DISCUSSION PAPER:

Guidance for developing a multi-scale cumulative effects monitoring program for wildlife in the Slave Geological Province

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1.0 Introduction:

There is a common interest among industry, government, aboriginal governments, communities and the monitoring agencies to develop and implement a framework for assessing and managing cumulative effects (CE) on wildlife and wildlife habitat in the Slave Geological Province (SGP). Development of a research and monitoring program to support such a framework is fundamental to its effectiveness.

The purpose of this document is to provide rationale and guidance for developing such a program. It is envisioned to be partnership-based, multi-scale and would: a) guide wildlife management and cumulative effects assessment, monitoring, and management initiatives in the SGP (CEAMM); b) ensure that project-specific environmental assessment (EA) support regional scale cumulative effects assessment and management (CEAM) and c) improve our understanding of the SGP ecosystem.

This draft document is intended to provide a basis for discussion of a path forward in the development of such a program. It is recognized that the various partners will have diverse mandates and interests as we move forward in addressing CE. At present, this guidance document has been developed from the lens of ENR's mandate. GNWT-ENR priorities for long term research and monitoring of wildlife in the SGP stem directly from its authority under the Wildlife Act to manage and conserve wildlife resources for present and future generations by working collaboratively with co-management partners. However, it is understood that as such an initiative goes forward, objectives and priorities will become more collective in scope.

2.0 Background

Recognition of the need for a regional approach to monitoring and research in the SGP has been longstanding since the early 1990s when increasing industrial activity drew attention to the lack of baseline information available to support decision-making. The West Kitikmeot Slave Study (WKSS) was established in 1996 as a multi-partner, regional monitoring program with a focus on baseline data and key research needs. Guided by a tailored research framework based on priority questions, the WKSS study supported over thirty projects on identified biophysical and social-science Valued Ecosystem Components (VECs) from science and traditional knowledge perspectives. Over the course of the WKSS, partners identified the need for a shift in focus from baseline data collection towards investigations of causative factors in changing trends. The initial research program was administered over five years by a dedicated Society; however, the WKSS continued to fund projects until 2007. This was intended to be an interim period until the establishment of a CE monitoring and research body for the region (WKSS 2001). A number of recommendations and initiatives around CE monitoring have emerged from the activities of the then-active NWT Cumulative Effects Assessment and Management Steering Committee (i.e. 2002 draft Regional Plan of Action for the Slave Geological Province) and the NWT Cumulative Impacts Monitoring Program (CIMP). CIMP has been implemented and continues to fund projects on baseline and causative factors; however, a comprehensive CE monitoring framework for the region has yet to take form.

Since the end of the WKSS, research and monitoring has been conducted largely on an ad hoc basis by government, industry and others according to their own processes and priorities. While the momentum of the WKSS has waned, the need for an overall regional framework for CE monitoring and research has grown stronger. The recent decline of the Bathurst caribou herd,

subsequent management actions to restrict harvest, concern among Aboriginal communities and ever intensifying development pressure have led to an emphasis on the Bathurst caribou herd as a priority focus for ENR and CIMP to develop such a framework for the SGP.

While GNWT-ENR has taken a lead facilitative role in addressing CE on the Bathurst herd, CEAMM is a shared responsibility amongst those with management authority over land and/or wildlife, those that use wildlife, and those that use the land. ENR has circulated a draft Cumulative Effects Assessment and Management Framework for the Bathurst herd (Appendix A) to explain the relationship between new and existing programs and processes for the herd in the context of CE. Whereas the regulatory process is geared towards the review and management of impacts of individual developments, the assessment and management of the impacts of multiple projects will occur through a combination of the Bathurst Range Planning process, which will set landscape-level objectives, and the long-term management planning process outlined in the Tlicho agreement, which will set herd-level objectives. Having a regional monitoring program in place to support these processes will be critical for their implementation. For example, the Bathurst Range Planning process is expected to identify key values on the range and monitoring targets for those values while also recommending key mitigations or management actions for maintaining the identified values. Once monitoring metrics are identified through this process, the existence of a regional CE monitoring program will ensure tracking of those metrics. In addition, once management actions and mitigations are identified and implemented, a process will be in place to test and adapt their effectiveness, if appropriate.

Recent environmental assessments for proposed development projects in the region, including the NICO and Gahcho Kue mines, have highlighted the importance that such a framework be multi-scale. The Mackenzie Valley Resource Management Act (MVRMA) requires assessment of CE as a component of the environmental assessment process. However, it has become increasingly clear that CE must be monitored, assessed and managed at the scale appropriate to the species of concern and not at the individual project scale. As such, regulatory requirements for effects monitoring at the project level must fully integrate with regional scale CE monitoring and research. In anticipation of regulatory requirements under the new NWT Wildlife Act, ENR is developing the Wildlife and Wildlife Habitat Protection Plan and Wildlife Effects Monitoring Plan Guidelines in collaboration with partners, which are envisioned to guide proponents in developing programs that integrate project level monitoring into monitoring at the broader CE scale.

The context to support the integration of local scale monitoring with regional level effects assessment in the SGP is emerging. Since 2009, ENR has been hosting workshops to facilitate the harmonization of objectives and the standardization of methods for monitoring several wildlife species in the SGP including grizzly bear, wolverine and barren-ground caribou. Significant progress has been made towards developing regional monitoring objectives and protocols for wolverine and grizzly bear. Discussions on objectives and the development of guidelines for barren-ground caribou monitoring are ongoing. Critical areas for further monitoring and research have been identified through these meetings. Ideally, any monitoring framework developed will also incorporate the monitoring needs identified through range planning and species planning processes.

By participating in a monitoring program for wildlife that is multi-scale, mines can contribute to CEAM by investigating ways to minimize their individual contribution to CE through mitigation at the project scale and by helping to understand how factors like development impact the size, trend and responses of key wildlife populations at the regional scale. Better information regarding mitigations and mechanisms of disturbance at a project-scale can support decision-

making throughout the regulatory process by informing the development of guidelines for industry or via terms and conditions on permits and licences granted to future projects. At the regional scale, a greater understanding of how populations are doing and the extent to which industrial activities affect them can inform the development of landscape-level mitigations (e.g., limits to development, protection of sensitive habitat, fire management, etc.) or wildlife management actions (e.g., harvest limits, predator control, etc.) through range and species-level planning processes. These types of mitigations and management actions and how they will be implemented will be the subject of Bathurst range planning and herd management processes.

3.0 Purpose of a regional monitoring program for wildlife

The development of a comprehensive, regional monitoring program is fundamental to an overall framework for assessing and managing CE to wildlife. *The main goal of a regional monitoring program would be to provide a multi-scale knowledge base to inform the assessment and management of cumulative effects on wildlife in the Slave Geological Province.* This goal could be achieved by the following objectives:

To Support Decision Making for Addressing Cumulative Effects by:

1) Developing and maintaining an information base that will support species-specific and landscape-level management planning processes and regulatory decisions in the region (i.e., Bathurst range planning process, Bathurst management planning processes, carnivore management plans; regulatory processes, etc.)
2) Providing data on key variables that can feed into to CE assessment modelling exercises.
3) Testing and adapting management actions against objectives established through species or landscape-level planning processes.

