Bulkley Valley Centre for Natural Resources Research & Management
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An integrated assessment of the cumulative impacts of climate change and industrial development on salmon in Western BC

Moose: Summary of objectives and knowledge for decision support

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Purpose of this document

This document provides information for decision-makers considering risks or benefits to moose (*Alces alces*) on behalf of the public. Making such decisions requires understanding public values and the effects of alternative decisions on these values.

Societal values[1] and knowledge provide the foundation for applying risk management[2] in natural resource decision-making (Figure 1). Values define the scope of risk assessment. Scientific and traditional ecological knowledge support assessment of risk and benefit. Objectives—describing the desired condition of values— help to determine what combinations of risk and benefit are acceptable. Values and knowledge come together in decision-making when a decision-maker weighs assessed risk and expected benefits against publically-defined objectives (Figure 1).

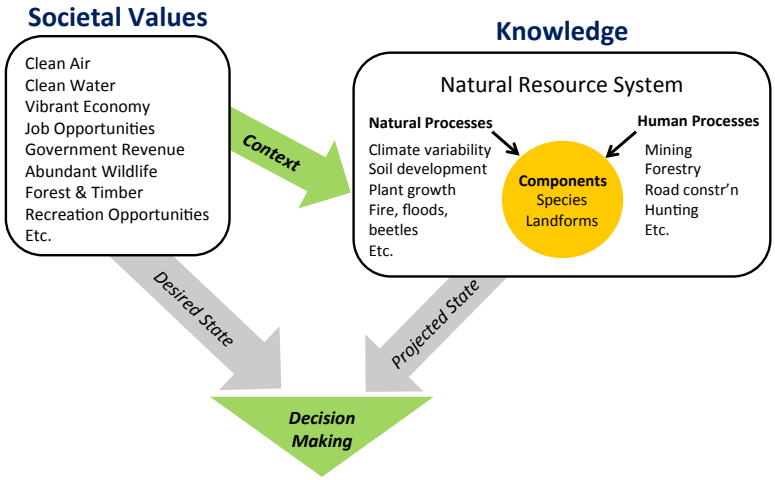

Figure 1. Diagram showing role of values and scientific knowledge in decision-making. Values are socially-defined and set the context and scope for an assessment of a natural resource system. Objectives define a socially-desired state for a value. Knowledge characterizes the influence of anthropogenic and natural changes to the landscape and determines the projected state of each value; indicators of state influence risk (or benefit) to each value. Resource management decisions consider weigh risks and benefits against public objectives.

This document summarizes information[3] for one value—moose—in the Northwest CEA Pilot Area (Figure 2 below). The next brief section describes the current status and distribution of moose. The document has two main sections: the first describing public direction; the second describing ecological knowledge. Ecological knowledge is based primarily on an expert workshop[4].

Distribution, ecology and status[5]

Distribution: Moose are found in northern forests across Europe, Asia and North America. In Canada, they range from British Columbia and Yukon to Labrador and Nova Scotia. Moose have expanded their

range dramatically in BC over the last 60 to 80 yr. BC supports about 170,00 moose, over 70% of which live in the north[6]. Moose are relatively abundant in the central and northern interior, sparse in the southern interior and absent from coastal BC (Figure 2). Typical population densities in BC range from 0.3 to 1.5 per km2. The pilot area supports a moderate density.

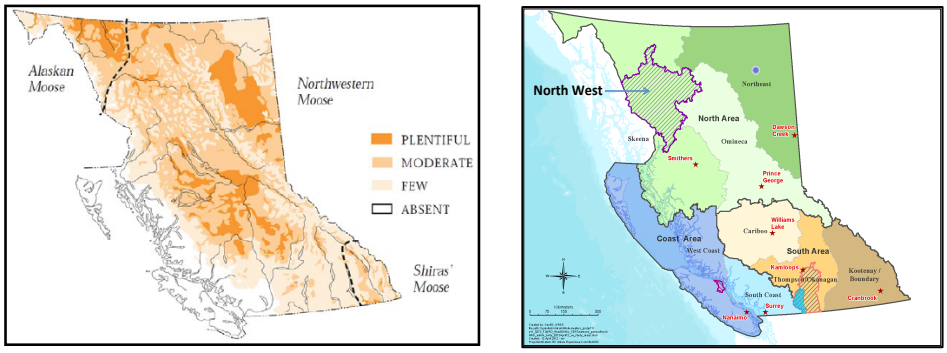

Figure 2. Distribution of moose in British Columbia (left); figure retrieved from Province of BC (2000)[7]. And location of Northwest Pilot Area.

