

TECHNICAL REPORT WOLF (DÌGA) MANAGEMENT PROGRAM JANUARY – OCTOBER 2024

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EXECUTIVE SUMMARY

The Tłıcho Government and the Government of the Northwest Territories (GNWT) are working together to implement management actions to reduce wolf (dìga) predation on the Bathurst (Koʻk'eeti) and Bluenose-East (Sahti) migratory barren-ground caribou (ekwoʻ) herds in response to conservation concerns related to significant population declines. The five-year program includes support for wolf harvesters to increase ground-based harvest of wolves, combined with a targeted research, monitoring and assessment program.

The GNWT and Tłįchǫ Government provided measurable wolf-centered objectives to the Wek'èezhìi Renewable Resources Board (WRRB) in response to WRRB's recommendation (#1-2020) and support an assessment of the impact and effectiveness of the program. Research and monitoring are important to help inform adaptive management of wolves, and to address the objectives of the current research and monitoring program. A summary of progress for each wolf-centered objective for the period of January 2024 to October 2024 is also provided. A comprehensive review of the five-year wolf management program will take place following this annual report.

1) Research and Monitoring. Undertaking research and monitoring to better understand wolf population abundance, movement and interaction with caribou on the winter range of the Bathurst and Bluenose-East herds is required to inform management actions and was identified as a measurable wolf-centered objective. One of the initial objectives for the wolf collaring program was to inform affiliation of wolves with specific caribou herds, but the program objectives were updated to reflect a broader focus on understanding wolf ecology in line with a recommendation from the WRRB.

Wolf collaring and movement. No collars were deployed in 2024 despite attempts due to poor weather (temperatures, high winds, and poor visibility). As of October 2024, 48 wolves have been collared over the preceding four years. The two remaining active collars were deployed in 2023 and 2021 and are scheduled to be released in 2025. An analysis of wolf movement patterns, cluster site investigations, and relationships with caribou movement will be conducted and presented in the five-year review report.

Den survey, pup count, and camera deployment. An aerial survey for wolf dens was conducted from May 24, 2024 to June 01, 2024 using a small-fixed wing aircraft on the Bathurst summer range. Seven active wolf dens were found during the 2024 survey, two of which were in the expanded study area in Nunavut, and one was found on an esker not flown in 2023. A survey in the same study area found two active wolf dens in 2023 compared to 22 active wolf dens found in 2012. When comparing the same study area as last year (excluding Nunavut and new eskers flown), three dens were found in 2024 and two dens were found in 2023, suggesting no significant change in the number of active wolf dens. Den sites were revisited

on August 09, 2024 and August 13, 2024 using a small-fixed wing aircraft and confirmed one to three pups present at three den sites. From September 4-8, 2024, cameras and autonomous sound recorders that had been deployed in 2023 were replenished and memory cards were retrieved. Analyses of camera images and sound recordings are currently underway.

Caribou winter distribution. Only 32.5% of the Bathurst range was overlapped by the Bluenose-East in October but increased to 48-68.8% for the remainder of the year similar to the overlap by the Beverly herd (34-56.6%). The Bathurst monthly winter ranges overlapped the Bluenose-East minimally in October (30.1%) and by variable amounts ranging from 71.6-90% November through May with the Beverly showing lower and variable amounts of overlap (16.2-34.6%) during the same time. Compared to last year, the magnitude of overlap decreased, but the overlap occurred in more months out of the year. Additionally, locations of collared caribou from herds monitored by the Government of Nunavut suggest there may be more herd mixing than previously thought. The high amount of spatial overlap likely had a strong influence on the distribution and abundance of wolves on the winter range of the Bathurst and Bluenose-East herds and the ability of the management program to target wolves predating on any particular herd.

2) Wolf Removal. The number of wolves removed annually through the five-year program was identified as a measurable wolf-centered objective. The GNWT and Tłıcho Government continued to provide enhanced support for wolf harvesters and the traditional economy, and closely monitored the ground-based harvest.

From January through May 2024, 141 wolves were harvested within the North Slave Enhanced Wolf Harvest Incentive Area (eWHIA) on the winter ranges of the Bathurst and Bluenose-East caribou herds. Hunting occurred primarily along the Tibbitt to Contwoyto winter road (49 wolves removed), around hunting camps set up by the Tłįchǫ Government (29 wolves), and by Inuit harvesters near Contwoyto lake (23 wolves). Forty wolves were removed by guided non-resident hunters. The number of wolves removed by ground-based harvest in the enhanced incentive area (incentive paid) has varied across years: 53 were removed in 2019-2020, 135 in 2020-2021, 50 in 2021-2022, and 98 in 2022-2023.

3) Measures of Effort. Catch-per-unit-effort (CPUE) metrics for wolf removals were identified as a measurable wolf-centered objective. Increased hunter-effort to find wolves may indicate that wolf numbers in an area are decreasing. Consequently, CPUE was calculated by measuring the effort of ground-based hunters (hunting days [CPUE-day] and distance traveled [CPUE-km]) per wolf removed and the hours flown per wolf sighted by survey crews.

Harvester Questionnaires and CPUE. Twenty-one questionnaires were completed between January 20 and May 2, 2024, and reflected 73 wolf harvests in the wolf harvest incentive area (out of a total harvest of 99 wolves because questionnaires were not provided for outfitted

hunts (n=40) or defense of life and property cases (n=2)). In 2024, CPUE-day for the Tłįchǫ Government's dìga harvest camp, Kugluktuk harvesters, and winter road harvesters was greater than all previous years. On average, the CPUE-day also increased from 2020-2024, suggesting more wolves were harvested over fewer days than previous years. The Tłįchǫ Government's dìga harvest camp reported a CPUE-km of 4.95 wolves/1,000 km in 2024, which was greater than 2023, 2022, and 2020, but was less than the CPUE-km from 2021 (8.3 wolves/1,000 km). Similarly, Kugluktuk and winter road harvesters reported a larger CPUE-km in 2024 compared to all previous years. On average, CPUE-km was highest in 2024, which suggests more wolves were harvested within a smaller distance than previous years. Further statistical modeling is needed to determine what factors, such as weather, harvester experience, and hunting in groups versus alone, influence harvest success of wolves. Basic comparisons of CPUE do not take these factors as well as assumptions made when forms are not filled out completely into account.

Hours flown per wolf sighted. No wolves were sighted during the March 2024 caribou collar deployment and consequently observations of wolves have decreased when compared to previous years of coordinated collar deployment of both wolves and caribou. Sighting rates of wolves during March caribou composition surveys decreased from 2010-2020 for the Bathurst herd. For the Bluenose-East caribou herd, sighting rates have generally stayed stable with the exception of seeing very few wolves in 2018 and zero wolves in 2021 and 2024. From 2020-2024, sighting rates of wolves in areas of high herd mixing and Beverly caribou only initially decreased and have slightly increased in the last year.

4) Demographics and Health. Age structure of harvested wolves was identified as a measurable wolf-centered objective. The GNWT committed to monitor the health, condition and demographics of wolves harvested through the five-year wolf management program. A sub-sample of wolves removed from the program undergoes a full necropsy. To determine if the age composition of harvested wolves has shifted from mostly adults to mostly young wolves (which may indicate a decrease in the wolf population), the age class of harvested wolves has been estimated and more accurate ages will be determined through cementum annuli analysis.

Eighty-four (39 males and 45 females) wolves of 99 harvested in the incentive area in winter 2024 were necropsied for demographics and health analyses. Age structure (based on tooth cementum age) was significantly lower in 2023 compared to 2021. Sample preparation and analysis of teeth for wolves harvested in 2024 is underway. A shift in age structure towards younger, immature animals is expected in a heavily harvested population. The probability of pregnancy did not vary over time when accounting for age class and harvest date. The number of pups being produced by females (litter size) also did not vary significantly over the program. Using multiple subjective and quantitative metrics of body condition, we did not detect a significant trend in nutritional status over time when taking age class into

account. Approximately 70% of wolf stomachs contained caribou, representing the most recent meal within the past 12-24 hours on average prior to harvest.

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INTRODUCTION

The Bathurst (Kǫk'èeti) and Bluenose-East (Sahtì) migratory barren-ground caribou (ekwǫ) herds have undergone significant declines in recent decades, resulting in serious and continued conservation concerns shared among co-management partners across the respective annual herd ranges in the Northwest Territories (NWT) and Nunavut (NU). The Bluenose-East population declined from an estimated 121,000 caribou in 2010 to 68,000 caribou in 2013 and 23,200 caribou in 2021 before rebounding to an estimated 39,500 individuals in 2023. The two most recent Bathurst surveys in 2021 and 2022 resulted in population estimates of 6,240 and 6,850, down from approximately 470,000 in 1996 (Adamczewski et al. 2022, 2023).

A variety of management actions for these two caribou herds have been implemented across their ranges within the NWT, including actions within and outside of the Wek'èezhìı management area¹ established under the Tłįchǫ Agreement. Because of the ongoing conservation concern for these two herds, the scope of management has extended beyond actions that initially emphasized implementing caribou harvest targets or total allowable harvests (WRRB 2010), including strategies focused on range disturbance and management of important habitat features (e.g. Bathurst Caribou Range Plan; see summaries in Wek'èezhìı Renewable Resources Board (WRRB) 2010, 2016a, 2016b, 2016c, 2016d, 2019a, 2019b) and reducing wolves (dìga) on the winter range of these two herds. Wolves are the primary predator of barren-ground caribou; wolf predation can influence the abundance of large migratory populations of caribou especially during the decline phase of cyclic populations (Couturier et al. 1990, Messier et al. 1988) and when caribou are at low numbers (Bergerud 1996, Messier et al. 1988).

Following the WRRB's (2016a, 2016b) recommendations on wolf management and completion of a wolf management feasibility assessment (WFATWG 2017), the Tłįchǫ Government and the Government of Northwest Territories (GNWT), Department of Environment and Climate Change (ECC) submitted a joint wolf management proposal to the WRRB in January 2020. The WRRB accepted the 2020 joint management proposal as a pilot project and approved a revised joint management proposal with a technical report in August 2020 (Nishi et al. 2020). The WRRB conducted a Level 2 review of the Revised Joint Management Proposal and other evidence submitted to the public record. The WRRB concluded that wolf management is needed to support

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¹ Although this report is focused in Wek'èezhìı, we also recognize the importance of co-management strategies and actions for Bathurst and Bluenose-East caribou that are also being implemented by other organizations across the herds' ranges including the Advisory Committee for Cooperation on Wildlife Management, Dél_lne ekwé Working Group, Kugluktuk Angoniatit Association, Łutsel k'e Dene First Nation, Nunavut Wildlife Management Board and Sahtú Renewable Resources Board.

caribou recovery and made 20 recommendations that were accepted or varied by the GNWT and Tłycho Government (Appendix A).²

The goal of the five-year wolf (dìga) management program is to sufficiently reduce wolf (dìga) predation on the Bathurst and Bluenose-East herds to allow for an increase in calf and adult caribou (ekwò) survival rates to contribute to the stabilization and recovery of both herds. This report summarizes wolf management and monitoring activities undertaken by GNWT and Tłącho Government during 2024. It provides an update to the previous reports on wolf management activities in Wek'èezhìi during winter 2020 (Nishi et al. 2020), 2021 (Clark et al. 2021), 2022 (Wilson et al. 2022) and 2023 (Wilson et al. 2023) and is intended to fulfill the WRRB's recommendation (#20-2020) that an "annual report be prepared by GNWT and TG and presented to the Board at a scheduled board meeting to allow for the discussion of adjustments in methodology based on the evidence, beginning fall 2021".

Specifically, the report provides an update on progress towards achieving the four wolf-centered objectives: 1) Research and monitoring, 2) Number of wolves removed, 3) Catch per unit effort and 4) Age structure of population. A comprehensive review of the five-year wolf management program will be completed following this annual report.

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² WRRB Reasons for Decision Final Report - 2020 Diga Management Proceeding.pdf

RESEARCH AND MONITORING

Wolf Collaring

Understanding wolf population abundance, movement, and interaction with caribou on the winter range of the Bathurst and Bluenose-East herds is important to help inform management actions. The collaring program addresses WRRB's recommendation (#11-2020) to: "continue the diga collaring program, beginning in 2021, using a statistically rigorous design to measure diga movements relative to the diga-ekwò spatial distribution, including reducing the uncertainties involved with assigning diga to ekwò herds." Since then, analyses (see Nishi et al. 2020, Clark et al. 2021, Wilson et al. 2022) have shown that movement patterns of collared wolves are highly variable with respect to caribou herds. In December 2022, the WRRB recommended that research and monitoring efforts should be centered on understanding wolf ecology rather than herd affiliation. The objectives of the wolf collaring program are similar to previous years, but have been updated:

- 1. Improve understanding of wolf movements within and between caribou herds.
- 2. Understand individual wolf movement and behaviour.
- 3. Quantify diet through kill site investigations.
- 4. Determine population trends through den surveys and pup counts.
- 5. Assess pack size and litter size through camera deployments at den sites.
- 6. Determine the fate, cause-specific mortality, and details of collar life through collar retrievals.

Capture and collaring of wolves adhered to GNWT Standard Operating Procedures using humane methods for the handling of wolves and was conducted under animal handling protocol WCC# NWTWCC2022-014 approved by the GNWT Wildlife Care Committee and GNWT Wildlife Research Permit #WL5011003.

March 2024 Capture and Handling

Between 6-13 March 2024, a team consisting of an experienced pilot and net-gunner, together with the ECC Wildlife Veterinarian and ECC Carnivore Biologist, attempted to carry out wolf capture and collar deployments based at Ekati Mine. However, poor weather (temperatures, high winds, and poor visibility) limited our ability to fly during this time and no collars were deployed.

Collar Retrieval

Stationary and released collars have been retrieved opportunistically throughout the program. From October 2023 to May 2024, five collars were investigated and retrieved. Three of these collars had been deployed in 2023 and prematurely dropped from the individual, as the release

³ www.gov.nt.ca/ecc/en/services/apply-research-observe-and-handle-wildlife-nwt/wildlife-care-committee

mechanism was intact, but the cotton insert was broken. The remaining two collars investigated were deployed on wolves in 2023 and 2022 and were later harvested; collars were returned to ECC. At this point in the program, 10% of collars are active, 19% are to be investigated (released and need to be retrieved, or stationary and need to be investigated), 40% were collected from a mortality (harvest or natural) and 31% have been investigated (retrieved or determined to be irretrievable; Table 1). Three collars are currently in NU (one released and two stationary), and ECC is working with the Government of Nunavut (GN) to retrieve these collars, investigate potential mortalities, and collect samples when possible.

Table 1. Status of wolf collars from 2020 to October 2024.

Wolf fate (2020 - October 2024)	Number (%) of collars
Active	2 (4%)
Released (to be retrieved)	1 (2%)
Stationary or malfunctioning (to be investigated)	11 (23%)
Harvested	8 (17%)
Mortality + assumed mortality ¹	15 (31%)
Released and retrieved ²	9 (19%)
Irretrievable	2 (4%)
TOTAL	48 (100%)

¹ Assumed mortality for two collars, as the mortality signal was received and classified as a stationary collar but needs to be investigated. Three collars were retrieved, but no details provided.

Discussion

As of October 2024, 48 wolves have been collared over the preceding four years (Tables 1 and 2). The two remaining active collars were deployed in 2023 and 2021 and are scheduled to be released in 2025. In combination with population surveys, den site investigations, and health screenings, this capture and handling program is intended to enhance monitoring efforts and improve our understanding of wolf movements within and between caribou herds on the central barrens. An analysis of wolf movement patterns relative to barren-ground caribou movements using GPS collar data from individuals of both species will be conducted and presented in the five-year review report.

² Four collars were removed and found on the ground, but the release mechanism was still intact for all collars. The cotton insert was broken on three of the four collars.

Table 2. Collar deployments and status from 2020-2024, as of October 2024.

Deplo	yed	Capture/Handling Mortalities (≤30 days from capture)	lities (≤30 Mortalities Stationary/Malfunctioning status (October 2024) capture) Mortalities Stationary/Malfunctioning status (October 2024)		Total Active Collars (October 2024)
2020a	13	4	5	1°	0
2021	19	0	6	6	1
2022	7	1	1	1	0
2023	9	0	0	3	1
2024	0	NA	NA	NA	NA
Total	48	5	6	11	2

^a One wolf was deemed unfit to release due to skin lesions and was euthanized (not related to capture and not included in table). Two wolves died during capture and were not fitted with collars.

Wolf Den Monitoring: Survey, Pup Count and Camera Deployment

ECC and the Tłįchǫ Government have been exploring ways to monitor trends in tundra wolf populations. Four vital rates influence wildlife population sizes, 1) survival, 2) reproduction, 3) immigration (movement of individuals into a population) and 4) emigration (movement of individuals out of a population). For wolves, newborn pups typically make up the largest age class in the pack, thus pup production, survivorship, and recruitment into the population are important components in determining trends in wolf abundance. Tundra-denning wolves tend to locate their dens on eskers or similar gravel/sand landforms formed by melting glaciers and often return to the same site each year, providing an opportunity to estimate trends in wolf numbers by tracking changes in wolf den site usage (occupancy) from aerial surveys. ECC has conducted wolf den surveys in spring and revisited all the active sites from that survey again in August to count pups for recruitment in 2012 (D. Cluff, ECC unpublished data) and 2023 (Wilson et al. 2023). The goal of this project was to conduct the same den survey and compare the results to the last survey in 2023 and 2012.

Methods

Over 100 wolf den sites in the NWT and NU are known from previous surveys and were revisited for activity (D. Cluff, ECC unpublished data 2012, D. Cluff, ECC unpublished report 2006). Late May and early June is an opportune time for the survey because wolves rest at the den site during the day and are easily visible. An aerial survey for wolf dens was conducted from May 24 to June 1, 2024, using a small-fixed wing aircraft on the Bathurst caribou summer range in the North Slave Region (Figure 1). The survey was based out of Gahcho Kue mine and Wekweètì. The survey

^b Post-capture mortalities were assumed to be from natural causes and not associated with capture or harvest. Two collars (2021) are assumed to be mortalities.

