Muskwa-Kechika Wildlife Management Plan

Part B: Technical Manual

August 2009

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Ministry of Environment

Muskwa-Kechika Wildlife Management Plan

Part B: M-KWMP Technical Manual

The Technical Manual provides the comprehensive management information needed for implementation of the Muskwa-Kechika Wildlife Management Plan.

August 2009

ISBN 978-0-7726-6239-2
Date: December 17, 2009
British Columbia. Ministry of Environment
Muskwa-Kechika Wildlife Management Plan [electronic resource]: Part B: Technical manual

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August 2009

Approved by:

_____ Date: _____

Barry Penner
Environment Minister

Acknowledgements

The Muskwa-Kechika Wildlife Management Plan, particularly this comprehensive Technical Manual, is the result of contributions of energy, time, debate, information, deliberation and studious consideration of many individuals, organizations, and agencies with wide-ranging perspectives. Funding support for development of the Technical Manual, which is the essence of the plan, was provided by the Muskwa-Kechika Management Area Trust Fund and the B.C. Ministry of Environment. Special appreciation is extended to the Muskwa-Kechika Wildlife Management Plan Advisory Group (see below), whose members put in days and weeks of work reviewing information and developing the details of wildlife management in the Muskwa-Kechika. The Kaska Dena provided invaluable support to the Advisory Group with timely, appropriate, and considered information to initiate discussion. Many others have provided very helpful contributions and shown much patience as this complex management plan has evolved over several years. This is the work of many minds and many hands, all committed to the vision of the Muskwa-Kechika.

Muskwa-Kechika Wildlife Management Plan Advisory Group

The following government and non-government agencies and organizations were regular participants at the Muskwa-Kechika Wildlife Management Plan meetings from July 31, 2000 until September 30, 2003.

B.C. Ministry of Forests
B.C. Ministry of Environment
Land and Water British Columbia Inc.
Land Use Coordination Office (B.C. Integrated Land Management Agency)
Kaska Dena
Muskwa-Kechika Management Area Advisory Board
B.C. Wildlife Federation
Guide Outfitter Association of British Columbia
Rocky Mountain Elk Foundation
Timberline Trail & Nature Club
Wild Sheep Society of British Columbia

Organization of the Muskwa-Kechika Wildlife Management Plan

The Muskwa-Kechika Area is a vast territory with many important wildlife species and habitats throughout. However, scientific knowledge of the specific geographic occurrences of populations and habitats is presently quite limited, and a key part of the plan is to expand this information base over time. To provide an effective, usable plan for such an area requires that it be outcome-focused, supported by comprehensive technical information consistent with present knowledge.

Therefore, the Muskwa-Kechika Wildlife Management Plan is comprised of two documents, which serve two important, related functions: (1) clear and concise strategic direction, and (2) comprehensive technical guidance.

Strategic Document	This contains the essence of the Wildlife Management Plan designed to stand as an approved local strategic plan as defined by the *Muskwa-Kechika Management Area Act.* As such, Part A can be referred to as "the Plan", while recognizing that an important aspect of the Plan is the support of a comprehensive Technical Manual, which is Part B.
Technical Manual	The Technical Manual, Part B in the full package of the M-KWMP, contains explicit technical direction and advice with respect to implementation of the Plan, including extensive appendices. Part B is designed to serve as a comprehensive reference to assist in implementing the approved Plan. Part B is referred to as "the Plan Manual." This Technical Manual has two major components: Part B-1: Summary Objectives Tables Part B-2: Technical Management Directions