Ecology: Moose inhabit areas with forest cover. Population densities vary in response to snow depth and winter browse supply. Moose are well-adapted to snowy regions because of their long legs, which help them to travel easily through deep snow (< 70 cm). In mountainous regions, moose usually migrate between winter and spring ranges in valley bottoms and high-elevation summer ranges. In winter, moose rely on dense browse associated with rivers, wetlands and burned or logged areas; dense browse is also found in the Spruce-Willow-Birch zone and along avalanche tracks. Moose browse primariliy on the twigs and bark of willow in winter, but also use other decidous shrubs and trees and balsam fir. Moose eat aquatic plants and the new leaves on shrubs and herbs in summer.

Life History: Starvation and predation cause most death in moose populations. During severe winters, moose that are in poor physical condition usually die from starvation or wolf predation. Black bears can kill a high proportion of calves. Grizzly bears kills calves and adults from spring to fall. Most moose in BC do not die from parasites. Humans are responsible for mortality from hunting and collisions with trains and motor vehicles. The annaul provincial moose harvest ranges from 8,000 to 14,000 animals.

Status: Moose are not a species of conservation concern in BC, being listed as provinically secure (S5, yellow listed)[8]. The moose population in the Nass (southern portion of pilot area) has declined over the last decade[9], but remains viable. Moose have become a limited food item for Gitanyow people[10]. Factors contributing to this decline may include

- increased road access (currently ~ 1.1 km/km^2) and subsequent overharvesting of cows;
- decreased supply of early seral forage, due to aging cut blocks;
- natural variability in bear and wolf depredation[11].

Other coastal populations have not declined so climate change is not thought to be the main cause of decline in the Nass.

Public direction for moose

Ecological and Social Context

Moose are broadly recognized as important to the people of the pilot area, from their key role in natural predator-prey systems, to their importance for subsistence and recreational hunting[12]. From an ecological perspective, moose play an important role in large mammal predator-prey systems, providing food for wolves, black bears and grizzly bears.

Historically and up to the present, First Nations in BC have relied extensively on moose for food, clothing and implements (MELP, 2000). In parts of BC, moose were the main source of meat. They also provided hides for moccasins, clothing, and shelter and bones and antlers for tools. Currently, the Gitanyow and Nisga'a also depend on moose meat for much of their sustenance[13].

Moose are an important game species in British Columbia, providing more meat than all other ungulates combined, and generating considerable license revenue for the province. Moose are also a valued trophy animal, providing income for guide-outfitters in northern communities. The Cassiar area is considered to have some of the best big game hunting in North America[14]. Moose provide several hundred thousand days of recreation for hunters and support subsistence lifestyles. Moose also have aesthetic value as a symbol of the northern wilderness and intrinsic worth, and really cute noses.

Objectives for Moose

Provincial

The Wildlife Program plan[15], in conjunction with the BC Conservation Framework[16], sets the primary direction for wildlife management in BC, including moose. The plan has the vision of maintaining "*naturally diverse and sustainable wildlife supporting varied uses for current and future generations*". It includes several objectives:

- *Conserve and restore native wildlife species and their habitats*
- *Maintain the health of wildlife in B.C. where health includes the capacity of individuals or populations to respond to… challenges from their environment.*
- *Provide and manage sustainable uses of wildlife*
- *Prevent or reduce negative effects of wildlife-human encounters*

The BC Conservation Framework includes the following goals:

- *…maintain the full diversity of native species and ecosystems*

- *…prevent species and ecosystems from becoming at risk*

The Forest Planning and Practices Regulation of the Forest and Range Practices Act includes the objective to *"conserve sufficient wildlife habitat… for… the survival of regionally important wildlife, and the winter survival of specified ungulate species"* without unduly[17] reducing timber supply.

Under the Identified Wildlife Management Strategy, moose are defined as a Regionally Important Wildlife Species (http://www.env.gov.bc.ca/wld/frpa/species.html). The goals of the IWMS are to *"minimize the effects of forest and range practices on Identified Wildlife situated on Crown land and to maintain their limiting habitats throughout their current ranges and, where appropriate, their historic ranges"*. Appendix 1 provides an overview of regulatons affecting moose in BC.

Hunting-related policy aims to be **"***commensurate with conservation*", to maintain the "*viability or genetic variability of native game populations*" and to "*limit the risk of harvesting to acceptable levels*"[18]. Related procedures for moose management include objectives to "**avoid declines**" in managed moose populations and to maintain specified bull to cow ratios[19].

In summary provinical goals and objectives aim to **maintain healthy (i.e., resilient) populations** that are sufficiently robust to **support use**, including harvest, **without becoming at risk**. The vision of maintaining naturally diverse populations and the objective of maintaining healthy populations imply that **populations should be well-distributed across their range**. Subordinate objectives that contribute to population objectives address habitat (particularly winter habitat) conservation and prevention of wildlife-human encounters.