^c Malfunctioning collar was scheduled to be released on 15 June 2024; last location was 04 November 2023.

focused on identifying eskers, searching for new den sites, and investigating historical den sites, flying approximately 8,500 km over 58 hours (Figure 1). The survey route also optimized flying over eskers and esker-like habitat between known den sites and served as a way to find new den sites. The survey area was characterized by a 10x10 km grid cell used in previous surveys and was nearly identical to previous den surveys completed in 2023 and 2012, with a focus on following the esker denning habitat. Our spring 2024 survey extended into NU to locate dens previously identified in 2012 on the Bathurst summer range, making it much longer than the 2023 survey (25-21 May 2023; 4,637 km over 46 hours). Den sites were revisited on August 9 and August 13, 2024 using a small-fixed wing aircraft to confirm the number of pups present at each den site. From September 4-8, 2024, cameras and autonomous sound recorders that had been deployed in 2023 were replenished with new batteries and memory cards and 2023 memory cards were retrieved (Figure 2). Two cameras from one den site were moved to a new den site and cameras were deployed at an additional three sites, resulting in eight sites total (Figure 2). One ARU and three cameras were placed at seven of the eight sites, one pointed at the den hole(s) and the other two pointed along any trails leading to the den site (see Wilson et al. 2023).

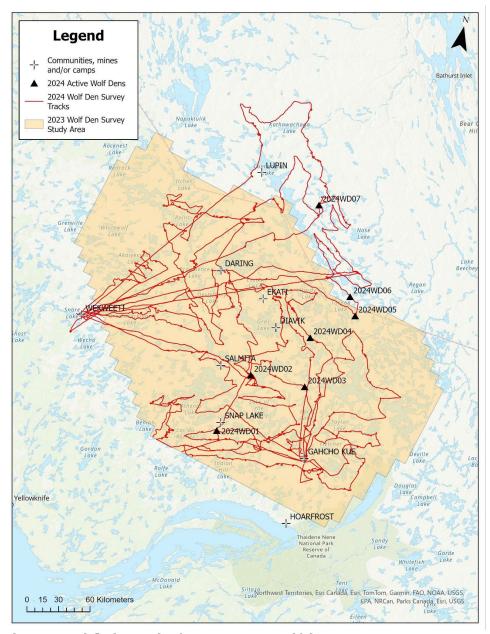


Figure 1. Study area and flight tracks for May 2024 wolf den survey.

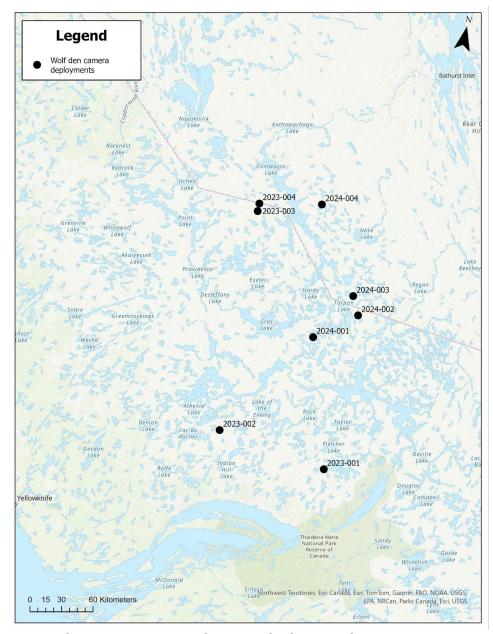


Figure 2. Camera and autonomous recording unit deployment locations.

Results

Seven active wolf dens were found during the 2024 survey, two of which were in the expanded study area in NU and one was found on an esker not flown in 2023. The survey crew also identified four sites where wolves were observed but no den site found. There were also five inactive dens with signs of fresh digging, suggesting potential activity. The survey crew observed 22 wolves in total, with pack sizes ranging from one to four wolves (Table 3). In late May/early June of 2023, a survey in the same study area found two active wolf dens compared to 22 active wolf dens found in 2012. When comparing the same study area as last year (excluding NU and

new eskers flown), three dens were found in 2024 and two dens were found in 2023, suggesting no real change in the number of active wolf dens. The two active dens found in 2023 were surveyed again this year; one was still active with a collared individual present at the den site and the other den was inactive. During the 2024 survey, five grizzly bears (one female with two cubs of the year and one female with a three-year-old cub) were also found.

The number of adults and pups sighted varied between August 9 and 13, 2024, likely due to differences in weather on those two days. On August 9, 2024, the weather was hot and windy with some intermittent heavy smoke, while on August 13, 2024, the weather was cool, mostly cloudy, and breezy from the northeast with no precipitation. When dens were revisited on August 13, 2024, one to three pups were sighted at three den sites and no pups were sighted at the remaining four den sites (Table 3). In late May/early June of 2012, a survey in the same study area found 22 active wolf dens and out of those dens, only one den site was confirmed to have a single pup and out of the two dens identified in 2023, zero to three pups were confirmed at each site. For comparison, the mean litter size of pregnant harvested wolves was 6.8 pups in 2020 (n=11), 8.6 pups in 2021 (n=13), 7.7 pups in 2022 (n=9), 7.5 pups in 2023 (n=15) and 7.5 pups in 2024 (n=8) (note that pup counts reported reflect number of observed implantations/fetuses in harvested females of that year and number of uterine scars in harvested females of the following year). However, this does not consider pup mortality rates before and after parturition. Given that the number of pups sighted is much lower than the number of pups in utero, it is reasonable to expect not all pups are surviving to adulthood.

Table 3. Number of adult wolves and pups sighted during den monitoring activities in 2023-2024.

Den Site ID from Aerial Survey	Camera ID	25-31 May 2024	09 Augu	st 2024	13 August 2024	
		Adults	Adults	Pups	Adults	Pups
2024WD07	2024004	2	3	0	4	2
2024WD06	2024003	4	6	0	7	3
2024WD05	2024002	2	4	0	2	1
2024WD04	2024001	3	5	0	0	0
2024WD03	No camera	2	0	0	0	0
2024WD02	No camera	1 ^a	0	0	0	0
2024WD01/2023WD02	2023002	1 (collared male)	0	0	0	0
2023WD01	2023001	0	NA	NA	NA	NA
No survey	2023003ь	0	NA	NA	0	0
No survey	2023004b	0	NA	NA	0	0

^a Revisited in May 2024 and saw no wolves.

All cameras deployed at den sites in 2023 were visited during the 2024 den survey to confirm cameras were still present and determine if wolves were present (Table 3). The one den that was active in 2024 and 2023 had cameras present at the den site to record pack size, pup survival, and pup mortality. Photos and sound recordings are being analyzed.

Discussion

Klaczek et al. (2015) demonstrated that wolves residing on the summer range of barren-ground caribou in the NWT and NU (i.e., Bathurst caribou herd) exhibited low reproductive success in denning areas and a decrease in density in response to caribou decline. Therefore, surveying regional wolf abundance and productivity at den sites located on the summer range of barrenground caribou may serve as a useful indicator of wolf abundance and trends over time in response to harvest. Our spring 2024 den survey revealed a similar number of wolves denning on the Bathurst summer range compared to late May/early June 2023 and 7.4x fewer dens compared to 2012.

Although wolves may relocate from a whelping den to a rendezvous site, this behaviour is not believed to have happened often when caribou were abundant (Klaczek et al. 2016). The same

^b 2023003 and 2023004 den sites were identified from GPS collar data, not observed on the May 2023 den survey.

esker systems were flown in 2023 and 2024 and the 2024 survey covered the same study area where active wolf dens were identified from 1996-2012 (Figure 3). The majority of active dens identified during this time have not been active during the last two years, suggesting a decrease in the wolf population. Understanding the distribution and recruitment of pups in late summer will help to determine if our den site monitoring is an effective index of wolf density. By combining GPS collaring with den surveys, we can determine and locate potential rendezvous sites for pup counts as well as camera and autonomous recording unit deployments. Den surveys may help to achieve the following objectives:

- Evaluate trends in wolf den occupancy and pup recruitment on the Bathurst caribou summer range.
- Investigate changes in spatial distribution of wolf den sites and pup survival on Bathurst caribou summer range.
- Investigate wolf fecundity and pup survival in response to the changing distribution and abundance of barren-ground caribou.
- Inform locations for June GPS collar deployments.
- Inform locations for deploying cameras and autonomous recording units to assess pack size, litter size, and survival for the next year, should the den be reused.

If wolves return to the same den site the following May, the ARUs can provide validation of wolf howls for developing wolf vocalization recognizers and identifying unique individuals and the cameras can provide images to assess pack size, litter size, and survival. A network of cameras at den sites would need to be maintained to determine trends and/or changes in these demographic parameters over time.

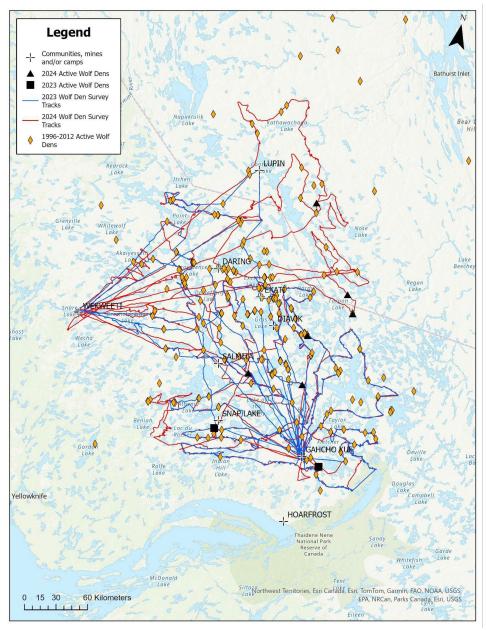


Figure 3. Study area and flight tracks for May 2023 and May 2024 wolf den surveys, active wolf dens for both years, and active wolf dens identified from 1996-2012.

Winter Distribution Patterns of Caribou in the North Slave Region

Grey wolves are a primary predator of barren-ground caribou and display strong spatial association with caribou (Musiani et al. 2007, Walton et al. 2001) especially during the winter (Hansen et al. 2013). In recent years (2021 onwards), barren-ground caribou herds have exhibited a greater amount of spatial overlap with adjacent herds, especially during winter (February-April) (Adamczewski et al. 2022, Clark et al. 2021, Nishi et al. 2020, Prichard et al. 2020). This may complicate application and evaluation of winter removal of wolves as a management action to help recovery of a specific caribou herd. Thus, understanding dynamics of

winter range use of caribou herds is integral to implementing and evaluating wolf management actions. The extent of overlap of the Bathurst, Bluenose-East, and Beverly herds during the fall and winter of 2023/2024 is reported on in this review.

Methods

Telemetry data collected by the GNWT between October 2023 and May 2024 were accessed for three herds: Bathurst, Bluenose-East and Beverly. Briefly, data were resampled to daily locations and restricted to include only collars that had at least ten daily locations per month and winter ranges were delineated using a kernel density estimation (KDE) approach on a monthly time scale (see Nishi et al. 2020, Clark et al. 2021, Wilson et al. 2022 and Wilson et al. 2023 for further details). The overlap of 2023-2024 monthly winter range boundaries between the three herds was quantified by calculating the percent of Bathurst and Bluenose-East herd ranges overlapped by the Bathurst, Bluenose-East or Beverly ranges and the percent that was part of all three herd ranges. Also calculated was the percent of each Bathurst and Bluenose-East monthly range not shared with the other two herds. Spatial analyses were conducted within the R environment (R Core Team 2024).

Results

Sample sizes of daily collar locations by month and herd are shown in Table 4. Herd is assigned to satellite collared female caribou in June of the year they are collared based on the calving ground used by the animal. Herd identity of collared bulls is established based on their late summer (July) distributions. Totals presented here include herd identifications from June 2024 applied retroactively to location data collected prior to herd assignment. The Beverly herd had the highest number of collars in March 2024 (n=62) compared to the Bluenose-East (n=73) and Bathurst (n=32) caribou herds but a much lower proportion of collared animals relative to herd size.

Table 4. Sample sizes of collared caribou by herd in 2023-2024.

	Bathur	st	Bluenose	e-East	Beverly			
	est. herd size: 6,8	851 (2022)	est. herd size: 39	9,525 (2023)	est. herd size: 103,400 (2018)			
Month	# Collared Caribou	#Locations	# Collared Caribou	# Locations	# Collared Caribou	# Locations		
October	29	899	59	1829	68	2107		
November	29	869	59	1769	68	2039		
December	29	863	59	1822	68	2108		
January	27	827	57	1756	68	2106		
April	26	779	73	2160	59	1737		
May	26	789	70	2156	55	1702		
February	26	751	56	1616	66	1884		
March	32	896	73	1969	62	1880		

Figure 4 shows monthly KDE utilization distributions for Bluenose-East, Beverly and Bathurst caribou herds from October to December 2023 showing the movement into and during rut in October, post-rut movements in November and subsequent movement onto winter ranges through December. Figure 5 shows monthly KDE utilization distributions for Bluenose-East, Beverly and Bathurst caribou herds from January to May 2024 showing the high amount of spatial overlap of the three herds during that time period.

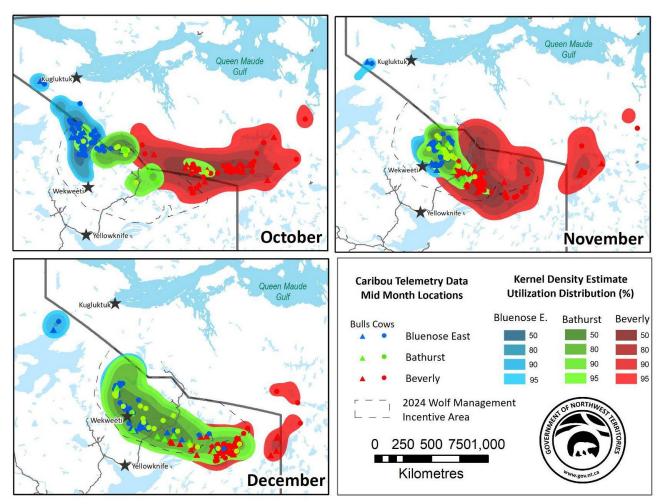


Figure 4. Monthly utilization distributions from October to December 2023 for Bathurst, Bluenose-East and Beverly caribou herds based on kernel density estimates.

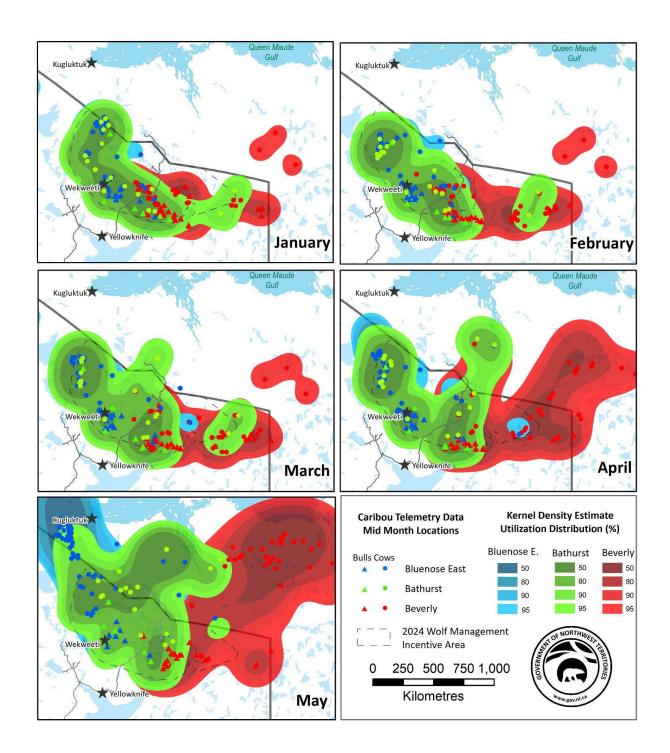


Figure 5. Monthly utilization distributions from January to May 2024 for Bathurst, Bluenose-East and Beverly caribou herds based on kernel density estimates.

Table 5 provides a summary of the spatial overlap of the Bathurst herd 95% home range contours overlapped by Bluenose-East and Beverly herds individually and combined from

October 2023 through May 2024. As seen in recent years, the winter range of the Bathurst herd was overlapped by both the Bluenose East and Beverly herds. Only 32.5% of the Bathurst range was overlapped by the Bluenose-East in October but then increased to between 48% and 68.8% for the remainder of the year. The Bathurst and Bluenose-East herds had less overlap at the beginning and end of winter in 2023 compared to 2024 but overlap in both years was still markedly higher compared to 2022 (see Wilson et al. 2022, Wilson et al. 2023). The Beverly herd overlapped the Bathurst monthly ranges by 34-56.6% and showed a more even overlap across months compared to Bluenose-East. Complete overlap of the monthly ranges of Bathurst by the Beverly was not observed in 2024. Both the Beverly and Bluenose-East herds started to overlap the Bathurst winter range in November (25.8%) and stayed relatively consistent throughout the year (13.2-21.7%; Table 5). In March and April 2024 (when the majority of wolf harvests occur), 48-56.4% of the Bathurst herd was overlapped by the Bluenose-East herd and 45.7-48.6% of the Bathurst herd was overlapped by the Beverly.

Table 5. Spatial overlap of collared Bathurst caribou monthly ranges (based on 95% kernel utilization distribution isopleths) with collared Bluenose-East and Beverly caribou during the 2023/2024 harvest season. No overlap represents the amount of territory where solely Bathurst caribou resided. Both herds overlap represents the amount of territory shared among all three herds.