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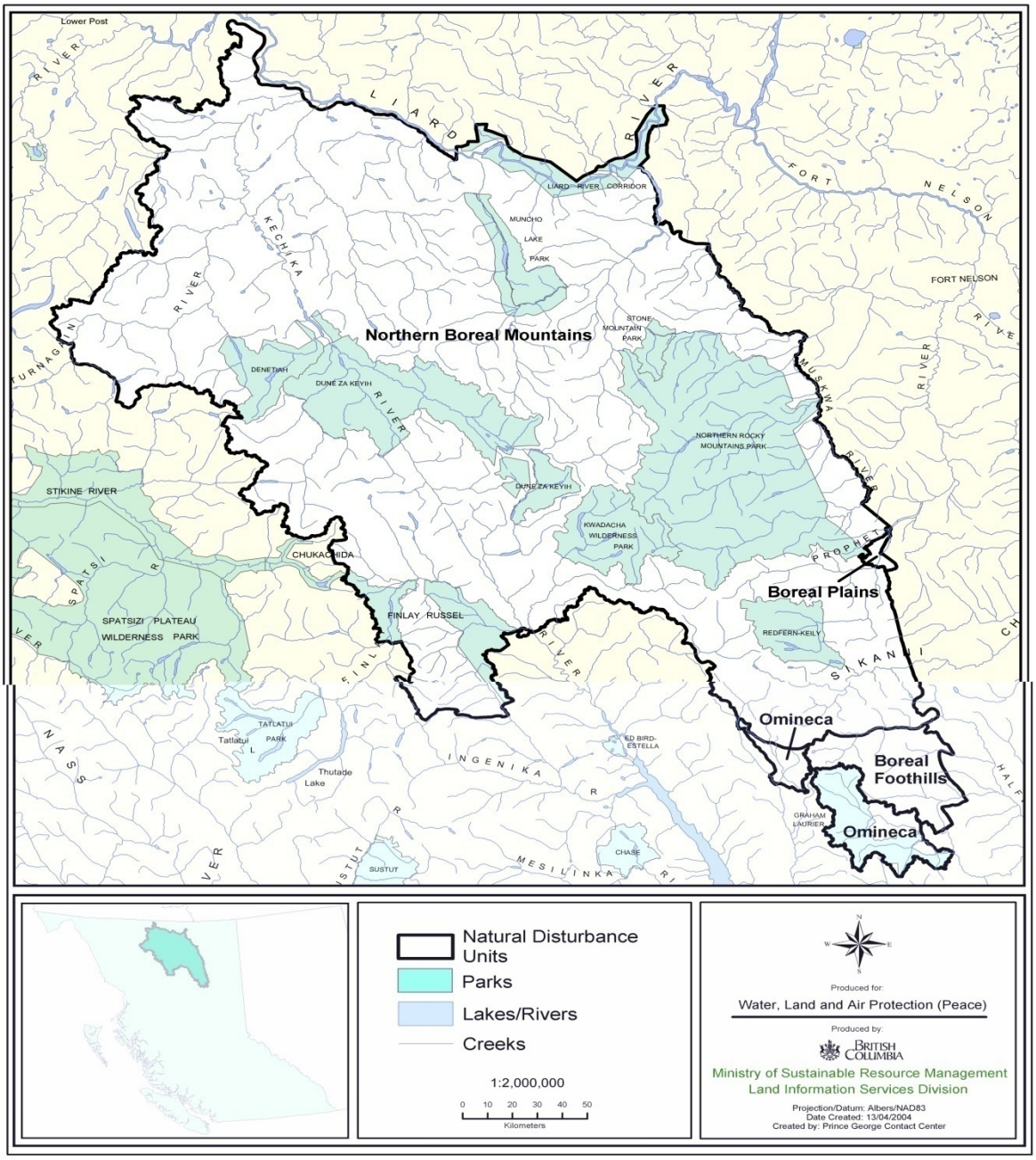


Figure 1. The Muskwa-Kechika Management Area.[3]

B-1: Summary Objectives Tables

The following tables are **summaries** of management directions provided in the Technical Manual for the Muskwa-Kechika Wildlife Management Plan, **Part B-2**. The text of Part B-2 is to be used as the guiding technical reference; these Part B-1 tables are merely summaries of Part B-2 for convenience purposes.

1.0 Habitat Management

Objectives	Management Directions	Outcomes
1.1 General Habitat Objectives		
Apply ecosystem approach to habitat management.	Manage to conserve/ maintain biodiversity as a priority. Should manage at different scales. Should manage to maintain scarce, representative, fragile, rare, endangered, and threatened species and ecosystems. Should manage to maintain important wildlife habitat. Should ensure that important wildlife habitat is incorporated into vegetation, habitat, and agency maps and databases. Should manage within natural range of variability.	The M-KWMP addresses the seven themes of ecosystem approach. Diversity and distribution of ecosystems remains within estimated natural variability. Important wildlife habitat is maintained. Priority species' numbers are maintained within desired ranges.
Apply best management practices to all resource uses.	Should complete guidelines and best management practices and make available. Should apply appropriate guidelines and guidebooks, and best management practices. Should monitor the effectiveness of guidelines.	Guidelines and best management practices are available and used.
Implement Climate Change Management	Gather information on the potential impacts of climate change on M-KMA wildlife. Develop tools and technologies to measure, mitigate and monitor the impacts of climate change in the M-KMA. Incorporate new information into future management direction.	Science-based climate-change model for wildlife in the M-KMA. Improved and specific climate-change management direction for wildlife in the M-KMA.