Region: Iskut-Stikine

The pilot area can be divided into two sub-regions based on administrative units. The Cassiar Iskut-Stikine Land and Resource Management Plan area ("Iskut-Stikine") covers the northern portion of the pilot area.

Most of the Iskut-Stikine lies in Tahltan territory; other First Nations in the area include Taku River Tlinget, Kaska Dena and Nisga'a[20]. Nisga'a have a land use plan, but it applies mainly to the Nass TSA and will be discussed below. Other First Nations do not have land use plans, although they have agreements with the Province governing collaboration. This section summarizes direction for moose from the the Cassiar Iskut-Stikine Land and Resource Management Plan.

Moose contribute to the broad vision of maintaining *a "healthy environment including...abundant… wildlife populations… (2.2)"*[21] and support broad goals related to biodiversity, viable natural predator-prey systems, hunting and guide outfitting.

Population-related objectives for moose include

- *Maintain habitat to support **healthy** wildlife populations (2.3.2.8.1)*[22].
- *Manage… populations to be a **sustainable**, renewable resource (2.3.5.1)*

Objectives that support population objectives address habitat (at a variety of scales), anthropogenic mortality and displacement.

- *Maintain habitat to support healthy wildlife populations (2.3.2.8.1); maintain the functional integrity of mapped moose winter range…(2.3.2.8.1); conserve riparian habitat… (2.3.2.1.5);* [provide] *contiguous areas of functional habitat creating an interconnected network of ecosystems and key wildlife habitats (2.3.2.4); maintain connectivity (2.3.2.7.2)*
- *Manage development and access to conserve… wildlife populations (2.3.2.8.2); …control… hunting…where required* (2.3.1.2)

In summary, regional objectives aim to **maintain healthy, abundant moose populations that support hunting** (i.e., a renewable resource) **and contribute to natural predator-prey systems**. Subordinate objectives address habitat conservation and limiting anthropogenic mortality risk. Regional and provinical objectives are very similar.

Region: South Nass

The Nass TSA covers the southern portion of the pilot area. Strategic land use plans cover the southern portion of the Nass TSA:

- the Nass South Sustainable Resource Management Plan[23]
- the Gitanyow Huwilp Land Use Plan[24]
- A Land Use Plan for Nisgaa Lands[25] and the Nass Wildlife Area, where Nisga'a, provincial and federal governments share wildlife management responsibility[26].

In the South Nass, moose are valued for their contribution to natural predator prey systems and for hunting, particularly for Gitanyow and Nisga'a First Nations.

> *"Large predator-prey systems…and their component wildlife species, are key values" in the Nass SRMP". (Nass SRMP)*
>
> *"The Gitanyow and Nisga'a depend on moose meat for sustenance and thus place a high value on moose habitat and moose population management". (Nass SRMP)*

Plan intent and goals aim to **ensure healthy populations of moose that support a sustainable harvest**.

> *"With respect to wildlife, the intent of the Nass South SRMP is… to maintain habitat to help ensure wildlife populations are capable of sustaining a Nisga'a hunter harvest….; to provide for Gitanyow continued use of wildlife resources; to provide for a sustainable harvest of big game species..." (Nass SRMP)*

> *"Manage moose winter range to help ensure healthy populations. Minimize pressure on moose population legal and illegal harvest through human access management." (Goals in Nass SRMP and Gitanyow LUP)*
>
> *"The continuing viability of the wildlife populations within in the Nass Wildlife Management Area is a high priority for the Nisga'a Nation." (LUP for Nisga'a)*

Gitanyow have established moose harvesting restrictions on their territory to address a recent decline in the moose population.

Knowledge for moose

Factors affecting moose

Moose (*Alces alces*) populations are controlled largely by mortality rate and also by habitat supply (Figure 1). In general, moose densities are limited by natural predators to levels well below the theoretical carrying capacity of the habitat[27]. Substantial habitat loss, or loss of critical habitat under specific conditions, can still cause population decline, particularly at smaller spatial scales. Moose have high natural population growth rates and are able to recover relatively rapidly when threats are removed.