	Bathurst			Bluenose-East		Beverly		Both Herds Overlap	
Month	Total Area (km²)	No Overlap (km²)	No Overlap (%)	Overlap (km²)	Overlap (%)	Overlap (km²)	Overlap (%)	Overlap (km²)	Overlap (%)
October	43,713.4	14,644.8	33.5	14,215.6	32.5	14,854.0	34.0	1.0	0.0
November	37,830.2	981.8	2.6	25,187.8	66.6	21,404.6	56.6	9,744.0	25.8
December	119,396.1	11,529.1	9.7	82,196.6	68.8	47,723.9	40.0	22,053.6	18.5
January	156,587.6	22,939.8	14.6	87,888.3	56.1	79,730.1	50.9	33,970.6	21.7
February	154,932.9	22,884.5	14.8	82,746.1	53.4	81,130.7	52.4	31,828.4	20.5
March	189,054.2	38,428.7	20.3	90,668.0	48.0	86,390.7	45.7	26,453.2	14.0
April	177,374.1	19,140.1	10.8	100,127.0	56.4	86,183.4	48.6	28,076.5	15.8
May	234,976.8	39,788.9	16.9	137,562.4	58.5	88,625.0	37.7	30,999.6	13.2

Table 6 provides a summary of the spatial overlap of the Bluenose-East herd 95% home range contours overlapped by Bathurst and Beverly herds individually and combined from October 2023 through May 2024. In late fall and winter of 2023/2024, the Bathurst monthly winter ranges overlapped the Bluenose-East minimally in October (30.1%) and by variable amounts ranging from 71.6-90% November through May, which is higher than last year and 2022. The Beverly herd monthly winter ranges overlapped Bluenose-East with a similar pattern; no overlap in October (0%) and variable amounts in November through May (16.2-34.6%). Both Bathurst and Beverly overlapped Bluenose-East monthly winter ranges the least in October (0%) before and during the rut, and then spatial overlap varied from 16.1-34.6% from November through May (Table 6).

Table 6. Spatial overlap of collared Bluenose-East caribou monthly ranges (based on 95% kernel utilization distribution isopleths) with collared Bathurst and Beverly caribou during the 2023/2024 harvest season. No overlap represents the amount of territory where solely Bluenose-East caribou reside. Both herds overlap represents the amount of territory shared among all three herds.

	Bluenose-East			Bathurst		Beverly		Both Herds Overlap	
Month	Total Area (km²)	No Overlap (km²)	No Overlap (%)	Overlap (km²)	Overlap (%)	Overlap (km²)	Overlap (%)	Overlap (km²)	Overlap (%)
October	47,217.2	33,001.6	69.9	14,215.6	30.1	1.0	0.0	1.0	0.0
November	33,809.0	8,208.6	24.3	25,187.8	74.5	10,156.6	30.0	9,744.0	28.8
December	91,305.1	9,108.5	10.0	82,196.6	90.0	22,053.6	24.2	22,053.6	24.2
January	98,302.3	10,414.0	10.6	87,888.3	89.4	33,970.6	34.6	33,970.6	34.6
February	94,196.1	11,139.1	11.8	82,746.1	87.8	32,139.3	34.1	31,828.4	33.8
March	103,816.2	9,385.9	9.0	90,668.0	87.4	30,195.5	29.1	26,453.2	25.5
April	121,435.5	14,962.7	12.3	100,127.0	82.5	34,422.3	28.3	28,076.5	23.1
May	192,246.7	54,506.4	28.4	137,562.4	71.6	31,177.4	16.2	30,999.6	16.1

Figure 6 shows collared caribou locations of Bathurst, Bluenose-East and Beverly caribou March 1, 2023 and March 1, 2024. The maps also include the GN collars on the Qamanirjuaq, Ahiak, Wager Bay and Lorillard herds for those dates. There has been a high level of mixing of these herds in recent winters, especially in the eastern part of the North Slave Region, NWT. The potential for movement between herds is also substantial, as collared cow fidelity among the Beverly, Ahiak, Lorillard and Wager Bay herds tends to be lower than the 96-98% commonly seen in NWT herds, suggesting that cows are moving between herds (Campbell et al. 2022). It is difficult to know how much of the mixing of the Ahiak, Lorillard and Wager Bay herds into the NWT is a new phenomenon or how much it reflects an increased collaring effort in the last few years from the GN. M. Campbell (personal communication to J. Adamczewski 2023) indicated that GN substantially increased collar numbers on the Wager Bay, Lorillard and Ahiak herds in the last two years (Campbell et al. 2022). Regardless, the presence of at least four caribou herds in the Enhanced Wolf Harvest Incentive Area (eWHIA) likely increases the number of wolves in the area and, in turn, may affect predation pressure (positively or negatively) on one particular caribou herd.

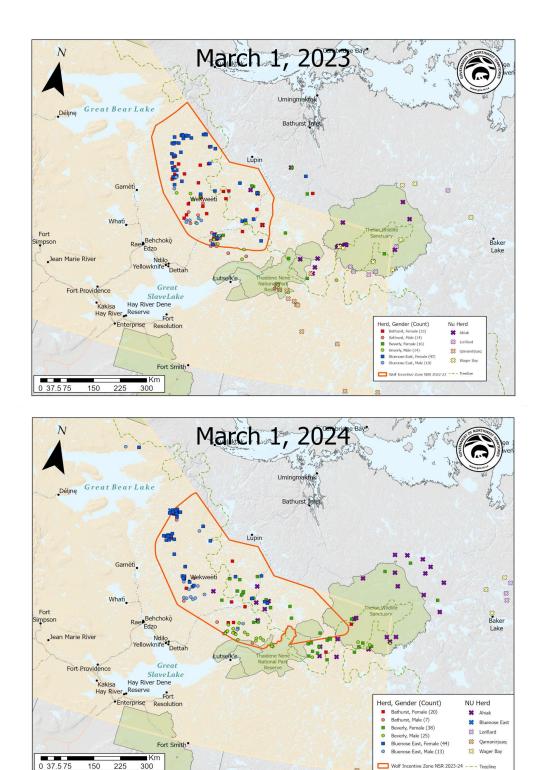


Figure 6. Collared caribou locations of Bathurst, Bluenose-East, Beverly, Qamanirjuaq, Ahiak, Wager Bay and Lorillard herds March 1, 2023 and March 1, 2024.

Discussion

The high amount of spatial overlap by all three herds in winter 2024, but especially in March and April, resulted in increased caribou density on the winter range compared to if the herds remained separated. The Bluenose-East herd was almost entirely overlapped by Bathurst and Beverly caribou herds in March. Compared to last year, the magnitude of overlap was lower, but the overlap occurred in more months out of the year. Additionally, locations of collared caribou from herds monitored by the GN suggest there was more herd mixing. The high degree of spatial overlap likely had a strong influence on the distribution and abundance of wolves on the winter range of the Bathurst and Bluenose-East herds and the ability of the management program to target wolves predating on any particular herd.

WOLF REMOVAL

GNWT's North Slave Wolf Harvest Incentive Program

Wolves are harvested as a furbearer and as big game in the NWT. Since the 2008-2009 harvest season, the North Slave Region (NSR) has administered a region-wide harvest incentive program to encourage more wolves to be harvested in the NWT as part of the traditional economy and to reduce wolf predation on Bathurst and Bluenose-East caribou (Cluff 2019a). The incentive began as \$100/carcass (skinned) for any wolf harvested within the region, dropped to \$50/wolf skull for the 2013-2014 and 2014-2015 harvest years but then increased to \$200/carcass (skinned or unskinned) during the 2015-2016 harvest season. The wolf harvest incentive was increased to further support caribou herd recovery.

An additional harvest incentive area for wolves was introduced in the 2018-2019 harvest season (Cluff 2019b). This enhanced wolf harvest incentive area was established where the Bathurst and Bluenose-East caribou herds were expected to winter in 2018-2019 and came into effect in January 2019. The incentive for harvesting a wolf (skinned or unskinned) in this new area that year was \$900/wolf for both Indigenous and resident hunters. In winter 2020 the financial incentive in the wolf harvest incentive area was increased to \$1,200/wolf and tag fees were rescinded across the NWT (cf. General Hunting Licence holders don't require a tag). The wolf harvest incentive area was implemented in January 2021, 2022, 2023 and 2024. In the latter three years, it was extended to the NWT and NU border to accommodate northward spring migratory movements of Bluenose-East and Bathurst caribou, respectively.

Methods

For the 2023-2024 wolf harvest season, the boundaries for the wolf harvest incentive area were again based on mid-January 2024 locations of female and male caribou from both the Bathurst and Bluenose-East herds. In winter 2024, the wolf harvest incentive area encompassed 122,639 km², which was larger than the 91,871 km² area in 2023 and the 97,464 km² area in 2022 (Figure 7). Harvesters received \$1,200 per carcass if the wolf was killed inside the eWHIA or \$200 per carcass when the wolf was killed outside the eWHIA. In addition to providing carcass payments, GNWT arranged for an Indigenous harvester to skin any submitted wolf carcasses with the hide on. Skinners would take possession of the pelt afterward. If a harvester shot and also skinned the wolf from the eWHIA and prepared the pelt for auction, they could receive \$1,950 per wolf (\$1,200 for the carcass, \$400 for the pelt and \$350 prime fur bonus). If the pelt sold for more than \$400, then the skinner would receive the difference between that price and the \$400 advance payment. Locations of harvested animals are reported by the hunter and the grid cells used for harvest reporting are 10x10 km.

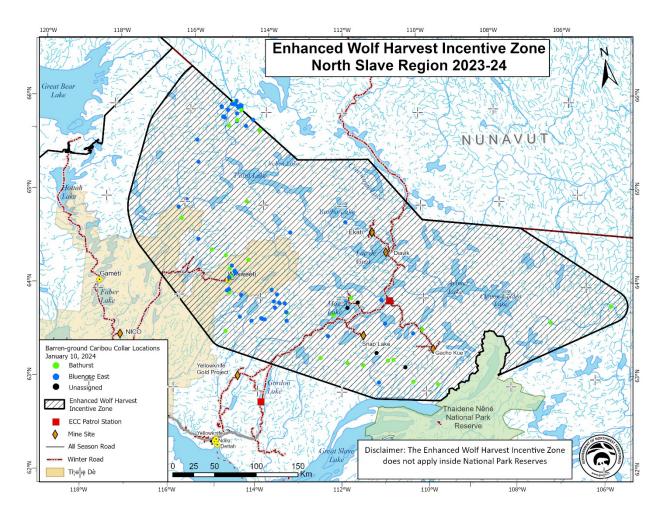


Figure 7. The 2024 Enhanced Wolf Harvest Incentive Area in the NWT to facilitate barrenground caribou recovery. The area is based on mid-January 2024 locations of collared caribou for the Bathurst and Bluenose-East herds.

Results and Discussion

During winter 2024, two hunting camps specifically for harvesting wolves were set up with GNWT support, one with Tłįchǫ hunters at Mackay Lake and another with Inuit hunters from Kugluktuk based at Contwoyto Lake and Pellatt Lake, NU. Although Inuit may harvest wildlife from their traditional use area within the NWT, permission was obtained from WRRB for the GNWT to issue a Special Harvester Licence (SHL) for Inuit hunters to hunt wolves in Wek'èezhìı. The WRRB supported the request on the basis it should promote recovery of the Bluenose-East and Bathurst caribou herds.

In total, 154 wolves were removed from the NSR in 2023-2024, 141 inside and 13 outside of the harvest incentive area, making it the third highest harvest year since 2010 (Table 7). The sex breakdown of the 154 wolves harvested was 67 females, 82 males and five where sex was not identified. Total incentive paid was \$123,600 for 103 wolves harvested in the wolf harvest

incentive area (no incentive paid for the 40 wolves harvested in outfitted hunts) and \$2,600 for the 13 wolves harvested outside the area (\$200/wolf). There were 1,366 free wolf tags issued in the NWT in the 2023-2024 hunting season, and of those 847 were issued in the North Slave Region (NSR).

Table 7. Number of wolves harvested within the NSR Region from 2010-2024. The harvest season spans 01 July to 30 June annually. The incentive began in 2010 as \$100/carcass (skinned) for any wolf harvested within the region, dropped to \$50/wolf skull for the 2013-2014 and 2014-2015 harvest years but then increased to \$200/carcass (skinned or unskinned) during the 2015-2016 harvest season. In 2018-2019, an additional incentive area was created and harvesters received \$900/wolf. From 2019-2020 to 2023-2024, harvesters received \$1,200/wolf removed within the incentive area which varies in extent each year.

Outside of Within Wolf Incentive Within Incentive **Total from** Total of all **Harvest Year** Harvest Area **Incentive** Wolves Area Incentive (Incentive (No incentive paid) Removed Area Area paid) 2010-2011 41 41 n/a 2011-2012 80 80 n/a 2012-2013 56 56 n/a 2013-2014 24 24 n/a 2014-2015 35 35 n/a 2015-2016 48 48 n/a 2016-2017 73 n/a 73 2017-2018 40 40 n/a 2018-2019 7 59a 1 b 67 60 2019-2020c 72 54 126 53d 1e 2020-2021 22 135^d135 157 $1^{e} + 19^{f}$ 2021-2022 22 50^d 70 92 2022-2023 $1^{e} + 44^{f}$ 16 98^d 143 159 2023-2024 13 99d $2^{g} + 40^{f}$ 141 154 Total 549 494 109 603 1152

The Tłįchǫ Government's dìga harvesting camp harvested 29 wolves (11 female: 18 male) from March 1-12, 2024 and March 21-26, 2024, all within the wolf harvest incentive Area (Figure 8). At \$1,200/wolf, that yielded a total harvest incentive payment from GNWT of \$34,800. The Inuit camp involved four hunters from Kugluktuk during April and May 2024 and harvested 23 wolves

^a\$900 incentive/wolf carcass (skinned or unskinned).

^b wolf euthanized by ECC.

^c An additional 36 wolves were removed by aerial removal, but not included in this table.

d\$1,200 incentive/wolf carcass (skinned or unskinned).

^e mortality from a vehicle collision.

foutfitters; no incentive paid.

^g Defence of Life and Property kill and one wolf kill submitted from Wekweètì; no incentive paid.

(14 females, nine males) in the incentive area (Figure 8). The GN did not pay their hunters to remove wolves within the NWT in 2024; therefore, ECC paid \$1,200/wolf for a total compensation to Kugluktuk harvesters of \$27,600. Another 49 wolves (24 females, 25 males) were taken in the wolf harvest incentive area by 14 hunters (Indigenous and resident hunters) accessing the Tibbitt to Contwoyto winter road (Figure 8). GNWT paid the \$1,200 incentive for 51 carcasses from Indigenous and resident hunters (total value \$61,200). There was also one wolf killed at the Gahcho Kué Mine (no incentive paid) and one wolf submitted from Wekweètì (no incentive paid).

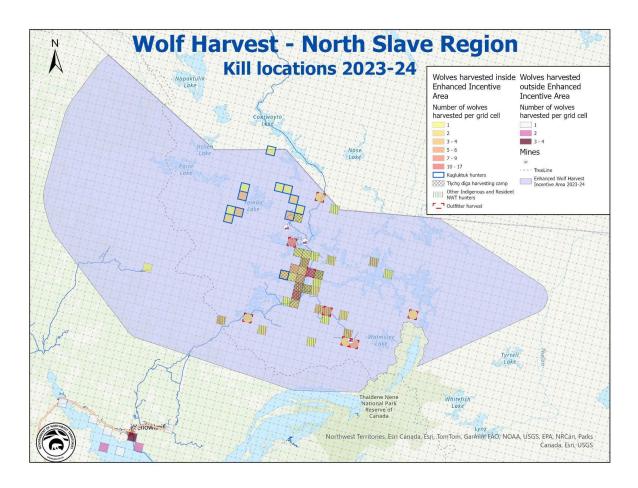


Figure 8. Location of 154 wolves harvested from 57 grid cells (10x10 km) in the NSR, 2023-2024. Most wolves were harvested inside (141) the enhanced wolf harvest incentive area, with 13 harvested outside. Location data were not provided for six harvested wolves. Grid cell fill colours (yellow to red) indicate the total number of wolves harvested in each cell, and cell outlines/fill patterns indicate which group of hunters harvested in each grid cell. Boundaries for the wolf harvest incentive area were based on the winter locations of collared Bathurst and Bluenose-East caribou in mid-January 2024 within the NSR.

The median number of wolves harvested per hunter was two (Figure 9). The Inuit camp averaged 7 wolves/hunter (S.E.=0.58, n=3 hunters, range 6-8 wolves/hunter), while the Tłycho

Government's diga harvesting camp averaged 4.8 wolves/hunter (S.E.=1.77, n=5, range 1-10 wolves/hunter). Other Indigenous and resident NWT hunters harvested an average of 2.6 wolves/hunter (S.E.=0.56, n=17 hunters, range 1-9 wolves per hunter). A total of 24 different individual hunters received the \$1,200 incentive in 2023-2024.

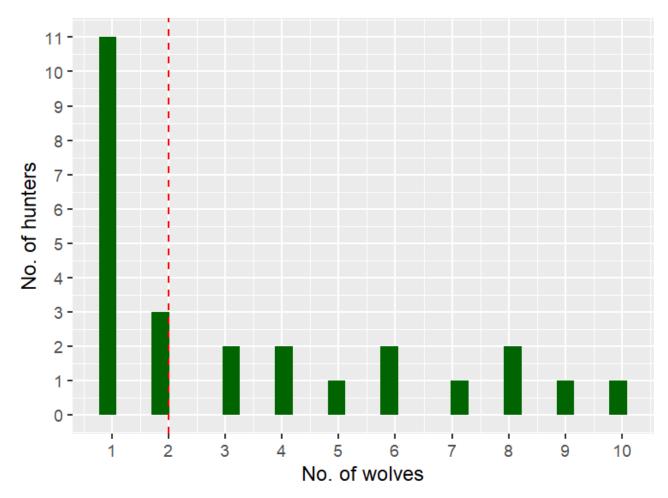


Figure 9. Number of wolves harvested per hunter (median = 2 [red dashed line]) within the enhanced wolf harvest incentive area of the NSR, 2023-2024. Outfitted hunters harvested 40 wolves and are limited to 2 wolves/hunter and are not included here. Of the remaining 101 wolves harvested, 29 are from a Tłįchǫ wolf hunting camp, 23 by NU hunters hunting in their asserted territory within the NSR, 47 by other Indigenous and resident NWT hunters (tags required), one Defence of Life and Property kill at the Gahcho Kué mine (no incentive paid), and one wolf submitted from Wekweètì (no incentive paid).