Objectives	Management Directions	Outcomes
Implement Cumulative Effects Management.	Should determine effects thresholds. Should implement Cumulative Effects Management. Should apply Effects Management measures.	Cumulative effects indicators are measured against thresholds, and used in planning.
1.2 Landscape-level Habitat		
Maintain natural range of seral stage and ecosystem distributions.	Must prepare and maintain up-to-date land cover information. Should consider disturbance patterns in planning. MoE and MFR should track range conditions. MoE should document existing seral stage and ecosystem distributions. MoE to monitor effects of large mammal management.	Presence/abundance of seral stage distributions are maintained in all biogeoclimatic units.
Manage and maintain connectivity of habitats.	Manage landscape connectivity. Maintain natural fragmentation levels. Identify and map links, corridors, routes, and trails, and landscape-level important wildlife habitat. Minimize development of new links and corridors. Include OGMAs, WTPs, and important wildlife habitat when planning connectivity. Should monitor development to document continued use of links and corridors by wildlife.	Links and large corridors remain undeveloped and used by wildlife. Connectivity is maintained over landscapes.
Maintain functional riparian areas.	Provide inventory, assess impacts, and monitor use of riparian areas. Maintain large, undisturbed vegetative buffers in riparian areas. Control chemical use, erosion and sediment. Obtain habitat inventory prior to development. Should maintain connectivity for riparian areas. Should avoid altering hydrological characteristics. Should assess potential impacts of development. MoE should provide guidelines and information.	Riparian zones have appropriate buffers. Hydrologic characteristics remain within the natural range of variability. Guidelines and best management practices are available and used.
1.3 Stand-level Habitat		

Objectives	Management Directions	Outcomes
Maintain supply of fragile, scarce, and representative ecosystems within a natural range.	Define, identify, describe, and track fragile, scarce, and representative ecosystems. Maintain supply of fragile, scarce, and representative ecosystems within a natural range. Should identify and address data gaps. Should apply PASO-type planning and analysis system in the M-KMA.	Fragile, scarce, and representative ecosystems are maintained within a natural range.
1.4 Species-specific Habitat		
Maintain important wildlife habitat for priority species.	Identify, track, and maintain occurrence and use of important wildlife habitat. Ensure that important habitat features are incorporated into vegetation, habitat, and agency maps and databases, and are updated. Should include important wildlife habitat when planning landscape connectivity. MoE should ensure that species-specific habitat management is consistent with national and provincial strategies.	Occurrence and wildlife use of important wildlife habitat is maintained. Important wildlife habitat is incorporated in planning and development.
1.5 Red- and Blue-listed Species and Communities		
Maintain the distribution of listed plants and plant communities in the M-KMA.	Apply existing or surrogate best management practices. Should identify and track occurrence of listed plants and plant communities. Should apply the Identified Wildlife Management Strategy procedures and standards for all Identified Plants and Plant Communities, and to all activities. Should determine distribution of listed plants and plant communities in the M-KMA.	Listed plants and plant communities persist. IWMS is applied to all development activities.
1.6 Fire Management		

Objectives	Management Directions	Outcomes
Manage fire to meet habitat objectives, within the natural range of variability.	Identify historic and current fire regime. Implement prescribed-burn monitoring recommendations. Prescribed burning should include individual site prescriptions to ensure that sites do not become degraded from repeated fire damage. Should consolidate existing Fire Management Plans into M-KMA Fire Management Plan.	Seral stage distributions are maintained within the natural range of variability. Fire management plan for the M-KMA is produced.
1.7 Migration Habitat		
Maintain important migration habitat.	Should identify and track important migration habitat. Should collaborate with neighbouring jurisdictions. Should restrict activities to avoid impacts to migration habitat. Should include likely migration habitat when managing landscape connectivity.	Number of species for which migration habitat is known and tracked. Continued use of migration habitat by wildlife.
1.8 Results-based Habitat Management		
Ensure that developments do not reduce habitat suitability.	Plan to avoid and mitigate impacts, and restore wildlife habitat. Monitor development to document continued use of important habitat features by wildlife. Identify current wildlife habitat values and use, and desired wildlife habitat results. Apply in order of preference: relocation, redesign, compensatory mitigation, and/or enhanced restoration. Should identify siting, mitigation, and restoration measures. Maintain database and map status and provide to proponents.	Habitat suitability remains within the natural range of variability.