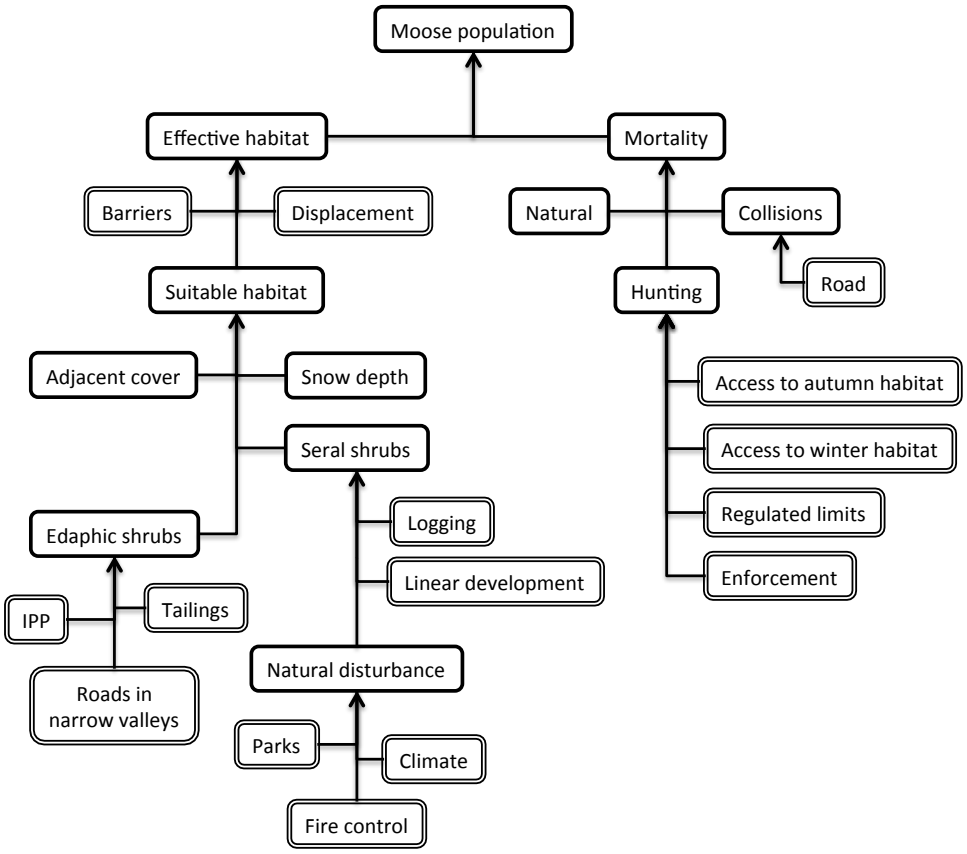

Figure 3. Concept map showing factors that influence moose populations. Boxes can be treated as nouns and arrows as the verb "influences". Double-lined boxes show factors controlled by management.

Mortality

Natural predators, hunting and collisions with vehicles are the main sources of mortality in moose populations (Figure 1). Natural predators of moose include wolves and bears (grizzly and black). Wolves use plowed (or snowmobile-packed) roads and corridors to increase hunting efficiency, however, effects on moose populations are likely minor.

Anthropogenic mortality includes collisions with motor vehicles and hunting. Rail collisions kill many moose[28], but no active rail lines occur in the pilot area (Don check xxxx). Road collisions depend on the proximity of roads to high-value forage and on the volume and type (e.g., heavy industrial versus public) of traffic[29 30]. Road class and hence traffic speed also influence collision risk. Convoys reduce collision risk in some situations.

Hunting is the largest source of anthropogenic moose mortality. Four types of hunting can be defined: open season (general public); limited entry (general public); First Nations' harvest and illegal hunting. First Nations have the first priority for harvest. Provincial harvest targets account for estimated First

Nations' harvest. Regulations control the number and gender of legal moose kills. Illegal hunting can be high and enforcement difficult in remote areas, leading to uncertainty about the effectiveness of management policies. As moose density declines due to overhunting, hunter density and related moose mortality also declines. Guide outfitters also hunt moose, but usually access areas with otherwise limited hunting (e.g., via air or horse).

Increased access to fall and winter ranges related to development increases hunter density and traffic within areas where moose congregate. The effects of road access at the population scale are not well documented, however. Loss of security cover (e.g., logging) further increases risk from hunting. Access and hunting regulations combine to influence mortality risk.

Several climate-related changes may also increase moose mortality risk, including increased winter ticks, increased snow packs and increased temperature (thermal stress). In addition forage could decline as pests invade the area (e.g., willow borer).

Habitat

Moose typically move among a variety of seasonal habitats, moving from higher elevations in summer and fall to lower elevations in winter and spring, depending on snowpack [31] [32].

Deciduous browse (shrubs and trees), adjacent forest cover, and a sufficiently shallow snowpack are the basic elements of moose habitat (Figure 1). Winter range habitat is least abundant (i.e., due to deep snow covering forage and hindering movement at higher elevations) and most limiting to populations. Riparian areas, along rivers, wetland complexes and other deciduous ecosystems ("edaphic shrubs") and early seral stages ("seral shrubs"; e.g., 10 to 30 yr old), created by burns and logging, provide the dense browse needed for winter survival. Edaphic shrub sites are relatively important where early seral forage is scarce.