To Integrate Project-level Assessment (EA) and Regional Level Assessment (CEA) by:

4) Assessing regional impacts of human activity on the distribution and abundance of wildlife at the appropriate scale for species of interest.
5) Serving as a forum for partners to align research and monitoring objectives and standardize methods.
6) Providing opportunities for industry proponents to contribute to initiatives that will satisfy requirements of their Wildlife Effects Monitoring Programs and feed adaptively into mitigations outlined in their Wildlife and Wildlife Habitat Protection Plans.
7) Investigating links between project-scale mitigations and landscape-scale effects.
8) Developing a consistent method for assessing project-level contributions to CE as required in the regulatory process.

To Better Understand the SGP Ecosystem by:

9) Establishing a long-term monitoring framework that identifies gaps, prioritizes needs (i.e., key indicators, causative relationships, etc.), emphasizes deeper understanding of how various factors interact to drive system change and evaluates the capacity of the system to absorb those changes (i.e., thresholds, carrying capacity, etc.)
10) Fostering the development of partnerships for addressing identified research gaps that are of common interest and which may fall outside of individual partners' mandates.
11) Valuing and supporting the role of Traditional Knowledge (TK) and community knowledge in developing the knowledge base for the region.

4.0 Monitoring for management of cumulative effects on wildlife

From a regulatory perspective, cumulative effects are the impacts on a population which result from the incremental stresses imposed by a human action or project when added to other past, present and reasonably foreseeable future projects or actions. Although CE are typically thought of in the context of development or human actions, from a wildlife management perspective, they cannot be assessed in isolation from natural stressors and other non-human factors that influence populations. Therefore, managing CE on wildlife involves tracking changes in species status indicators along with multiple causative factors (natural and human-induced) and then targeting management actions (i.e., mitigations) towards the most important drivers that we can manage to achieve management objectives.

Table 1. General indicators of species changes and driving factors. Driving factors in bold represent those that are most likely to be targeted though management actions (asterisk=indirectly)

Indicators of species status	Driving factors
- Abundance (relative, population estimates, etc.) - Population trend - Density - Birth rate - Recruitment - Sex Ratio - Health - Condition - Mortality (by age and cause) - Movement/distribution	- Climate / climate change - Food (forage availability; prey abundance, etc.) - **Habitat** (quantity, quality) - **Predation** - **Harvest** - **Disease & Parasites** - Insects - Natural disturbance (i.e. **fire**; extreme weather events) - **Human disturbance (direct & indirect)**

Currently in the SGP, the overarching CE question is what factors have contributed to the decline of the Bathurst barren-ground caribou herd? This is critical for knowing what factors need to be managed to promote herd recovery. Possible explanations include natural cycles, range condition, industrial development, harvest, predation, climate, disease, insect harassment and natural disturbances like fire. While some factors such as weather are beyond our ability to control, others, such as harvest and human disturbance, can be managed. Without some understanding of which variables are the most important, management risks being redundant, resource-intensive or unsuccessful, particularly if the factors that can be managed are not the main factors driving the population. Management objectives need to be built around thresholds beyond which change is deemed unacceptable or unsustainable while the actions triggered in approaching these levels need to either target the most important factors or take action on a collection of manageable factors that together result in lowering the cumulative impact below a threshold. This points to the role of research. While the development of these levels may to some extent be value-based, research informs our understanding of the system and its ability to

absorb change and so can help refine management objectives and actions. As such, an effective research framework for CE may emphasize identification of key indicators for monitoring, development of thresholds and questions of relative causation among multiple variables.

There is a reciprocal relationship between research and monitoring in the context of CEAM. On one hand, research into causative effects is an essential component of a monitoring program as it can inform the choice of the key variables to be monitored over the long term. On the other hand, the availability of high quality, long-term monitoring datasets can help answer key questions regarding relationships among variables to support effects assessments. A monitoring framework built around well-defined questions would guide decisions about where resources should be focused and partnerships established to ensure that key variables required for long-term monitoring are tracked.

A carefully built CE monitoring program developed around indicators and drivers of species change (Table 1) based upon targeted questions will help to:

a) Determine which human and natural factors are driving species specific population size and trend,
b) Inform the selection of metrics that are most feasible for continued long-term monitoring
c) Identify levels of disturbance or harvest above which the size and trend of the population is negatively impacted,
d) Inform the development of management objectives (e.g., focus management actions on those factors that have a significant impact on population size and trend and can be managed),
e) Assist in selection of management actions and development of mitigations to achieve these objectives,
f) Provide insights into the effectiveness of management actions/mitigations through adaptive management.

5.0 Where are we at?

Gunn et al. (unpublished) identified four levels of monitoring needed to contribute to assessment and management of CE on wildlife; 1) species monitoring, 2) environmental monitoring, 3) landscape level monitoring, 4) project-specific effects monitoring. In addition to monitoring within each of these levels, CEAM is further supported by consideration of key research questions related to interaction between the levels to refine our understanding of the system. The following summary of monitoring activities in the SGP is not meant to be exhaustive, as the specific indicators to monitor will depend on a number of criteria including the availability of data, the questions being asked and the modelling or analytical approach taken. However, it is meant to provide a broad overview of the important elements of a CE monitoring program and identify where potential gaps occur. A more systematic assessment will be required to fully inform the development of a monitoring framework for a regional program.

5.1. Species monitoring

Monitoring population or demographic trends for the species of interest is fundamental to this program. ENR Wildlife Division monitors parameters that directly contribute to its ability to assess population trends, manage harvest and other factors for priority wildlife species within its

mandate. The current emphasis of ENR's program in the SGP is barren-ground caribou, with some monitoring of large carnivores and small mammals. Wildlife effects monitoring conducted by the diamond mines in the SGP has also contributed population information for carnivores, particularly as the mines have begun to coordinate their efforts through DNA hair snagging programs. Table 2 provides a summary of demographic monitoring in the SGP.

Demographic monitoring of all NWT caribou herds is a key feature of the GNWT's 2010-2015 Barren-ground Caribou Management Strategy (GNWT 2011), as it provides critical information on caribou herd size and trend. This information is used to inform harvest recommendations and other management actions, as appropriate. For some herds, information goes back several decades and can provide some history on natural population cycling, vital rates, caribou movements, and harvest levels. Traditional knowledge also provides critical information and extends beyond ENR's surveys.