2.0 Wildlife Species Management

2.1 General Species Direction

Objectives	Management Direction	Outcomes
Populations		
Improve the status of priority wildlife within natural range of variability.	Should obtain periodic population assessments. Should set population targets at the medium level. Should maintain and encourage co-operation with neighbouring jurisdictions. Should only apply wildlife control to maintain or recover species at risk or red- and blue-listed priority species.	Populations of priority wildlife are sustained at or above target levels.
Health		
Ensure that health issues do not threaten priority species.	Should establish a volunteer program with M-KMA users to monitor population health. Should enforce existing environmental regulations. Should manage potential disease vectors in the M-KMA. Should develop a response plan. Should collect samples in a registry.	Animal health indicators remain at acceptable levels. Game-farmed animals and banned exotic species are not present in the M-KMA.
Disturbance		
Maintain habitat suitability.	MoE will complete guidelines and make available. Apply appropriate guidelines. Implement Results-based Habitat Management. Apply existing guidelines, guidebooks, and best management practices. Develop and apply precautionary best management practices. Maintain habitat suitability. Inventory of important wildlife habitat by tenure holders. Monitoring of continued use and suitability by enforcement staff.	Persistent use of important wildlife habitat. Guidelines are available and used.

Objectives	Management Direction	Outcomes
Minimize impacts due to access.	Minimize impacts due to access. Should track effects and manage access. Should co-ordinate access among users. MoE should develop and provide access thresholds. MoE and MoT should track vehicle collisions and implement traffic restrictions.	Number of vehicle collisions with wildlife is reduced. Access does not occur above thresholds.
Harvest		
Maintain sustainable harvests as per provincial policy.	MoE will monitor harvest levels and direct population inventory and research. MoE should manage to reflect conservation and biodiversity goals first, followed by First Nations priorities and opportunities for hunting and trapping. MoE should maintain ongoing liaisons with First Nations to achieve improved harvest management.	Harvested species are sustained at or above functionally significant levels.

2.2 Ungulates

2.2.1 Stone's Sheep

Objectives	Management Direction	Outcomes
Habitat		
Maintain adequate early seral grass-shrub areas.	MoE should lead prescribed burning, in cooperation with MFR. MoE should apply prescribed fire for key habitats. Should include Stone's Sheep in the M-KMA Fire Management Plan. Should opportunistically use wildfire.	Supply of early seral grass-shrub areas is adequate for Stone's Sheep. Sheep management is included in the M-KMA Fire Management Plan.
Population		
Maintain or increase number of sheep.	Avoid creation of predator access (trails) to Stone's Sheep areas. MoE should obtain a minimum observed population estimate every 6 years (1 SOU/year).	Sheep numbers are maintained or increased.
Health		
Identify and avoid contagions.	MoE should establish baselines and opportunistically monitor. Should ban potential carriers of wild sheep contagions.	Baseline health parameters for sheep are available. Sheep are not exposed to potential carriers.
Disturbance		
Minimize disturbance.	MoE will provide timing windows. Apply timing windows. Minimize disturbance. Should monitor impacts on Stone's Sheep. Should apply flight guidelines. Should identify and manage disturbance types and levels. Should schedule activities using timing windows.	Disturbance to sheep is minimized.
Harvest		
Maintain a conservative approach.	MoE should coordinate compulsory inspection. MoE should modify harvest regulations as required.	Sheep numbers are maintained or increased.

2.2.2 Woodland Caribou

Objectives	Management Direction	Outcomes
Habitat		
Maintain large patches of suitable habitat.	Maintain large patches of suitable habitat. Minimize habitat fragmentation and maintain landscape connectivity (especially riparian). Should maintain lichen winter ranges and suitable mature coniferous forest. MoE will lead in maintaining and monitoring Caribou habitat inventory. MoE should regularly assess Caribou habitat for suitability and connectivity. Should include Caribou in the M-KMA Fire Management Plan	Large patches of suitable habitat area available for Caribou. Caribou management is included in the M-KMA Fire Management Plan.
Population		
Maintain or increase Caribou numbers.	Avoid creation of predator access trails to Caribou areas. Address human access management. MoE should identify fall age/sex ratios for each herd every 2 years.	Caribou numbers are maintained or increased. Human access is coordinated and managed.
Health		
Identify and avoid contagions.	MoE should establish baselines and monitor. Should prohibit potential disease carriers and game farms in or near the M-KMA.	Baseline health indicators are available for Caribou. Caribou are not exposed to potential disease carriers.
Disturbance		
Minimize disturbance in natality sites and winter range.	Minimize disturbance in natality sites and winter range. Apply timing windows. Minimize habitat fragmentation and maintain landscape connectivity (especially riparian). Should apply IWMS to all activities. Should plan and manage disturbance to minimize impacts. MOE will provide timing windows.	Disturbance in natality sites and winter range is minimized. Habitat fragmentation is minimized, and connectivity is maintained.
Harvest		
Maintain a conservative approach.	Should co-ordinate compulsory inspection. Should modify harvest regulations as required. Should retain current harvest restrictions. Should prepare management plans for Caribou herds.	Caribou numbers are maintained or increased.