Forest cover adjacent to shrub ecosystems (and mixed forest) provides security and shelter and eases movement by intercepting snow. Moose overheat easily and need thermal cover (shade) in winter as well as summer[33]. Snow interception affects survival and migration ability and may be particularly important in the "snow belt" that runs from Meziadin to Bell Two[34].

Coastal moose populations should be distinguished from interior ones[35]. Coastal areas, including the lower Iskut, Stikine, Nass and parts of Bob Quin watersheds, have less natural early seral forest and deeper snowpacks, thus valley-bottom riparian forage gains importance.

Habitat loss and fragmentation

Forage supply can be increased or decreased by development activities. Logging increases the abundance of early seral forage. Development activities can damage riparian forage by flooding or

draining riparian areas (e.g., for independent power projects; IPP) or filling riparian areas to support roads or facilities. Development can also damage mineral licks.

Harvesting mature forest adjacent to forage removes security, snow interception and thermal cover and has the theoretical potential to substantially impact moose populations; evidence of impact is lacking, however[36].

Logging increases early seral forage, reduces mature forest cover and increases access to hunters. The net effect likely depends on the spatial and temporal scale of harvesting. Over time, cutblocks will fill with trees, increasing security cover initially and eventually reducing forage supply, thus, the distribution of disturbance over time matters.

Development can also disrupt connectivity within the winter range. In general, barriers to habitat and displacement from habitat have relatively minor effects on moose populations.

Risk of moose population decline

Anthropogenic mortality and habitat loss contribute to risk of population decline. Anthropogenic mortality is most influential. Although this document focuses on risk to moose populations, positive effects of development, such as increased forage supply, must also be evaluated.

Definition of risk

In the context of the Northwest BC cumulative effects assessment pilot, risk is defined as the chance of not meeting a stated management objective.

According to provinicial objectives, moose populations should be

- **healthy (i.e., resilient and not at risk);**
- **diverse;**
- **well-distributed across their range (to maintain health and genetic diversity);**
- **capable of supporting hunting;**
- **capable of supporting to natural predator-prey systems.**

In addition the province does not wish to infringe of First Nation's rights with respect to harvesting moose.

Risk assessment requires clear definitions of desireable or undesireable consequences, and includes the temporal and spatial scales that give consequences meaning. Based on the objectives described above we define the desireable consequence as a near-natural population size and distribution of moose

(Table 1). We define the undesireable consequence as a non-temporary population decline within a non-trivial portion of the population range.

Table 1. Assumed influence of population status on stated population objectives.

Population status	Health	Hunting	Predator-Prey
1. Stable at near-natural levels or better	✓✓	✓✓	✓✓
2. Stable at lower population level	✓	X*	✓
3. Viable	X	X	X
4. Non-viable	X	X	X

*May still support First Nations hunting.

In expert workshops, we used the following definition of risk:

Risk (Y-axis) is the probability of moose population decline that lasts more than a decade.

Scale of assessment

Wildlife management units or landscape units may be the best spatial scale for assessing risk to moose from a provincial perspective for three reasons. First, assessing population distribution (i.e., well distributed populations imply resilience and diversity) requires assessment at a finer spatial scale than the population unit. Second, moose populations, are poorly defined in the pilot area and should be better delineated. Third, risk should be estimated and managed in a way that meshes with the existing hunter management (i.e., wildlife management units).

For Gitanyow, the appropriate spatial scale for assessment is the Wilp, based on traditional management scales. Risk curves developed in expert workshops are sufficiently general that they can be applied at the scale of the Wilp.

The probability of population decline varies with time scale considered. For the purposes of the workshop, we considered changes that would cause a decline over a period of at least ten years. A short temporary decline of less than ten years is less relevant to moose population resilience and to hunter opportunity; it may be difficult to distinguish from natural variability.

Risk curve 1: probability of population decline versus roaded habitat

This section describes a graphical hypothesis relating risk of moose population decline to an indicator of hunter access. Different curves are developed for different levels of regulation.

Indicator definition

The X-axis indicator is defined as follows:

X = the proportion of suitable fall and winter forage sites within 500m of a road or trail.

Fall and winter forage consists of edaphic (e.g., riparian) and early seral shrub sites that occur at lower elevations (i.e., fall and winter range). The indicator does not include adjacent forest cover, assuming that relatively few moose are shot within forest cover. Existing maps of high-value habitat include riparian forage, but not early seral forage (check xxxx).

This indicator reflects the notion that roads increase hunter density within habitats that support high moose density during hunting seasons. It assumes hunting success is greatest within 500 m of roads. Most hunters (80-90%) stay within a kilometer of their vehicle and shoot moose from less than 200 m away.

