RANGE ASSESSMENT AS A CUMULATIVE EFFECTS MANAGEMENT TOOL:

A RECOMMENDED APPROACH FOR ENVIRONMENT YUKON

Prepared for:
Environment Yukon
Fish and Wildlife Branch
Regional Programs

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Preface

Yukon is undergoing unprecedented mineral exploration and development. Through the environmental assessment process, effects of the associated industrial activity are considered on a project by project basis. Given the concentration of multiple exploration activities and projects in some regions of Yukon, we must also address the need for long-term baseline data collection and monitoring to support the broader assessment of cumulative effects conducted through the Yukon's Socio-economic and Environmental Assessment Board (YESAB) review process.

Solid baseline information on key fish and wildlife indicators has been identified as a limiting factor in assessments for areas with high levels of industrial activity. This report was commissioned to enable the Fish and Wildlife Branch to develop a coordinated and well planned approach to data gathering and preparation using sound, science-based methods that allow for the identification of probable responses to be used in support of the assessment of industrial activities at a regional scale.

This work is a contribution to the Yukon government's inter-departmental framework for cumulative effects management.

Range Assessment as a Cumulative Effects Management Tool:

A Recommended Approach for Environment Yukon

FINAL REPORT
May 31, 2013

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Environment Yukon
Fish and Wildlife Branch
Regional Programs

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SUMMARY

1 Overview

This report describes a recommended approach for Environment Yukon to conduct range assessments for northern mountain ecotype woodland caribou (*Rangifer tarandus caribou*). While woodland caribou were identified as the initial Yukon focal wildlife species to be considered for range assessment methods, the general approach described here may also be broadly applicable to grizzly bear, moose or sheep. The range assessment methods described in this report should be viewed as an initial, achievable step towards improved cumulative effects assessment (CEA) and cumulative effects management (CEM) in Yukon.

1.1 What is a Range Assessment?

A range assessment is a structured process intended to assess risk to population viability, define management objectives and identify actions to meet the objectives for focal wildlife species. Conducting a range assessment is similar to a land use planning process but socio-economic considerations are not formally evaluated and integrated. Range assessments result in an integrated package of reports and maps that can be used by assessors and decision-makers to evaluate and manage the effects of proposed and ongoing multiple land use activities.

Focal wildlife species range assessments are intended to facilitate improved CEA and CEM. They do not attempt to address all species and biodiversity concerns, and are not intended to replace land use planning, as they do not directly assess socio-economic trade-offs. Range assessments complement and support integrated conservation planning or regional land use planning by assessing risk and providing specific management objectives that can then be considered in a broader socio-economic context during other processes.

1.2 Why Are Range Assessments Required?

The relative lack of identified landscape-level management objectives for much of the territory (i.e., planning) creates challenges for effective CEA and CEM. While processes to establish landscape-level objectives exist, such as Chapter 11 regional land use planning, or integrated resource management planning initiatives, these processes are progressing slowly and will not be in place in all areas of Yukon in advance of development pressures.

Focal wildlife species range assessments are intended to establish species-specific landscape-level management objectives and management strategies that would benefit project-level assessment and mitigation. For Environment Yukon, a major benefit of this approach is that it can initiate and manage the range assessment process within its existing mandate.

2 Recommended Range Assessment Approach

The recommended range assessment approach has been adapted from the *Canadian Boreal Forest Agreement Methodological Framework for Caribou Action Planning* (Antoniuk et al. 2012) and tailored to the Yukon management context. The suggested approach is also generally consistent with the recommended methods and objectives of the *Management Plan for the Northern Mountain Population of Woodland Caribou in Canada* (Environment Canada 2012), and the *Woodland Caribou Management Guidelines for Yukon* (Yukon Department of Renewable Resources 1996).

2.1 Roles and Responsibilities

At this time, it is recommended that the range assessment process should be lead and completed by a *Range Assessment Team* composed largely of existing Environment Yukon staff with expertise in caribou habitat, caribou populations, predators, harvest management, and environmental assessment and management. Other departments and agencies, most notably Yukon Energy, Mines and Resources, will also have roles and responsibilities to participate and provide current and ongoing information to support the monitoring of human land use activity.

2.2 Methods

A focal species range assessment should contain at least three major components:

1. The relative level of risk to focal wildlife species population viability, and key contributing factors;
2. Well-defined management objectives; and
3. Recommended actions to meet the defined management objectives.

A six step process for conducting a range assessment is recommended:

1. Issues scoping;
2. Characterize range condition;
3. Characterize level of risk;
4. Define management objectives and performance measures;
5. Determine management strategies; and
6. Monitoring and adaptation.

2.3 Pilot Project

At this time, there are relatively few examples of range plan or assessment products in other jurisdictions that can be used as a template for this recommended approach. Therefore, conducting a pilot project may be the most effective means to advance the range assessment concept from a proposal stage to an applied management tool. A pilot project would provide:

- A visible demonstration of the range assessment concepts and methods described above;
- An opportunity to test, refine, and potential modify the proposed methods;
- An opportunity to gain insight into required resources;
- An opportunity to apply the range assessment results to project-level assessment and decision making; and
- A formal process to evaluate the effectiveness of the range assessment approach.

Two caribou herd ranges are suggested as candidate pilot project areas:

- Carcross Caribou Herd Range (Southern Lakes); and
- Klaza Caribou Herd Range (Dawson Plateau).

Range Assessment as a Cumulative Effects Management Tool:
A Recommended Approach for Environment Yukon

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1 INTRODUCTION

1.1 What is a Range Assessment?

Focal wildlife species such as caribou, moose, grizzly bear and sheep have high social values and are important components of healthy, functioning ecosystems. These focal wildlife species are frequently identified as '*valued ecosystem components*' in environmental assessments. Many of Environment Yukon's management and monitoring activities are directed toward these species.

A range assessment[1] is a structured process intended to assess risk to population viability, define management objectives and identify actions to meet the objectives for focal wildlife species. Conducting a range assessment is similar to a planning process but socio-economic considerations are not formally evaluated and integrated. Range assessments result in an integrated package of reports and maps that can be used by assessors and decision-makers to evaluate and manage the effects of proposed and ongoing multiple land use activities.

Focal wildlife species range assessments are intended to facilitate improved cumulative effects assessment (CEA) and cumulative effects management (CEM). They are not intended to replace regional land use planning as they do not directly assess socio-economic trade-offs. Range assessments complement and support regional land use planning by assessing risk and providing specific management objectives that could then be considered in a broader socio-economic context during regional land use planning.

1.2 Why Conduct Range Assessments?

In Yukon, the Yukon Environmental and Socio-economic Assessment Board (YESAB) generally evaluates the potential effects of projects on identified values on a 'project-by-project' basis. Yet concerns about impacts to fish, wildlife and ecosystems are often associated with the total, or cumulative, level of impacts resulting from all human land uses and activities. With this project-by-project assessment method, it is currently challenging to effectively assess and manage these potential cumulative effects.

Francis et al. (2013) completed a problem analysis outlining current challenges to effective CEA and CEM in Yukon. While a number of challenges were identified (e.g., unclear mandates, legislation, organizational issues, mitigation strategies, information gaps and infrequent monitoring), the lack of identified landscape-level management objectives for much of the territory (i.e., planning) was recognized as an underlying challenge to effective CEA and CEM.

The report provided recommendations for Environment Yukon to improve its participation in, and input to, the YESAB project-level review process, particularly for CEA and CEM considerations. Recommendations were provided along two 'tracks'—a '*project assessment*

[1] Range assessment was previously referred to as '*range planning*'. Adopting the term '*range assessment*' better reflects the intended nature of this exercise. Range assessments are not intended to be a formal management plan. Their purpose is to assess risk, define management objectives and identify actions to meet the objectives for focal wildlife species.

track' and a '*CEM track*' (**Figure 1**). It was noted that for the project assessment track to work effectively (i.e., the YESAB project-level review process), it must be informed by landscape-level management objectives, and that such objectives would ideally result from land use planning.

While processes to establish desired landscape-level objectives exist, such as Chapter 11 regional land use planning, or integrated resource management planning initiatives, these processes are progressing slowly and will not be in place in all areas of Yukon in advance of development pressures. Given this situation, the report identified the need to explore alternative processes to establish landscape-level management objectives that are needed for effective project-level CEA and CEM.

Francis et al. (2013) recommended that Environment Yukon could use its existing mandate and expertise to conduct range assessments for focal wildlife species in areas with high levels of land use activity. These range assessments would result in species-specific landscape-level management objectives that would benefit project-level assessment and mitigation (**Figure 1**). For Environment Yukon, a major benefit of this approach is that it can initiate and manage the range assessment process within its existing mandate.

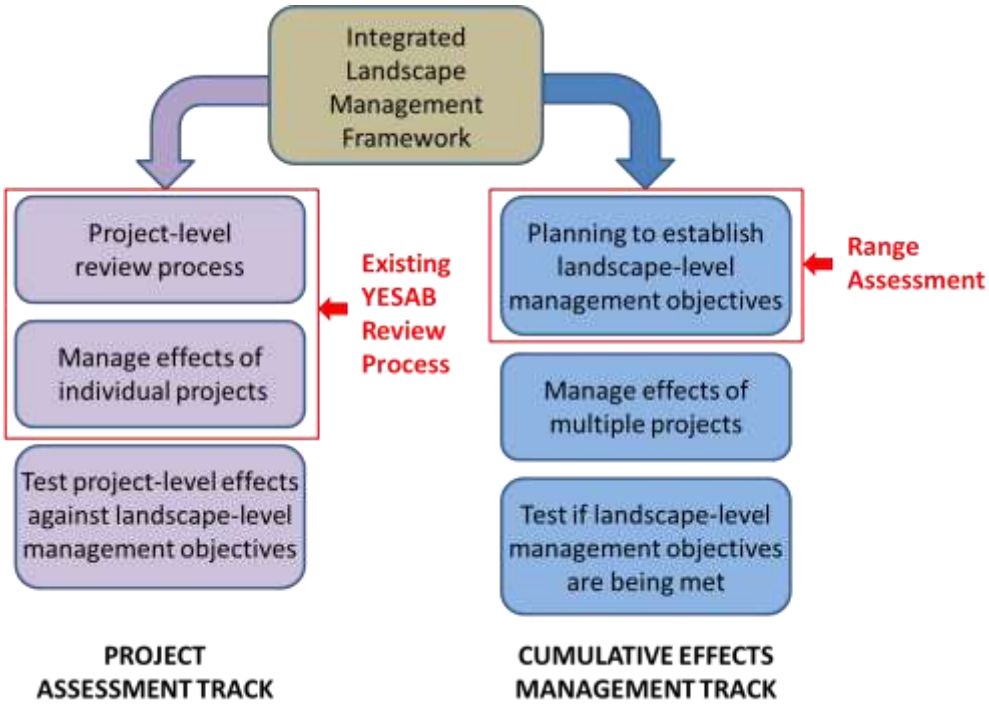

Figure 1. Conceptual 'dual track' integrated landscape management framework, showing linkage between project-level assessment activities (left column) and landscape-level cumulative effects management activities (right column). Conducting range assessments as proposed by this report is intended to establish landscape-level management objectives to improve project-level review, and to better manage the cumulative effects of multiple projects. Figure adapted from Francis et al. (2013) and Axys and Salmo (2003).

1.3 Purpose of Report

This report describes a recommended approach for Environment Yukon to conduct range assessments for northern mountain ecotype woodland caribou (*Rangifer tarandus caribou*). Given their high management profile, woodland caribou were identified as the initial Yukon focal wildlife species to be considered for range assessment methods. However, the general approach described here may also be broadly applicable to grizzly bear, moose or sheep. The range assessment methods described in this report should be viewed as an initial, achievable step towards improved CEA and CEM in Yukon.

This report has three major objectives:

1. Identify important considerations for the range assessment concept;
2. Describe a recommended approach for conducting range assessments; and
3. Provide suggestions for conducting a pilot project.