Demographic monitoring for carnivores provides an understanding of the status of carnivore populations which is an important indicator of ecosystem health and can provide some indication of predation pressure on caribou and other ungulates. Data on predation rates or carnivore diet composition can further illuminate role of specific predator-prey interactions and inform management actions. Carnivores that are currently monitored in the SGP through existing programs include grizzly bear, wolverine and wolves. Both grizzly bear and wolverine have been assessed as species of Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), making the development of a management plan a necessary step for conservation of the species under the federal Species at Risk Act if they are listed. Data generated through regional grizzly and wolverine hair-snagging programs and GWNT wolf den monitoring will be used: a) as inputs into CEAM for the Bathurst herd, b) as the fundamental inputs into CEAM of grizzly bear and wolverine to determine the impact of industrial and other activities on their distribution and abundance and c) to inform carnivore management planning by the GNWT.

Table 2. Demographic monitoring

Metric	How	Rationale	Who
Bathurst caribou			
Breeding females (contributes to population size estimates)	Calving ground photo survey – frequency dependent on herd status, currently every 3 year; may change to every 4-6 years as herd status improves	Track changes in population size and trend	GNWT
Overwinter calf survival (calf:cow ratio)	Spring (March) recruitment survey	Provides an assessment of young caribou recruited into the herd after 9 months of age when their survival rate becomes the same as for adults. In conjunction with modelling and knowledge of other indicators, it allows predictions of potential population trajectory.	GNWT
Sex ratio (bull:cow)	Fall composition survey	Contributes to estimate of herd size as calving ground only counts breeding females; helps monitor changes in sex ratio due to harvest; provides an indicator of status and health of populations (i.e., higher bull:cow ratios associated with higher population numbers.	GNWT
Index of breeding cows; extent & location of calving grounds	Calving ground reconnaissance survey	Used to track herd trend between population surveys	GNWT
Pregnancy rate	June calving ground survey, community health and condition monitoring programs and community hunts	Indicator of reproductive success	GNWT, Tlicho Government, YKDFN and LKDFN
Condition, health	Community and harvester programs. Caribou monitors are given sample kits and are trained to work with the hunters to sample some basic indicators of condition level and pregnancy rate (throughout the winter).	Provides indication of health, body condition and pregnancy rates.	GNWT and community monitors through Tlicho Government, YKDFN and LKDFN
Movement & Range Use	Satellite collars	On the Bathurst range, collaring is primarily used to locate the herd to conduct other surveys. Proves some data on variation in calving ground locations and range use.	GNWT
Harvest mortality	Harvest studies in which caribou monitors interview hunters about the number, location and sex of harvested caribou (ie resident harvest questionnaires, household	Indication of harvest levels and locations. Information is forwarded to ENR and weekly harvest tables and maps are produced to track harvest.	GNWT and community monitors through Tlicho Government, YKDFN and LKDFN

	surveys) from winter road check stations, community hunts		
Grizzly Bear			
Abundance / Density	DNA hair snagging studies	To monitor changes in the distribution and abundance in the study area over time; for assessing mine impacts and to support management planning and CE assessment.	Ekati, Diavik, Snap Lake, Gahcho Kue; and Government of Nunavut
Population trend	WMIS central barrens grizzly bear tracking 1988-2004	Phase 1 – delineate population structure in the SGP, ended 2000. Phase 2 – population estimate – never conducted. 2001-2004 – GPS collars – bear movements in relation to mine infrastructure, e.g., Misery Road	GNWT
Harvest mortality	Harvest studies; export permit tracking	Monitor harvest and defence of life and property (DLP) kills for sustainability	GNWT
Wolf			
Population trend and distribution	Den occupancy surveys and pup counts in early June	To monitor population trend, pup survival and recruitment	GNWT, with support from industry
Mortality	Wolf carcass collection program; harvest studies and export permits	Attempt to monitor harvest, physical condition, and investigate for changes in early birth litter size with changing caribou densities.	GNWT
Movement and activity	Wolf collaring program 2013-2014	To monitor activity patterns and movements relative to collared caribou	GNWT and academia (UNBC)
Wolverine			
Abundance/density	DNA hair snagging studies	To monitor changes in the distribution and abundance of wolverines in the study area over time and test revised impact predictions by mines.	GNWT, Ekati, Diavik, Nunavut
Mortality; health, age structure; sex ratio	Carcass collection; harvest studies	Monitor harvest and defence of life and property (DLP) kills for sustainability	GNWT
Raptors			
Nest occupancy and productivity and production	Every five years, contributing to the Canadian Peregrine Falcon Survey (next one 2015)	To monitor changes in the distribution and abundance and test revised impact predictions by mines.	GNWT, Ekati, Diavik, Snap Lake
Small mammals			
Abundance of voles, shrews, mice and lemmings	Museum trap protocol in 5 ecozones across NWT, including Daring Lake in the SGP	Key stone species, base of food chain, cycles linked to fluctuations in predator populations	GNWT

Possible gaps / points to consider at the species level:

- In general, there appears to be a good base of demographic data either available, or in development, to inform assessment and analysis of CE to caribou and carnivores; however, commitments and resources are needed to ensure on-going, long term monitoring needs are met.
- Similarly, there are a number of factors that may be monitored by different sources or programs and some work is required to compile, collate and organize the data into useable formats. For example, harvest and other human induced mortality is monitored through various programs and initiatives (harvest, defense of life and property kills, export permits, community harvest studies, carcass collection programs). However, there is no single database that compiles and calculates mortality by cause.
- Monitoring of predator population trends is critical for managing carnivores in the central barrens and for accounting for the influence of predation on caribou populations; however, information on predation rates and the role of competition and access to alternate resources may also assist in assessing the significance of predation on caribou population dynamics.
- Development of more feasible ways to monitor grizzly bear and wolverine population trend either between hair-snagging study years or instead of hair-snagging is required (e.g., collaring?)
- More information on the response of wildlife to industrial development and linear features in the barrens (i.e., movements, avoidance behaviours, energetic costs of disturbance) is required to supplement demographic information to scale up to population levels.
- Further information on the health and disease status of caribou is needed. While looking the role of pathogens in causing disease/mortality is important, their subclinical role in influencing body condition, productivity and survival is also important. Any consideration of diseases & parasites also has to look at their cumulative contribution to reducing the viability or resilience of individuals and populations.
- Demographic monitoring of other ungulate species (musk oxen, moose) that may compete with Bathurst caribou on the winter range or be available as alternate prey for carnivores is needed.