Risk relationship

Roads accessing fall and winter habitat, and hence areas of high moose density during hunting season, increase the probability of moose population decline (over the scale of at least a decade; Figure 2). Risk varies as a function of hunting effort, controlled partly by regulations. Four separate levels of regulation are considered in Figure 2:

- Open season for non-native and First Nations people plus illegal hunting[37];
- Open season for First Nations people plus illegal hunting (non-native hunting closed);
- Regulated First Nations harvest plus illegal hunting;
- Only illegal hunting.

Where no efforts are taken to restrict hunting, the first road into moose fall and winter forage sites brings substantial risk of population decline (solid line in Figure 2), based on assumptions described below. As road access increases, risk increases less steeply but population decline still becomes highly likely when roads influence 75% of forage sites. Increasing restrictions on non-native and then First Nations hunting decreases risk, however illegal hunting prevents risk from dropping to zero (dashed lines in Figure 2). Ideally off-road accessibility and proximity to population centres should also be considered in this risk relationship.

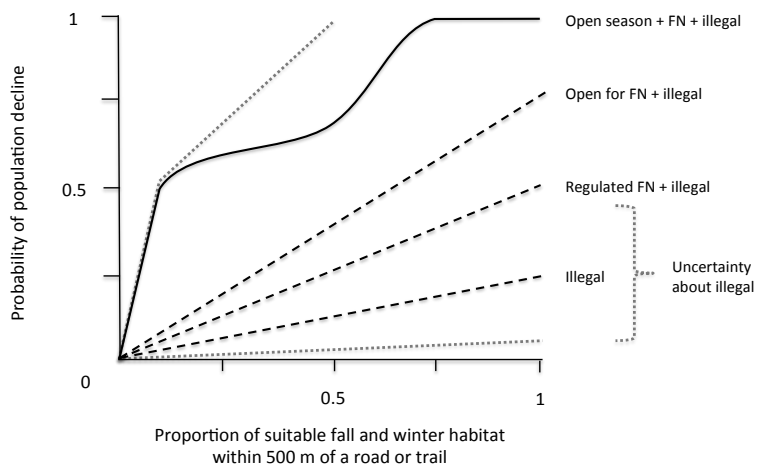

Figure 4. Probability of population decline over a ten year period versus proportion of suitable fall and winter forage habitat affected by roads. Solid line shows best estimate without increased hunting regulation. Dashed lines show effect of hunting regulations. Dotted lines show breadth of uncertainty.

Assumptions

The risk versus roaded habitat relationship is based primarily on the estimated impacts of legal and illegal hunting. It does not address increased mortality related to high-traffic roads.

The rapid increase in risk with the first road is based on three assumptions:

- the road accesses high-value valley bottom habitat first
- moose are initially naïve to hunters
- hunter density increases initially to satisfy local demand and outside demand and then declines as the road network expands

Other assumptions include

- Most hunting occurs within 500 m of roads.
- Hunter density declines if moose density declines.
- At some point, hunting guides will switch from fly-in and horse hunting to using roads, thereby increases pressure on roaded areas.
- No change in human population sources (e.g., no growing communities or camps).

Uncertainty

Sources of uncertainty include

- Uncertainty about illegal harvest is high in remote areas (Figure 2).
- Sightlines and hence roadside vegetation (i.e., screening) influence hunter success.
- Off road accessibility (e.g. , via quad) and sightlines (e.g., roadside vegetation) influences hunter success: interior watersheds have better off-road accessibility and sightlines than coastal ones.
- Roads that are not plowed become inaccessible in winter
- Maps of forage sites are uncertain.

Risk curve 2: probability of population decline versus loss of critical winter habitat

This section presents a graphical hypothesis relating risk of population decline to loss of critical winter habitat. Loss of critical habitat may reduce overall habitat quality and could decrease moose population growth rate and density, even in predator-limited populations[38]. The risk curve applies to specific situations where little early-seral forest exists and where snow limits access to suitable habitat (e.g., some coastal populations)[39]. Where forage supply is not thought to be limiting, habitat loss may have little influence on risk (e.g., some interior populations).

Indicator definition

The X-axis indicator is defined as follows:

X = the proportion of suitable high-value winter habitat remaining.

High value winter habitat includes riparian areas and adjacent forest cover. These areas have been mapped for portions of the study area. The denominator of the proportion is the area of suitable high-value habitat occurring naturally (i.e., natural may be less that capability[40] due to natural disturbance).

Risk relationship

Workshop participants estimated that about 25% of high-value habitat could be lost before risk of population decline increases (solid line in Figure 3). Uncertainty is high. Loss of riparian habitat could be of little consequence if moose can use other habitat (lower dashed line in Figure 3).