2 CONSIDERATIONS FOR THE RANGE ASSESSMENT CONCEPT

The range assessment concept was suggested by Francis et al. (2013) as a potential approach to improve Environment Yukon's input into the YESAB project-level review process. It was recognized that range assessments could assist in the improved assessment and management of cumulative land use impacts on focal wildlife species. The following topics require consideration when designing practical and efficient methods for assessing Yukon woodland caribou herd ranges:

- The process for conducting assessments;
- Providing effective support for assessment, decision-making and management processes;
- Adequate information; and
- Other environmental values.

Each is discussed below.

2.1 Process for Conducting Range Assessments

Important considerations for the range assessment concept are roles, responsibilities and capacity:

- Who conducts the range assessment?
- When will range assessments be conducted?
- Who is responsible for collecting and contributing information to the range assessment?
- Who is responsible for ongoing monitoring, review and updates?

Environment Yukon has an existing mandate to sustainably manage fish and wildlife populations and habitats. It is therefore reasonable to assume that the department already has the mandate to define management objectives and appropriate CEM guidelines for fish and wildlife values. While Environment Yukon is not the final decision-maker on approving land use activities, it has expertise in and can provide guidance on the following topics, all of which are components of range assessments:

- Estimating risk to fish and wildlife populations as a result of increased land use;
- Characteristics and locations of key habitats;
- Clearly defined management objectives (desired outcomes); and
- Develop coordinated mitigation options that can then be considered and applied by others.

An important factor that influences how range assessments are completed (i.e., staff resources, timelines and cost) and used by assessors and decision-makers is if the range assessment process is viewed as an 'assessment' versus a 'plan'.

2.1.1 Range Assessment versus Management Plan

If range assessments are viewed as a technical exercise that does not directly address socio-economic considerations, then range assessments can largely be completed as an internal Environment Yukon technical exercise. This approach has the advantage of Environment Yukon being able to initiate and manage the range assessment process within its existing mandate.

In contrast, if range assessments become formalized as multi-stakeholder '*caribou management plans*', it becomes a broader exercise that requires formal acceptance and approval between multiple partners and potentially governments. Formalized management plans would contain such items as implementation plans, pre-defined management responses when certain conditions or risk levels are encountered, and similar items. Such plans would directly affect land use decisions.

Considering range assessments to primarily be a technical exercise that provides guidance for assessment and decision-making has the benefit of being able to be completed rapidly and for relatively low cost. The potential drawback is that the recommendations and information is guidance only—it may not be directly used or respected by assessment bodies and regulators. Considering range assessments as 'management plans' has the opposite benefits and

drawbacks; plans may take more time and cost to complete, but would more likely result in formalized, agreed-upon management actions and approaches.

In consideration of these two approaches, at this time it is recommended that range assessments be viewed mainly as a technical exercise completed largely internally by Environment Yukon. While the range assessment process can be initiated and managed by Environment Yukon, it needs to be well designed and implemented to gain support and buy-in from assessors, regulators and potentially other stakeholders. This will increase the likelihood that the risk assessment, objectives and recommended strategies are used to support decision-making. Over time, consideration could be given to having the 'assessments' evolve into formalized 'caribou management plans'.

2.1.2 Roles, Responsibilities and Capacity

While Environment Yukon is anticipated to lead the range assessment process, it will require inputs and assistance from other Yukon Government departments, particularly regarding existing and anticipated land use activity—both during the range assessment process, and for ongoing monitoring. Conducting range assessments will also require internal or contracted capacity that must be identified and planned for.

The recommended range assessment process described in Section 3 attempts to integrate current resources and programs to the extent possible by forming a *Range Assessment Team* from existing Environment Yukon and potentially other government staff. Recommendations regarding roles and responsibilities for the range assessment process are discussed in Section 3.1.6 and **Table 9**. Potential resources and timelines that could be anticipated for conducting range assessments have been described in Section 4.1.1. and **Table 10**. Capacity requirements are recommended to be more fully developed by conducting a pilot project.

2.2 Support for Assessment, Decision-Making and Management Processes

Range assessments are intended to provide the currently missing landscape-level considerations for the project-level review process (see **Figure 1**). Therefore, to be effective, range assessments must contain the appropriate tools and components to assist project assessors and decision-makers with evaluating project-level effects and determining appropriate mitigation strategies. The CEA gap analysis completed by Francis et al. (2013) highlighted key challenges to effective CEA and CEM in Yukon. This analysis can be used to inform the design of an effective range assessment process for Yukon.

2.2.1 What Should Range Assessments Contain?

As suggested by Francis et al. (2013), range assessments should contain at least three components:

1. The relative level of risk to focal wildlife species population viability, and key contributing factors;
2. Well-defined management objectives; and
3. Recommended actions to meet the defined management objectives.

Establishing well-defined management objectives and recommended management actions are currently the key missing pieces of the CEM track shown in **Figure 1**. Objectives are required to: 1) identify cumulative effects concerns; 2) establish measures of significance to gauge individual projects against, and 3) provide guidance to proponents and regulators regarding when and what management actions may be required.

Over the past decade, a large amount of effort has been focused on identifying targets, thresholds and limits of acceptable change for focal wildlife species in northern Canada, particularly for woodland caribou, grizzly bear and moose. All of these concepts have been generally termed '*management objectives*'. Francis et al. (2013) reviewed relevant management studies and frameworks from northern and western Canada. In Yukon some of the original work to establish thresholds for woodland caribou management included Axys (2001) and Anderson et al. (2002). Adamczewski et al. (2003) applied some of these concepts to the winter range of the Little Rancheria Herd. The North Yukon Regional Land Use Plan (Yukon and Vuntut Gwitchin Governments 2009) utilized a limits of acceptable change approach, based on tiered thresholds, as the basis for its CEM framework.

In the recommended range assessment methods, objectives are defined as specific statements of desirable condition for a specified value, while indicators and indicator levels provide the desired level of performance for the objective. These concepts are further discussed in Section 2.2.2, below.

2.2.2 Use of Planning and Structured Decision-making Concepts

Range assessments will be more effective if they incorporate planning and structured decision-making concepts. *Structured decision-making* is an approach to organize complex issues in ways that help individual and groups provide common understanding, identify relevant information, and find innovative solutions to challenging management issues (Gregory et al. 2012). The concepts of structured decision-making are embodied in a well-designed planning process where higher level issues and goals are clearly linked with detailed strategies and performance measures. These linkages can be organized and communicated through the use of a results-based management framework or influence (impact hypothesis) diagrams.

Figure 2 shows the major elements of a *results-based management framework*. This framework is a structured way to illustrate how specific issues affect identified values, and how recommended management strategies support specific objectives and monitoring. In this framework, objectives state the desired management outcome. Monitoring of indicators and the desired performance level for those indicators helps to determine if the objectives are being met. Strategies are approaches and actions that can be used to achieve the defined objectives, and may include specific recommendations and best management practices. Strategies can be adjusted in response to the changing status of indicators, facilitating an adaptive management process.

The recommended range assessment process described in this report has been structured around a results-based management framework, where specific components of the framework shown in **Figure 2** are addressed in a logical, step-wise manner. Section 3 and **Figure 4** describes how the range assessment process incorporates these concepts.

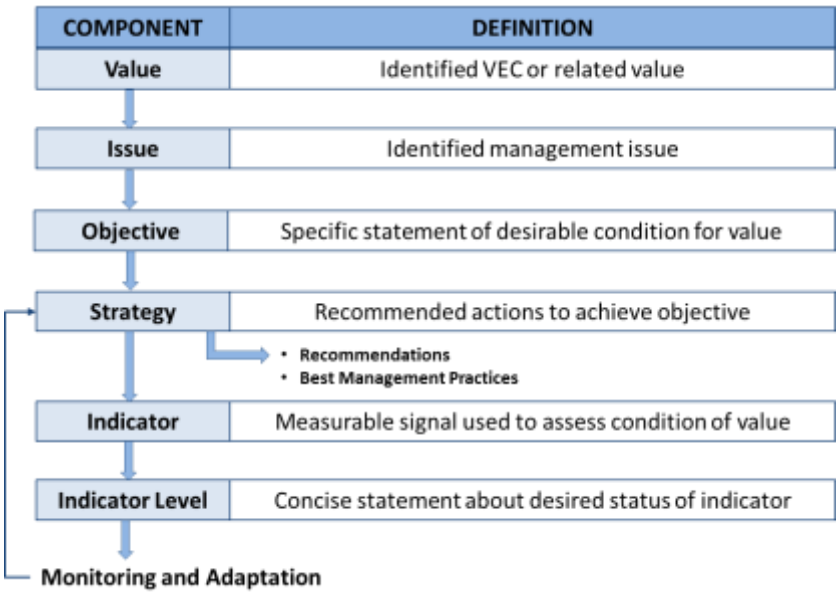

Figure 2. Components of a results-based management framework. Figure adapted from North Yukon Regional Land Use Plan (Yukon and Vuntut Gwitchin Governments 2009).

2.2.3 Linkage with Other Management Plans and Initiatives

For the range assessment process to be effective, it must also integrate with and support other management plans and initiatives. At least four existing initiatives require consideration:

1. Yukon cumulative effects management framework;
2. Regional land use planning;
3. Sector-specific planning; and
4. Wildlife harvest management

Each is discussed below.

2.2.3.1 Yukon Cumulative Effects Management Framework

The Yukon Development Assessment Branch is leading a multi-departmental working group to develop a CEM Framework for Yukon. The range assessment concept is well suited to support such a framework as a flexible tool that could be employed in areas with cumulative effects concerns. Maintaining adequate linkage between the range assessment exercise and the developing CEM Framework should be viewed as a priority.

2.2.3.2 Regional Land Use Planning

The range assessment concept would support regional land use planning, and provide 'interim information' until integrated regional land use plans are in place. Range assessments are not intended to replace regional land use plans as they do not directly assess socio-economic trade-offs. Range assessments complement and support regional land use planning by assessing risk

and providing specific management objectives that could then be considered in a broader socio-economic context during regional land use planning.

2.2.3.3 Sector-specific Planning

A number of sector-specific planning initiatives exist in Yukon. Two of the most important are forest management planning and the Oil and Gas Disposition Process. Both of these initiatives would benefit greatly from range assessment results, particularly in areas where regional land use plans have not been completed.

2.2.3.4 Wildlife Harvest Management

Harvest management planning and monitoring is an important activity for Environment Yukon. The proposed range assessment methods are intended to establish habitat and population objectives and associated performance measures that can be used as benchmarks for decision-making. If population-related objectives and strategies are established through the range assessment process without consideration of existing harvest management plans or agreements, the two processes could potentially contain conflicting objectives. Developing adequate linkage between harvest planning and management, and the objectives and management strategies identified through the range assessment process is therefore required. This topic is further discussed in Sections 3.1.4 and 3.1.5.

2.3 Information Requirements

The range assessment process must be supported by an adequate information base. Environment Yukon and other Yukon Government departments already develop and manage a number of data sets that directly support the information needs of a woodland caribou range assessment process. In cases where information is not currently available, it could be developed as required or expert opinion and local knowledge could be used.

2.3.1 Existing Information

While the amount of knowledge varies greatly between different areas of Yukon, and between different caribou herd ranges, the following caribou data sets are available:

- Caribou herd ranges (**Figure 3**); and
- Caribou herd population estimates and trends (**Table 1**).

These caribou data sets are updated when possible. Other existing habitat and species data sets that could be used to support the range assessment process include:

- Yukon fire history mapping;
- Wildlife Key Areas;
- Wolf and grizzly bear density;
- Ecological and Landscape Classification products (i.e., broad ecosystem mapping); and
- A number of habitat and land cover mapping products (e.g., lichen mapping for selected caribou ranges).

2.3.2 Information Gaps

While much information exists, some information is only available for parts of Yukon, or would need to be created for specific herd ranges. This includes:

- Land use footprint mapping;
- Land use activity locations and intensity (mineral exploration, harvesting areas, recreation areas, etc.);
- Habitat mapping; and
- Caribou habitat use and characteristics.

As discussed in the CEA gap analysis (Francis et al. 2013), the lack of a formalized and consistent approach to tracking land use activity in Yukon is currently viewed as a major challenge to CEA and CEM initiatives. How this information is collected, maintained and distributed is an important topic for many land and resource initiatives. Further considerations around land use activity and footprint tracking are discussed throughout Section 3.