5.2 Landscape level monitoring

Key information required at the landscape level includes:

a) *Habitat.* Base layers including land cover and vegetation community types are generally obtainable and available for the SGP, although some processing is required depending on the analysis being conducted. Available data sets include:
   - WKSS vegetation classification (Matthews et al. 2001)
   - the New Circa 2000 Land Cover Map of Northern Canada (NLC),
   - EOSD Land Cover Classification, and
   - Normalized Difference Vegetation Index (NDVI) Data which can be used to measure green-up patterns on caribou ranges.

b) *Land use.* Such data would include footprint and/or point data for industrial developments, mining claims, mineral leases, outfitter/exploration camps, linear features, communities, etc. and can be used in CE assessment to monitor and derive indices such as cumulative direct habitat loss, indirect habitat loss (if coupled with

information on zones of influence), fragmentation indices, and density of linear features. Currently data for individual studies are often accessed through the various government departments and agencies that issue land use permits (i.e., AANDC, MVLWB, WLWB), but work is often required to collect and compile them, and several inconsistencies are usually apparent in the data. Some reasonably complete compilations have been developed for such projects at the Gahcho Kue environmental impact assessment project (Golder 2010) and the demonstration project of CE modelling approaches for the Bathurst summer range conducted by ENR (Nishi et al. in publication). However, ongoing monitoring to update such files and making them centrally available would be required. Given the importance of land use as a major component of the overall impact of human activity on wildlife, there is a paucity of readily-usable up-to-date, consistent data available to describe the type, intensity, temporal and spatial extents of land use. Information gaps also exist for activities that do not require a land use permit or for transitory activities.

There are initiatives underway to coordinate the accessibility of landscape data; however, it will likely be some time before any of them are operational at a level that can provide ongoing support for repeated cumulative effects assessment exercises. The Mackenzie Valley Land and Water Board is beginning to require that proponents submit spatial data with applications and is developing guidelines for submission of these data by proponents. They are also looking to create a spatial database for older archived files. Plans for housing and managing the data have yet to be developed. The Inventory of Landscape Change initiated by AANDC-CIMP is seeking to be a central repository of datasets from various sources that will track human and natural disturbance. This initiative is in its initial work planning stages, although a pilot project has been identified for the Sahtu region. While it is unclear as to when data would be available to support ongoing CE assessment in the SGP, devolution of this group to the GNWT may provide more opportunities to advance work directly relevant to this region.

c) *Natural disturbance*. Data on the location, extent and date of fires in the NWT (forested and barren-lands) have been monitored and updated annually by ENR-Forest Management Division since 1965.

Possible gaps / points to consider at the landscape level:

- Is there value in establishing permanent vegetation plots on the Bathurst range? Who will monitor them?
- What are the key habitat variables to track for caribou, grizzlies, wolverine, wolves?
- What are the opportunities for remote sensing data analysis of disturbance? Is there a role here for collaboration with NASA and for collaboration with the NWT Centre for Geomatics landscape disturbance mapping and inventory (LMI) project?
- Can we identify areas that should be protected from fire? Can we identify areas likely to burn in the next 10, 25, 50 years?

5.3 Environmental monitoring

Environmental monitoring is critical for obtaining an understanding of natural variability in the system and climatic processes relevant to wildlife. For example, environmental monitoring of appropriate variables in relation to caribou demographic data could help us understand the role of insect harassment in relation to condition, icing events that might affect foraging, timing of freeze-up in relation to survival or green-up in relation to calving success.

In the central barrens, Environment Canada Meteorological Information is mostly restricted to NWT communities. Over the past decade or so, data has been collected at Ekati and at the Tundra Ecosystem Research Station (TERS) which is run by ENR. CircumArctic Rangifer Monitoring and Assessment Network (CARMA) has developed a caribou range climate database based on NASA's Modern Era Retrospective Analysis for Research and Applications (MERRA) dataset.

Possible gaps / points to consider:

- Are data on the necessary environmental variables available for the SGP?
- What are the key environmental variables to monitor in the long term and at what temporal scale (monthly, annually, seasonally)?
- What role can new developments play in improving meteorological data for the region?

5.4 Project-level monitoring

Industry contributes to monitoring of project-level baseline conditions and impacts through requirements under environmental assessment processes, regulatory requirements and environmental agreements. Once a project is underway, surveillance monitoring and mitigation measures outlined in the Wildlife and Wildlife Habitat Protection Plan (WWHPP) can help ensure human safety and avoid adverse wildlife interactions while effects monitoring for direct and indirect effects typically required as part of follow-up programs are captured under the Wildlife Effects Monitoring Program (WEMP). Monitoring outlined in a proponent's WEMP is meant to test the validity of impact predictions made during environmental assessment and to test the effectiveness of mitigations.

Wildlife effects monitoring conducted by existing mines in the SGP has typically been tailored to the specific predicted impacts of the project on identified VECs and has included:

- Community based programs
- Onsite surveillance monitoring (wildlife presence,# of encounters / incidents, # of deterrent actions taken and # of mortalities)
- Direct habitat loss
- Dust levels
- Metal levels in lichens
- aerial surveys for caribou distributions
- track count surveys
- behaviour monitoring

If monitoring programs are designed to specifically address project impacts with hypotheses, objectives, and consideration of statistical power and thresholds, metrics developed through effects monitoring at the project-level can be scaled up to the landscape level to be used as

inputs into CE assessment. For example, metrics such cumulative habitat loss, zones of influence (areas of reduced avoidance around project sites, linear disturbances, etc.), encounter rates, behaviour changes, etc. can be entered into models to help evaluate thresholds under different development scenarios. At the management end of things, mitigation testing that clearly links the reduction or elimination of a predicted impact to mitigation actions through well-chosen monitoring indicators and effective design can inform best practices, if information is shared among developers. Guidelines for industry developed around specific mitigation topics can minimize a mines' individual contribution to CE.

Recognition that effects monitoring for large-ranging wildlife species required as part of a WEMP is best focused at large spatial and temporal scales has prompted coordination of some monitoring approaches. Through ENR-hosted monitoring workshops, DDMI, DDEC, and DeBeers (Snap Lake & Gahcho Kue) have harmonized monitoring objectives and approaches for grizzly bear and wolverine. The agreed-upon monitoring objective for both wolverine and grizzly bear is "to provide estimates of wolverine/grizzly bear distribution in the study area over time." It has been agreed that DNA hair-snagging is the best approach to addressing this objective, and standardized monitoring protocols for both species are being developed. While each mine continues to collect data around their individual projects, they are also contributing to the collection of demographic data over larger scales. These data will be used to generate density information, which can inform CE assessment and species management for carnivores and caribou.

As of the most recent ENR-hosted wildlife monitoring workshop in March 2013, the process of harmonizing research objectives and standardizing approaches for caribou in the SGP is ongoing. Existing monitoring objectives are:

a) *To determine if caribou behaviour changes with distance from the mines*. Addressing this objective may involve routine behaviour monitoring. Executed properly, with careful consideration for observer bias, conditions, and multiple other covariables, behaviour data has the potential to allow activity budgets to be developed and scaled up to model energetic costs on caribou in encounters with various project components (i.e., roads, infrastructure, etc.). Currently, standard approaches for monitoring behaviour of caribou have yet to be developed.

b) *To determine whether the zone of influence (ZOI) changes in relation to mine activity.* Based on analysis of historical collaring data and aerial surveys, ZOI around the Diavik and Ekati mines in the SGP has been estimated to be 14km (Boulanger et al 2011). The extent to which ZOI might change given mitigations or production level changes is still seen by many as an outstanding question. Given the high cost and often low data return of survey flights around the mines (i.e., when caribou are not present in high numbers), determination of the conditions under which continuing these flights is feasible needs to be examined. While collaring could provide a alternate means of obtaining ZOI, this approach has not been feasible given that community concerns have limited the number of collars that can be placed on the herd to 20.

b) *To determine if caribou abundance and distribution changes in the study area over time.* While monitoring of distribution and abundance in the Bathurst herd is conducted by ENR, interest has been expressed by mining companies to contribute to monitoring and research programs that improve the understanding of factors that

affect the health and trend of caribou herds and other species. This third objective has only recently been introduced as a *potential* monitoring objective by the mines, and is subject to further discussion. As abundance and distribution data is fundamental to any CE monitoring program, contributions to government programs to conduct this fundamental monitoring is being considered as one way industry can support CE work at the regional level.