Outfitted hunts for wolves typically involve non-resident hunters, who are not eligible to receive the incentive and have not submitted any carcasses. Most of these hunters kept the head/skull of the wolves they shot. Reporting of harvest metadata (location of harvest, sex of wolf and effort of harvest) as well as carcass collections were not required from outfitted hunts. Much of the information below was provided voluntarily by the outfitter upon request. Some key information like sex of the wolf was often not recorded, but discussions were held with the outfitter to

facilitate collection of this data in subsequent years. The kill locations provided were descriptive, and therefore they are approximate. We used these descriptions to identify the mostly likely grid cell for plotting. Kill site coordinates are estimated using the grid cell centroid. There were 40 wolves harvested by non-resident hunters in 2023-2024 (Figure 8). The reported sex ratio of these wolves was 17 females and 23 males. The 40 wolves were removed over seven grid cells (Figure 8) and ranged from two to 15 wolves killed/grid cell and averaged 5.7 wolves/grid cell (S.E.=1.82). By comparison, wolf harvest by non-resident hunters totaled 44 wolves in 2023 and 19 wolves in 2022.

Another 13 wolves (two females, six males and five unknown sex) were harvested by ten hunters (six Indigenous and four resident) outside the wolf harvest incentive area but within the NSR (Figure 8). At \$200/carcass for these wolves, a total incentive payment of \$2,600 was paid.

Thcho Government's 2024 Community-based Diga Harvesting Camp

Through implementation of the Tłıcho Agreement, the Tłıcho Government and citizens have been undertaking programs that emphasize their role as stewards within their traditional territory. With an emphasis on direct on-the-land activities by staff and citizens, Tłıcho Government has implemented three innovative programs in Ekwò monitoring and Dìga management respectively. The Ekwò Nàxoède K'è (Boots on the Ground) program was initiated in 2016 with the objectives to examine the conditions of and health of hozìi ekwò (barren-ground caribou) on its summer range, focusing on four key indicators: (1) habitat; (2) ekwò, condition; (3) predators and (4) industrial development. The program is led by Tłycho Government, with collaborative support from ECC and WRRB (Tłycho Government 2021). In 2020, Tłycho Government implemented the Ekwò Harvest Monitoring program focusing efforts on monitoring harvest on the Beverly ekwò along the Tibbitt to Contwoyto Winter Road. Objectives of the winter road program also focuses on educating and promoting traditional harvesting laws as well as ensuring Tłycho harvesters are following the rules of the "no-hunting zone" (Mobile Core Bathurst Caribou Management Zone). The third program is the Diga Harvesting Program. In 2019, the Tłycho Government implemented the Diga Harvesting Program with the main goal to sufficiently reduce dìga predation on the Koketi Ekwò and Sahti Ekwò herds to allow for an increase in calf and adult ekwò survival that would contribute to stabilization and subsequent recovery of both herds. Based on the WRRB's review and recommendation (#4-2020 Predator4), Tłicho Government initiated a community-based Diga Harvesting Program in the winter 2019/2020 alongside ECC's Enhanced North Slave Wolf Harvest Incentive Program. Presented below are sections of the full

⁴ Wek'èezhìı Renewable Resources Board. 2019. Reasons for Decisions Related to a Joint Proposal for the Management of the Kok'èetì Ekwò (Bathurst ekwò) Herd. Wek'èezhìı Renewable Resources Board. 53pp. + 8 Appendices.

report that summarizes the implementation of the community based diga harvesting program for the 2023/2024 season. The full report can be requested from Tłącho Government.

Methods

Prior to the 2023-2024 winter hunting season, a meeting with the wolf harvesters and advising elders took place in Behchokò on November 9-10, 2023. In this meeting we explored the option of focusing efforts in the Mackay Lake area rather than going to the Roundrock Lake area again. At the meeting, we had more participants from Wekweètì so that we could get the perspective from the community members and get an idea of the wolf abundance in that area to help in our decision. One of the reasons for changing locations was because of the concern with weather and the conditions for traveling from Behchokò to Wekweètì; a long trip of 8-12 hours by snowmobile.

In previous years, the hunting crew would depart Behchokò by snowmobile early in the day to arrive in Wekweètì at a reasonable hour. However, this has not been the case, at times the trip would take almost 12 hours or more to get to the community. During the winter of 2023, the trip from Behchokò to Wekweètì took even longer than usual, because unseasonably warm temperatures caused snow to be wet and slushy with overflow near creeks, rivers, and lakes. Due to these unfavorable conditions, the hunters were exhausted when they arrived in the community; one traveler was injured on the trip.

Unfortunately, the ice road to Wekweètì is generally not constructed early enough to support operations for the start of the wolf program. By the time the ice road is open in mid-March, the ekwò and dìga have generally started moving north reducing accessibility to hunters. Because we chose to focus our efforts in the Mackay Lake area, we had to wait until the Tibbitt to Contwoyto winter road opened. Like last year, we have been experiencing warmer temperatures than usual and this caused a lot of uncertainty on when the program would start. The winter road opened two weeks later than usual; it usually is open by January 31 but it did not open till February 12. The mean temperatures for Wekweètì, which has a similar latitude and climate as the Mackay Lake area, ranged from -43°C to -9°C in February, which is typically one of the coldest months of the year. The temperature was relatively mild because it had few occurrences where it was below -30°C. There were many factors considered in planning the program and we developed alternative plans for the different scenarios that may arise. At the end of the meeting, we decided that the route to Mackay Lake would be easiest and should support efforts to target wolves that were among the Bathurst herd. We selected two suitable camp locations at Mackay Lake (Figure 10) that would be accessible by winter road and not require aircraft charters. The plan was that the hunters would get dropped off along the road at the potential camp site, then they would take all their gear and set-up camp, but it was suggested that maybe we use True North Safari's lodge when the hunters first get out there until they could find an adequate location to set up camp. So, we reached out to True North Safaris to see if they could accommodate us until we were able to identify a good camp location and they agreed.

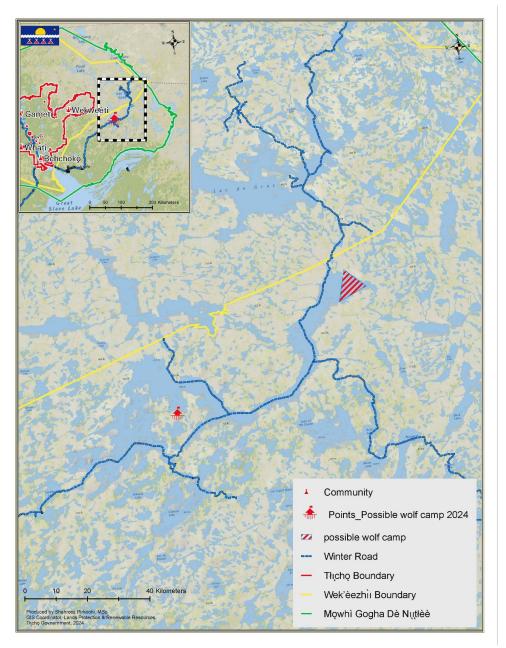


Figure 10. Possible camp locations identified during the diga harvesters meeting in Behchokò on November 9-10, 2023.

Reconnaissance

Each year before the program starts and once a camp location has been determined by the elders and harvesters, a request is made to ECC to do a reconnaissance flight to confirm if there are any sightings of diga or ekwò in the area we choose to set up camp. For the first two years (2019-

2020), ECC has done these surveys but due to the difficulty that the COVID-19 pandemic brought, logistically it was not feasible to be done for the 2021/2022 season. Rather than a reconnaissance survey done by aircraft, local harvesters were hired to scout the area to determine if there was any diga activity. For the 2022/2023 season, a reconnaissance survey was done just prior to the program starting, a couple of days before. During the 2023/2024 season, there was no reconnaissance survey done.

Camp Preparation

With the True North Safaris Lodge, there was not much camp preparation that needed to be done. In previous years when the camp was located at Roundrock Lake, we hired residents of Wekweètì to set up camp just before the hunter's arrival, we did not have to do this for this year. The intention was that once the hunters arrived at Mackay Lake, they would stay at the True North Safaris Lodge only until they set up their own camp, this did not happen, they stayed at the Lodge the entire time they were out hunting – it was logistically easier for them to stay there.

Team Dynamics

Typically, the teams consist of eight people, which includes, a cook and camp helper, and six hunters. This year in the first crew we had two cooks and five hunters and in the second crew we had only three hunters. The cook and camp helper make sure the hunters are fed before going out harvesting and to have the camp ready when hunters return. The camp helper gets firewood if needed, maintains a tidy camp, and helps the cook prepare meals. Among the harvesters, there are designated roles such as a k'àowo (foreman), and a safety person. The k'àowo makes decisions including daily plans, travel routes for the day and prayers each day. The safety person is usually the designated first aid person who leads safety meetings, maintains electronic equipment (satellite phone, InReach, and GPS) and is responsible for tagging and storing of harvested dìga and must complete the harvester questionnaires provided by ECC. After each dìga is harvested, the ECC questionnaires are filled out and submitted to the program manager at the end of their rotation.

Hunting Methods

Each day consists of a safety meeting in the morning to plan for the day and determine hunters' travelling routes. The hunters would break up into groups. In the first crew they had a group of two and a group of three hunters and in the second crew all three hunters travelled together. One Garmin InReach is given to each group of harvesters, and one is kept at the camp with the cooks. Each group has an InReach to record distances travelled and hunting locations and to also use as a safety communication device.

The harvesters go out by snowmachines in the morning, search for signs and look for diga. Once a diga is spotted, they start the chase. During the chase, sometimes they would break up so that

they can reach the diga at separate angles and the one person with the best angle would take the shot. If the diga is wounded but still on the go, they will go after it with the kill shot. Once the diga is shot, the hunter will insert the muzzle of the gun into the diga's mouth, pay respects and thank it for its life, tag it and put it into a heavy plastic bag then it is stored until the carcasses are picked up.

To follow Tłįchǫ Elders' recommended protocols, immediately after shooting a dìga it was placed into a thick plastic bag so that the dìga's blood would not spill onto the snowmobiles or the sleds. Before putting the carcass into the bag. The harvesters did not want to skin the dìga at camp and so the carcasses were picked up by a Tłįchǫ harvester who skinned the wolves and took the carcasses to ECC in Yellowknife. Following Tłįchǫ protocols, typically the carcasses were sent straight to Yellowknife so that there would not be any blood of dìga dropped in any of the Tłįchǫ communities as requested at the elders meeting.

Results

The plan was for the diga crew to start shortly after the monitors from the Ekwo Harvest Monitoring Program started which was on February 16; a couple of days after the winter road opened. We wanted to get insight from the ekwò crew on abundance of dìga in the area before sending out a diga harvesting crew. There was a lot of feedback from hunters and the ekwò monitors indicating that there were a lot of diga in the Mackay Lake area. The plan was set for the diga hunters to head out to the True North Safaris Lodge on March 2; once they arrived at the lodge they were to scout for a suitable location to set up camp at the same time as hunting for dìga. There was an abundance of ekwò in the area the entire time our hunters were there. Ekwò hunting was occurring at the same time, so the area was very busy with diga and ekwò hunters. With the amount of ekwò in the area this made for easy hunting for the ekwò hunters as well as for dìga and so the dìga hunters focused on the area where there was heavy ekwò hunting (Figure 11). Initially, hunters saw many diga in the Mackay Lake area. The first crew consisted of five hunters with two cooks and were out for ten days (March 2-12) and harvested 22 diga during that time (Figure 12). The plan was to stop hunting when the crew stopped seeing diga or by March 12 because two hunters had prior commitments. But since hunters were still seeing diga, we planned to send out another crew. There was too much going on at the time in the communities which made it difficult to find participants to switch out the first crew with; so we gave the participants on the first crew an opportunity to return to camp but only three wanted to, so we sent them back out on March 21 till the 26th, where they harvested an additional seven dìga (Figure 12). In total, we harvested 29 dìga for the Dìga Harvesting Program in 2024. Table 8 shows the total amount of diga harvested through the Tłycho Government's diga harvesting camp since its inception.

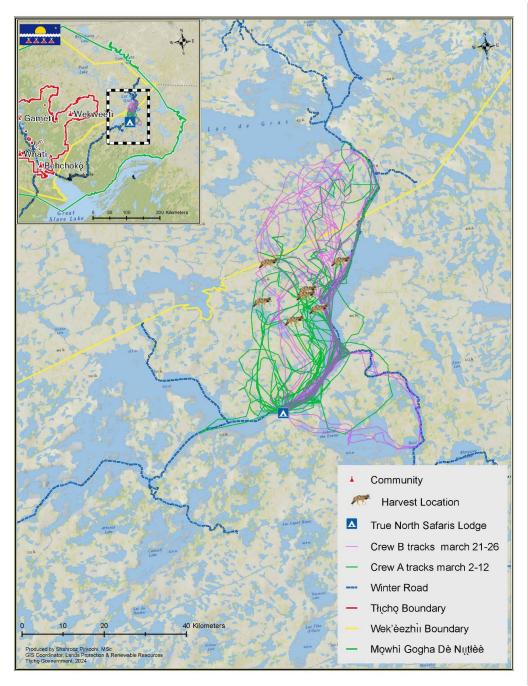


Figure 11. Harvester trails (green – crew A; purple = crew B) and harvest locations from the Diga Harvesting Program in March 2024.

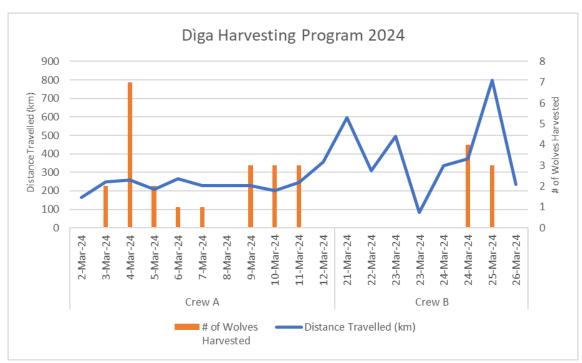


Figure 12. Data collected during the Diga Harvesting Program in 2024 (Year 5); this includes the number of diga harvested, and the daily distance (km) travelled by hunters.

Table 8. Summarized data for the Tłıçhǫ Government's dìga harvesting camp in all years that the camp was implemented.

Year	# of Field Days	# of Hunters	Days Spent Hunting	Distance Travelled	Harvested Dìga
2019/2020	49	19	37	4,484	3
2020/2021	66	15*	49	3,839	32
2021/2022	31	12	21	3,951	9
2022/2023	29	9	19	3,778	15
2023/2024	17	8	17	5,856.2	29

^{*}affected by COVID-19 public health and travel restrictions

Discussion

Since the inception of the Tłįchǫ Government's Dìga Harvesting Program in 2019, there have been many important lessons learned for harvesters and the program manager. Dìga harvesting has been a long-lost practice that has not been done by many in the Tłįchǫ region for quite some time. Tłįchǫ have many strong cultural beliefs about harvesting dìga. There is a very strong spiritual and cultural connection between the Tłįchǫ people, ekwò and dìga. Thus, when harvesting either species it has to be done in the most respectful way. As the Dìga Harvesting Program evolved, there has been many significant cultural practices that the Tłįchǫ people take

pride in which has been incorporated into planning and methods of the program. Such practices include:

- Avoid having any drop of dìga blood into the Tłįchǫ communities
- Avoid having any women at camp because it is said that a woman compels such a strong spirit especially when on their cycle that it may interfere with the harvesting of dìga
- Equipment used for the Diga Harvesting Program cannot be used for any other program
- Pay respect to the animal immediately after the hunt by thanking it for its life

There have also been non-traditional ways that we have identified where our hunters can be more respectful and that includes using certain calibers to ensure a quick and humane kill. Although chasing an animal to kill it seems disrespectful, having a quick kill ensures they do not suffer as long. Other techniques were used to avoid chasing the animal, which includes snaring and trapping diga, but the fear of capturing non-target species such as ekwò is high and therefore we decided to not use snares or traps.

Incorporating other cultures and expertise into the program has also contributed to the learning process for the program manager. Getting advice from the Kugluktuk hunters and working with them has been positive for the program. Since time immemorial, dìga hunting has been a part of the Inuit culture; working directly with experienced Inuit has increased the overall success of the program. In December 2022, a dìga harvester's workshop was held in Yellowknife. Key participants included Tłįchǫ hunters who have worked for the harvesting program as well as experienced wolf hunters from Kugluktuk and two trappers from Yellowknife. This workshop was collaboratively organized by ECC, Tłįchǫ Government and the Kugluktuk Hunters and Trappers Organization. The goal of this workshop was for the Kugluktuk and Tłįchǫ hunters to share their knowledge and experiences. This was a very well perceived workshop; it provided a great opportunity of knowledge exchange as well as clarity on what is done with the dìga after they have been hunted. A wildlife veterinarian from ECC demonstrated necropsies to show health indicators on wolf carcasses.