The lack of information developed specifically for Yukon relating to biologically-based land use activity thresholds, targets or limits of change concepts has frequently been considered an 'information gap' by Yukon wildlife managers. However, based on the review of Francis et al. (2013), it is suggested that enough information currently exists to approach this topic from the perspective of assessing and managing risk. For boreal ecotype woodland caribou, at least two population viability models have been developed (Environment Canada 2011; Schneider et al. 2010) that could provide a starting point for application to Yukon northern mountain ecotype woodland caribou herds. The North Yukon Regional Land Use Plan (Yukon and Vuntut Gwitchin Governments 2009) provides an example of a tiered threshold approach to CEM that adapted boreal ecotype caribou herd population viability models with local considerations. Reid et al. (*in prep*) recently applied the boreal ecotype population viability models to the Carcross Caribou Herd range. The use of disturbance-population relationships is further discussed in Sections 3.1.3 and 3.1.4.

2.4 Other Environmental Values

During initial discussions of the range assessment concept, it was recognized that range assessments would not be able to fulfill all requirements of environmental assessment and management. Range assessments are intended to provide information for focal wildlife species—the many other ecological values on the landscape will not be directly represented through these assessments. The current approach to improving CEA and CEM is to start with woodland caribou, and once methods and applications are better understood, then to expand this approach to other focal species such as grizzly bear, moose or sheep.

While completing range assessments for woodland caribou or other focal wildlife species will not directly address all environmental values, developing objectives relating to minimizing human-caused disturbance and fragmentation, maintaining appropriate amounts of important habitats such as old forests, and managing human access may also have benefits for other species and values.

Existing data sets and project-specific review methods, such as the Wildlife Key Area database, the Conservation Data Centre, wildlife surveys, harvest monitoring and coarse-filter mapping, are available and will continue to be used to assess the potential impacts of projects on other species and environmental values.

The proposed range assessment process, currently focused on woodland caribou, should be viewed as an initial, tangible step towards improving CEA and CEM in Yukon. It does not attempt to address all species and biodiversity concerns. Such issues can only be addressed through comprehensive regional land use planning or integrated conservation planning where multiple values are considered and evaluated and integrated with socio-economic considerations.

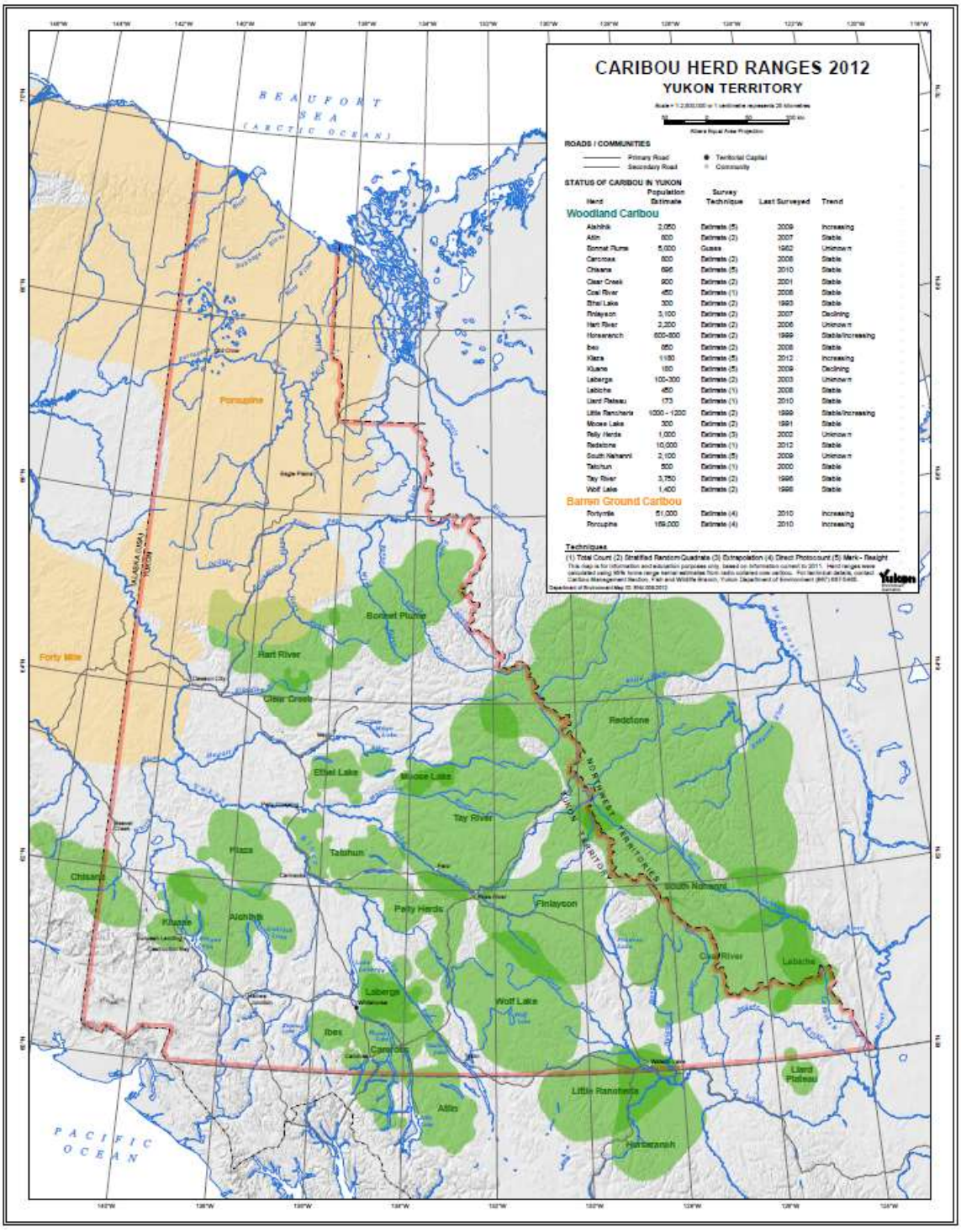

Figure 3. Distribution of Yukon caribou herd ranges. Woodland caribou, northern mountain ecotype, are shown in green; barren ground herds are shown in orange. Source: Environment Yukon Map ID: ENV.009.2012.

STATUS OF CARIBOU IN YUKON

Herd	Population Estimate	Survey Technique	Last Surveyed	Trend
Woodland Caribou				
Aishihik	2,050	Estimate (5)	2009	Increasing
Atlin	800	Estimate (2)	2007	Stable
Bonnet Plume	5,000	Guess	1982	Unknown
Carcross	800	Estimate (2)	2008	Stable
Chisana	696	Estimate (5)	2010	Stable
Clear Creek	900	Estimate (2)	2001	Stable
Coal River	450	Estimate (1)	2008	Stable
Ethel Lake	300	Estimate (2)	1993	Stable
Finlayson	3,100	Estimate (2)	2007	Declining
Hart River	2,200	Estimate (2)	2006	Unknown
Horseranch	600-800	Estimate (2)	1999	Stable/Increasing
Ibex	850	Estimate (2)	2008	Stable
Klaza	1180	Estimate (5)	2012	Increasing
Kluane	180	Estimate (5)	2009	Declining
Laberge	100-300	Estimate (2)	2003	Unknown
Labiche	450	Estimate (1)	2008	Stable
Liard Plateau	173	Estimate (1)	2010	Stable
Little Rancheria	1000 - 1200	Estimate (2)	1999	Stable/Increasing
Moose Lake	300	Estimate (2)	1991	Stable
Pelly Herds	1,000	Estimate (3)	2002	Unknown
Redstone	10,000	Estimate (1)	2012	Stable
South Nahanni	2,100	Estimate (5)	2009	Unknown
Tatchun	500	Estimate (1)	2000	Stable
Tay River	3,750	Estimate (2)	1996	Stable
Wolf Lake	1,400	Estimate (2)	1998	Stable

Survey Technique:
(1) total count, (2) stratified random quadrat, (3) extrapolation, (4) direct photocount, (5) mark – resight

Table 1. Status of woodland caribou herds in Yukon based on 2011 data, showing estimated population, method of survey, date of last survey, and estimated population trend. Source: Environment Yukon Map ID: ENV.009.2012.

3 A RECOMMENDED APPROACH FOR CONDUCTING WOODLAND CARIBOU RANGE ASSESSMENTS IN YUKON

Suggested methods for conducting Yukon woodland caribou range assessments are described below. This approach has been recommended based on the considerations outlined in Section 2, above, and the CEA-CEM problem analysis undertaken by Francis et al. (2013). Specifically:

- The suggested approach has been designed to provide required information and guidance to the YESAB project-level assessment process, and to decision-makers in Yukon Government (e.g., Yukon Energy, Mines and Resources; Executive Council Office; Highways and Public Works; or Community Services) for assessing potential cumulative environment impacts, and the significance of those impacts. The recommended strategies are intended to provide coordinated mitigation guidance for managing the potential cumulative environmental impacts;
- The suggested approach can be completed as a technical exercise by Environment Yukon staff, within its existing departmental mandate;
- Much of the suggested range assessment methodology will integrate existing Environment Yukon products and information into a 'single package'. To this end, Environment Yukon can utilize existing programs, products and expertise to conduct range assessments in a cost effective and efficient manner;
- 'Keeping it simple' is a requirement for the initial range assessment activities. Once a well-structured process has been developed, and the assessments are used to guide Yukon land and resource decision-making, other techniques and approaches may be considered; and
- An important aspect of the range assessment process is to characterize the relative level of risk affecting individual herds, and then establishing management objectives and strategies to manage these risks. Information sources to support these tasks will never be perfect. Therefore, the best available information, existing literature and expert opinion must be used to establish management direction.

Environment Yukon caribou range planning and assessment work in the Little Rancheria Caribou Herd winter range of southeast Yukon (Adamczewski et al. 2003; Florkiewicz et al. 2003) and the winter range analysis of the Carcross Caribou Herd in the southern lakes region (Florkiewicz et al. 2006) incorporate elements of the proposed approach. The suggested methods provide a standardized means for conducting range assessments for woodland caribou ranges throughout Yukon, but would also have direct application to other focal wildlife species such as grizzly bear, moose and sheep.

3.1 Suggested Methods

Woodland caribou range assessments should consider:

- The habitat that caribou require for all stages of their life history;
- Natural factors that affect caribou reproduction and survival; and
- The influence of human land use activities on caribou habitat quality, reproduction and survival.

Figure 4 shows the six general suggested steps for conducting woodland caribou range assessments in Yukon:

1. Issues scoping;
2. Characterize range condition;
3. Characterize level of risk;
4. Define management objectives and performance measures;
5. Determine management strategies; and
6. Monitoring and adaptation.

The general methods have been adapted from the *Canadian Boreal Forest Agreement Methodological Framework for Caribou Action Planning* (Antoniuk et al. 2012) and tailored to the Yukon management context. The suggested approach is also generally consistent with the recommended methods and objectives of the *Management Plan for the Northern Mountain Population of Woodland Caribou in Canada* (Environment Canada 2012), and the *Woodland Caribou Management Guidelines for Yukon* (Yukon Department of Renewable Resources 1996). Specific technical methods are anticipated to differ by range and environmental setting (e.g., different habitat data inputs, different population estimation techniques, etc.); such methods will be determined by range assessment teams.