2.2.3 Wood Bison

Objectives	Management Direction	Outcomes
Habitat		
Provide/maintain adequate early seral habitat.	MoE should lead prescribed burning, in co-operation with MFR. MoE should apply prescribed fire for key habitats. Should include Wood Bison in the M-KMA Fire Management Plan. Should opportunistically use wildfire.	Supply of early seral areas is adequate for Wood Bison. Bison management is included in the M-KMA Fire Management Plan.
Gather habitat use information.	Should participate in research and inventory.	Useful habitat information is acquired.
Population		
Maintain or increase numbers of Wood Bison.	MoE should attempt to monitor recruitment levels and obtain an absolute population estimate every 2 years.	Wood Bison numbers are maintained or increased.
Health		
Maintain disease-free condition of the population. Maintain genetic integrity of the population.	MoE will attempt to monitor Bison health, incidental mortalities, and their distribution. MoE will seek to maintain genetic integrity of the population. MoE should establish baselines.	Baseline health parameters for Wood Bison are available. Wood Bison are maintained in genetic isolation from other Bison.
Disturbance		
Minimize disturbance at calving time.	MoE will provide timing windows. Apply timing windows. Minimize disturbance at calving time. Schedule activities using timing windows.	Calving Bison are not disturbed.
Minimize vehicle-related impacts.	MoE will lead the habitat program. Should manage habitat and apply measures to control movement. MoT should track vehicle collisions. Road mortalities should be reported.	Reduced Bison mortalities.
Harvest		
Manage harvest to reflect conservation goals.	MoE will maintain harvest restrictions.	No harvest-related mortality.

2.2.4 Plains Bison

Objectives	Management Direction	Outcomes
Habitat		
Provide/maintain adequate early seral habitat.	MoE should lead prescribed burning, in co-operation with MFR. MoE should apply prescribed fire for key habitats. Should include Wood Bison in the M-KMA Fire Management Plan. Should opportunistically use wildfire.	Supply of early seral areas is adequate for Plains Bison. Bison management is included in the M-KMA Fire Management Plan.
Gather habitat use information.	MoE should lead, and co-operate with appropriate resource managers and users. Should participate in research and inventory.	Useful habitat information is acquired.
Population		
Maintain or increase numbers of Plains Bison.	MoE should attempt to obtain an absolute population estimate every 6 years, and estimate age/sex ratios yearly. MoE should improve population assessment.	Plains Bison numbers are maintained or increased.
Health		
Maintain disease-free condition of the population. Maintain genetic integrity of the population.	MoE will seek to prevent interactions between Plains Bison and Wood Bison or domestic Bison. MoE will maintain drift fence. Should establish baselines and opportunistically monitor health. Should plan and develop measures to maintain genetic diversity.	Baseline health parameters for Plains Bison are available. Plains Bison are maintained in genetic isolation from other Bison.
Disturbance		
Minimize disturbance at calving time.	MoE will provide timing windows. Minimize disturbance at calving time. Schedule activities using timing windows.	Calving Bison are not disturbed.
Minimize vehicle-related impacts.	Apply traffic restrictions and gating on industrial roads. Should track vehicle collisions. Should manage habitat and apply measures to control movement. Should report mortalities.	Reduced Bison mortalities.
Harvest		
Maintain a conservative approach.	MoE will review hunting regulations annually. Should use improved population assessment.	Plains Bison numbers are maintained or increased.

2.2.5 Moose

Objectives	Management Direction	Outcomes
Habitat		
Create/retain early seral shrub land.	MoE should lead prescribed burning, in co-operation with MFR. MoE should apply prescribed fire for key habitats. MoE and MFR should include Wood Bison in the M-KMA Fire Management Plan. Should opportunistically use wildfire.	Sufficient early seral shrub land to support Moose populations. Moose management is included in the M-KMA Fire Management Plan.
Population		
Maintain or increase numbers of Moose.	MoE should attempt to obtain absolute population estimate every 6 years (1 SOU/year). MoE should apply habitat management strategies.	Moose numbers are maintained or increased.
Health		
Monitor parasite loads.	MoE should establish baselines and monitor.	Baseline health parameters for Moose are available.
Disturbance		
Minimize disturbance in natality sites and winter range.	MoE will provide timing windows. Apply timing windows. Schedule activities using timing windows.	Moose are not disturbed when in important range.
Harvest		
Maintain a conservative approach.	MoE should modify harvest regulations as required.	Moose numbers are maintained or increased.