Possible gaps / points to consider at the project level:

- Define conditions and methodology for monitoring zone of influence for caribou (if and when).
- Develop protocols for monitoring caribou behaviour.
- What are the causative mechanisms for caribou ZOI? What mitigations can impact ZOI?
- Should mines also be monitoring changes in caribou distribution and abundance in the study area over time (similar to carnivore species)?

6.0 Developing a Monitoring Framework

Successful long-term monitoring programs are built around well-defined and tractable questions (Lindenmayer & Likens 2009). Questions that are developed collaboratively by partners around a collectively-accepted conceptual model of the system lay the groundwork for the systematic selection of monitoring indicators and the development of a robust experimental design. Ideally, questions should be developed at the outset before monitoring takes place. However, in the context of the SGP, development of a cumulative effects monitoring program for wildlife will involve integrating existing initiatives with new initiatives. Depending on the species in question, development of a monitoring framework may have to take into account more than one process. For the Bathurst herd, the range planning process will likely deal with the identification of key indicators to be monitored and prioritization of questions surrounding caribou habitat and disturbance on the range while the comprehensive management process will likely identify key indicators and prioritize questions related to the impacts of harvest, predation and disease (Figure 1). As such, development of a comprehensive monitoring framework for caribou will require identifying a mechanism for incorporating inputs from these processes while ensuring that partnerships are formed to monitor and increase our understanding of other influential drivers that fall outside the realm of manageability (i.e. environmental / climate factors). Given that fewer planning processes exist for grizzly bear, wolves, and wolverine, there are opportunities to develop a more comprehensive framework without cobbling together input from multiple planning processes.

6.1. Develop a Conceptual Model

A conceptual model is a representation of the current understanding of the relationships and pathways of effect in the system being studied. Each pathway in the model can represent a hypothesis to guide the development of key monitoring questions. Collaboration in generating questions based on the relationships outlined in the model is necessary to ensure that questions are framed in a way that an appropriate design and execution will actually answer the question.

Figure 1 shows a conceptual model for cumulative effects pathways on caribou (Greig et al. 2013) and can provide the basis for development of key questions around CE on caribou. The enclosed shapes indicate possible key drivers of caribou populations and status indicators, while the arrows provide examples of pathways of effect and can essentially represent hypotheses to be tested. The coloured boxes generalize the concerns related to the different processes that need to be integrated to address CE on caribou. The conceptual model for caribou is provided as the Bathurst herd has been identified as a priority and could be considered the “pilot” project for CEAM; however, a conceptual model for any other species of interest would look similar, with some adjustments made to key factors and connections.

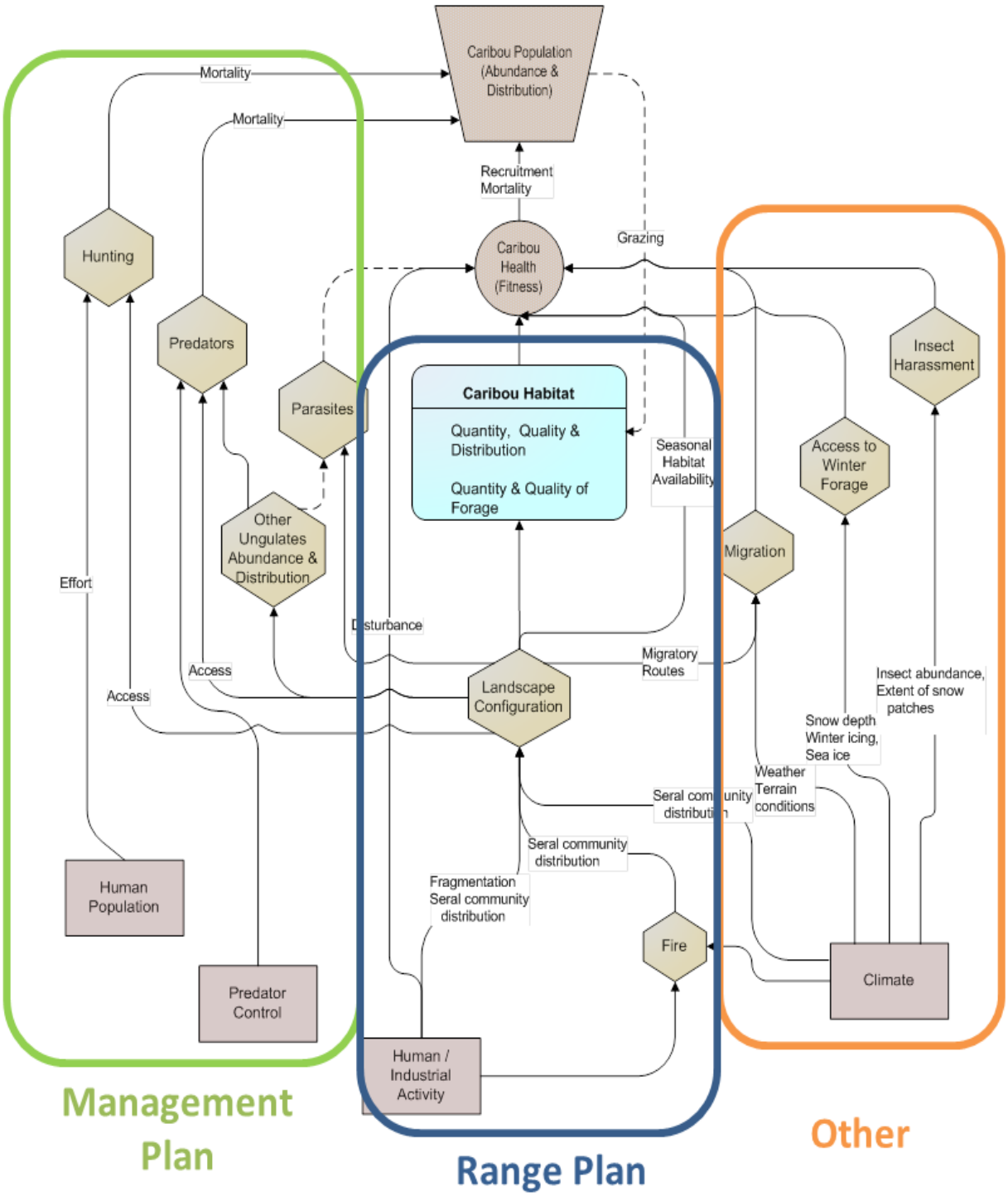

Figure 1. Conceptual model of cumulative effects pathways for caribou (Greig et al. 2013)

6.2. Identification of Questions

Table 3 contains a list of key CE pathway questions for various species in the SGP that have emerged through past workshops, EA processes and expert advice. Depending on the species in question, a more systematic approach to identifying and prioritizing questions and related monitoring needs could be part of the development of a targeted monitoring framework to guide the activities of a regional monitoring program and, if applicable, can incorporate priority setting that is part of species-level and range-level planning processes.