When diga sightings and harvest numbers declined over a week, it was suggested that camp be moved. In one of the meetings with participants, a harvester mentioned that when hunting or trapping you cannot stay in the same location, you have to move around. It has been considered to move camp a couple of times, but logistically it became too difficult with having such a large camp. Alternatively, we offered to lend the hunters our equipment and provide supplies if anyone wanted to go out on their own. Being adaptable has shown to be the most critical tool in the success of running the Diga Harvesting Program.

The success of the program also heavily relies on experienced harvesters. There is a limited number of people that have this skill set. As described earlier, the Tłįcho people have strong connections to dìga and so only certain families are allowed to harvest this sacred animal. The

small pool of potential participants has added complexity in planning for the program. Not only are we limited with hunters due to cultural considerations, but we are also competing with the people's priorities of hunting for ekw $\hat{\phi}$. The program has also been constrained for time because the winter road is open only for a short period and hunters from the isolated communities may not be available because they prefer to travel south when the road is accessible and stock up on groceries. There are many factors that are considered each year of running this program all for the hopes of its success of decreasing the amount of d \hat{g} a on the landscape with the end goal of helping the ekw $\hat{\phi}$.

MEASURES OF EFFORT

Wolf Harvester Questionnaire

In winter 2024, a wolf harvester questionnaire was used to collect information on harvesting effort. The questionnaire asked hunters about harvest location and number of wolves taken, wolf and caribou sightings, hunter effort (i.e., hunting days and kilometers traveled), weather conditions, and other relevant factors and observations. Winter road harvesters were provided \$50 gas cards for the submission of completed questionnaires. ECC handed out questionnaires to hunters traveling on the Tibbitt to Contwoyto Winter Road, who were encouraged to stop at the ECC check stations. The same questionnaires were also given to the Thcho and Kugluktuk harvesters at their respective camps. Revisions to the questionnaires were completed in 2022 after evaluating responses to the questionnaires from previous years and receiving feedback from the harvesters. Harvesters used either the revised questionnaire from 2023 or the 2024 version, which asked harvesters to circle if a full carcass was submitted for each harvested female and if a skull and baculum was submitted for each harvested male (see Appendix B).

Data Compilation

Harvesters returned 21 completed questionnaires, dated between January 20 and May 2, 2024, reflecting 73 wolf harvests in the North Slave wolf harvest incentive area. Skull and baculum were submitted for four individuals by Kugluktuk harvesters. Based on the completed questionnaires, there were 103 days when hunters were active in the wolf harvest incentive area. During this period, 17 harvesters were actively hunting for wolves in the wolf harvest incentive area. Eight questionnaires from winter road harvesters could not be linked up with individual harvesters and were excluded from the total harvester number. Kugluktuk harvesters were active from April 5 to May 2, 2024; winter road harvesters were active between January 20 and March 20, 2024, and Thcho harvesters were active from March 3 to 25, 2024 (Figure 13). No wolves were reported to have been baited. Two questionnaires were submitted by the same hunting party with the same hunting dates and effort data; therefore, only one questionnaire was used for reporting weather and effort data.

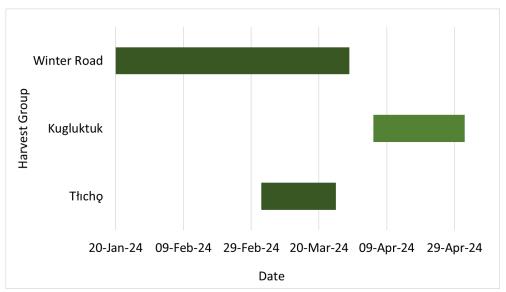


Figure 13. Comparative timeline of wolf harvesters: winter road, Kugluktuk, and Tłıcho. All groups were finished hunting by 02 May 2024. The Tibbett-Contwoyto Winter Road was open to public traffic from 12 February 2024 - 31 March 2024.

Hunting Experience

Hunting experience likely influences a hunter's ability to harvest wolves and should be accounted for when assessing harvest data. Three questions were asked related to hunter experience. The first question was "How many years have you been hunting wolves?" with responses that included <5, 5-10, or over 10 years for 19/21 submitted questionnaires. Eighty-four percent of completed questionnaires reported that they have been hunting wolves for over ten years. The second question was "How recently have you hunted wolves?" with responses including before 2010, 2010-2015, 2015-2020, 2020-present for 19/21 submitted questionnaires. The majority of completed questionnaires reported that hunters had recently hunted, 2020-present (79%). The last question was "How many wolves have you harvested in your lifetime?" For this question, responses were categorized into three groups: <5 wolves, 5-10 wolves, and >10 wolves for 18/21 submitted questionnaires. Most (61%) of the completed questionnaires reported >10 wolves harvested in their lifetime (Figure 14).

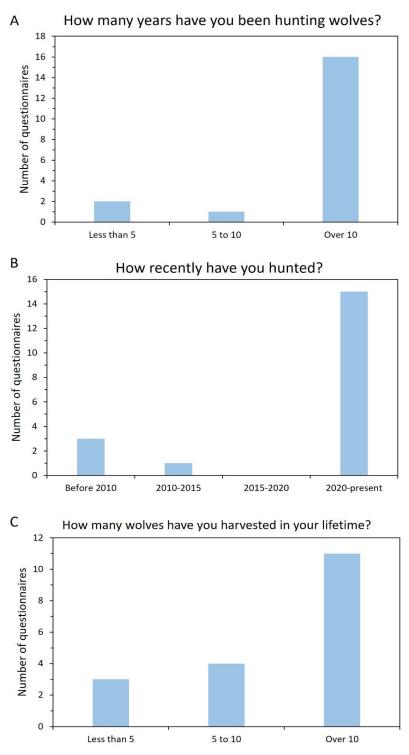


Figure 14. Qualitative summary of hunting experience reported in 2024 harvester questionnaires.

Wolf Sightings and Effort

To better understand how the number of wolves may be changing on the landscape, the questionnaire asked three questions related to wolf sightings and hunting effort. The first question was "In total, how many wolves did you see on your trip?". The second question was "How big were the packs (circle number range)?" with choices of <5, 5-10, 10-15, 15-20, and over 20. The last question was "How hard was it to find wolves (circle one)?" with choices of very difficult, somewhat difficult, easy, and very easy. These answers can provide a qualitative indication of annual changes in the wolf population. If fewer wolves are sighted during hunting trips, packs were smaller, and finding wolves was more difficult, it may suggest that the wolf population numbers are lower than the previous hunting season. Responses to these questions were not recorded for the Tłicho Government's diga harvesting camp. Most questionnaires (13/18) reported seeing between one and six wolves, while four questionnaires reported seeing 15-17 wolves, three of which were likely from the same hunting party. One questionnaire reported seeing no wolves. The majority (89%) of the wolf pack sizes reported in 18 of the 21 submitted questionnaires were less than five wolves and none had more than 15 wolves. Eleven harvesters reported that finding wolves was difficult (69% combined somewhat and very difficult responses) out of 16 submitted questionnaires. None reported that finding wolves was very easy and 31% reported that finding wolves was easy (Figure 15).

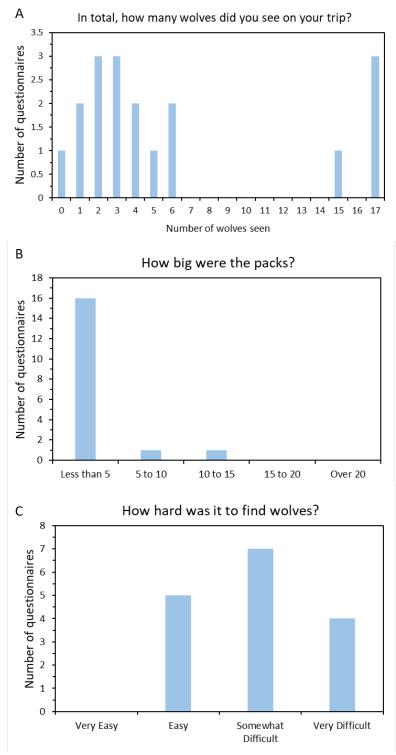


Figure 15. Qualitative summary of wolf sightings and effort reported in 2024 harvester questionnaires.

Number of Caribou Observed and Other Harvest

Respondents were asked to record the number of caribou seen while hunting wolves. Winter road hunters reported seeing groups of caribou anywhere between 0 and over 500, with 44% questionnaires reporting over 500 caribou. Thicho hunters reported seeing over 500 caribou while hunting wolves (one reported number for the camp). All Kugluktuk hunters reported seeing caribou groups with 101-500 individuals, except for one hunter that reported no caribou seen while hunting wolves. In addition, hunters were asked to record the number of caribou carcass remains that they thought were a result of wolf kills. Kugluktuk harvesters recorded seeing five to ten and <5 caribou remains likely killed by wolves, while Thicho hunters reported seeing five to ten caribou remains likely killed by wolves. All winter road harvesters recorded seeing <5 caribou remains likely killed by wolves, except for one harvester that reported seeing five to ten caribou remains likely killed by wolves. Due to the questionnaire format, the respondents only provided one instance of observation for the duration of the trip. In other words, a group would record seeing 21-100 caribou during their trip whether they saw the same or different herd once or multiple times or if they also encountered other herds of smaller sizes. Therefore, the response summary to these questions should be interpreted with caution as they could underestimate, or overestimate hunters' sightings of caribou groups and carcass remains. Kugluktuk harvesters also reported harvesting wolverine and fox while hunting wolves. The winter road harvesters reported harvesting fox, muskox, wolverine, and other species (not identified), while the Tłıcho harvesters did not report harvesting other species (Figure 16).

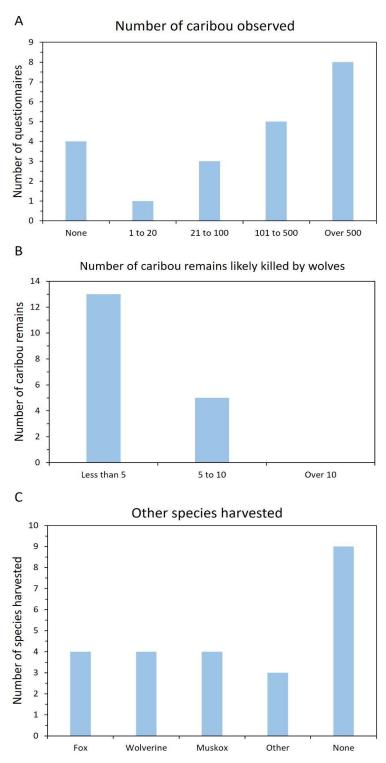


Figure 16. Qualitative summary of number of caribou observed and other harvests reported in 2024 harvester questionnaires.

Weather Conditions

In the wolf harvester questionnaire, hunters were asked to comment on the weather conditions during each day of their trip by circling perfect, good, bad (low visibility), or very bad (stormed in). Out of 47 hunting days, 31 reported comments about the weather. Responses to these questions were not recorded for the Thçhǫ Government's dìga harvesting camp, two winter road harvesters, and one Kugluktuk harvester. More than half (67%) of the hunting days were reported to have good (48%) and perfect (19%) weather conditions. The other hunting days (32%) recorded bad weather and zero days were recorded as being very bad. In comparison, more than half of the questionnaires reported good weather conditions in 2023 and approximately half (47%) of questionnaires reported poor and adverse weather conditions, such as "cold", "windy days", "white-out", "blowing snow", or "soft snow conditions", in 2022.

Discussion

Overall, responses to hunting experience questions indicate that 2024 harvesters were experienced (majority responded with over ten years of hunting experience and over ten wolves harvested) and had recent hunting experience (2020-present). Responses to wolf sightings and effort may suggest that wolf numbers are low given harvesters saw few wolves during hunting trips (between one to six), pack sizes were reported to be <5, and it was difficult to find wolves. These results are similar to last year where the majority of questionnaires reported seeing between one to five wolves, pack sizes were <5 wolves and none had more than ten wolves, and it was difficult to find wolves (52.8% of questionnaires in 2023; Wilson et al. 2023). Combined with the information provided in the hunting experience questions, a lack of harvester experience does not explain the difficulty in finding wolves. Qualitatively, it appears that a high number of caribou were observed (62% saw 101 to over 500 caribou), yet there were few caribou carcasses likely killed by wolves (72% reported <5 caribou remains), which may suggest that caribou numbers were high and that wolf numbers were low or the detectability of caribou carcasses killed by wolves was low. Linking weather conditions to the number of wolves removed may provide insight on hunters' ability to find wolves and/or relative changes in wolf numbers. Given good weather was reported for the majority of hunting days, these data may suggest that weather did not limit the success of wolf removals.

Catch Per Unit Effort

Catch per unit effort (CPUE) is used to model the relationship between the probabilities of harvest and hunting effort to elicit information about the harvested population's abundance (Allen et al. 2020, Mitchell et al. 2022). CPUE is derived by dividing the total catch (i.e., harvest) by a unit of effort over a specified period of time (i.e., daily, weekly, or monthly). This report used two units of hunter effort, days spent hunting (CPUE-day) and kilometers traveled daily (CPUE-km), for harvesting a wolf. The questionnaire asked hunters to record the number of hours spent hunting each day, which was used to estimate the number of days spent hunting (i.e., >0 hours

was classified as a hunting day; one hour would be rounded up to one day; see Wilson et al. 2022 for justification) and the number of kilometers spent hunting each day of their trip. The intent of these questions was to collect the time spent and distance traveled on the hunting grounds while searching for wolves and once wolves are seen, such as stalking, active pursuit and shooting.

Methods

The analysis for the 2024 CPUE is based on the questionnaires completed by harvesters from Kugluktuk, Tłıçhǫ Government's dìga harvesting camp and hunters accessing the Tibbitt to Contwoyto Winter Road. A series of steps were taken to only include questionnaires with usable data, resulting in 17 questionnaires used for CPUE analysis:

- Started with 21 questionnaires provided by harvesters.
- Three questionnaires from winter road harvesters did not report the number of wolves harvested or any effort data and therefore were not included in the CPUE analysis.
- Removed one questionnaire with duplicate effort (i.e., multiple questionnaires from the same hunting party based on number of hunters in group, hunting dates, hunting hours, and kilometers traveled).

The questionnaires reported 73 wolf harvests, accounting for 73% of the carcasses submitted to ECC. To compare CPUE-day and km across multiple years, a series of steps were taken to standardize harvest and effort data from previous years (see Wilson et al. 2022). Kugluktuk harvesters typically hunt in groups and often report the same hunting trip on multiple forms. Thus, field days, hunting days, and kilometers traveled were removed for hunters reporting within the same party. Given that winter road harvesters typically travel alone, and inconsistent information was reported, it was assumed there were no duplicates for winter road harvesters. Some Kugluktuk harvesters also only reported effort data on days that wolves were harvested, even though hunting was assumed to occur on days when no wolves were harvested. For example, effort data was provided for 04/03/2023 and 04/13/2023, but not every day in between these two dates. Even if hunters were active during those days, we do not know if they were hunting and therefore assumed they were not. The data used to calculate the catch per unit effort metrics are shown in Table 9.

Table 9. Number of field days, hunters, harvested wolves, days spent hunting and distance traveled calculated from harvester questionnaires for non-baited wolves only from 2020-2024.

	# of Field Days	# of Hunters	# of Harvested Wolves	# of Days Spent Hunting	Distance Traveled (km)	# of Questionnaires used for CPUE
Tł _į chǫ¹						
Year 1 - 2020	49	19	3	37	4,484	0
Year 2 - 2021	66	15	32	49	3,839	0
Year 3 - 2022	31	12	9	21	3,951	0
Year 4 - 2023	23	10	11	21	3,070	1
Year 5 - 2024	17	5	29	16	5,856	0
Kugluktuk						
Year 1 - 2020	134	9	36	118	19,869	12
Year 2 - 2021	189	15	86	142	19,505	16
Year 3 - 2022	30	7	25	18	3,484	3
Year 4 - 2023	27	9	45	20	4,883	5
Year 5 - 2024	9	4	23	9	1,544	3
Winter Road						
Year 1 - 2020	51	10	1	47	11,170	23
Year 2 - 2021	82	20	14	60	15,734	25
Year 3 - 2022	46	10	19	46	27,001	12
Year 4 - 2023	42	13	15	41	13,036	13
Year 5 - 2024	18	15 ²	21	18	3,417	14

¹ Data for Thcho Government's dìga harvest camp was provided for years 1-3 and 5 but was not recorded or consistent on questionnaires.

Results

To compare across multiple years, CPUE was calculated for each group and year (Figure 17A-B). Thcho Government's diga harvest camp reported a CPUE-day of 1.71 wolves/hunting day in 2024, which was greater than all previous years. The effort data reported by Kugluktuk harvesters showed an increase in CPUE-day from 2020-2024. The effort data reported by the winter road harvesters showed an increase in CPUE-day from 2020-2022, but a decrease in 2023 (0.37 wolf/hunting day) compared to 2022 (0.41 wolf/hunting day). In 2024, CPUE-day for winter road harvesters was greater than all previous years (1.17 wolves/hunting day). On average across all groups, the CPUE-day also increased from 2020-2024 (Figure 17A). Thcho Government's diga harvest camp reported a CPUE-km of 4.95 wolves/1,000 km in 2024, which was greater than 3.6 wolves/1,000 km in 2023, 2.3 wolves/1,000 km reported in 2022, and 0.7 wolves/1,000 km in 2020, but was less than the CPUE-km from 2021 (8.3 wolves/1,000 km). Winter road harvesters reported a larger CPUE-km in 2024 compared to all previous years. Kugluktuk harvesters reported a CPUE-km of 14.90 wolves/1,000 km, which was higher than 2023 (9.21 wolves/1,000 km) and 2022 (7.2 wolves/1,000 km). On average, CPUE-km was highest in 2024, similar and moderate in 2021-2023, and lowest in 2020 (Figure 17B).

² Eight questionnaires did not have names recorded; therefore, could have been a duplicate hunter.