2.2.6 Mountain Goat

Objectives	Management Direction	Outcomes
Habitat		
Maintain habitat connectivity.	Maintain connectivity for Mountain Goats. Consider connectivity to mineral licks in development planning.	Mountain Goats continue to access important habitat.
Population		
Maintain or increase numbers of Mountain Goats.	Avoid creation of predator access (trails) to Mountain Goat areas. MoE should attempt to obtain an absolute population estimate every 6 years (1 SOU/year) and determine the levels of natality and mortality.	Mountain Goat numbers are maintained or increased.
Health		
Identify and avoid contagions.	MoE should establish baselines and opportunistically monitor. Should ban potential carriers of wild Mountain Goat contagions.	Baseline health parameters for Mountain Goats are available. Mountain Goats are not exposed to potential carriers.
Disturbance		
Minimize disturbance.	Minimize disturbance. Apply flight guidelines and buffer zones. Schedule activities using timing windows. Should monitor aircraft activity and its effects. MoE will provide timing windows.	Disturbance to Mountain Goats is minimized.
Harvest		
Maintain a conservative approach.	MoE will modify harvest regulations as required. MoE should coordinate compulsory inspection. MoE should continue to discourage female harvest.	Mountain Goat numbers are maintained or increased. Females are a relatively low proportion of the harvest.

2.2.7 Elk

Objectives	Management Direction	Outcomes
Habitat		
Maintain large early-seral grassland areas.	MoE should apply prescribed fire for key habitats. MoE and MFR should consider Elk in the M-KMA Fire Management Plan. Should opportunistically use wildfire.	Sufficient early seral shrub land to support Elk populations Elk management is included in the M-KMA Fire Management Plan.
Population		
Maintain or increase numbers of Elk.	Manage human access to control effects of predation. MoE should attempt to obtain absolute population estimate every 6 years (1 SOU/year).	Elk numbers are maintained or increased.
Health		
Identify and avoid contagions.	MoE should establish baselines and opportunistically monitor. Should ban potential carriers of wild Elk contagions.	Baseline health parameters for Elk are available. Elk are not exposed to potential carriers.
Disturbance		
Minimize disturbance in important Elk range.	MoE will provide timing windows. Schedule activities using timing windows.	Disturbance to Elk is minimized when in important range.
Harvest		
Maintain a conservative approach.	MoE should modify harvest regulations as required.	Elk numbers are maintained or increased.

2.2.8 Mule and White-Tailed Deer

Objectives	Management Direction	Outcomes
Habitat		
None specific.		
Population		
Maintain numbers of Deer.	MoE should opportunistically track Deer numbers.	Deer numbers are maintained.
Health		
None specific.		
Disturbance		
Minimize disturbance in Deer winter range.	MoE should provide timing windows. MoE should schedule activities using timing windows.	Disturbance to Deer is minimized when in winter range.
Harvest		
Maintain a conservative approach.	MoE should modify harvest regulations as required.	Deer numbers are maintained.

2.3 Large Carnivores

2.3.1 Gray Wolf

Objectives	Management Direction	Outcomes
Habitat		
None specific.		
Population		
Maintain or increase numbers of Gray Wolf.	MoE should monitor ungulates and Wolves, and obtain a Wolf population estimate every 12 years (1/2 SOU/year).	Wolf numbers are maintained or increased.
Health		
Monitor population health.	MoE should establish baselines and opportunistically monitor.	Baseline health parameters for Wolf are available.
Disturbance		
Prevent den abandonment.	MoE should locate dens and identify use patterns, and establish guidelines. Should apply appropriate guidelines. Should avoid denning areas. MoE should lead in tracking den sites and areas.	Den sites are not abandoned above natural rate. Denning areas are not compromised.
Harvest		
Maintain harvest.	Should modify harvest when necessary for conservation.	Wolf numbers are maintained or increased.

2.3.2 Grizzly Bear

Objectives	Management Direction	Outcomes
Habitat		
Maintain landscape connectivity.	Maintain and monitor connectivity for Grizzly Bears. Consider connectivity for Grizzly Bears in planning. Should include important Grizzly Bear habitat in connectivity.	Connectivity between important habitat.
Population		
Maintain or increase numbers of Grizzly Bears.	MoE should lead and improve population assessment.	Grizzly Bear numbers are maintained or increased.
Health		
Monitor population health.	MoE should establish baselines and opportunistically monitor.	Baseline health parameters for Grizzly Bears are available.
Disturbance		
Prevent den abandonment.	MoE will establish guidelines. MoE should monitor dens and denning areas. Apply appropriate guidelines. Identify, protect, and track active dens and denning areas. Should monitor den use. Should apply IWMS to all activities.	Den sites are not abandoned above natural rate. Denning areas are not compromised.
Harvest		
Maintain a conservative approach.	MoE should co-ordinate compulsory inspection. MoE should modify harvest regulations as required.	Grizzly Bear numbers are maintained or increased.