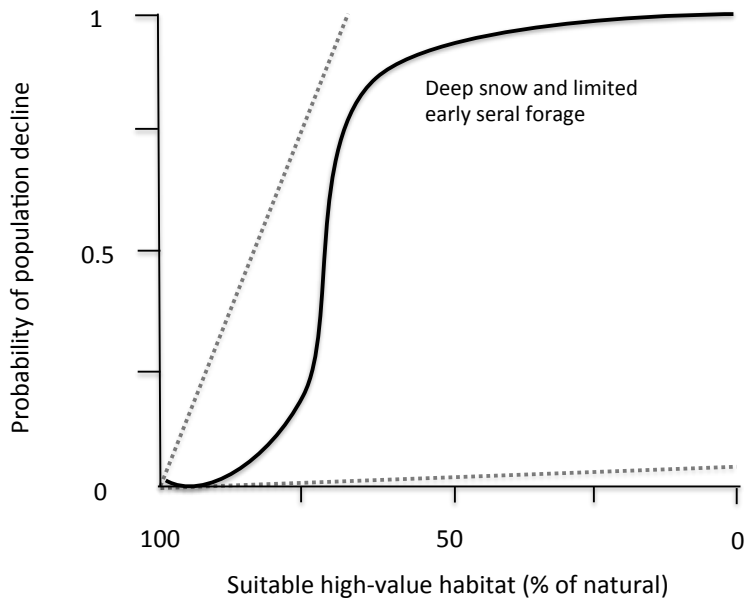

Figure 5. Probability of population decline for at least a ten year period versus percent of suitable riparian habitat with adjacent cover (mapped high value winter habitat[41]) remaining. Solid line is best estimate for areas with deep snow packs and limited early seral forest. Dotted lines show uncertainty.

Assumptions

- Low elevation riparian habitat supports populations during severe winters with deep snow; hence riparian habitat can limit population growth rate.
- There is a limited supply of early seral forage and non-riparian deciduous stands on the landscape or these stands are avoided because of deep snow.
- Mortality threats are relatively stable.

Uncertainty about the response relationship

If populations are subject to high natural predation, risk due to habitat loss decreases because habitat has less influence on population level.

- If low-elevation, early-seral forest increases or decreases, then risk decreases or increases.
- If winter snow-packs increase or decrease due to climate change, then risk increases or decreases.
- Habitat maps are uncertain: although habitat classification is based on one algorithm, actual occupancy of habitat patches varies; not all areas have maps[42].

Appendix 1: Regulatory Framework for Moose

Provincial

Wildlife Act

The Wildlife Act provides the Minister responsible the ability to acquire, administer or designate areas (i.e. Wildlife management Areas-WMAs) to manage and protect wildlife. The Wildlife Act also provides the Minister responsible to issue hunting licenses, set bag limits, hunting seasons for non-aboriginal residents and non-residents and set quotas for guide-outfitters based on resident/non-resident allocation. Regional MFLNRO Wildlife Biologists monitor mule deer populations to advise on appropriate hunting seasons, bag limits and quotas by management unit in each region.

Forest and Range Practices Act

The Forest and Range Practices Act (FRPA) contains objectives set by Government for wildlife and authorizes the Minister responsible to establish ungulate winter range areas (UWRs) and objectives for UWRs, Wildlife Habitat Areas (WHAs) and objectives for WHAs and General Wildlife Measures (GWMs). UWRs, WHAs and GWMs are established under a Government Action Regulation (GAR) Order under the *FRPA*. *Forest Act* tenure holders with replaceable forest licenses that are required to prepare a Forest Stewardship Plan (FSP) must specify results and strategies that are consistent with the objectives specified in the GAR order.

Wildlife management must consider effects on timber supply. Under existing policy, the total reduction in timber supply due to non-timber management measures cannot exceed a specified limit, thus wildlife managers must rank the value of different conservation measures.

Regional

There are no ungulate winter ranges for moose[43] or Wildlife Management Area for moose designated in the pilot area[44].

Gitanyow have established moose harvesting restrictions on their territory to address a recent decline in the moose population. Gitanyow are collaborating with the Ministry of Environment to enforce harvesting restrictions.

Notes and References

[1] Values are defined as " the things that the people of British Columbia care about and see as important to ensure the integrity of the province's people and communities, economies and ecological systems" (REF xxxx)

[2] Risk management provides a formal approach to decision-making that weighs assessed risk against expected benefits across multiple values. It aims to identify development options where expected benefits outweigh the potential for loss or damage and where unacceptable risks are avoided (BC MoF 1999, Wise et al. 2004).

[3] This document should be considered as an **early draft of best available information** for assessing risk to moose in the pilot area. Risk estimates were developed at an expert workshop with wildlife managers familiar with the pilot area, however, the document requires more supporting literature and more review to be considered best available information. On a broad multi-discipline scale, the quality of knowledge is intermediate, based mainly on scientific extrapolation (partially-reproduceable science) of peer-reviewed and gray literature with some scientific judgement (see classes defined by the Institute for Regulatory Science: http://www.nars.org/bas.html). This summary is intented to be a living document that can be improved by further review and by incorporating new knowledge.