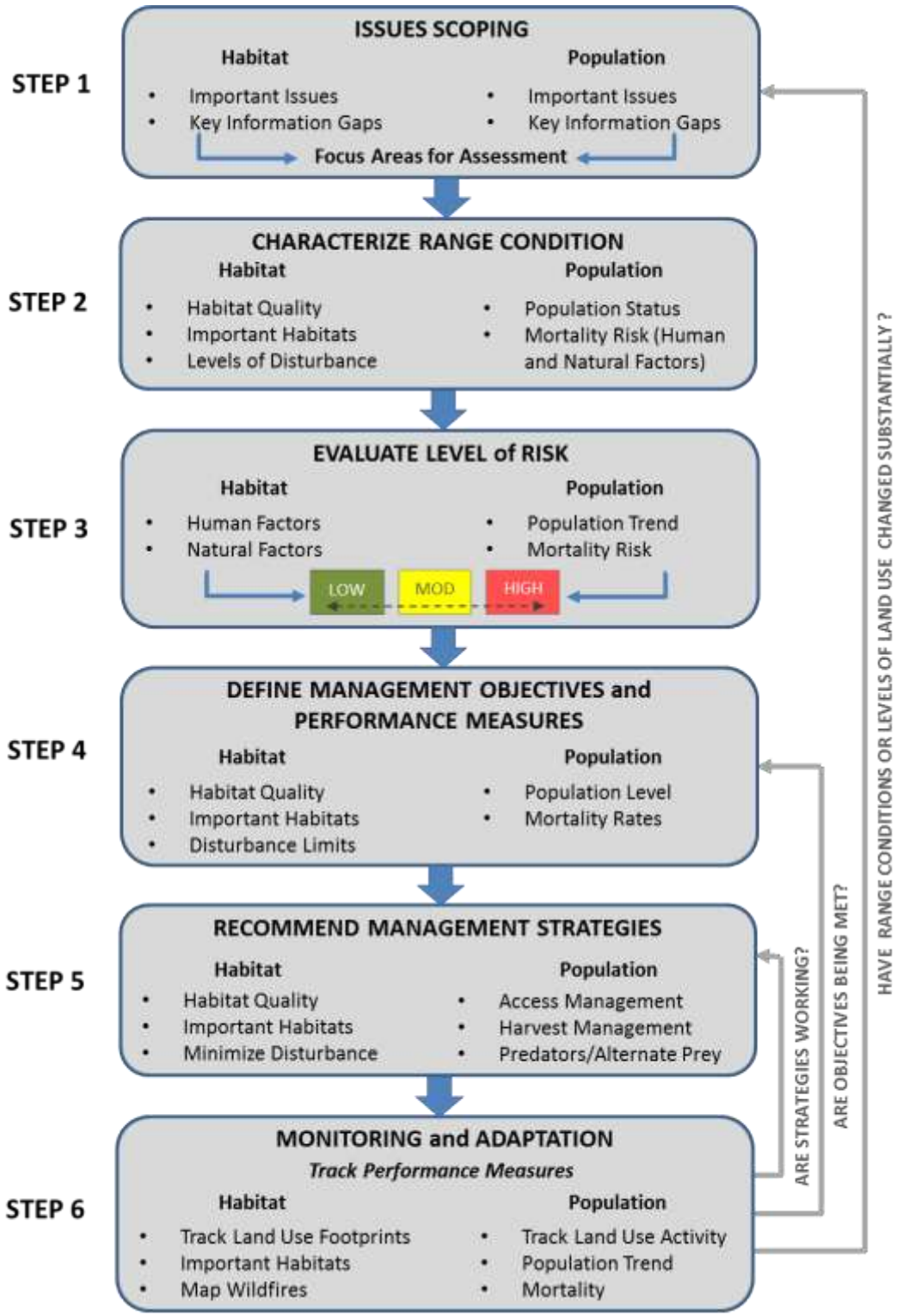

Figure 4. Suggested methods for conducting woodland caribou range assessments in Yukon.

The suggested steps are similar to those of a well-defined planning process. The initial step—issues scoping—is intended to identify important issues and information gaps that will provide focus for the range assessment. The second step—characterize range condition—gathers information about the current state of the range, both habitat and population conditions, current levels and types of land use, and potential stressors. The issues scoping provides focus for these efforts. The third step—risk assessment—is intended to define the most important issues that may affect the viability of the herd and integrity of its habitats. The risk assessment results in a characterization of the relative level of risk to herd viability from the combined effect of natural and human-caused effects.

The fourth step—management objectives and performance measures—is the process of defining desirable habitat and population conditions, and meaningful ways to measure if these objectives are being met. The fifth step is where different management strategies (best practices or specific recommendations) are suggested to help achieve the stated objectives. The sixth and final step—monitoring and adaptation—is required to determine if the objectives are being met, if management strategies are working as anticipated, or if significant changes in the status of the range or population are occurring, potentially requiring a new range assessment. Each step is described below.

3.1.1 STEP 1: Issues Scoping

Issues scoping is intended to provide initial scope and focus to the range assessment. This step is recommended to be carried out as an expert-based assessment of key issues affecting the herd. These identified issues will provide focus for information collection or other assessment steps.

Knowledge of other planning initiatives or decision-making processes will assist in determining what information from the range assessment may be required to support these initiatives. At this stage it may be determined that relatively few risks currently affect some herds, and that completing the full range assessment process at this time may not be required. Alternatively, new issues may arise during *STEP 2: Characterize Range Condition* that were not initially contemplated. A number of techniques including influence (impact hypothesis) diagrams (**Figure 5**) or consequence tables (**Table 2**) may assist with the issues scoping phase.

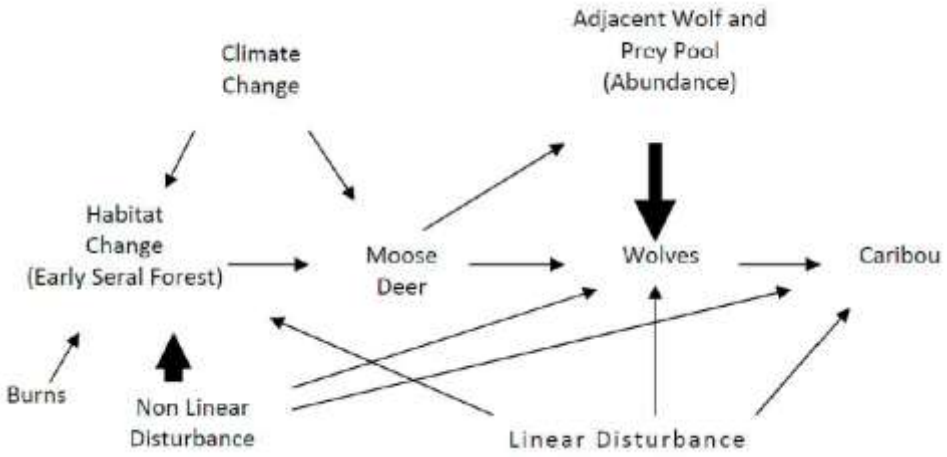

Figure 5. Example influence (impact hypothesis) diagram showing relationship between natural and human factors affecting caribou. Width of arrows illustrates magnitude of effects. Source: Figure 1 from WCACLPT (2008).

Factors Affecting Woodland Caribou	Magnitude of Effects	
	Habitat	Population
Mining		
Oil and Gas		
Agriculture		
Forestry		
Residential		
Harvest		
Predation		
Wildfire		

Table 2. Example consequence table used to illustrate the potential magnitude of different factors affecting caribou habitat and population conditions.

3.1.2 STEP 2: Characterize Range Condition

Characterizing range condition is the 'information gathering' stage of the assessment process. This involves understanding the types, location and intensity of existing and anticipated land uses, habitat conditions, population status and trends, sources and levels of mortality, and key risks that may affect long-term herd viability. Land and wildlife management, existing land tenure, and administration units should also be considered. Comprehensive and current data sets will not be available for all Yukon woodland caribou ranges; in these situations, using the best available information, expert opinion and local knowledge will be required. Results of *STEP 1: Issues Scoping* should be used to focus data collection and areas of special consideration.

While habitat and population considerations are integrated at *STEP 3: Risk Assessment*, here they have been discussed separately to clearly identify information requirements and important factors to consider while characterizing the range condition. It is currently assumed that the 23

woodland caribou ranges identified for Yukon (**Figure 3**) will provide the spatial units for range assessment activities.

3.1.2.1 Land Use Activities, Administrative Units and Land Tenure

Land Use Activities

The following land use information is required for conducting the habitat and population assessment:

- Types, locations and intensity of current land use features and activities should be mapped:
    - human footprint (surface disturbance) mapping will be required to determine level of direct surface disturbance and linear feature density.
    - areas with high levels of aircraft-supported exploration activity (location and intensity).
    - harvest locations and hunting areas will be important during the population and risk assessment, and for developing management recommendations.
- If future land use scenario analysis is to be undertaken, future anticipated land use features and activities will also need to be identified (i.e., a development scenario) in order to assess future risk.

Administrative Units and Land Tenure

Administrative units, management areas and existing land tenures that affect land use patterns and management actions should be noted, including:

- First Nation Traditional Territories;
- Game Management Zones;
- YESAB Assessment Districts;
- Mineral claims;
- Oil and Gas permits;
- Forest Management Units and plans (if applicable); and
- Land use or Local Area Plans (if applicable).

3.1.2.2 Habitat Assessment

Important Habitats

Delineating and describing important caribou habitats should take into account the following:

- Locations of high suitability habitat, which may include:
    - areas with high lichen cover
    - mature coniferous forests
    - exposed ridges
    - wetlands

- Location of important seasonal habitats:
    - any areas or features that are disproportionately important for caribou (e.g., calving areas, areas of concentrated use, core winter ranges and movement corridors)

Caribou habitat suitability is defined by local habitat use relationships. Such relationships can be quantified through the use of expert or local land user interviews, resource selection function (RSF) analysis, or similar methods. A variety of existing Yukon map products are available to represent caribou habitat conditions including satellite based land cover mapping, broad ecosystem mapping, and forest cover mapping. Identifying habitat types with high lichen cover, mature coniferous forests, and/or exposed conditions is a common approach to mapping areas of high habitat suitability.

Factors Affecting Habitat

A number of human and natural factors affect caribou habitat, primarily through disturbance effects. As part of the habitat assessment, the following information should be considered:

1. **Human Factors**
    - Surface disturbance (habitat conversion or removal):
        - amount of area disturbed
        - location of area disturbed
        - intensity of disturbance (permanent vs. temporary)
        - pattern of disturbed areas (dispersed vs. aggregated; linear vs. polygonal)

2. **Natural Factors**
    - Wildfire:
        - recently burnt areas[2]
        - fire rate and size distribution

[2] Recently burnt areas are considered unsuitable caribou habitat as forest structure and lichen biomass has not adequately recovered to a suitable condition. Caribou may therefore avoid or use these lower quality recently burnt habitats less frequently. Recovery rates may differ between different areas of Yukon and by habitat type; it may also be influenced by fire intensity. The Environment Canada (2011) nation-wide boreal ecotype woodland caribou population viability model uses an average age of 40 years to define the period of time a fire affected area remains in a 'recently burnt' condition. Nagy (2011), working in central NWT, considered recently burnt areas to be up to 50-years of age. Whenever possible, fire age values specific to a herd range should be determined and used.

3.1.2.3 Population Assessment

Current Population Status and Population Trend

Range assessment requires an understanding of:

- Current population size
- Estimated population trend (based on minimum of three year period)

The estimated size and trend status of Yukon caribou herds current to 2011 is shown in **Table 1**, above. Where caribou monitoring data do not exist, current population trends may be inferred from empirically-based disturbance-population relationships such as Environment Canada (2011). These relationships provide information on general trends (decline vs. growth) rather than actual demography (Sleep and Loehle 2010), but provide a potential initial approach to describe current population status and trends where monitoring data do not exist.

Factors Affecting Populations

In addition to habitat effects, other human and natural factors affect caribou populations, primarily through direct mortality. As part of the population assessment, the following information should be considered:

1. **Human Factors**
   - Direct mortality:
     - number of animals harvested annually
     - number of animals killed by vehicle collisions
     - losses from wounding and illegal harvest (poaching)
   - Indirect effects:
     - timing, location and level of harassment caused by land use activities, such as aircraft over-flights (this may have energetic and reproductive effects)
     - habitat loss and zone of influence associated with land use activities or footprints (this may have energetic and reproductive effects)

2. **Natural Factors**
   - Direct mortality:
     - predation rate (number of animals killed by predators annually)
   - Predator distribution and density (e.g., wolf, grizzly bear), where available
   - Alternate prey distribution and density (e.g., moose, elk, bison, deer, etc.), where available
   - Weather factors or climate change (i.e., snow conditions that may have energetic or reproductive effects; changing fire regime or habitat conditions), if applicable
   - Population health (mortality associated with pathogens and/or parasites)

3.1.3 STEP 3: Evaluate Level of Risk

Based on information collected in *STEP 2*, above, the risk assessment should identify key relationships, important areas, and any factors known or suspected to increase risk to caribou population sustainability. The risk assessment should include factors related to:

- Low population size (e.g., relative to the minimum viable population of 300 identified by Environment Canada 2008);
- Current predator density and predator-related caribou mortality rate;
- Existing land use;
- Harvest and other human-caused mortality sources;
- Natural disturbance rate (i.e., wildfire); and
- Habitat quantity, quality and spatial configuration.