Table 3. Key questions related to CE of various species that have emerged past monitoring workshops, environmental assessment processes and expert advice and the potential process or group best situation to address the question.

Question	Potential source of prioritization and implementation
What is the impact of industrial development on the distribution and abundance of large, wide ranging species including caribou, grizzly bear, wolverine and wolves?	Industry and government through collaborative monitoring
How will climate change affect the range (vegetation, natural disturbance patterns, weather condition and insect levels) and distribution of wildlife species?	Academic partnership
How is the Bathurst summer range condition affecting the condition and pregnancy rate of cows?	Academic partnership
What trends in fire frequency and extent can be expected for the Bathurst winter range and how does this relate to key habitat availability	Academic partnership
Where are the high value habitat areas for caribou?	Range Planning
What is the significance of predation by different carnivores on caribou at high and low points in the herd cycle?	Academic Partnerships
How does caribou foraging affect the range and vice versa?	Academic partnership
What are the key indicators that should be monitored regularly and in perpetuity so that we can continue to monitor CE on wildlife?	Range planning processes
What is the relative abundance of grizzly bear/wolverine/wolves in the SGP?	Collaborative monitoring
What is a sustainable harvest level for harvested species?	Government & co-management partners
What are the causative mechanisms of ZOI on caribou? How can we mitigate factors that cause caribou avoidance?	Industry
What are the effects of new roads and increased road traffic on the behaviour and movements of carnivore species? On caribou?	Industry
What are the thresholds for disturbance to caribou?	Range Planning
What are the best practices for reducing wildlife attraction at small camps, given other environmental	Government /Industry

concerns such about air quality associated with burning of wastes?	
What are the effects of 'X' mitigation or management action on the species of concern?	Various

6.3 Prioritize Key Questions

As resources are limited, not all questions can be addressed at once. Priority setting requires the development of criteria by which questions are selected. Criteria might include: Is it feasible? Is it necessary to answering other questions? Does it address a specific public concern? Is answering it realistic? Does it address an information gap? Is there already some momentum to addressing it? Can it link to other key questions? Will the information help to inform decision about wildlife and range management? For species for which range or management planning processes are already in place, priorities identified through process specific criteria can be incorporated.

6.4. Determine WHAT needs to be monitored

From a basic CE perspective, some monitoring at each of the levels identified in Section 5.0 needs to occur to ensure that a range of questions can be addressed; however, the specific metrics to be monitored will depend on the specific question. For example, questions about how increased human access and industrial development will affect stress levels in grizzly bears might require:

a) Demographic metrics such as grizzly bear population trend, recruitment, cub/adult mortality and physiological data
b) Landscape metrics such as density of linear features
c) Other linking metrics such as trends in human use of linear features, bear density in relations to linear features and bear responses to human use.

For the Bathurst range plan, monitoring needs relating to questions of how identified values can be maintained on the landscape or to the impact of identified management actions will emerge out of the range planning process. Monitoring needs are also expected to be identified through the Bathurst management planning process.

6.5. Determine HOW monitoring and analysis will occur

Depending on how a question is framed, consideration needs to be given to whether traditional knowledge approaches or scientific methods would be best suited to tracking the chosen metric. If monitoring is to be conducted by more than one partner, monitoring protocols should be developed to ensure compatibility among datasets and provide guidance to new proponents in the development of their WEMPs. For science based indicators, evaluation of how the selected metric is predicted to change in relation to the sensitivity of the sampling method is required. Some type of statistical power analysis is required to determine whether an effect can be detected or whether another metric needs to be considered. This will require some forethought to the analytical approach that will be used to address the question.

Given the complexity of CE assessment, a number of tools and models have been developed to address broader CE questions. ENR is currently evaluating tools and options for the analysis of CE (Grieg et al. 2013). Different models have different emphases and the selection of the appropriate model is not straightforward. Models that could be used for assessing CE on caribou can generally be classified into three groups a) habitat models, b) caribou population models and c) those that model the landscape at a given point in time (Grieg et al. 2013). However, existing models are not generally able to synthesize all types of information required to assess the impact of a wide range of variables or pathways on their own. To a large extent, the way in which a question is framed can influence which model is best selected, though an approach that can integrate multiple tools or models might be required to investigate larger CE questions. For example, a demonstration project initiated by ENR sought to link modeling techniques that have been used to explore habitat selection, energetics and land use dynamics (Nishi et al, in preparation), while also incorporating Tlicho traditional knowledge. While the project was useful for showing ways that the models can be integrated and provided some direction on potential analytical approaches, work remains to be done to develop a more simplified approach for continual and regular assessments. Further training of NWT-based practitioners in the use of these tools is also required.

While the analytical approach can inform the process for assessing CE, it is important to recognise that the collaborative process to frame the questions based on collective values is as important as the choice of models. Models are tools that can be used to get at questions, but the choice of questions and associated variables to monitor must have relevance to the human dimension if they are to lead to relevant and effective management/mitigation objectives.

6.6. Coordination and implementation of monitoring

If the monitoring is meant to be undertaken by multiple parties, coordination is required to address participation, roles, responsibilities and logistics. The means by which partnerships are developed and collaboration is pursued will relate to the structure and funding of the monitoring program (See Section 7).

6.7. Adaptive monitoring and management

Effectively designed and implemented, a multi-scale CE monitoring program for wildlife can be used to identify the need for adapting objectives and mitigations/management actions recommended in management or range-level plans. Results of monitoring can be used to identify whether objectives are being met, and whether the identified management and mitigation techniques are helping to meet those objectives. This requires a deliberate plan or process for revisiting goals and objectives, evaluating whether they're being met and whether we are really making progress towards a better understanding of the whole system and the factors that we can actually manage. Much like an adaptive approach to management examines the results of monitoring to make changes to the applied management action or the monitoring approach, an adaptive monitoring approach allows a monitoring program to evolve to changing questions and information needs as questions become answered, when new questions need to be posed or when new protocols or mitigations are identified.