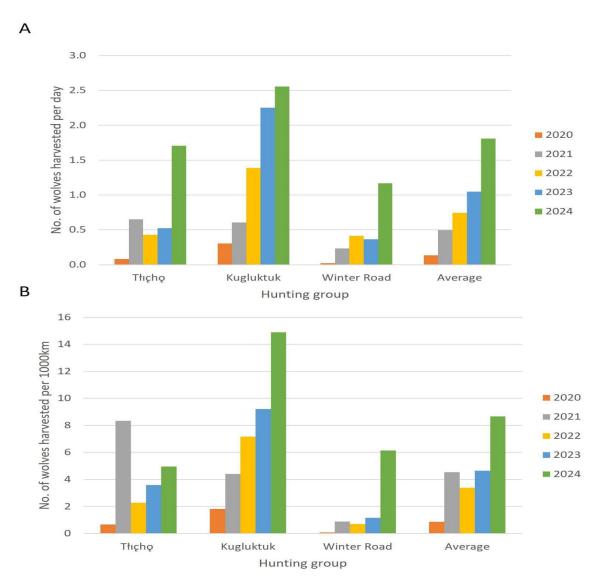


Figure 17. Catch per unit effort (CPUE) relative to hunting days (A) and distance travelled (B) for the Thçhǫ Government's dìga harvest camp, Kugluktuk harvesters, and winter road harvesters in 2020, 2021, 2022, 2023 and 2024 as well as the average CPUE across all groups within each year.

Discussion

Overall, the revised questionnaires provided ample space for harvesters to record information for every day of their trip, were easy to fill out, and captured the information needed to calculate CPUE. Eighty-one percent of questionnaires (17/21) were usable for the CPUE analysis, three questionnaires did not report effort data, and one reported duplicate effort within the same hunting party. The number of wolves harvested per hunting day increased for Kugluktuk, Tłįchǫ, and winter road harvesters as well as on average from 2020-2024. Similarly, the number of wolves harvested per 1,000 km also increased for Kugluktuk harvesters, winter road harvesters,

and on average. For Tłıçhǫ Government's dìga harvesting camp, the number of wolves harvested per 1,000 km increased from 2020-2021 and 2022-2024 with a peak in 2021. Together, the overall tendency for increases in CPUE measured by time and distance may indicate that the effort it took to harvest wolves decreased over the course of the wolf removal program.

The general trend of increased CPUE over the five-year wolf management program could provide an indication of the impact of wolf removals on the wolf population within the Bathurst and Bluenose-East caribou winter ranges. However, assumptions underlying CPUE and additional analyses need to be considered before ascribing trends in CPUE to changes in population size of the harvested species. A general assumption of CPUE is that the harvested population is closed, meaning that there is not significant movement of individuals in or out of the population within the given period and area when harvest effort is applied (reviewed by Hubert and Fabrizio 2007). Thus, in a closed population and with other covariates held constant, CPUE should decrease as abundance and density of animals are reduced by the cumulative harvest. Another assumption is that the population is relatively constant with respect to its exposure to harvesting effort. In this context, non-migratory wildlife are more likely than migratory wildlife to meet this assumption of constant exposure to harvest. For example, it would be difficult to attribute changes in CPUE solely to a reduction in density due to cumulative harvest for a given area, when the overall density changes are also strongly influenced by the transient and dynamic occurrence of migratory wildlife in the area. In addition, the response of CPUE to declining population abundance may be scale dependent, which means that a detectable reduction in CPUE may occur within a small, localized area, but that same trend may not be detectable within a larger area.

Additional analysis is required to assess whether training and/or incentivizing wolf hunters is sufficient to elicit a measurable effect to lower wolf density, i.e., a numerical reduction through higher rates of additive mortality and how to determine if a declining trend in CPUE is a reliable indicator of reduced wolf density (abundance). It is difficult to determine if it is easier to harvest wolves because of changes in wolf density and/or hunter ability. For example, wolf densities may not have changed over time, but hunters have learned and are better at hunting wolves than in previous years. Wolves may also be showing changes in behaviour in response to harvest pressure. Baillie-David et al. 2024 found that wolf control caused a numerical reduction of wolf numbers and a functional change in wolf behaviour, as post-control occupancy models revealed fewer wolf detections, but the same distribution, and a negative association with linear features (Baillie-Davie et al. 2024). Given the increased number of caribou along the winter road in winter 2024, it is not surprising that more wolves would be present and CPUE would suggest it is easier to harvest wolves. Monitoring of wolves post removal efforts would be needed to determine if a behaviour change influenced CPUE in this system.

Further statistical modeling will be completed in the five-year review report to determine what factors influence harvest success and consequently CPUE and will assist in determining if CPUE is an appropriate measure of effort.

Sighting Rates

The number of wolves sighted per hour flown during aerial surveys or collaring efforts has been used as a metric to monitor changes in the number of wolves on the landscape over time. A decrease in the number of wolves sighted per hour flown may suggest a decrease in the number of wolves present and therefore less opportunity for predation on caribou. Zero wolves were sighted during the March 2024 caribou collar deployment, which is decreased from previous years of coordinated collar deployment of both wolves and caribou (0 wolves per hour in 2023, 0.86 wolves per hour in 2022, and 1.82 wolves per hour in 2021). However, the March 2024 captures were focused in a small area with not much search time required, given the crew was targeting known caribou collars. Sighting rates of wolves during March caribou composition surveys decreased from 2010-2020 for the Bathurst herd. For the Bluenose-East caribou herd, sighting rates have generally stayed stable with the exception of seeing very few wolves in 2018 and zero wolves in 2021 and 2024. From 2020-2024, sighting rates of wolves in areas of highly mixed caribou and Beverly caribou only initially decreased and have slightly increased in the last year (Figure 18). For further information on predator sighting rates during caribou calving ground surveys, please see Boulanger et al. 2024.

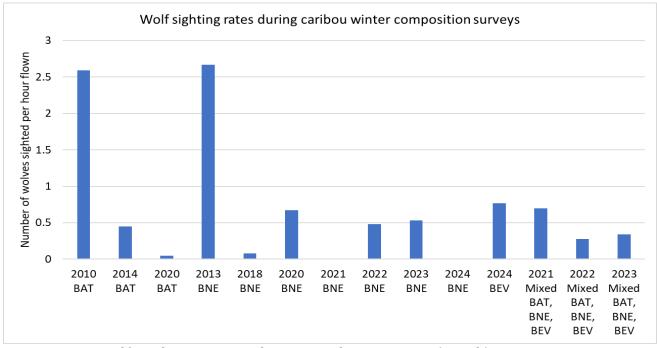


Figure 18. Wolf sighting rates during caribou winter (March) composition surveys. Abbreviations are as follows: BAT - Bathurst, BNE - Bluenose-East, BEV - Beverly.

For comparison, sighting rates during wolf management activities have varied over the years (Figure 19). Helicopter flights for wolf collar deployment were conducted with a separate crew and targeted already collared wolf packs in March 2023 resulting in a sighting rate of 1.23 wolves per hour. During the wolf den survey conducted in May 2023, six wolves were sighted over 46

hours (0.13 wolves per hour) compared to a sighting rate of 0.38 wolves per hour on the same survey in 2024 (see Wolf Den Monitoring: Survey, Pup Count and Camera Deployment). Due to differences in methodologies that can influence sighting rates (e.g. aircraft type, observer experience, weather conditions, and snow cover), sighting rates reported for different types of management activities should be interpreted with caution.

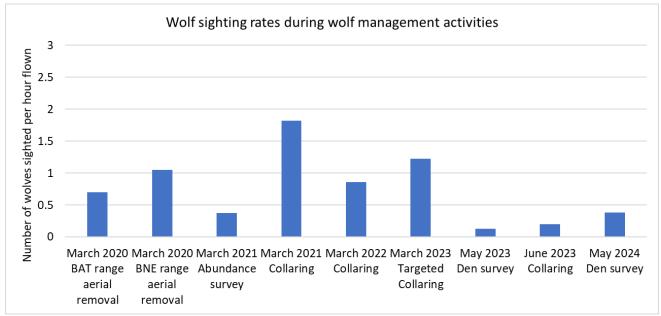


Figure 19. Wolf sighting rates during various wolf management program activities. Sighting rates are based on actual hours flown on survey (e.g. time spent capturing wolves) and ferrying/repositioning flights are not included.

DEMOGRAPHICS AND HEALTH OF HARVESTED WOLVES

Based on the Joint Proposal on Management Actions for Wolves (diga) submitted in August 2020, and responses to the WRRB Reasons for Decisions Related to a Joint Proposal for Diga (Wolf) Management in Wek'èezhìi, necropsies were conducted on a sub-sample of wolves removed from the wolf harvest incentive area in order to assess the health and condition of harvested wolves.

Objectives

Necropsies were conducted on a subset of wolves harvested as part of the wolf management program in order to assess individual animal health, reproduction, and animal indicators of demography. It should be noted that some numbers in this report are different than in the *Veterinary Assessment of Wolf Removal Outcomes 2021*. This is the result of a post-hoc adjustment made to analyze only animals harvested inside the eWHIA. The 2021 report contained 12 animals harvested outside the wolf harvest incentive area, which have since been removed from the dataset for consistency and to allow year-to-year comparisons specific to this enhanced management program and its unique variables (prescribed area, increased monetary incentive amount, management/monitoring objectives, etc.). Necropsy assessments (n=311) were done on a majority sample of wolves harvested in the wolf harvest incentive area between 2021 and 2024 (n=385). Assessments were also conducted on animals harvested outside the wolf harvest incentive area, but those individuals were removed from this document for analysis and reporting.

Methods

From January 26 to April 19, 2021, 02 February 2-8, 2022, 13 December 13 to April 9, 2023, and 15 December 15, 2023 to May 2, 2024, 327 (full or partial) carcasses of gray wolves were submitted by at least 60 different harvesters to ECC. Necropsies were conducted on wolves harvested by either ground-based shooting or trapping methods. Examinations included an assessment of health and harvest-related injuries, in addition to standard biological monitoring. Wolf carcasses were identified by a tag which had fields for harvesters to indicate location of kill/death, date of kill, method of kill, submitter name, and animal sex. Carcasses submitted to ECC were stored frozen at -20 degrees Celsius until examination by a wildlife veterinarian. Storage conditions between harvest in the field and submission of carcasses are unknown.

In lieu of available ante-mortem harvest data and to gain additional perspectives on necropsy findings, ECC's wildlife veterinarian consulted with wildlife health professionals, wildlife biologists, and experienced Indigenous Knowledge holders/community wolf harvesters locally, at a Tłąchǫ Government harvester workshop (December 2021), at meetings with Kugluktuk wolf

harvesters and the Kugluktuk Angoniatit Association Hunters and Trappers Organization (June 2022), and at the wolf harvester workshop (December 2022).

General Necropsy and Health Investigation

All necropsies followed standard protocols recognized for wild and domestic canids and were conducted by or under the direct supervision of a wildlife veterinarian. All individuals involved in necropsy procedures had up-to-date rabies pre-exposure prophylaxis vaccination and used appropriate personal protective equipment, and necropsy equipment and surfaces were washed or replaced between specimens.

Individually assigned identification numbers, date of necropsy, and any information included on the tag associated with each wolf carcass were recorded. Skinned weight of carcasses was obtained using a laboratory-grade floor scale and recorded to the nearest hundredth of a kilogram, and any missing body parts for each individual carcass were documented. High resolution full body photographs of wolves laying in lateral recumbency, both left and right, were taken using a digital single-lens reflex camera. All necropsies were performed in left lateral recumbency for consistent examination and sample collection. All four limbs were reflected initially to examine associated skeletal and soft tissue structures/spaces.

Morphometric Measurements and Age Structure Approximation

Morphometric measurements recorded in centimeters included full contour length (tip of nose to base of tail), neck girth, chest girth (at axillae; using measuring tape), and rump fat depth (millimeters; using laboratory-grade electronic calipers, CARMA 2008; see Figure 20) on already-skinned carcasses. Skull measurements were taken using calipers, including zygomatic width, condylobasal length, and total skull length (Larter et al. 2012). High resolution photos of skulls were also taken, including dorso-ventral, rostro-caudal (with focus on incisor dentition), and right and left lateral views. Age class was approximated visually according to Gipson et al (2000), sorted into puppy, juvenile (1-2 years), adult (3-7 years), and geriatric (est. 8+ years). A premolar tooth will be submitted to an external reference laboratory (Matson's Laboratory, Manhattan, MT) for aging by cementum annuli analysis (Ballard et al. 1995).

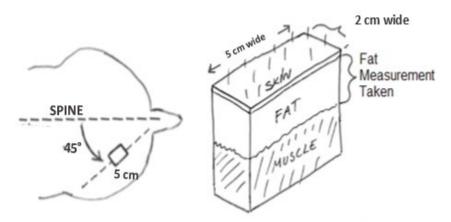


Figure 20. Location used to measure rump fat depth as an indicator of wolf body condition status.

Assessment of Nutritional Condition

An external body condition score was assigned on a semiquantitative scale of 0-4 (with 0 being poorest and 4 being best condition) based upon coverage and thickness of subcutaneous fat stores. Similarly, an internal nutritional condition score was assigned based on abdominal visceral fat deposits. An average of external and internal scores provided an overall coarse subjective nutritional condition indicator for each wolf. The right femur was collected, cleaned, measured for circumference, diameter, and length using calipers, and marrow was extracted from the diaphysis and air dried to determine percent femoral marrow fat as an indicator of nutritional condition (adapted from Lajeunesse and Peterson 1993, Lefebvre et al. 1999, CARMA 2008). Where the right femur was damaged or unavailable, the left femur was collected instead. Kidneys were removed with peri-renal fat per methods described in Riney (1955) and weighed. They were subsequently weighed with peri-renal fat removed to facilitate calculation of renal fat index (Riney 1955). The entire xyphoid/falciform fat pad was excised, weighed, and subsampled.

Examination of Abdominal Cavity

The abdominal cavity was opened and the integrity (presence or absence of negative pressure) of the thoracic cavity was assessed using a small incision to the abdominal surface of the diaphragm. The right rib cage was removed with large shears at the level of the vertebral column and costochondral junctions. Photographs were taken of the internal neck, thoracic, and abdominal cavities, in addition to wider full body internal photos. The 'pluck' (tongue, esophagus, trachea, thymus, heart, lungs, and associated structures) was removed by disarticulating the hyoid bone and releasing the tongue from skeletal muscle attachments through the ventral jaw, and extending the incision along the neck, to the thoracic inlet, and into the thoracic cavity while applying ventral tension to the tongue along the length of the thoracic tissues being removed. The pluck was photographed ex-situ and also examined in detail for any trauma or pathology – this included incising esophagus and trachea, lung tissue, and gross examination of the heart

(unless incision was indicated). Subjective/relative prominence of the thymus was recorded as a contributing indicator of age class estimate. Abdominal organs, including the liver, spleen, stomach, intestines, kidneys, adrenals, gonads (when applicable), and lymph nodes, were examined incised when indicated by evidence of trauma or pathology.

Sample Collection

Samples were collected in sterile WhirlPak™ bags, individually labeled to correspond with the identification number assigned to each carcass and stored at -20°C. The small and large intestines were tied off at the proximal duodenum and distal colon/rectum and stored frozen for future analysis. A subsample of lung tissue (caudodorsal lobe), heart (except in 2022), and tongue were collected from the pluck. Kidneys (2021 only), liver sample, and spleen were also collected. Hair samples (when available) were plucked and placed in paper envelopes and stored at room temperature for future analysis (i.e., genetics, stable isotopes) − samples were taken from wherever available on the already-skinned body, typically the perianal region or tail. Blood was collected on Nobuto filter paper strips from the femoral artery. When this was not possible, jugular venous or carotid arterial blood, blood from the thoracic cavity (when not contaminated by ingesta), or blood directly from cardiac structures (thoracic aorta, inferior vena cava, or heart) was used. Eight to ten strips were collected for each animal where possible, and air dried for 24 hours before being stored in envelopes at room temperature. Filter paper eluate are being submitted to reference laboratories for analysis of exposure to various canine pathogens related to individual and population health.

Stomach Contents

The full stomach was removed at the esophageal cardia and the gastroduodenal junction and weighed with contents. If the stomach contained contents, these were removed from the organ, photographed, and subsampled. The empty stomach was then weighed. Photos of stomach contents and/or subsamples were sent to an experienced contractor for analysis and identification. If caribou and another food source was present, it was counted as caribou only and not double counted. For example, one stomach contained caribou and bird, but was only counted as caribou.

Reproductive Status

The uterus was removed (when applicable). Immature or non-pregnant females were identified based on small size of the uterine body and ovaries and the absence of placental scarring or implantations/fetuses in the lumen or endometrial lining of the uterus. Recent pregnancy was identified based on the presence of uterine scarring from placental attachments of a pregnancy from the previous breeding season. Pregnant females were identified when fetuses or fetal implantations were identified in the lumen of the uterus or embedded in endometrium. Ultimately, animals were categorized as pregnant (implantations or fetuses in utero) or open (immature or unbred, including presence of placental scars). Litter size estimates for each year

were based on total implantations, fetuses, or placental scars in an individual's uterus; placental scar counts informed litter size estimates from the previous year. In cases where one uterine horn was too damaged to count placental scars or other indicators of litter size, total litter size count was adjusted to estimate that the number of pups would be equal to the contralateral horn (Tsutsui et al. 2002). Adjustments to include placental scar counts into litter size estimates for the previous year as well as account for damaged uterine horns were done and incorporated into relevant models. Some animals could not be examined for uterine characteristics due to autolysis, scavenging, or tissue destruction due to location of wound tracts. When fetuses were developed enough, crown-rump lengths and fetal weights were collected. Samples collected were analyzed in-house, submitted to reference laboratories, or archived for future analyses.