Through this analysis, key management issues may be confirmed (from *STEP 1*) or new issues may be identified that will provide focus for defining management objectives and performance measures (*STEP 4*), and recommended management strategies (*STEP 5*). The analysis should be conducted at the scale of the caribou range[3]. The suggested general approach for conducting the caribou range risk assessment is described below.

3.1.3.1 Suggested General Approach

1. **Determine Level of Direct and Indirect Habitat Impacts**
    - Using GIS, calculate direct human-caused surface disturbance.
    - Buffer all land use features or areas of high land use activity to account for indirect effects (i.e. zone of influence), and calculate total direct and indirect area of disturbance[4].
    - Overlay buffered land use features on habitat map and calculate proportions of disturbance within different habitat types.
    - Calculate linear feature density.

[3] The Athabasca Landscape Team (2009) buffered caribou ranges by 20 km to account for landscape changes and alternate prey and predators in adjacent areas that would impact the range conditions. This approach could be considered for use in Yukon.

[4] The size of woodland caribou zone of influence buffers around land use features has received a large amount of research attention. Depending on the land use feature type, reported zones of influence range from 100m to > 5km. The Environment Canada (2011) boreal caribou population viability model uses an average 500m buffer around all land use features. A Yukon project examining potential cumulative effects of land use on the Carcross Caribou Herd used different literature supported buffer sizes, depending on land use feature type (AEM 2004). Whenever possible, zones of influence relevant to the caribou herd range under assessment should be selected during the range assessment process.

2. Determine Amount of Recent Wildfire Activity

- Query the most current Yukon Fire History database and select all wildfires less than the defined age for 'recently burnt area' (see Section 3.1.2.2, above).
- Merge all fires to create a total extent map.
- Calculate fire rate (annual area burned) and fire size distribution for period of available fire records.

3. Use Disturbance-Population Relationships to Provide Initial Estimate of Risk

- Use risk-based level of disturbance-probability of population persistence relationship identified by Environment Canada (2011) (**Figure 6**) to provide initial estimate of potential level of risk at range scale.
- Please see Section 3.1.3.2, below, for further considerations about this topic.

4. Consider Direct Mortality Effects

- Consider the potential effects of harvest pressure, level of harvest, and other sources of human caused mortality on the initial estimate of risk established through disturbance-population relationships.
- Consider the effect of natural predation (wolf density), as illustrated in **Table 3** from Dzus et al. (2010).

5. Characterize the Range Using a Three-Tiered Risk Ranking System

- See **Table 4**
- Integrate the above factors to categorize the range with a current level of risk that integrates habitat and population-level effects.
- Based on the above points, provide rationale for the selected risk categorization.
- State level of confidence in the risk categorization, and identify areas of uncertainty due to information gaps, etc.

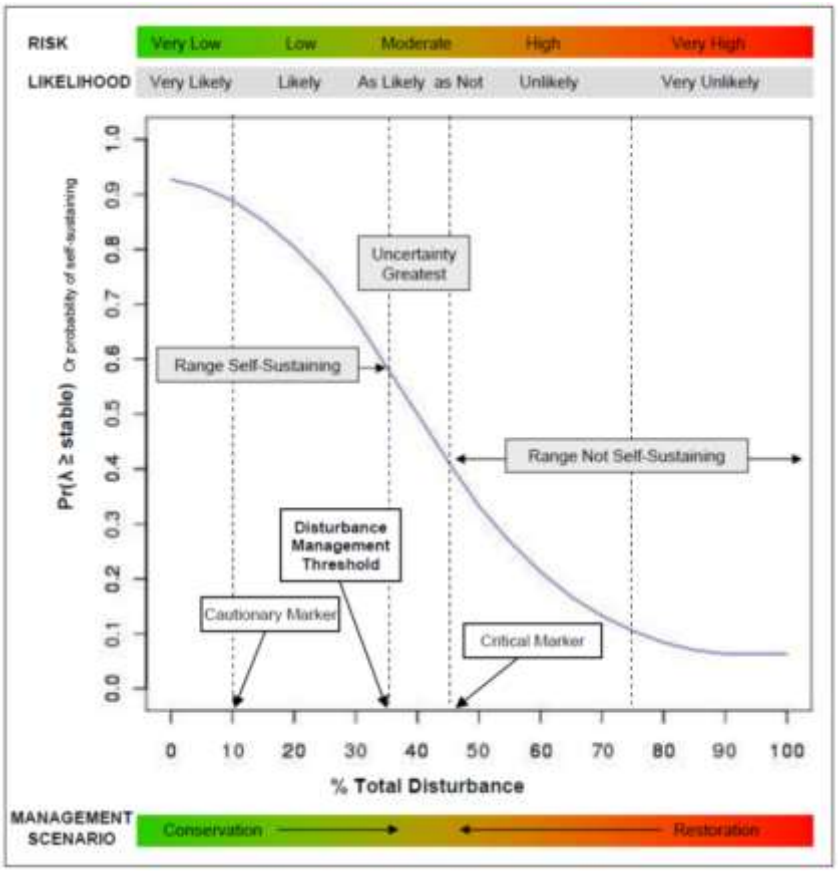

Figure 6. Tiered management thresholds for managing risk associated with boreal caribou habitat recovery planning. Source: Figure 5 from Environment Canada (2011).

Threat to caribou population persistence	Range of Values relative to 'risk zone' for caribou	Management Considerations
Low Risk		
Cumulative disturbance[a]	0-20% of caribou population range[b]	Carefully and proactively planned expansion of industrial effect is possible.
Linear feature density	<0.6 km/sq. km[c]	
Wolf density	< 4/1000 sq. km[d]	
Moderate Risk		
Cumulative disturbance[a]	20-40% of caribou population range[b]	Consider contribution of additional development to cumulative effects. Coordinated habitat recovery of industrial features should be made a priority.
Linear feature density	0.6- 1.2 km/sq km[c]	
Wolf density	4-6/1000 sq. km[d]	
High Risk		
Cumulative disturbance[a]	>40% of caribou population range[b]	Net expansion of industrial effect by applicant that adds to cumulative disturbance must not occur. Coordinated habitat recovery of industrial features must be undertaken.
Linear feature density	> 1.2 km/sq. km[c]	
Wolf density	>6/1000 sq. km[d]	

[a] proportion of the landscape with human-induced and natural disturbances of < 50 years (including infrastructure and linear features).
[b] Environment Canada (2008)
[c] Athabasca Landscape Team (2009)
[d] Bergerud (2007) and Hayes et al. (2003)

Table 3. Example framework for incorporating risk of boreal caribou population persistence into caribou management considerations. Specific thresholds should be validated based on regional considerations. Source: Table 2 in Dzus et al. (2010).

Risk Category	LOW	MODERATE	HIGH
Example Criteria	• Remote range • Moderate - large population (400 - >4,000) • Stable or increasing population • Low human footprint • Low amounts of recent wildfire activity • Low human activities (mineral exploration, harvest, other) • Low-moderate predator density (<4-6 wolves / 1,000km2)	• Accessible range • Moderate population (400 - 4,000) • Stable or increasing population • Moderate human footprint • Low amounts of recent wildfire activity • High human activities (mineral exploration, harvest, other) • Moderate predator density (4-6 wolves / 1,000km2)	• Accessible range • Small population (<400) • Stable or declining population • High human footprint • Moderate amounts of recent wildfire activity • High human activities (mineral exploration, harvest, other) • High predator density (>6 wolves / 1,000 km2)

Table 4. Example three-tiered risk categorization system for Yukon woodland caribou ranges. Population ranges from Yukon Department of Renewable Resources (1996). Predator density ranges from Table 2 in Dzus et al. (2010).

3.1.3.2 Assessing Risk with Disturbance-Population Relationships

At least two risk-based disturbance-population relationships (dose-response curves) have been developed to predict boreal ecotype woodland caribou herd viability. The spatially explicit Environment Canada (2011) relationship incorporates fire and buffered human disturbance (footprint) (**Figure 6**). This relationship was developed with data from across Canada and is generally applicable to ranges in the boreal forest. The Sorensen et al. (2008) equation and a recent update by Schneider et al. (2010) were developed with data from a relatively small number of moderate to very highly disturbed caribou ranges in Alberta. The Alberta range-scale relationships also incorporate fire and anthropogenic disturbance but used different methodologies, with a focus on linear features. The Alberta relationships may therefore be most relevant to developed multi-use areas in the Western Canadian Sedimentary Basin in northern Alberta and northeast British Columbia (Antoniuk et al. 2012).

Reid et al. (*in prep*) recently applied the Environment Canada (2011) and Schneider et al. (2010) boreal ecotype caribou herd viability models to the northern mountain ecotype Carcross Caribou Herd range in the Yukon Southern Lakes region. While neither of the models are designed to explicitly deal with the large areas of high elevation alpine and subalpine habitats of the Carcross range, both models fairly closely approximated the current herd population trend of stable to increasing if the high elevation habitats are considered 'good quality'. The Environment Canada (2011) model was considered the most applicable of the two boreal ecotype models, as it deals with all human footprint types (whether linear, polygonal or forest cutblocks), and buffers all features, thereby accounting for potential zones of influence to account for avoidance or increased mortality risk.

Given these findings, the Environment Canada (2011) disturbance-population risk relationships developed for boreal ecotype woodland caribou are reasonable starting points for northern mountain ecotype caribou range assessments. However, in Yukon the additional effects of seasonal ranges and caribou harvesting on population viability must also be considered.

3.1.3.3 The Use of Development Scenarios to Assess Future Risk

In addition to characterizing current risk levels, range assessments may also require a future perspective that combines our current understanding of range conditions with plausible scenarios of future landscape change. A primary concern for caribou management is whether cumulative range disturbance (human and natural) is expected to increase or decrease relative to current conditions over the coming decades, and whether habitat will recover over time.

Scenarios of land use change, industrial development, or climate change are well suited to evaluate risk and better understand uncertainty. Scenario analysis may also assist in establishing objectives and performance measures (*STEP 4*), and management strategies (*STEP 5*). Scenarios are plausible descriptions of how the future might unfold (Duinker and Greig 2007; Mahmoud et al. 2009). Computer-based landscape or population models can be used to assess the influence of assumptions or management approaches under changing landscape conditions, and to explore alternative strategies and key uncertainties for mitigating cumulative effects.

The specific methods for conducting scenario analyses are beyond the scope of this report, but the exercise can be made as simple or complex as required. It is recommended that the need for conducting scenario analyses, and the amount of effort directed to these activities, should

be explored during *STEP 1: Issues Scoping*. In situations with high resource pressures and high socio-economic values, detailed simulation modeling may be warranted. In other situations, where management pressures are not as high, or where the risks are considered to be lower, developing plausible development scenarios with mapped footprints, and performing a GIS overlay with current habitat mapping and associated interpretations, may be adequate to provide necessary insights into potential future risk levels.

As a Yukon example, Francis and Hamm (2011) used a landscape simulation model to explore potential risks to barren-ground caribou resulting from proposed oil and gas development in Eagle Plain. The scenario analysis was conducted in support of the North Yukon Regional Land Use Plan (Yukon and Vuntut Gwitchin Governments 2009), and informed the establishment of recommended acceptable levels of human-caused surface disturbance as part of the Plan's CEM framework.

3.1.4 STEP 4: Define Management Objectives and Performance Measures

Establishing management objectives for Yukon woodland caribou herds is a key contribution of the range assessment exercise. As discussed in Section 2.2, objectives are statements that describe a desirable condition for an identified value. Within a results-based management framework, an important part of establishing objectives is developing concise statements about the desired performance of an indicator. Performance measures are required to evaluate if the stated objectives are being met. Chapter 4 of Gregory et al. (2012) is recommended reading for considerations related to establishing objectives for land and resource management.