7. What would a regional monitoring program look like?

7.1 Partnership-based

The form and structure of a regional monitoring program to support CEAM will depend on the values of the stakeholders. A fundamental feature of such a program is prescribed by the socio-political context of the NWT – it must be partnership based. Regulators, industry, aboriginal governments, co-management boards, and communities all have a stake in the effective implementation of a multi-scale CE monitoring program for wildlife. A collaborative structure would be a pre-requisite for ensuring that this program is credible to communities, government and researchers alike. If undertaken carefully and deliberately, collaboration will allow more efficient use of resources.

While the specific players would need to be determined by the group, involvement of industry, government, communities and co-management boards with interest in the SGP would be important. Coordination with industry is important given that industrial activity and funding will play a role in driving monitoring activities. Some level of engagement with neighbouring jurisdictions (i.e., Nunavut) will be required given the geographic scope of the program. For example, the Bathurst herd is of critical importance to harvesters in the NWT; however, the calving grounds and post-calving range of this herd occur in Nunavut. Therefore, collaboration between NWT and Nunavut will be required as range planning and management planning processes proceed. Community involvement is critical for ensuring that the direction taken is relevant to addressing their concerns around CE.

7.2. Scope

This program is proposed to be primarily biophysical in scope, focused on question-based monitoring of wildlife and wildlife habitat and the natural and anthropogenic factors that can affect these.

While there are other components of the environment (physical, cultural, social, etc.) that have the potential to be affected by multiple, cumulative impacts,; the nature of CE is complex, inherently multifactorial and politically sensitive. Building a CE framework and monitoring program that is wildlife based can provide a model for subsequent expansion to include other areas of focus (i.e., broader biophysical components or links to socio-economic and cultural components, etc.). Also, because of the current emphasis on the Bathurst caribou herd and the already established relationships around wildlife monitoring in the SGP, there is already some momentum to proceed by linking to existing and emerging wildlife initiatives. The Bathurst herd would then be considered the “pilot project” of the CE monitoring program.

While the current emphasis for CEAM programs is on the Bathurst caribou herd and range (see Background), this program is intended to support assessment and management of all species recognized as VECs. Ultimately, as our understanding of the system increases, it will facilitate a shift to a broader ecosystem-based approach.

The geographic scope of this program is proposed to cover the general area of the SGP and the historical range of the Bathurst Herd. Partners may wish to delineate an area similar to that used by the WKSS and shown in Figure 2.

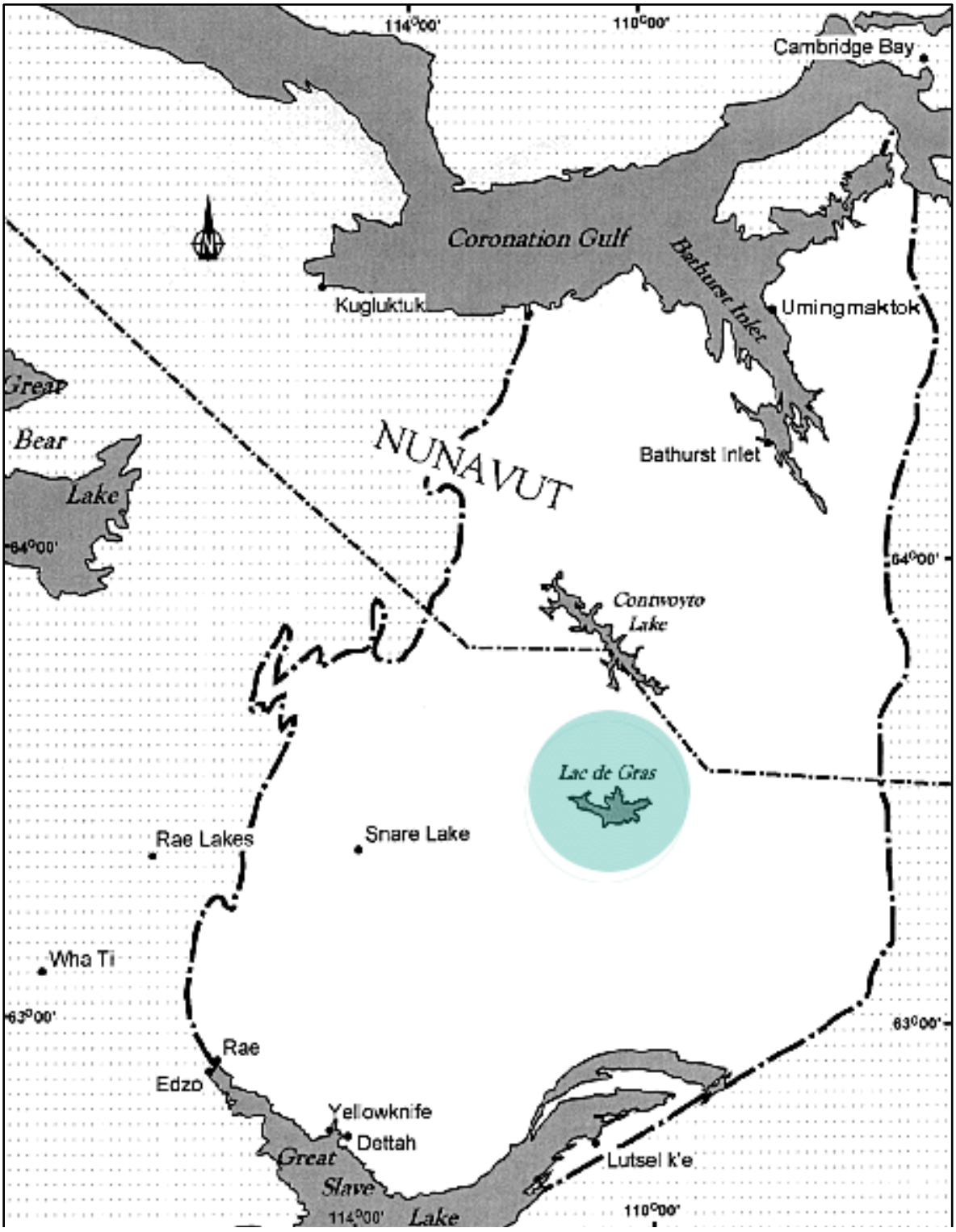

Figure 2. Geographic scope of the West Slave Kitikmeot Study

7.3. Management Structure

Partnership can take many forms from informal to formal and development of a management structure needs to account for several considerations:

- Who will lead?
- Where will it be housed?
- What level of independence from specific interests is desired? Practical?
- How would coordination of research/monitoring activities be handled? Is a Secretariat necessary to provide administrative support, facilitation and coordination?
- How will it be funded? Who will leverage the funding?
- Who would be represented?
- Does the structure build partnerships and collaborative approaches?
- How will the structure support the link between identified research/monitoring needs and funded activities? (i.e., Request For Proposals for specific questions versus general funding pool)
- What are the financial implications of the structure (is there overhead?)
- How will communication occur between monitoring programs and other relevant processes (i.e., range planning, species-level management)
- Consensus based decision making?
- What will the relationship with/role of CIMP be with regards to this initiative post-devolution?