2.3.3 Black Bear

Objectives	Management Direction	Outcomes
Habitat		
None specific.		
Population		
None specific.		
Health		
Monitor population health.	MoE should establish baselines and opportunistically monitor.	Baseline health parameters for Black Bears are available.
Disturbance		
None specific.		
Harvest		
Maintain harvest.	MoE should modify harvest regulations as required.	Black Bear numbers are maintained.

2.3.4 Coyote

Objectives	Management Direction	Outcomes
Habitat		
None specific.		
Population		
Maintain presence of Coyotes.	MoE should opportunistically monitor populations.	Coyotes are not extirpated from the M-KMA.
Health		
Monitor population health.	MoE should establish baselines and opportunistically monitor.	Baseline health parameters for Coyotes are available.
Disturbance		
None specific.		
Harvest		
None specific.		

2.3.5 Cougar

Objectives	Management Direction	Outcomes
Habitat		
None specific.		
Population		
Maintain presence of Cougars.	MoE should opportunistically monitor populations.	Cougars are not extirpated from the M-KMA.
Health		
Monitor population health.	MoE should establish baselines and opportunistically monitor.	Baseline health parameters for Cougars are available.
Disturbance		
None specific.		
Harvest		
Maintain a conservative approach.	MoE should retain harvest option.	Cougar numbers are maintained.

2.4 Furbearing Animals

2.4.1 Wolverine luscus *subspecies*

Objectives	Management Direction	Outcomes
Habitat		
Maintain landscape connectivity.	Should maintain connectivity for Wolverines. Should include important habitat in connectivity.	Connectivity between important habitat.
Population		
Maintain or increase numbers of Wolverines.	MoE should lead population assessments. MoE should identify risks to Wolverines. MoE should improve population assessment.	Wolverine numbers are maintained or increased.
Health		
Monitor population health.	MoE should establish baselines and opportunistically monitor.	Baseline health parameters for Wolverines are available.
Disturbance		
Prevent abandonment of dens.	MoE will establish guidelines. MoE should monitor dens and denning areas. Apply appropriate guidelines. Report active dens. Identify, protect, and track active dens and denning areas. Should avoid access within 2 km of active dens. Should monitor den use. Should avoid facilities and high activity in high-use habitat. Should apply IWMS to all activities.	Den sites are not abandoned above natural rate. Denning areas are not compromised.
Harvest		
Maintain a conservative approach.	MoE should modify harvest regulations as required. MoE should continue trapper education programs.	Wolverine numbers are maintained or increased. Trappers use methods that exclude Wolverines.

2.4.2 Lynx

Objectives	Management Direction	Outcomes
Habitat		
None specific.		
Population		
Maintain or increase numbers of Lynx.	MoE should follow population trends.	Lynx numbers are maintained or increased.
Health		
Monitor population health.	MoE should establish baselines and opportunistically monitor.	Baseline health parameters for Lynx are available.
Disturbance		
Prevent den abandonment.	MoE will provide guidelines. Should apply appropriate guidelines. Should identify, protect, and track active dens.	Den sites are not abandoned above natural rate.
Harvest		
None specific.		

2.4.3 Marten

Objectives	Management Direction	Outcomes
Habitat		
Manage for important habitat at the stand level.	MoE will provide guidelines. Apply appropriate guidelines.	Suitable levels of coarse woody debris are retained.
Population		
Maintain or increase numbers of Marten.	MoE should follow population trends.	Marten numbers are maintained or increased.
Health		
Monitor population health.	MoE should establish baselines and opportunistically monitor.	Baseline health parameters for Marten are available.
Disturbance		
None specific.		
Harvest		
None specific.		

2.4.4 Fisher

Objectives	Management Direction	Outcomes
Habitat		
Manage for important habitat at the landscape and stand levels.	MoE will provide guidelines. MoE should track Fisher habitat. Should apply appropriate guidelines. Should manage and track important habitat at the landscape and stand levels. Should retain large, windfirm stands of suitable Fisher habitat. Should provide relatively large streamside retention.	Large patches of suitable habitat.
Population		
Maintain or increase numbers of Fisher.	MoE should improve population assessment. MoE should determine distribution.	Fisher numbers are maintained or increased.
Health		
Monitor population health.	MoE should establish baselines and opportunistically monitor.	Baseline health parameters for Fisher are available.
Disturbance		
Prevent den abandonment.	MoE should monitor denning areas. Identify, protect, and report active dens and denning areas. Should track important habitat. Should apply IWMS to all activities.	Den sites are not abandoned above natural rate. Denning areas are not compromised.
Harvest		
Reduce accidental kills.	MoE should monitor accidental kills and provide trapper education.	Accidental kills are reduced.