STEP 4 in the range assessment process provides direct project-level assessment guidance to YESAB, and other assessors and decision-makers, by partially fulfilling the missing landscape-level objectives required for efficient CEA and CEM (**Figure 1**). Setting clear objectives and related performance measures is a key part of a CEM system as it provides important information to proponents, assessors and regulators, including: 1) the identification of cumulative effects concerns; 2) measures of significance; and 3) what management response, in the form of both project-specific and cooperative mitigation measures, may be required.

A large amount of information and approaches to establish management objectives and associated performance measures for woodland caribou is available (much was summarized in Francis et al. 2013, and is also discussed in Section 3.1.3.2 of this report). When establishing objectives and performance measures, the following points should be considered:

- Where possible, objectives and performance measures should be structured in the form of a results-based management-framework (see **Figure 2**). In the framework, indicators and indicator levels are the performance measures. Examples of potential habitat and population objectives and performance measures, structured in this format, have been provided as examples in **Table 5** and **Table 6** below.
- When establishing objectives, both population and habitat objectives should be considered. However, in many situations there may not be enough information to establish well-defined population objectives. In these cases, focusing on habitat-based objectives with the goal of maintaining the range in a suitable condition to sustain caribou will likely be the major focus.

- Limited research has been conducted on Yukon woodland caribou population – disturbance relationships. The use of using existing literature and professional judgement to develop risk-based objectives and performance measures will therefore be required, with consideration of the following points:
    - influence or impact hypothesis diagrams (see Section 3.1.1) can be useful in exploring the type and relative magnitude of different factors affecting caribou habitat and populations. These can be used to develop and refine working hypotheses for understanding important issues and setting objectives.
    - in situations where uncertainty is high, land use scenarios can assist in understanding potential levels of risk associated with different levels of impacts, and better informing the process of defining habitat and population objectives. Such scenario analysis can be performed as part of the steps used to characterize risk levels for the range (*STEP 3* or Section 3.1.3.3, above).
    - management objectives should be more precautionary when there are higher levels of uncertainty.
    - the approach to developing objectives and associated performance measures should be tested in a pilot project. This will allow methods and assumptions to be examined and refined for use in other range assessments.

3.1.4.1 Habitat-related Objectives and Performance Measures

There are two general types of habitat-related objectives:

- Objectives that establish parameters for the maximum amount of human disturbance on a caribou range, or parts of a range (e.g., winter range); and
- Objectives that establish parameters for the amount of habitat or a specific habitat type that should be maintained in a specified condition (e.g., amount of natural or undisturbed habitat, old age class of forest, etc.).

These two types of objectives are inversely related, where high amounts of human disturbance result in low amounts of natural or undisturbed habitat. Both approaches therefore rely on knowledge of the amount of human disturbance, or footprint, on a landscape.

Objectives that establish parameters for levels of human disturbance can theoretically be managed through the project-level regulatory process, while habitat-based parameters are a 'derivative' of human disturbance. Habitat objectives that are based on levels of human disturbance may therefore be preferable to habitat-based parameters, as they can be integrated into project-level assessment and land and resource decision-making processes. However, levels of human disturbance are commonly expressed in terms of their habitat effects.

Regardless of the specific objective or indicator, minimizing the level of human disturbance and maximizing the amount of undisturbed or high value habitat is the primary habitat objective for reducing the risk of population-level decline. The Environment Canada (2011) model of boreal ecotype woodland caribou population viability (**Figure 6**) incorporates both the amount of human disturbance (direct footprint buffered by 500m) and habitat condition (amount of forest

greater than 40 years old) as a predictor of a herd's risk of population decline or probability of persistence[5].

Potential Objectives and Performance Measures

Potential habitat-related management objectives for woodland caribou are listed in **Table 5**. An example habitat objective for maintaining adequate amounts of winter range habitat, structured in the form of a results-based management framework, is shown in **Figure 7**. As a Yukon example, the CEM framework for the North Yukon Regional Land Use Plan used habitat-related objectives and indicators to provide guidance on acceptable levels of human disturbance in the winter range of the Porcupine Caribou Herd (Yukon and Vuntut Gwitchin Governments 2009).

[5] As discussed in *STEP 2* and *STEP 3*, Yukon-specific zone of influence buffers and burn recovery rates should be considered during the range assessment process.

Manage Levels of Human Disturbance			
Issue	***Objective***	***Indicator***	***Desired Indicator Level***
Habitat loss	Minimize habitat loss	**Amount of surface disturbance:** The amount of area physically disturbed by human activities, including structures, roads, gravel quarries, seismic lines, access trails and similar features. These all create physical *footprints* on the land, resulting in direct habitat loss or alteration. Some disturbances are relatively permanent, while others may be temporary.	< x % surface disturbance
Habitat fragmentation and increased human access	Minimize fragmentation and human access	**Linear density:** The total length of all human-created linear features (roads, seismic lines, access trails, etc.) in a given area. Linear density can be used as an indicator of fragmentation—the division of larger areas of habitat into smaller areas. Increasing levels of access may result from linear feature development, potentially leading to greater harvest of wildlife and fish, higher predation rates, and a change in how people and wildlife use the land. For this reason linear density is sometimes referred to as 'access density'.	< x km/km2 linear density
Maintain Habitat Conditions in Specified Condition			
Issue	***Objective***	***Indicator***	***Desired Indicator Level***
Habitat loss	Maintain adequate undisturbed habitat	**Amount of undisturbed habitat:** Area of habitat that is unaffected (direct + indirect effects represented by 500m buffer) by human land use features.	> x % undisturbed habitat
	Maintain adequate high value habitat	**Amount of high value lichen habitat:** Area of high value lichen habitat as defined and mapped through stated criteria (e.g. pine forests with >30% lichen ground cover).	< x % loss of pine-lichen habitat
Habitat fragmentation	Maintain large areas of intact, unfragmented habitat	**Core area:** Amount of undisturbed habitat in large patches (e.g. amount of area >500m from human features in patches >1,000 ha)	> x % core area

Table 5. Potential habitat-related objectives and performance measures for use in woodland caribou range assessments.

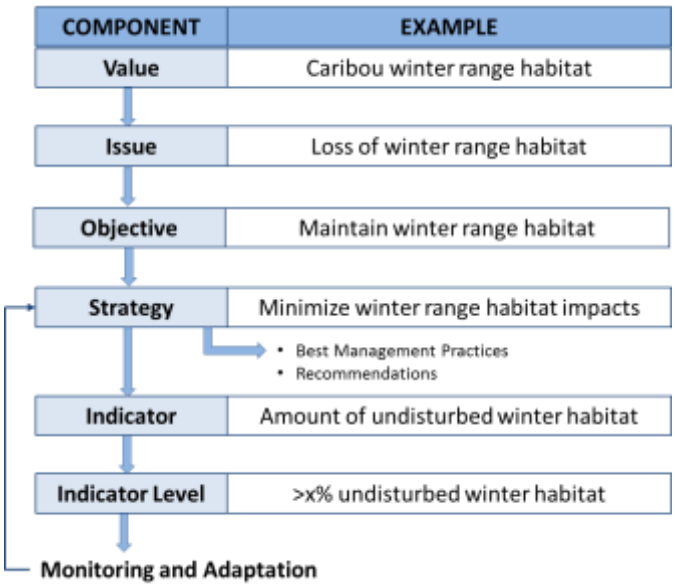

Figure 7. Example caribou habitat objective, structured in the form of a results-based management framework.

3.1.4.2 Population-related Objectives and Performance Measures

Population-related objectives may be considered of two general types:

- Objectives that establish parameters or limits for direct or indirect human-caused population effects, (e.g., level of harvest or maximum number of vehicle collisions); or
- Objectives that establish parameters for the desired population or demographic condition of a herd (e.g., herd size, cow/calf ratios).

Objectives that establish parameters for human-caused population effects usually focus on direct mortality effects such as harvest or vehicle collisions. Indirect effects such as aircraft over-flights may also be considered. These mortality-related effects can theoretically be managed through harvest limits, access controls, or similar actions. Objectives that establish parameters for herd population size or demographic ratios are affected by both natural and human factors, and are therefore more difficult to manage directly. Population objectives that are based on direct or indirect human effects may therefore be preferable as they provide guidance for management actions that can be linked to project-level regulation or harvest management. However, for human-caused mortality effects to be used effectively as objectives, they must still be able to be linked to population change. Desired population levels must therefore also be determined when considering human-caused mortality effects, which can be explored through population dynamics modeling.

Although population status or trend is often used as an indicator, it can be a challenging parameter to monitor because of the cost, the infrequency of surveys and high variability in population estimates. Consequently, other proximate parameters such as adult survival, calf productivity or yearling recruitment may be more sensitive indicators that lend themselves to more robust monitoring designs. This emphasizes the need and value of influence (impact

hypothesis) diagrams to show how the parameters are linked to objectives, and whether they are direct and proximate indicators of population status.

The Environment Canada (2011) model of boreal caribou population viability (**Figure 6**) incorporates the combined effects of human and natural disturbance (direct and indirect footprint), recent wildfire, and natural predation as a predictor of a herd's risk of population decline or persistence. This relationship does not directly incorporate harvest effects on population performance. Consideration of harvest effects must therefore be included as part of the risk assessment methodology described in Section 3.1.3.1, above (*STEP 3: Risk Assessment*).

Potential Objectives and Performance Measures

Potential population-related management objectives for woodland caribou are listed in **Table 6**. An example population objective for maintaining harvest rates at current levels, structured in the form of a results-based management framework, is shown in **Figure 8**.

Link to Harvest Management

For herds that are harvested, population-related objectives established through a range assessment process and recommended management strategies must have an explicit link to caribou harvest planning and management. If harvest levels are established in the absence of other herd management objectives, there is the possibility that the objectives and harvest levels may be incompatible. If *STEP 3: Risk Assessment* of the range assessment process determines a high risk situation for a specific herd, then additional harvest restrictions or closure may be required (Yukon Department of Renewable Resources 1996). Developing adequate linkage between harvest planning and management, and the objectives and recommended management strategies identified through the range assessment process, is therefore required.

Manage Human-caused Mortality or Disturbance			
Issue	***Objective***	***Indicator***	***Desired Indicator Level***
Increased harvest	Maintain sustainable level of harvest	**Number of animals harvested:** The total number of animals harvested annually. Sustainable harvest is generally defined as 2-3% of adult population (Yukon Department of Renewable Resources 1996).	< x animals harvested per defined period
Increased vehicle collisions	Minimize number of vehicle collisions	**Number of vehicle collisions:** Number of vehicle collisions resulting in mortality. Along busy roadways such as the Alaska or South Klondike Highway, this may be an important additional source of mortality contributing to population decline.	< x vehicle collisions per defined period
Increased harassment due to aircraft over-flights	Minimize number of harassment events	**Number of aircraft over-flights across caribou range:** Number of fixed wing and helicopter flights across caribou ranges, or important portions of ranges. Aircraft harassment may cause partial range abandonment or energetic effects, resulting in reduced recruitment or survivorship.	< x aircraft over-flights per defined period
Maintain Specified Population Conditions			
Issue	***Objective***	***Indicator***	***Desired Indicator Level***
Population decline	Maintain population at current level	**Current Population:** The existing population status determined either from surveys or estimated.	≥ current population level
	Increase current population level	**Level of Population Increase:** Level of population increase over a specified period of time.	> x % population increase in defined period
	Maintain or increase calf recruitment	**Cow/Calf Ratio:** The ratio of cow to calf caribou. This is a key indicator of population recruitment, and overall population trend. Herds with >30-35 calves/100 cows in the fall period are generally considered stable or increasing; herds with <30 calves/100 cows are generally in decline (Yukon Department of Renewable Resources 1996).	> x calves/100 cows
	Reduce predation	**Mortality rate from predators:** The number of mortalities as a percentage of the total population or a specific demographic due to natural predation.	< x % predator-caused mortality
	Reduce alternate prey density	**Population levels of alternate prey species:** The density of alternate prey species such as deer or moose.	x % reduction in specified alternate prey species

Table 6. Potential population-related objectives and performance measures for use in woodland caribou range assessments.