Given these questions, a range of options can be examined, including, but not limited to:

a) *The status quo*. Monitoring activities are taken up on the basis of need or funding availability according to the interests of those conducting the monitoring. Annual or semi-annual workshops are hosted by ENR to provide the venue by which discussions on program direction can take place, and collaboration can be developed on a project-by project basis based on Memorandums of Understanding (MOUs) or similar type agreements.
b) *A framework-driven, Working Group collaboration*. A CE monitoring framework for wildlife could be developed by a Working Group that operates according to Terms of Reference and is convened by an ENR (or other organization) administrative lead. The Working Group can facilitate specific task groups (for development of specific protocols, or for addressing specific questions) or MOU-based joint-ventures around individual questions and annual meetings/workshops can be held with broader participation to share results, and modify the framework as appropriate.
c) *Other?*

Regardless of the management structure chosen, annual workshops with the broader array of interested parties should continue to be a key outlet for discussion of the status and direction of monitoring initiatives in the SGP.

7.4. Source of funding

ENR will likely continue to support demographic monitoring in the SGP that fits under its mandate, provided funding is available and depending on other government priorities. ENR

does not have the funds to support a regional monitoring program (including a management structure) on its own. Secretarial support of such a program, depending on where it would be housed, would require seeking of core funding. Some support from developers looking to contribute to CE assessment and satisfy requirements of their Wildlife Effect Monitoring Programs could be a source of funding. Consideration could be given towards the establishment of a tax or levy on industry revenues to support such a program (as is the case with the Alberta Biodiversity Monitoring Institute). Foundation money and academic funding could also be accessed, if appropriate. Federal funding might be available through specific funding programs (i.e., CIMP, etc), although devolution renders some of the current sources of federal funding uncertain.

7.5. Plan for integration of results into decision-making

Given the objectives of a regional wildlife monitoring program to support and test range planning and species management planning processes, explicit links between these programs will need to be built in.

7.6. Information Management

A plan to house and share the information created through the monitoring program is required. Right now, ENR makes caribou, wolverine and wolf demographic data available through its Wildlife Management Information System and has agreed to house data from the mines' grizzly bear monitoring program. However, a more detailed information management and data sharing strategy may be needed depending on the type of structure chosen for implementation of this program. One possibility for housing data is the NWT Discovery Portal.

7.7. Commitment to providing opportunities for capacity building at the community level

A plan for creating opportunities for capacity building at the community level will need to be incorporated and can include, among other items, funding for wildlife monitors, academic and job training opportunities, etc.

8.0 Next steps

As outlined herein, several elements needed to establish a multi-scale CE monitoring program for wildlife in the SGP are already in place. However, greater coordination is required to ensure that monitoring can effectively contribute to the objectives outlined in Section 3.0. This document has attempted to show that such a program is a collaborative effort and will require a combined approach to a) ensure continued support for existing monitoring activities and b) lay the foundation for developing new initiatives and analytical approaches that address outstanding monitoring needs. Determining the next steps in this process is part of a larger conversation among all partners. Some suggestions for consideration by the group include:

- Create a working group to develop a monitoring framework centred abound key questions that identify monitoring needs and analytical approaches for answering the questions.
- Investigate options for program structure.
- Seek funding.

- Continue to work on developing protocols and aligned research objectives for monitoring caribou at the project level.
- Discuss approaches for establishing protocols, determining priorities, sharing information and reporting.
- Seek senior management approval of the program design and implementation

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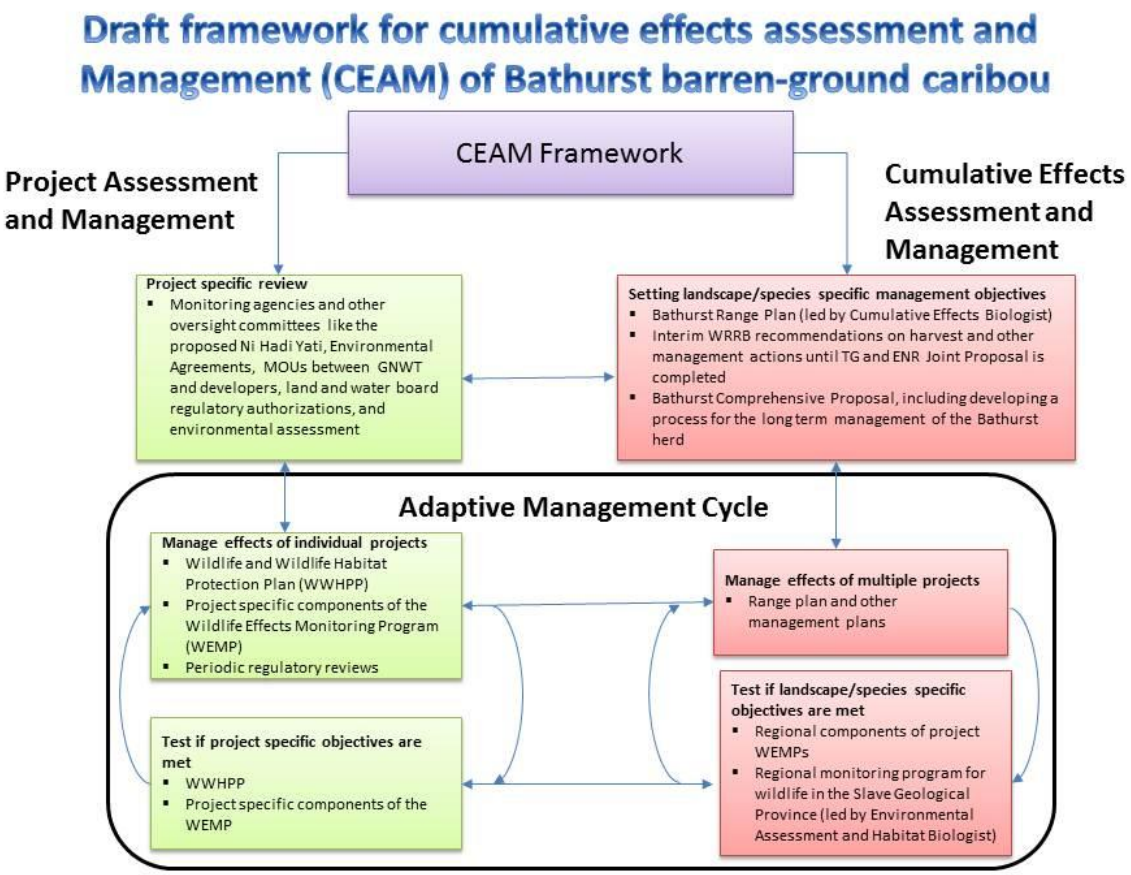
APPENDIX A:



Draft Cumulative Effects Assessment and Management Framework for the Bathurst Caribou Herd