead acted as the NPS representative on the Technical Committee and contributed to the 'Caribou Trails' newsletters. NPS, through Western Arctic Parklands and GAAR, contributed financial and logistical support to the Western Arctic Caribou Herd Working Group and the Western Arctic Caribou Herd Technical Committee meeting.

New Products Completed Prior to the End of Reporting Period

Information on the WAH was disseminated in several mediums in the current monitoring year (see below). Most of the following products can be found on ARCN's Caribou Vital Sign webpage, which is located at <https://www.nps.gov/im/arcn/caribou.htm>; use the "Find all articles, report, and data here" link.

Technical Reports

Joly, K., and M. D. Cameron. 2022. Caribou vital sign annual report for the Arctic Network Inventory and Monitoring Program: September 2021–August 2022. Natural Resource Report NPS/ARC/NRR—2022/2484. National Park Service, Fort Collins, Colorado.
<https://doi.org/10.36967/2295319>.

Scientific Journal Articles

Bartsch, A., H. Bergstedt, G. Pointner, X. Muri, K. Rautiainen, L. Leppänen, K. Joly, A. Sokolov, P. Orekhov, D. Ehrich, and E. M. Soininen. 2023. Towards long-term records of rain-on-snow events across the Arctic from satellite data. *The Cryosphere* 17: 889-915. DOI: 10.5194/tc-17-889-2023.

Couriot, O., M. D. Cameron, K. Joly, J. Adamczewski, M. W. Campbell, T. Davison, A. Gunn, A. P. Kelly, M. Leblond, J. Williams, W. F. Fagan, A. Brose, and E. Gurarie. 2023. Continental synchrony and local responses: climatic effects on spatiotemporal patterns of calving in a social ungulate. *Ecosphere* 14 (1): e4399. DOI: 10.1002/ecs2.4399.

Prichard, A. K., K. Joly, L. S. Parrett, M. D. Cameron, D. A. Hansen, and B. T. Person. 2023. Achieving a representative sample of marked animals: a spatial approach to evaluating post-capture randomization. *Wildlife Society Bulletin* 47 (1): e1398. DOI: 10.1002/wsb.1398.

Outreach

ARC/N's Caribou Vital Sign Monitoring Team provided caribou information at grade school educational programs as well as multiple media outlets, Caribou Trails, and public presentations. Multiple presentations about work revolving around the Caribou Vital Sign were also presented at the joint meeting of the 19th North American Caribou Workshop and 16th Arctic Ungulate Conference held in Anchorage, Alaska in May 2023. The team also helped organize the conference. Presentations were also provided to the NPS' national Leadership Team, Alaska Region NPS staff, and USFWS Resource Information Technicians.

Discussion

GPS collars were deployed in the WAH for the first time in 2009. Since then, over 900,000 relocations have been collected during the first 14 years of vital sign monitoring. During this reporting period (September 2022–August 2023), 56 additional GPS collars were deployed, and 65 complete years' worth of data were collected. Due to the decreasing trend of collared caribou crossing the Kobuk River and late migration, net gunning was used again to deploy collars in April 2023. Our successful spring capture efforts highlight how effective helicopter deployments can be and we expect the need to continue employing this method as long as fall migration remains irregular and unpredictable for the WAH. Collaboration with the ADFG continues to be an integral part of achieving Vital Sign objectives and greatly improves the capacity of the program.

One of the most notable aspects of this monitoring year was the high mortality documented: just 73% of the caribou that were collared in the spring of 2023 survived through end of August 2023, marking the lowest 5-month survival rate of spring-captured caribou on record. This low survival rate was lower than all but 1 previously reported 12-month survival rate of fall captured caribou. The difficulties of the spring 2023 cohort were mirrored in the caribou that were collared previously: only 67 of 88 (76%) of these collared caribou survived the 6-month period from December 2022 through the end of May 2023. This suggests the winter of 2022-2023 was difficult for the WAH, but especially so for the individuals that overwintered south of the Brooks Range. Annual survival of the caribou collared prior to spring 2023 was 73% (65 out of 89). While this is a very low annual survival rate, it indicates that survival was decent outside of the winter and spring seasons. As part of the Caribou Vital Sign's periodic review, a comprehensive review of mortalities is nearly ready to be submitted for peer review and further research on the relationship between the environment and demographic parameters is underway. Adult survival has the largest impact on population trajectory for this herd and lower adult female survival has the potential to slow herd growth or even contribute to population declines. The last photo-census (2023) completed by the ADFG revealed a decrease in the population to 152,000 caribou (Alex Hansen, *personal communication*, 2022). Measures to improve cow survival, such as reducing cow harvest, currently hold the most promise to improve the herd's outlook.