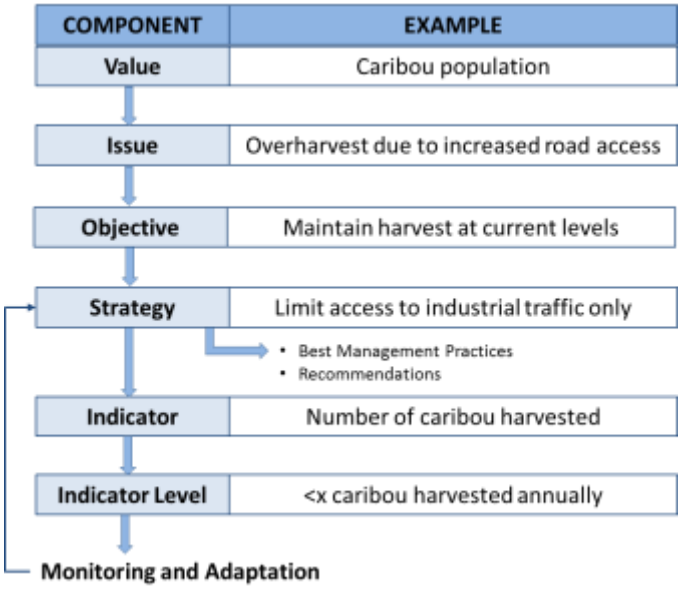

Figure 8. Example caribou population objective, expressed in the form of a results-based management framework.

3.1.5 STEP 5: Recommend Management Strategies

STEP 5 is the 'action' part of the range assessment process that recommends suitable management strategies to assist in achieving the defined objectives and performance measures. In the range assessment process, recommended management strategies are anticipated to be both best management practices (BMPs) and specific recommendations. As discussed in the CEA gap analysis (Francis et al. 2013), using a landscape-level approach to developing coordinated mitigation strategies during the project-level assessment process is currently challenging. Recommending suitable management strategies through the range assessment process will therefore provide guidance to assessors and decision-makers for determining appropriate project-level mitigation measures that assist in achieving landscape-level management objectives.

It is essential that management strategies be clearly linked to issues and objectives. As discussed previously, this can be achieved by structuring the strategies in the form of a results-based management framework. In the example objectives and performance measures provided above (**Table 5** and **Table 6**), adding a new 'strategies' column to these tables creates this link where each issue and objective has clearly defined actions. Structuring the strategies in this manner provides clear rationale why specific actions or recommendations were selected.

In many situations, multiple strategies will contribute to achieving the same objective, or a single management strategy may contribute to multiple objectives (e.g., reducing the amount of linear features decreases both habitat fragmentation and potential human access). A number of Yukon sources exist for determining caribou-related BMPs and recommendations, including:

- *Yukon Woodland Caribou Management Guidelines* (Yukon Department of Renewable Resources 1996);
- *Best Management Practices for Seismic Exploration* (Yukon Energy, Mines and Resources 2006);
- *Flying in Caribou Country: How to Minimize Disturbance from Aircraft* (Environment Yukon and MPERG 2008); and
- *Yukon Mineral and Coal Exploration Best Management Practices and Regulatory Guide* (Yukon Chamber of Mines 2010).

Relevant national reviews of potential management strategies and the relative effectiveness of different mitigation measures for boreal caribou are:

- *Caribou and the National Boreal Standard: Report of the FSC science panel* (Dzus et al. 2010)
- *Woodland Caribou Recovery: Audit of Operating Practices and Mitigation Measures Employed within Woodland Caribou Ranges* (Forest Products Association of Canada 2013).

The Forest Products Association of Canada (2013) reference is particularly relevant. Potential generalized habitat and population-related management strategies that support defined objectives are listed below. These potential strategies are not intended to be an exhaustive list of all possible management actions; such actions will need to be determined during the range assessment process.

3.1.5.1 Habitat-related Management Strategies

There are two general types of habitat-related management strategies:

- Strategies that attempt to manage the direct or indirect effects of human-caused habitat impacts, (e.g., amount of surface disturbance); or
- Strategies that attempt to manage natural factors that affect caribou habitat (e.g., wildfire).

Management strategies that attempt to manage the direct and indirect effects of human impacts on habitat can theoretically be implemented through the project-level regulatory process, or through other management plans. However, in the absence of defined objectives and performance indicators, selecting the most appropriate management strategies becomes challenging at the project-level review or management stage.

Potential Management Strategies

Potential habitat-related management strategies for woodland caribou are listed in **Table 7**. The listed strategies are general in nature—more specific actions or implementation activities may be required when applied to specific caribou ranges. Each strategy is linked to a habitat issue and objective.

Manage Levels of Human Disturbance		
Issue	***Objective***	***Strategy***
Habitat loss	Maintain adequate undisturbed habitat	**Minimize amount of surface disturbance:** • Air access only • Temporary surface access only (ice roads; winter access) • Coordinated surface access and sharing of road and other industrial infrastructure • Full reclamation • Aggregated development patterns
Reduction of habitat quality	Maintain adequate high value habitat	**Maintain high value habitats:** • Establish caribou conservation zones that preclude or modify forest harvest or development patterns
Habitat fragmentation and increased human access	Minimize fragmentation and human access	**Minimize amount of linear features:** • Air access only • Coordinated surface access and sharing of road and other industrial infrastructure • Reduce life-span of linear features (low impact seismic; low grade roads that are easily decommissioned) • Aggregated development patterns **Access Management:** • Access controls on public use of resource roads
Manage Natural Factors that Affect Habitat		
Issue	***Objective***	***Strategy***
Habitat loss or reduction of habitat quality	Maintain adequate high value habitat	**Maintain high value habitats:** • Establish priority fire suppression zones to maintain lichen habitats

Table 7. General strategies to achieve habitat-related objectives for potential use in woodland caribou range assessments.

3.1.5.2 Population-related Management Strategies

Population-related management strategies may be considered of two general types:

- Strategies that attempt to manage the direct or indirect effects of human-caused population effects, (e.g., level of access or harvest); or
- Strategies that attempt to manage natural factors that affect caribou populations (e.g., predation).

Management strategies that attempt to manage the direct and indirect effects of human activities on populations can theoretically be implemented through the project-level regulatory process, or through other management plans. However, in the absence of defined objectives and performance measures, selecting and coordinating appropriate management strategies becomes challenging at the project-level review or project mitigation stage.

Potential Management Strategies

Potential population-related management strategies for woodland caribou are listed in **Table 8**. The listed strategies are general in nature—more specific actions or implementation activities will be required when applied to range-level management. Each strategy is linked to a population-related issue and objective.

Manage Human-caused Mortality and Disturbance		
Issue	***Objective***	***Strategy***
Increased harvest	Maintain sustainable level of harvest	**Manage harvest levels:** • Harvest closures • Permit hunts only • Harvest reporting **Manage access to harvest areas:** • Access controls on public use of resource roads
Increased vehicle collisions	Minimize number of vehicle collisions	**Reduce caribou-vehicle collisions:** • Speed reductions • Manage road-side vegetation (reclamation, clearing) • Reduce use of road salt and other attractants
Increased harassment due to aircraft over-flights	Minimize number of harassment events	**Reduce caribou-aircraft encounters:** • Flying height guidelines • Timing windows • No fly areas over important habitats
Manage Natural Factors that Affect Populations		
Issue	***Objective***	***Strategy***
Population decline	Maintain population at current level	**Maintain current population:** • Manage harvest (see above) • Manage habitat impacts (see Habitat Strategies)
	Increase current population level	**Increase population:** • Reduce habitat impacts (see Habitat Strategies) • Reduce harvest • All of strategies below
	Maintain or increase calf recruitment	**Increase recruitment success:** • Fencing enclosures • Manage predator populations or movement patterns (see below)
	Reduce predation	**Manage predator populations or movement patterns:** • Predator control • Reduce or reclaim linear features (see Habitat Strategies)
	Reduce alternate prey	**Manage population levels of alternate prey species:** • Increase size or female composition in harvest of alternate prey species • Reduce amount of alternate prey habitat

Table 8. General strategies to achieve population-related objectives for potential use in woodland caribou range assessments.

3.1.6 STEP 6: Monitoring and Adaptation

STEP 6 in the range assessment process has two main purposes:

- To monitor the identified performance measures or other indicators identified in *STEP 4* (**Table 5** and **Table 6**) to determine if the stated objectives are being achieved; and
- To determine if the recommended management strategies (best management practices and specific recommendations) from *STEP 5* are being implemented and are effective (**Table 7** and **Table 8**). If the strategies are not being used, or are not achieving their intended objectives, then changes may be required.

The Canadian Boreal Forest Agreement considers adaptive management to be "*an explicit recognition of uncertainty about the outcome of some management activities and the need to learn by doing that includes careful observation of the effects to guide change over time*." This step of the range assessment process is intended to support the goal of continuous improvement through monitoring and adaptation.

In the flow chart **Figure 4**, *STEP 6: Monitoring and Adaptation* is shown as the 'final' step in the range assessment process. While illustrated as a discrete step, these activities should be viewed as part of an ongoing cycle. *STEP 6* will likely be the longest 'phase' of the range assessment process, as a period of years may elapse between when range assessments are initially developed and formally reviewed. However, monitoring is required during this time period to determine if and when reviews and changes should occur.

In **Figure 4**, the ongoing cycle is shown through feed-back loops between monitoring and adaptation, *STEP 4* (objectives and performance measures) and *STEP 5* (management strategies). A link is also shown between monitoring and adaptation and *STEP 1*, when the entire range assessment process is repeated. Deciding who is responsible, what steps to review, and how frequently, are important considerations for the ongoing cycle of range assessment activities.

3.1.6.1 Current Challenges

As discussed in the CEA gap analysis of Francis et al. (2013), monitoring and 'follow-up' of land use activities in Yukon are generally conducted infrequently. The following points present challenges to this step of the range assessment process:

- The location, timing and intensity of Class 1 mineral exploration activities following claim staking, such as aircraft supported exploration, are not currently reported or well known;
- After the project-level assessment and approval processes are complete (i.e., a project approval is granted), there is no standard follow-up actions to determine:
    - what land use activities actually occurred.
    - how effective the recommended mitigation measures were, or if they were followed.
- No formal mechanism for tracking land use footprint (surface disturbance and linear density) or other activities (e.g., hunting or recreation) is in place; and

- Due to limited resources and competing priorities, the tracking of important biological indicators such as caribou herd size and trend, or habitat mapping updates, may happen only infrequently.

Advances in these areas will be required for range assessment, and overall land and resource management processes, to function effectively. It is also important to recognize that implementing adaptive management principles for woodland caribou is further challenged by potentially long response times. In some cases, the full impact of management actions may not be known for many years or even decades after their implementation (Dzus et al. 2010).

3.1.6.2 Considerations for Monitoring and Adaptation

At this time it is not possible to fully articulate how monitoring and adaptation activities will be completed. How monitoring activities will be carried out, and how caribou range assessments will be reviewed and updated, should be considered as part of the range assessment process. These tasks will also require consideration during Environment Yukon's and potentially other departments annual work planning and budgeting activities. **Table 9** provides suggested approaches for consideration.

Monitoring	
Topic	***Suggested Approach***
Who Who is responsible for monitoring of indicators identified by the range assessment?	Environment Yukon should remain responsible for habitat and population-related data collection and monitoring. Yukon Energy, Mines and Resources should become responsible for providing land use information for Class 1 mining activities, land tenure, and activities for which land use permits are required (i.e., mapping and tracking of surface disturbance). The Mineral, Oil and Gas and Forest Management Branches, and the Community Services and Highways and Public Works departments could also provide information on anticipated locations and levels of future activity, to assist with risk assessment and development of land use scenarios, when required.
Review and Updating of Range Assessments	
Topic	***Suggested Approach***
Who Who is responsible for reviewing and potentially updating the caribou range assessment?	Environment Yukon should remain the lead agency for conducting and reviewing caribou range assessments.
What What parts of the range assessment will be reviewed?	Depending on the level of change or concern, all components of a range assessment can potentially be reviewed and updated (*STEPS 1-6*). For example: • If *STEPS 1 to 3* determines the range risk level has changed from low to moderate, different Objectives, Strategies and Monitoring and Adaptation steps may be required. • If there are increases in land use activities (e.g. mineral exploration) but no other changes in population status or habitat quality, potentially only the recommended Strategies require review and updating.
When Will range assessment reviews be conducted on a regular schedule, or will a review be conducted when conditions change substantially?	Caribou range assessments should be reviewed when circumstances change or the range conditions change with consideration of: • Population trend changes from stable to declining; • Major increases in land use activity are occurring (mining, harvest, residential, etc.); or • Wildfires affect a large portion of a range.