In 2024, an amendment to requested samples from harvested wolves was made by the GNWT and Tłįchǫ Government to allow for only the skull of harvested males to be submitted in lieu of a full carcass. In these cases (n=16 in 2024), a section of temporal muscle was sampled for stable isotopes analyses and genetics archive, the tongue was sampled if available, skull measurements (Larter et al. 2012) were taken, and the first premolar tooth was extracted.

Statistical Analysis

R 4.4.1 was used to perform any descriptive or regression statistical analyses. The Shapiro-Wilk test and visualization of q-q plots were used to assess normality assumptions of data. Parametric statistical tests (t-tests, linear models, ANOVA, and Tukey post-hoc tests) were used for analyses of normally distributed data assessing temporal trends and interrelationships among metrics of health. Non-parametric tests (Kruskal Wallis, Spearman Rank correlation, Chi-Square, Mann-Whitney U tests, logarithmic/binomial regressions) were used when normality assumptions were not met. ANOVAs were considered robust enough to deal with non-normal data sets where total sample size was sufficient (n> 100).

Results

Ninety-nine (99) wolves from the 2021 wolf harvest incentive area, 45 wolves from the 2022 wolf harvest incentive area, 83 wolves from the 2023 wolf harvest incentive area, and 84 wolves from the 2024 wolf harvest incentive area were necropsied (n=311 total). Sixteen (16) heads (only) were submitted from harvested animals (14 males, two females) in 2024.

Information documented from each animal included date, method of kill, harvester name, location, and an indication of observed animal sex, but no antemortem data (Appendix K of Feasibility Assessment; Hampton et al. 2015) was documented on the tags. Most tags attached to the harvested wolves did not have complete data recorded. Further information such as if the animal was baited, hunter experience, and weather was recorded on the harvester questionnaires.

Decomposition or tissue damage suspected to be from freeze-thaw cycles and post-mortem scavenging was common among carcasses (present to some degree in 100% of carcasses examined) and hindered complete examinations; many animals were missing the limbs, head, and/or other appendages to varying degrees, and the majority of carcasses (264/311) were already skinned at time of presentation to the veterinarian and presented with varying degrees of skinning artifact, which also impacted interpretation of injuries at necropsy.

Age Structure

The wolves examined were distributed across sex and estimated ages (or subjective age classes). Subjective age classes (Gipson et al. 2000) as well as confirmed sex are presented in Table 10. Age determined by cementum annuli analysis (Ballard et al. 1995) results are presented in Figure 21.

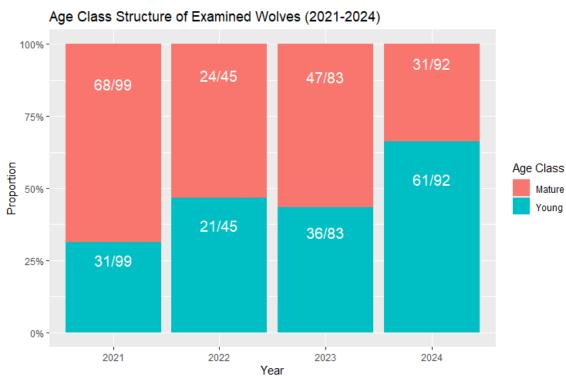


Figure 21. Bar plot visualizing the proportion of examined animals in each year (2021 to present) classified at necropsy as Young or Mature. Over the four years of study, the odds of a harvested animal falling into the juvenile age class increased significantly (p<0.01).

Table 10. Summary of sex (determined on necropsy examination) and age classes (juvenile = 1-2 years old, adult = 3-7 years old, geriatric = 8 years or older; n=328) of harvested wolves, including animals with just head submitted.

Sex	2021 (Freq)	2022 (Freq)	2023 (Freq)	2024 (Freq)
Male	52 (52.5%)	22 (48.9%)	49 (59.0%)	53 (53.0%)
Female	47 (47.5%)	23 (51.1%)	34 (41.0%)	47 (47.0%)
Total Wolves	99	45	83	100
Age Class	2021 (Freq)	2022 (Freq)	2023 (Freq)	2024 (Freq)
Young of Year (YOY)	0 (0%)	1 (2.2%)	4 (4.8%)	1 (1.0%)
Juvenile	31 (31.3%)	20 (44.4%)	32 (38.6%)	60 (60.0%)
Adult	50 (50.5%)	20 (44.4%)	39 (47.0%)	30 (30.0%)
Geriatric	18 (16.2%)	4 (8.9%)	8 (9.6%)	1 (1.0%)
Unknown	0 (0%)	0 (0%)	0 (0%)	8 (8.0%)

Age structure by subjective age class, grouped as young (juvenile, YOY) and mature (adult, geriatric), significantly varied between years (Chi Square test, p<0.01); see Figure 21. A majority of animals sampled were adults until 2024, when the majority switched to the juvenile age class. Ages were confirmed by cementum annuli analysis in 152 study animals, where teeth were available, in 2021 (n=89), 2022 (n=32) and 2023 (n=31). Preliminary age data are presented in Figure 22; there was a significant difference in cementum ages over the years (Kruskal Wallis test, p<0.05). Once cementum annuli aging results are available from the full dataset, they will be added to these analyses.

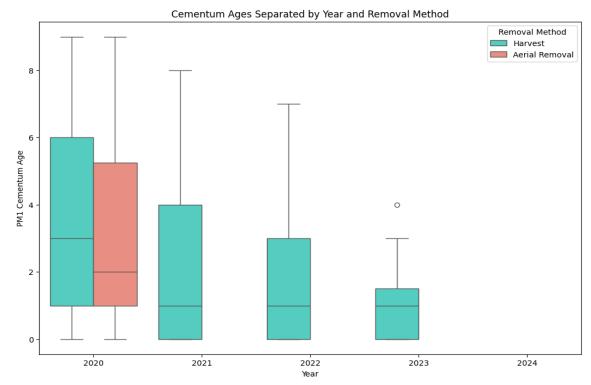


Figure 22. Preliminary analysis of cementum age data from 2020-2023, separated by year and harvest method. Ages are included from all wolves removed from within the respective eWHIA for each year from which cementum age data was available, not just those assessed by the veterinarian. Aging analyses of full dataset still pending.

Body Condition

Various subjective and quantitative metrics were taken to describe nutritional body condition of examined wolves. Although total weight of carcasses was taken, due to the variable state of submitted carcasses (i.e., different appendages missing, degrees of scavenging, and freeze-thaw and dehydration artifact), these weights are not considered comparable or consistent metrics of a given parameter. Internal and external nutritional body condition scores (BCS) assigned ranged from 0.0-4.0. The average coarse (internal and external combined) nutritional condition score was 2.6 (0.0-4.0) in 2021, 1.5 (range: 0.0-3.5) in 2022, 1.9 (range: 0.0-3.5) in 2023 and 2.3 (range: 0.0-3.5) in 2024. Condition scores varied significantly with age class (Kruskal Wallis test, p<0.01), but not with sex (Kruskal Wallis test, p>0.05); post-hoc pairwise comparison analyses found that BCS was significantly lower for young compared to mature animals. We did not detect a significant trend in BCS over time when taking age class into account (Figure 23). Average nutritional condition score across all examined wolves was 2.2, subjectively considered fair nutritional condition.

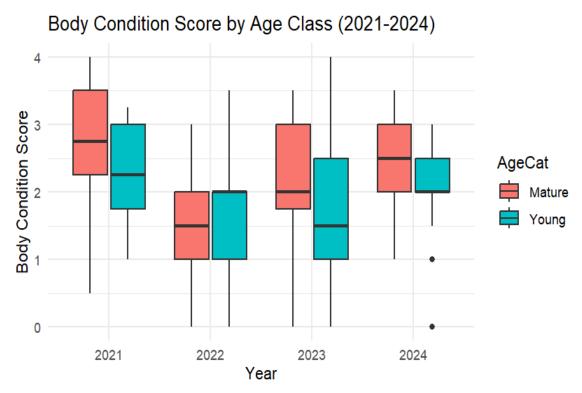


Figure 23. Body Condition Scores (0-4) assigned at necropsy to animals examined in years 2021 to 2024 of the program, grouped by age classification. No significant trend in BCS over the years of collection is detected, but a model considering both age class and year confirms these covariates as significant co-predictors of BCS (p < 0.01).

Quantitative metrics of nutritional body condition are summarized in Table 11. Xyphoid fat weight varied significantly with the influence of animal age class and animal sex, whereby younger and female animals were more likely to have less xyphoid fat by wet weight (g). Xyphoid fat did not show any significant trend over years, even when taking these covariates into account.

Table 11. Summary of quantitative body condition metrics determined at necropsy in harvested wolves. Sample sizes varied as the state of carcasses was not always conducive to collecting certain metrics.

Year	Xyphoid Fat Weight (median ± SD) (g)		Rump Fat Depth (median ± SD) (mm)		Kidney Fat Index (median ± SD) (%)		Femur Marrow Percentage (median ± SD)	
	Young	Mature	Young	Mature	Young	Mature	Young	Mature
2021	101.1±64.5	143.1±68.3	6.2±2.9	7.6±4.1	59.6±26	67.5±32	86.5±6.8	91.9±18.3
n=	29	66	31	68	27	60	30	67
2022	71.05±76.1	114.0±85.3	6.4±5.9	5.6±2.9	46±38.9	66.6±34	85.7±23	85.8±24.7
n=	18	21	21	24	18	16	21	23
2023	132.6±69	144.8±101.2	6.7±5.0	9.7±2.9	56.9±30.6	69.9±31.7	89.5±15	89.5±14.3
n=	34	46	36	47	28	41	36	47
2024	110.7±48.1	128.7±61.9	10.6±3.8	12.2±2.9	61.8±28.3	59.5±31.8	85.9±11.9	86.5±8.7
n=	53	26	58	26	49	23	57	26

Rump fat and Kidney Fat Index (KFI) varied significantly with age class (Kruskal-Wallis, p<0.05); post-hoc pairwise comparisons found that the differences were most prominent between pups and the remaining age classes (Dunn Test, p<0.05). Rump fat depth however was not significantly influenced by animal sex, whereas KFI was significantly higher in females than males (p<0.05). Rump fat depth measured from skinned wolves at necropsy significantly increased over the four years of study, even when taking age class into account. KFI did not significantly change over the years of collections. Bone marrow fat percentage also did not vary with time but was significantly higher in mature animals compared to juveniles and pups (p<0.05).

Reproductive Status

Findings on reproductive status of females examined as well as observed litter sizes are summarized in Table 12 and Figure 24. Age class of animal and date of harvest were significant predictors of probability of an animal being pregnant at the time of harvest (p<0.01), whereby older animals and animals harvested later in the season had an increased likelihood of pregnancy detected at necropsy. Probability of pregnancy did not vary over time when accounting for age class and harvest date. Litter size did not vary significantly over time (Figure 24); note that litter sizes in 2020 were extrapolated using placental scar observations in 2021-harvested animals.

Table 12. Summary of female wolf reproductive status data. Characteristics defining reproductive categories are described in the Methods section. Note: Age Class and Date of Harvest significantly influenced probability of detecting pregnancy in necropsied animals and are descriptively presented here for context.

	2021	2022	2023	2024	TOTAL
Harvest Date (median +/- IQR)	3/9 (2/21 to 4/9)	3/28 (3/13 to 4/3)	3/21 (2/27 to 4/4)	3/8 (3/3 to 4/5)	3/18 (2/26 to 4/5)
Age Ratio (Young:Mature)	0.68	0.77	0.62	1.65	0.89
Open - Unbred	24 (51%)	14 (60.9%)	18 (52.9%)	30 (63.8%)	86 (56.9%)
Open - Recently bred (placental scars)	11 (23.4%)	6 (26.1%)	7 (20.6%)	6 (12.8%)	30 (19.9%)
Pregnant	7 (14.9%)	2 (8.7%)	9 (26.5%)	8 (17.0%)	26 (17.2%)
Unknown	5 (10.6%)	1 (4.3%)	0 (0%)	3 (6.4%)	9 (6.0%)
TOTAL FEMALES	47	23	34	47	151

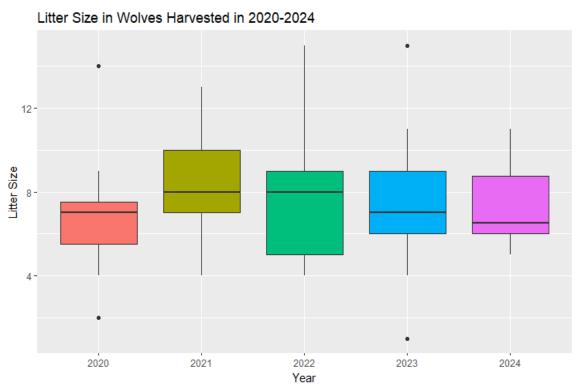


Figure 24. Litter size determined at necropsy in animals harvested in 2021 through 2024 harvest seasons. Litter sizes for each year reflect the number of fetuses/fetal implantations in utero from that year, as well as the number of placental scars detected in animals harvested the following year. No significant trend in litter size over the years of collection is detected.

Stomach Contents

During necropsy, it was determined if the stomach was empty or had contents. If the stomach had contents, a photograph and/or subsample was submitted to the contracted expert for identification. The results of the gross analysis of the wolf stomachs (empty and contents) are provided in Table 13. Note that 9.6% of wolves examined from 2023 harvest were baited according to harvester surveys; this should be considered when interpreting prevalence of wolves with certain contents identified. No wolves were reported to have been baited in 2024. From 2020-2024, the percentage of empty wolf stomachs ranged from 2-25% and peaked in 2023. The percentage of wolf stomachs that contained caribou at harvest was highest in 2020 (88%) and lowest in 2022 (45%).

Table 13. Results of gross analysis of stomach contents confirmed by high resolution photographs and/or physical analysis of stomach content subsample by a wildlife veterinarian and/or a contracted expert. Results were summarized to reflect likely identity of species or material in the sampled ingesta. 2020 data was not included due to inconsistent removal methods that influence stomach content data (aerial removals).

	2020a	2021	2022	2023	2024
	# wolves (% total)				
Number of wolves removed within wolf harvest incentive area	89	135	50	98	99
Total necropsied by veterinarian	36	99	45	83	84
Total stomachs analyzed	58ª	126	47	83	76
Empty	1 (2%)	25 (20%)	2 (4%)	21 (25%)	9 (12%)
With contents	57 (98%)	108 (86%)	25 (53%)	62 (75%)	67 (88%)
Specific contents					
Caribou	51 (88%)	94 (75%)	21 (45%)	49 (59%)	54 (71%)
Other ^b	4 (7%)	3 (2%)	0 (0%)	1 (1%)	8 (11%)
Anthropogenic Source	3 (5%)	1 (1%)	2 (4%)	0 (0%)	0 (0%)

^a Includes aerial removals (n=36) and ground-based harvest (n=22).

^b Other includes vegetation, ptarmigan, grouse, rodent, unidentified ungulate, carnivore, small mammal, bird, porcupine, hare, and fish etc.

Incidental Findings

Eleven cases with incidental pathological findings unrelated to cause of death (i.e., tumors, congenital anomaly, signs of chronic inflammation or infection, etc.) were sampled more extensively compared to the standardized approach. Fixed and frozen tissues sampled from cases requiring additional diagnostics by histopathology were submitted to the CWHC Western/Northern Node. These cases appeared to have relevance on an individual health level, but not necessarily a population level.

Discussion

Monitoring the status and trends of wolf demography, health, and reproduction is an important component of the Tłįchǫ Government and GNWT Wolf (Dìga) Management Program. These measures have the potential to help inform the impacts of management action at the individual and population levels for wolves. The necropsy examinations and biological sampling can help provide some insights into several factors that can impact wolf health: diet/nutrition, gene flow, demographics, morphology, stress, reproduction, survival, and infection or exposure to pathogens and parasites. In this report, information specific to demography, nutritional condition, recent diet, and reproduction in harvested grey wolves which were located within the eWHIA was summarized. Future or pending health analyses not included here include pathogen and parasite diversity testing, genetics, stable isotope analysis, and fecal glucocorticoids (subacute stress biomarker).

Assessment of Nutritional Condition

Nutritional body condition is an important indicator of animal health which reflects the available energy reserves to that individual, which is necessary for survival and reproduction, particularly in overwintering animals. An animal with greater available energy reserves would reasonably have greater overall fitness, reproductive success, and resilience to stressors such as disease, competition, and environmental change (Sacks 2005, Schulte-Hostedde et al. 2005).

All metrics of body condition, subjective and quantitative, were significantly influenced by age class – younger age classes were in poorer body condition. This is not surprising as younger animals are often subordinates in pack structure and/or dispersing and not benefiting from hunting success of the pack. Mass of the xyphoid fat deposit along the falciform ligament is an indicator of wolf nutritional condition (Robitaille et al. 2012). In the harvested wolves examined, the size of this deposit was significantly influenced by sex, with females having less compared to males. However, in contrast, females tended to have significantly more peri-renal fat, as indicated by the KFI, than males. This could be explained by females tending to deposit more fat around the ovarian proper ligament and areas where the reproductive tract and surrounding connective tissues are continuous with the retroperitoneal space, which is not the case in males.

On gross necropsy, rump fat depth was subjectively variable; it depended on where an incision was made over the rump muscle and where a measurement was taken, despite attempting to standardize the approach. Moreso, because carcasses presented on necropsy were already skinned, it was unknown as to how much subcutaneous fat might have been removed or disrupted with extraction of the hide or if carcass dehydration artifact was a factor. There was a significant increase in this metric over time, which contrasted the directional trends of other indicators. No significant change over time was detected for the remaining indicators of body condition.

Overall, these findings suggest that it is important to look at multiple metrics of body condition and to consider that fat deposition may vary across demography. Continued monitoring of this determinant of health is recommended. The relationships between energetics/nutritional condition and other health indicators, such as reproduction or disease, should also be further explored.