[4] Reference to workshop summary.

[5] Unless otherwise noted, this section is based on Blood, D.A. 2000. Moose in British Columbia: ecology, conservation and management. Province of BC. Available online.

[6] Province of BC. 2000. Moose in British Columbia: ecology, conservation and management.

[7] Blood, D.A. 2000. Moose in British Columbia: ecology, conservation and management. Province of BC. Available online.

[8] B.C. Conservation Data Centre. 2013. Species Summary: Alces americanus. B.C. Minist. of Environment. Available: http://a100.gov.bc.ca/pub/eswp/ (accessed Mar 15, 2013).; Province of BC. 2002. Species ranking in British Columbia. Available: http://www.for.gov.bc.ca/hfd/library/documents/bib89068.pdf (accessed Mar 15, 2013).

[9] Province of BC. 2012. Factsheet: Moose population estimates down in Cariboo, Omenica.

[10] Based on a survey of Gitanyow Wilp members.

[11] Based on Daust, D. and D. Morgan. 2013. NW CEA Pilot: Moose workshop summary. Available at xxxx.

[12] Anon. 2000. Cassiar Iskut-Stikine Land and Resource Management Plan.

[13] Province of BC. 2012. Nass South Sustainable Resource Management Plan.

[14] Anon. 2000. Cassiar Iskut-Stikine Land and Resource Management Plan.

[15] Ministry of Environment. Undated. Wildlife Program Plan. Retrieved Jan 30, 2103 from http://www.env.gov.bc.ca/esd/.

[16] Ministry of Environment Conservation Framework: http://www.env.gov.bc.ca/conservationframework/

[17] The term "unduly" is not defined in legislaton. Dictionary definitions of unduly include "disproportionate" and "unwarranted".

[18] Ministry of Environment. 2010. Game harvest management. Policy Manual 4.7.01.07.

[19] Ministry of Environment. 2010. Moose harvest management. Procedure Manual 4.7.01.07.

[20] Anon. 2000. Cassiar Iskut-Stikine Land and Resource Management Plan.

[21] Cassiar Iskut-Stikine LRMP.

[22]Numbers in brackets identify goals and objectives in Cassiar Iskut-Stikine Land Use Plan.

[23] Province of BC. 2012. Nass South Sustainable Resource Management Plan.

[24] The Gitanyow Lax'yip Land Use Pan forms Schedule A and B of the 2012 Gitanyow Huwilp Recognition and Reconciliation Agreement. The Nass South and Gitanyow plans have substantially similar content.

[25] Nisgaa Lisims Government 2002. A Land Use Plan For Nisga'a Lands.

[26] The Nisga'a Final Agreement (1999) establishes the Nass Wildlife Area and the right of Nisga'a citizens to harvest wildlife throughout the area; it also establishes the Wildlife Committee with members from Nisga'a, BC and Canada.

[27] Messier, F. 1994. Ungulate population models with predation: a case study with the North American moose. Ecology 75 (2): 478-488.

[28] Canadian National Railway reports about 125 moose mortalities per year, a high proportion of which are cows and calves.

[29]Gitanyow have been collecting traffic and wildlife collision data within their territory for several years. They have also conducted traffic assessments at Meziadin Junction.

[30] Traffic from the Yukon also uses Highway 37 (e.g., Wolverine Mine, Yukon Zinc)

[31] Seasonal movement patterns vary among moose: some stay within a small area of habitat; others migrate short distances; others long distances.

[32] See also Province of BC. 2000. Moose in British Columbia: ecology, conservation and management.

[33] Moose in winter coats become stressed at -5 C and in summer coats at 14 C: Renecker, L.A. and R.J. Hudson. 1986. Seasonal energy expenditure and thermoregulatory response of moose. Can. J. Zoology. 64:322-327.

[34] BEC subzones include snow depth estimates.

[35] Based on BEC zones and Ecosections, for example.

[36] Implications of midterm timber supply decisions to moose. Draft report provided by Doug Heard.

[37] Open season harvest still restricts the number of moose killed per person; illegal harvesting likely still occurs.

[38] Messier, F. 1994. Ungulate population models with predation: a case study with the North American moose. Ecology 75 (2): 478-488.

[39] Coastal and interior population units should be defined for the pilot area.

[40] Defn of capability xxxx

[41] Moose winter range has not been mapped for the entire pilot area.

[42] Assessments for major projects provide opportunities to improve habitat use data.

[43] Government Actions Regulations: http://www.for.gov.bc.ca/hth/frpa-admin/frpa-implementation/gar.htm

[44] Wildlife Management Areas: http://www.env.gov.bc.ca/fw/habitat/conservation-lands/wma/