Table 9. Considerations for monitoring and adaptation activities associated with woodland caribou range assessments.

4 PILOT PROJECT

We view a pilot project as the primary means of implementing the concepts and methods described in this report. As recommended by Francis et al. (2013), a pilot project may be the most effective means to advance the range assessment concept from a proposal stage to an applied management tool. A pilot project would provide:

- A visible demonstration of the range assessment concepts and methods described above;
- An opportunity to test, refine, and potential modify the proposed methods;
- An opportunity to gain insight into required resources;
- An opportunity to apply the range assessment results to project-level assessment and decision making; and
- A formal process to evaluate the effectiveness of the range assessment approach.

To maximize learning, the pilot project should include Yukon woodland caribou ranges with different levels of existing information and different types of cumulative effects or management concerns. Recommendations for conducting a woodland caribou range assessment pilot project are described below.

4.1 Range Assessment Team

As described in previous sections, it is recommended that Environment Yukon lead the woodland caribou range assessment process. A pilot project would allow the department to develop appropriate coordination and technical capacity to conduct range assessments.

As the lead department, Environment Yukon should carry out the range assessment activities primarily as an internal technical exercise. To this end, the pilot project should be conducted by an Environment Yukon *Range Assessment Team*. This team should be composed of current staff with expertise in caribou habitat, caribou populations, predators, harvest management, and environmental assessment and management. Regional biologists in the selected pilot areas are anticipated to play important roles in range assessments. The assistance of a facilitator with land and resource management planning expertise may also be useful to guide the group through the proposed range assessment steps (**Figure 4**).

While the technical work of the *Range Assessment Team* should be largely completed by Environment Yukon staff, representatives from YESAB, Yukon Energy, Mines and Resources, the Yukon Development Assessment Branch, and potentially other groups or agencies, should also participate in the pilot project. As these groups are essentially the 'clients' for the range assessment, maintaining their involvement in the pilot project would be beneficial to ensure the range assessment meets assessors and decision-makers needs, thereby increasing the likelihood they will be used to support assessment and decision-making.

Environment Yukon should also consider the potential role of affected Renewable Resource Councils in the pilot project areas, and if or how they may contribute to the exercise. If the aims of the assessment are to provide guidance for decision-making, and not to develop specific

management plans, then performing the range assessment as an internal Yukon Government exercise may be adequate. However, links between range assessment recommendations relating to caribou harvest management or other species management plans may require the involvement of Renewable Resource Councils.

4.1.1 Capacity Required to Support Range Assessment Activities

As discussed above, it is recommended that the range assessment process should be completed by a *Range Assessment Team* composed largely of existing Environment Yukon staff with expertise in caribou habitat, caribou populations, predators, harvest management, and environmental assessment and management. The amount of time and resources required to complete a woodland caribou range assessment (or for other focal species), will vary depending on the amount and quality of existing information, the nature and level of concern with current and possible future management pressures, and the number and type of participants.

Assuming a 'typical' range assessment process for a woodland caribou herd with moderate management pressures and low levels of existing information, **Table 10** outlines potential resources and timelines that could be anticipated for Environment Yukon. With adequate preparation, a full range assessment process may take approximately six months to one year to complete. Emphasis for the assessment should be on evaluation and objective setting versus data collection. Regularly-scheduled *Range Assessment Team* workshops are anticipated to be the primary means of completing the assessments.

In **Table 10**, it should be noted that some of these resources are not necessarily 'new', as many data collection activities are already occurring without a formal range assessment process (e.g., broad ecosystem mapping, caribou lichen habitat mapping, and caribou or predator population surveys). The range assessment process provides an opportunity to more effectively plan for and coordinate such ongoing activities. Environment Yukon's annual work planning and budgeting cycles can be used to coordinate resources between different branches and programs to secure required annual resources. The pilot project will provide an opportunity to examine human resource requirements and efficiencies.

Step	Tasks	Estimated Staff Resources	Potential Timelines
STEP 1: Issues Scoping	• Using a workshop format, discuss overall approach and scope issues for selected range. • Discuss approach for STEP 3. • Develop workplan and methodology for data collection/creation/synthesis.	• All *Range Assessment Team* (habitat, caribou and predator populations, Regional biologist, harvest and environmental assessment). • 1 process lead/facilitator develop workplan	• 2 day meeting. • 5 days to develop workplan.
STEP 2: Characterize Range Condition	• Assemble or create required data sets (habitat, footprint/activity mapping). • Collect caribou/predator population data, if required. • Perform required analysis to inform STEP 3. • If management scenarios are to be evaluated, construct as required.	• Participation of *Range Assessment Team* members as required. • *Range Assessment Team* meeting (1 day) to review data sources and prepare for STEP 3.	• 1-6 months, depending on availability of existing information. • Data collection is the most variable portion of process and should be scoped carefully.
STEP 3: Evaluate Level of Risk	• Using a workshop format, perform risk evaluation. • If management scenarios are used to support risk evaluation, discuss as required and integrate into evaluation.	• All *Range Assessment Team* (2-3 days) meeting. • If management scenarios, full *Team* for additional 2-days. • 1 process lead/facilitator write-up.	• 2-3 day meeting. • Management scenarios may need 1 additional 2-day meeting. • 5-days to develop risk evaluation documentation.
STEP 4: Define Management Objectives and Performance Measures	• Based on outcome of risk evaluation, develop objectives and indicators to support risk management. • Develop management strategies (STEP 5) concurrently with objectives and indicators	• All *Range Assessment Team* (2-3 days) meeting. • 1 process lead/facilitator write-up.	• 2-day meeting. • 5-days to develop objectives, indicator and strategy documentation.
STEP 5: Recommend Management Strategies	• Develop management strategies concurrently with STEP 4. • Evaluate linkage/practicality of strategies to meet objectives. • Ensure linkage with other management (e.g., harvest).	• 1 additional meeting of all *Range Assessment Team* (1-2 days) may be required to review and modify objectives, indicators and strategies. • 1 process lead/facilitator write-up.	• Possible 1 or 2-day meeting. • 3-days to modify or refine objectives, indicator and strategy documentation, if required.
STEP 6: Monitoring and Adaptation	• Develop monitoring and assessment procedures and workplan.	• 1 meeting of full *Range Assessment Team.* • 1 process lead/facilitator write-up.	• 1-day meeting. • 1-2 weeks to create range assessment report and maps.

Table 10. Potential Environment Yukon resources and timelines that could be anticipated to support a woodland caribou range assessment process.

4.2 Candidate Areas

During development of this report and the CEA gap analysis (Francis et al. 2013), two candidate pilot project areas were discussed:

- Carcross Caribou Herd Range (Southern Lakes); and
- Klaza Caribou Herd Range (Dawson Plateau).

These two areas have different levels and types of land use pressures, and also differ in their level of existing information. Each is described below.

4.2.1 Carcross Caribou Herd Range (Southern Lakes)

The Carcross Caribou Herd range in the Southern Lakes region was initially suggested by Francis et al. (2013) as a candidate location to conduct a woodland caribou range assessment pilot project, and was also discussed during development of this report. Portions of the Carcross Herd range are the most heavily developed and populated areas of Yukon (approximately 80% of the total Yukon population lives in and around the range). Settlements, rural residential properties, highways, roads, trails, agriculture, forestry, mining and extensive outdoor recreation activities all occur on the range.

Detailed human footprint mapping and a number of land cover and ecological land classification products have been developed for the Carcross Herd range. Florkiewicz et al. (2006) conducted a detailed analysis of habitat and habitat use, which have become the primary land use-related management guidelines for the herd. Reid et al. (*in prep*) applied boreal ecotype woodland caribou population viability models to this northern mountain ecotype woodland herd, gaining insight into their potential application.

The Carcross Herd population is currently estimated to be 800 individuals and is considered stable (**Table 1**), largely as a result of harvest management. Hunting closures and a voluntary hunting ban by local First Nations have been in place for the past decade. Key future risks to the herd are considered to be the expanding human population of the Whitehorse area and its effect on caribou habitat and population (habitat loss, habitat avoidance, harassment due to human activities, increased mortality due to vehicle collisions, etc.)

4.2.2 Klaza Caribou Herd Range (Dawson Plateau)

The Klaza Caribou Herd is a moderately remote herd on the Dawson Plateau that resides south of the Yukon River and north of Aishihik Lake. While the area has no permanent settlements or major roads, over the past 10 years the range has experienced a high level of mineral exploration activity. A number of exploration trails cross the area and a large portion of the range is staked with mineral claims. Large mineral exploration targets such as Casino and the operating Minto Mine are within or adjacent to the range.

In comparison to the Carcross Herd range, the Klaza Herd range has received limited study. Relatively few existing habitat and footprint mapping data products are available. A broad ecosystem map was recently completed for much of the area (Makonis Consulting Ltd. 2012), providing initial habitat-related mapping information.

The Klaza Herd is currently estimated at 1,180 animals and is thought to be increasing in size (**Table 1**). Future risks to the herd are anticipated to be increasing levels of mineral exploration, and the potential development of a large operating mine site (Casion) with all-season road access through the herd's winter range. Options for a road alignment through the herd's range are being discussed.

4.3 Methods

The pilot project is intended to 'test drive' the proposed methods described in Section 3 (illustrated graphically in **Figure 4**). The pilot project would provide Environment Yukon with an opportunity to:

- Experiment with data collection methods (*STEP 2*);
- Evaluate risk assessment approaches (*STEP 3*);
- Determine efficient ways to establish meaningful objectives and associated indicators (*STEP 4*);
- Consider appropriate management strategies and best management practices (*STEP 5*); and
- Examine potential monitoring approaches (*STEP 6*).

As part of the pilot project, a scenario approach should be used to examine how the range assessment would be used by YESAB in project-level review and by decision-makers and regulators in project approvals and potential follow-up activities. Hypothetical management scenarios should be examined prior to applying the range assessment to real projects. In this manner, potential problems and improvements can be addressed as part of the pilot project prior to formal implementation.

Evaluating risk to herd viability and the desire to determine habitat and land use thresholds has been an ongoing conversation in Yukon for many years (e.g., Axys 2001; Anderson et al. 2002). The range assessment pilot project would provide a formal opportunity to examine different approaches that are applicable to northern mountain ecotype woodland caribou. The recent work of Reid et al. (*in prep.*) in the Carcross Herd range is relevant to this topic. Given the migratory nature of most Yukon woodland caribou herds (i.e., the summer season is spent in high elevation areas, and the winter season is spent in lower elevation valleys, where most land use activity occurs), placing additional emphasis winter ranges may be warranted.

Also, as discussed in *STEP 6: Monitoring and Adaptation*, there are currently many challenges to effective and consistent monitoring of land use and its effects in Yukon. A pilot project could examine methods and responsibilities for different aspects of required monitoring to determine if objectives are being met, and if the recommended strategies are being used, and are effective.

4.4 Assessment of Pilot Project

The aim of the pilot project is to demonstrate and evaluate the proposed methods, and to learn where changes or improvements may be required. To this end, the pilot project should include a formal follow-up and assessment phase. This will be required to determine the following:

- Was the *Range Assessment Team* effective, and were the right people involved?
- What information was found to be the most useful and cost effective?
- Were any major issues identified when the range assessment was applied to hypothetical management scenarios?

Over the longer-term, after the range assessment has progressed past the pilot project stage and has been implemented to support land and resource management activities, the following questions will become relevant:

- Was there adequate linkage to assessment and decision-making processes (YESAB project-level review, project approvals, follow-up and monitoring)?
    - was the range assessment used?
    - was the range assessment effective – did it support the intended processes?
    - would range assessments be more effective as formalized 'management plans'?

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