Range use by GPS-collared cows during this reporting period was restricted compared to previous monitoring years, primarily due to the very few collared animals moving south of the Selawik River for winter, but not as much as the previous reporting year. The heavy use of the central Brooks Range led to the herd's annual distribution looking most similar to 2020-2021 and 2017-2018, with the core annual area in western GAAR. Winter distribution was clustered in 3 areas: the central Brooks Range, the upper Kobuk River valley, and the interior portion of the western North Slope. The herd did not range as far west in late-summer than it has in previous years. Interestingly, despite the overall larger range use than the previous year, the average annual movement (2859 km) decreased and was lower than the long-term average.

WAH caribou continued to use NOAT more consistently, over the course of the year, than other park units. This is likely due to its strategic location in relation to spring and fall migration routes as well

as containing summer habitat. However, use of GAAR was greater than NOAT in both the winter and spring seasons during this reporting period. Moreover, NOAT had its lowest use ever reported for the fall and spring seasons. After heavy use of KOVA in the winter of 2021/2022, no collared caribou were found there during the winter of 2022-2023, which is more reflective of the long-term average for this season. Overall, use of park areas besides GAAR was lower. For the fifth year in a row, no collared caribou used BELA this monitoring year. This represents a sharp change from previous use of BELA which was used every winter from 2010-2011 through 2017-2018. Similarly, no collared entered the Seward Peninsula this monitoring year. This is a remarkable turnaround from 7–8 years ago, when the Seward Peninsula represented a major winter area for the herd and 72–75 % of collared caribou wintered in BELA. No collared caribou came within the vicinity of the Red Dog Mine and the Delong Mountain Transportation System this monitoring year.

Range use this monitoring year was characterized by reduced migration for the WAH. After 1 year (fall 2021) of a relatively high percentage of collared caribou crossing the Kobuk River, the percentage crossing for fall 2022 (21%) was the 3rd lowest on record and only about ¼ of the average (82%) that crossed from 2010–2015. It was also the 3rd lowest percentage of caribou crossing Selawik River (14%). More surprisingly, the percentage crossing the Noatak River (27%) was, by far, a record low. This was due to many collared caribou staying north of the river and overwintering in western GAAR. For comparison, an average of 88%, 81%, and 76% of collared caribou crossed the Noatak, Kobuk, and Selawik Rivers, respectively, from 2010–2015. For the few caribou that did so, the average timing of the Kobuk River crossing in 2022 was near the long-term average. The first crossing of the Kobuk River (September 21) was 3 days later than average but the earliest since 2017. Similarly, the timing fall of 2022 crossing of the Noatak and Selawik Rivers were near long-term averages.

The root causes of these changing migratory and range-use patterns are unknown. Climate change is leading to snow and cold temperatures occurring later in fall, which may contribute to the delayed migration patterns we have been documenting (Cameron et al. 2021). Another potential factor in reduced and later migrations is the smaller size of the herd (Joly et al. 2021). After nearly 20 years of population decline, the herd is about a third of its peak size (490,000 individuals) in 2003. Smaller populations use less space than larger ones, thus smaller populations tend to have shorter migrations than larger ones. Winter and spring seasons with deep, wet snow can be difficult for caribou, and the spring of 2023 was characterized by these conditions in the mountainous region a majority of the herd overwintered (Sousanes and Hill 2023). The poor survival rate of caribou during the winter and spring of 2022–2023 suggests that the WAH faced these conditions, which may also affect the herd's population trajectory.

Delayed migration patterns have important implications for subsistence users of caribou: later migrations can coincide with rapidly decreasing temperatures and pan ice running in the river, which can prevent hunting and make travel difficult. Moreover, later arrival of caribou in fall can mean they arrive in some hunting areas during the rut, when the meat of males is unpalatable. This can increase harvest pressure on females and has the potential to put additional downward pressure on the herd.

Three scientific journal articles on caribou ecology were published. We were able to quantitatively confirm that female WAH caribou can be considered adequately mixed with the rest of the herd at calving to be considered representative of the herd (Prichard et al. 2023). This allows us to start utilizing data from newly collared data upon their first calving season after collaring. The second paper was an analysis of caribou calving across the North American Arctic. The study revealed there was continental-level synchrony in calving, but local conditions did impact timing. Specifically, deep, wet snow delayed, and in some cases prevented, caribou from reaching their calving grounds (Couriot et al. 2023). The last paper introduced new methods for detecting long-term trends in icing events within the ranges of northern caribou herds, including the WAH (Bartsch et al. 2023). Being able to identify and better understand icing events is important to increase our knowledge about the effects of winter conditions on caribou space use and survival. These research papers have important management implications. Further research is ongoing, such as the collaboration with USGS to analyze video collar data from their first round of deployments in 2021 to understand summer diet and activity patterns, and hopefully additional papers will be available for the next annual report. A large number of products and presentations, including these 3 scientific papers, have been developed in conjunction with monitoring this Vital Sign; most of which are available on-line at <https://www.nps.gov/im/arcn/caribou.htm>.

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