Stomach Contents

Stomach contents were assessed as indicators of prey/diet composition for individual animals. A large proportion of stomachs assessed in harvested wolves were empty. This may be an indication that a wolf had not ingested a recent meal, but also could reflect behaviour, such as the wolf vomiting or voiding its gastrointestinal tract. Contents of full stomachs only reflect the most recent meal by that animal; in domestic dogs, natural gastric emptying time has been demonstrated to range between six and 15 hours (Boillat et al. 2010). This time can also be influenced by circumstantial factors, such as high levels of stress or sympathetic drive. The proportion of stomachs that contained barren-ground caribou tissue declined from 2020-2022 and has slightly increased in recent years. The proportion of empty stomachs was relatively consistent. On average (2020-2024), 6.2% of stomachs contained other food sources including vegetation, ptarmigan, grouse, rodent, unidentified ungulate, carnivore, small mammal, bird, porcupine, hare, and fish. The percentage of stomachs with other food sources was high in 2020 and 2024, but low to zero in between those years. As of 2022 harvesters were variably baiting animals, but not always reporting bait type. This should be accounted for when interpreting stomach contents at time of death.

Age structure Approximation

Age structure of submitted wolves based on age class identified at necropsy showed a significant trend to younger animals (young of the year, juvenile) compared to mature breeding adults (adult, geriatric) since 2021. These outcomes can be considered from two key perspectives – first, as being indicative of the demography of animals that were removed from the population by this wolf management program; and second, as potentially representative of population level changes in age structure. Depletion of younger individuals may reduce the availability of local maturing wolves to contribute to reproduction in the population, and perhaps dispersal of young

animals between packs (Adams et al. 2008). If it is assumed that all hunter-selection biases for demography of the harvested animals remained constant, a shift towards younger harvested animals across the years may reflect population-level changes in composition within the eWHIA. Skewing of age structure towards younger, immature animals is often expected in exploited populations (Fuller and Novakowski 1955, Fuller et al. 2003). This might be explained by increased production, increased survival of younger animals, or evidence of younger, dispersing animals immigrating from adjacent areas due to pack splintering and opportunities to fill gaps in pack structure. A decreasing age structure suggests the population is numerically compensating for or recovering from human-caused mortality from harvest, and can indicate or have implications on individual survival, increased population productivity, predation success, dispersal rates and movements, territory, and pack social behaviours (Fuller et al 2003).

Reproductive Status

Probability of an animal being pregnant, and the litter sizes produced by pregnant animals did not vary significantly over the course of the program. This suggests that shifts in population demography are not expected to be due to increased productivity of the population. It was noted that the odds of pregnancy increased with later dates of harvest and with increased age class; both these findings are considered biologically appropriate and expected. Further work is recommended to explore these determinants of fecundity and productivity with consideration of other covariates, such as body condition, gene flow, and movement behaviours, as these all may be potential indicators of wolf population resiliency, response to management, and other extrinsic factors.

Additional health analyses of existing archived samples collected over the years of this management program may be used to further assess diet, health, response to wolf management, and predator-prey dynamics. These include evaluating stable isotope profiles of wolves and prey species (underway), determining genetic structure of wolf populations and potential barriers to genetic diversity (underway), assessing parasite diversity trends and dynamics as trophic and environmental-use indicators, and surveying pathogens that are shared between wolves and prey species. Additional metrics of health such as stress and reproductive steroid hormone profiles; infectious pathogens and parasites that may impact reproductive success, survival, resilience, or be indicators of proximity to domestic animals; contaminants and heavy metal profiles; and changes in demography and behaviour could also be measured.

DISCUSSION AND LESSONS LEARNED

The goal of the wolf management program is to sufficiently reduce wolf predation on the Bathurst and Bluenose-East caribou herds to allow for an increase in calf and adult caribou survival rates to contribute to the stabilization and recovery of both herds. To evaluate the impact of the management actions, both caribou and wolf centered objectives are used (Tables 14-16).

Targets for caribou used to measure the effectiveness of the wolf management program include:

- No less than 85% adult cow survival rates,
- A fall calf to cow ratio between 49-51 calves per 100 cows,
- A late-winter (or spring) calf to cow ratio between 38-45 calves per 100 cows,
- Two consecutive estimates of breeding females, adult females, and herd size with no decline. (Breeding females are assumed to be pregnant, adult females include pregnant and non-pregnant females, and the herd estimate includes adult females and males.)

While a target of no less than 85% adult caribou cow survival rates was established at the start of the wolf management program, caribou collar numbers remain relatively low. Therefore, collar-based survival is best assessed over a two-to-three-year span as one year's estimate can be variable due to small sample size. Stability of caribou herds is typically associated with a range of cow survival rates between 83-87%. The average adult cow survival rate over the last four years is also presented in Tables 14-16.

Targets for wolves used to measure the impact of the wolf management program include:

- A decrease (with no reduction in effort) in the number of wolves removed.
- A decrease in catch per unit effort by hunters (number of days spent hunting and kilometers traveled while hunting).
- A decrease in wolf sighting rates per hour flown during March caribou composition survey.
- An increase in the number of young wolves harvested compared to adult wolves through cementum age analysis.

A comprehensive assessment of the five-year wolf management program is underway to determine whether the objectives have been met, not met, or partially met. Outcomes of the evaluation will help to inform whether further predator management actions are needed and provide guidance on how to implement them.

Table 14. Targets for Bathurst caribou used to measure impact of the wolf management program. No calving ground survey was completed in 2019, 2020, 2023 and 2024. Average adult cow survival rate across four years is in brackets.

Metric	2019	2020	2021	2022	2023	2024	Target met?
Adult cow survival rates (%)	95	87	73	80.5 (83.9)			No (Average range yes)
Fall calf to cow ratios	32	39.1		38.4	36.8	27.3	No
Late-winter calf to cow ratios		30.4		No survey due to herd mixing	No estimate due to herd mixing	No estimate due to herd mixing	No
Breeding females estimate			2,878	3,237			Yes
Adult females estimate			3,808	4,179			Yes
Herd estimate*			6,240	6,850			Yes

^{*}Rate of decline has slowed after 2018, but not yet any clear evidence of stability.

Table 15. Targets for Bluenose-East caribou used to measure impact of the wolf management program. No calving ground surveys were conducted in 2019, 2020, 2022 and 2024. Average adult cow survival rate across four years is in brackets.

Metric	2019	2020	2021	2022	2023	2024	Target met?
Adult cow survival rates (%) ⁵	80	83	85	81 (82.3)			Yes
Fall calf to cow ratios	37.8	51.7	49.6	52.3	51.4	48.8	Yes
Late-winter calf to cow ratios		41.8	46.7	46.9	40.9	47.5	Yes
Breeding females estimate			12,863		18,580		Yes
Adult females estimate			13,991		24,466		Yes
Herd estimate			23,202		39,525		Yes

The four years of collar-based cow survival for both herds up to and including 2022 have met the target value associated with a stable herd, with an average of 83%. There is a trade-off when considering calf recruitment; if fall and late-winter calf to cow ratios (calf numbers) are high, then a slightly lower cow survival is associated with stability; if they are lower, then a slightly high cow survival is associated with stability. For example, while the average Bluenose-East adult cow survival rate was 82%, calf recruitment was greater than our targets, suggesting population

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⁵ The year for collar-based survival estimation begins in June and ends in May, i.e., the year 2020 is from June 2020 to May 2021. Therefore, 2023 results for adult cow survival rates will be available later in 2024.

stability. Updated cow survival and, where available, other demographic estimates for 2024 will be included in the five-year review to provide a more complete assessment of whether cariboucentered objectives were met.

Table 16. Targets for wolves used to measure impact of the wolf management program. Abbreviations are as follows: BAT – Bathurst, BNE – Bluenose East, BEV – Beverly.

Metric	2020	2021	2022	2023	2024	Target met?
Number of wolves removed by ground-based harvest within wolf harvest incentive area (incentive paid)	53	135	50	98	99	No
Average CPUE day	0.14	0.50	0.74	1.05	1.84	No
Average CPUE distance	0.86	4.54	3.39	4.65	9.03	No
Sighting rates (wolves/hour)	0.05 (BAT)	0 (BNE) 0.7 (Mixed)	0.48 (BNE) 0.28 (Mixed)	0.53 (BNE) 0.34 (Mixed)	0 (BNE) 0.77 (BEV)	Yes
Age structure*	3.4	2.1	1.6	1.0	In progress	Yes

^{*}Average cementum age, but cementum ages not available for all removed individuals (2020 (n=84), 2021 (n=120), 2022 (n=32), 2023 (n=31), 2024 (n=0)).

Based on the 2021 estimates of breeding females and adult herd size and analyses of demographics for the Bathurst and Bluenose-East herds of barren-ground caribou reported in the 2021 calving ground photographic survey reports (Adamczewski et al. 2022, Boulanger et al. 2022), the demographic indicators for a stabilizing population have improved for the two herds since 2018, most notably in the Bluenose-East herd. The estimates for the Bluenose-East herd for 2021 suggest stabilization from 2018, based on estimated numbers of females, and possibly the beginnings of recovery based on the herd estimate that includes the males. This was a major improvement from the trend in 2018 for that herd, which was in rapid decline. The most recent calving ground survey was conducted on the Bluenose-East herd in June 2023 and estimated 39,500 individuals, which was a 32% increase since the last survey done in 2021 (Boulanger et al. 2024). The estimate for the Bathurst herd (6,850 in 2022) suggests a slower rate of decline and an improvement in demographic indicators from 2018. While population estimates and demographic indicators have improved, it is difficult to know to what extent it may reflect wolf removals, any other specific management action currently being undertaken, and/or changing environmental conditions. Additional demographic and modeling analyses will be conducted to evaluate this further and will be presented in the five-year review report.

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PERSONAL COMMUNICATION

Jan Adamczewski, Wildlife Biologist (Ungulates). Government of the Northwest Territories. Yellowknife, NT. June 5, 2023.

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APPENDIX A – WRRB RECOMMENDATIONS

Reference	Response	Final Recommendation
#1-2020	VARY	GNWT and TG update the objectives of the dìga management program to be measurable for effects on ekwò and dìga in order to be able to assess the impacts of the program and provide these objectives to the WRRB by May 1,2021 July 31, 2021. Updated objectives should consider that the Kòk'èetì and Sahtì ekwò herds have different vulnerabilities and vital rates and, thus, success may be measured differently.
#2-2020	VARY	GNWT and TG identify and implement alternative methods to measure and index diga abundance and calibrate these with the Ungulate Biomass Index to ensure the most accurate and precise population estimates are used for diga management by May 31-March 31, 2021.
#3-2020	ACCEPT	Dìga sighting rates, during 2ekwò sex and age composition surveys, be assessed by GNWT to determine if and how it contributes to understanding seasonal trends in dìga abundance on the Kòk'èetì and Sahtì ekwò ranges by May 1, 2021.
#4-2020	VARY	The ground-based harvest proceed as proposed with the addition of harvester supports provided by TG and GNWT. This should include 2ekwò, and dìga distribution information, gas caching, and could include 40 bait stations, starting in the 2020/2021 harvest season. These supports are necessary for ground-based harvest removals as per the Wolf Technical Feasibility Assessment: Options for Managing Dìga on the Range of the Bathurst Barren-ground Caribou Herd (2017).
#5-2020	ACCEPT	GNWT and TG improve the harvest reporting program to ensure that appropriate information is being collected through questionnaires, starting 2020/2021 harvest season. This could be accomplished by using a contractor with expertise in this area.
#6-2020	VARY	GNWT and TG incorporate lessons learned from Nunavut's high success rate with their harvester's questionnaire responses and ensure invite Nunavut harvesters to attend Harvester Training Workshops, starting 2020/2021 harvest season.
#7-2020	VARY	GNWT and TG should not continue aerial removals of diga on Koʻk'èeti` and Sahti ekwò ranges in winter 2020-2021. Instead, more resources should be put towards ground-based harvest. Subject to review based on an annual assessment of evidence during the annual review of the program, the WRRB would consider a proposal of other methods of diga removal
#8-2020	VARY	TG and GNWT explore alternative methods of assigning harvested diga to an 2ekw\(\righta\) herd and to statistically determine confidence in the allocation. GNWT and TG should provide enough information to determine how the uncertainty affects the success of the program and submit results to the WRRB by September 30, 2021.
#9-2020	VARY	GNWT and TG will review the feasibility of monitoring diga den occupancy to measure pup production, recruitment, and diet and disease incidence to describe the extent of compensatory breeding and to better understand the minimum number of diga on the Kòʻk'èeti` and Sahtì ekwòʻ summer ranges, starting in the 2020/2021 harvest season.

#10-2020	VARY	GNWT and TG ensure all a sufficiently representative sample of diga removed as part of this program from 2021-2024 undergo a full necropsy to determine injuries, physical condition, reproductive status, and diet, to fully understand health of the diga on the ranges of the Kò, k'èeti` and Sahtì ekwò herds.
#11-2020	ACCEPT	GNWT continue the dìga collaring program, beginning in 2021, using a statistically rigorous design to measure dìga movements relative to the dìga-2ekwò spatial distribution, including reducing the uncertainties involved with assigning dìga to 2ekwò herds.
#12-2020	VARY	GNWT and TG develop an approach to assessing complete a caribou (ekwò) calf mortality study in conjunction with 2021 calving

APPENDIX B - WOLF HARVESTER QUESTIONNAIRE



Wolf harvest survey in the North Slave Region, NWT

		WO	LF HARVEST - Pleas	e report every wolf	harvest	ed				
Date (MM/DD/YYYY)	Wolf ID		with fur (kg)	Latitude		ongitude	Baited? (circle one)	Submitted to ECC? (circle one) Female = full carcass Male = skull + baculum		
		male / fe	emale				Yes / No	skull + bacul	um / full carcass	
		male / fe	emale				Yes / No	skull + bacul	um / full carcass	
		male / fe	emale				Yes / No	skull + bacul	um / full carcass	
		male / fe	emale				Yes / No	skull + bacul	um / full carcass	
		male / fe	emale				Yes / No	skull + bacul	um / full carcass	
		male / fe	emale				Yes / No	skull + bacul	um / full carcass	
		male / fe	emale				Yes / No	skull + bacul	um / full carcass	
		male / fe	emale				Yes / No	skull + bacul	um / full carcass	
		male / fe	emale				Yes / No	skull + bacul	um / full carcass	
			emale				Yes / No	skull + bacul	um / full carcass	
	WOLF SI	GHTINGS				HUNT	ING EXPERIEN	CE		
1. In total, how ma		ears ha	ave you been hunting wolves (circle one)?							
-				Less than 5		5-10	over 10			
	ne packs (circle numb			How recently have you hunted wolves (circle one)?						
Less than 5	5-10 1	10-15 15-20	over 20	Before 2010		2010-2015		5-2020	2020-present	
3. How hard was it	t to find wolves (circle	e one)?		About how many wolves have you harvested in your lifetime (circle one)?						
Very difficult	somewhat dif	ficult easy	very easy	Less than 5						
	HUNTING FEE	FORT AND CONDITION	NS - Please report		timata k			hasa)		
Date	Number of	Number of	Number of hours	Number of kilometers						
(MM/DD/YYYY)	wolves harvested	hunters in group	spent hunting	spent hunting		Weather (circle one)				
, , , ,	initial desired the second sec		.,			Perfect / Go	od / Bad (low	visibility) / Ver	y Bad (stormed in)	
						Perfect / Go	ood / Bad (low	visibility) / Ver	y Bad (stormed in)	
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						Perfect / Go	ood / Bad (low	visibility) / Ver	, , ,	
						Perfect / Go Perfect / Go	ood / Bad (low ood / Bad (low	visibility) / Ver	y Bad (stormed in)	
						Perfect / Go Perfect / Go Perfect / Go	ood / Bad (low ood / Bad (low ood / Bad (low	visibility) / Ver visibility) / Ver visibility) / Ver	y Bad (stormed in) y Bad (stormed in)	
						Perfect / Go Perfect / Go Perfect / Go Perfect / Go	ood / Bad (low ood / Bad (low ood / Bad (low ood / Bad (low	visibility) / Ver visibility) / Ver visibility) / Ver visibility) / Ver	y Bad (stormed in) y Bad (stormed in) y Bad (stormed in)	
						Perfect / Go Perfect / Go Perfect / Go Perfect / Go Perfect / Go	ood / Bad (low ood / Bad (low ood / Bad (low ood / Bad (low ood / Bad (low	visibility) / Ver visibility) / Ver visibility) / Ver visibility) / Ver visibility) / Ver	y Bad (stormed in) y Bad (stormed in) y Bad (stormed in) y Bad (stormed in)	
			WILDLI	FE OBSERVED		Perfect / Go Perfect / Go Perfect / Go Perfect / Go Perfect / Go	ood / Bad (low ood / Bad (low ood / Bad (low ood / Bad (low ood / Bad (low	visibility) / Ver visibility) / Ver visibility) / Ver visibility) / Ver visibility) / Ver	y Bad (stormed in)	
Number of carib	oou seen while huntir	ng wolves (circle one)		FE OBSERVED 1-20	21-10	Perfect / Go Perfect / Go Perfect / Go Perfect / Go Perfect / Go Perfect / Go	ood / Bad (low ood / Bad (low ood / Bad (low ood / Bad (low ood / Bad (low	visibility) / Ver visibility) / Ver visibility) / Ver visibility) / Ver visibility) / Ver	y Bad (stormed in)	
		ng wolves (circle one) ed by wolves did you	? None		21-10	Perfect / Go Perfect / Go Perfect / Go Perfect / Go Perfect / Go Perfect / Go	ood / Bad (low ood / Bad (low	visibility) / Ver visibility) / Ver visibility) / Ver visibility) / Ver visibility) / Ver visibility) / Ver	y Bad (stormed in)	