2.4.5 River Otter

Objectives	Management Direction	Outcomes
Habitat		
Maintain riparian habitat suitability.	MoE will provide guidelines. Apply appropriate guidelines. Minimize riparian disturbance. Maintain fish and fish habitat. Should apply appropriate guidelines to maintain riparian habitat.	Suitability of riparian habitat. Prey species abundance.
Population		
Maintain or increase numbers of River Otter.	MoE should improve population assessment. MoE should determine distribution.	River Otter numbers are maintained or increased.
Health		
Monitor population health.	MoE should establish baselines and opportunistically monitor.	Baseline health parameters for River Otter are available.
Disturbance		
Minimize riparian disturbance.	MoE will provide guidelines and habitat information. Apply appropriate guidelines. Should identify and map trails prior to development. Should monitor water use. Should not remove water from fish-bearing or Otter ponds. Should manage motorboat access.	Trails are not abandoned.
Prevent den abandonment.	MoE will provide guidelines and habitat information. MoE should monitor active denning areas. Apply appropriate guidelines. Protect and report active dens and denning areas. Should track important habitat.	Den sites are not abandoned above natural rate. Denning areas are not compromised.
Harvest		
Maintain a conservative approach.	MoE should continue trapper education.	River Otter numbers are maintained or increased.

2.4.6 Beaver

Objectives	Management Direction	Outcomes
Habitat		
None specific.		
Population		
None specific.		
Health		
Monitor population health.	MoE should establish baselines and opportunistically monitor.	Baseline health parameters for Beaver are available.
Disturbance		
Minimize development impacts.	Evaluate alternatives to dam destruction. Should protect dams and lodges. Should not draw water from active ponds.	Impacts to dams and lodges are minimized.
Harvest		
Direct harvest to resolve conflict.	MoE should modify procedures to be more conservative in the M-KMA.	Beaver numbers are maintained.

2.5 Red- and Blue-listed Species

Objectives	Management Direction	Outcomes
General		
Maintain important habitat.	MoE will conduct baseline inventory. MoE will provide guidelines. Provide known habitat and distribution information. Apply appropriate guidelines. Assess impacts for proposals, and deliver listed species information. Adaptive management will consider the effects on listed species. Should apply appropriate guidelines to high-potential habitat.	Improved knowledge of red- and blue-listed species distribution and habitat.
Develop and implement recovery and management plans.	MoE will conduct baseline inventory. MoE should determine baseline data on species, numbers, and distribution. MoE should analyze habitat data to identify potential high-value habitat. MoE should utilize/encourage public reporting. Should include red- and blue-listed species in land use planning. Should participate in recovery planning. Should participate in monitoring.	Improved knowledge of red- and blue-listed species distribution and habitat. Recovery and management plans for red- and blue-listed species.

2.5.1 Northern Myotis

Objectives	Management Direction	Outcomes
Habitat		
Identify and protect important habitat.	MoE should search potential habitat for bat use. Maintain important habitat suitability. Should track known roosts and hibernacula.	Important bat habitat is identified and protected.
Population		
Determine presence or absence of breeding populations.	MoE should search for active breeding in potential habitat.	Improved distribution knowledge.
Health		
None specific.		
Disturbance		
Prevent abandonment of roost sites and hibernacula.	MoE will provide guidelines. Apply appropriate guidelines. Report roosts. Protect hibernacula from disturbance. Should protect roosts from disturbance. Complete surveys prior to caving. Should restrict use and activities around or in bat caves. Should track important habitat.	Roost sites and hibernacula are not abandoned.

2.5.2 Sandhill Crane

Objectives	Management Direction	Outcomes
Habitat		
Identify and protect important habitat.	MoE should identify and protect important habitat. MoE should search potential habitat for use. Should regionally track breeding and staging areas.	Important habitat is identified.
Population		
Determine presence or absence of breeding populations.	MoE should search for active nests in potential habitat.	Improved knowledge of breeding range.
Health		
None specific.		
Disturbance		
Maintain suitability of breeding and staging areas.	MoE will provide guidelines and known habitat information. Identify breeding and staging areas. Apply appropriate guidelines. Track important habitat. Avoid disturbance to important habitat during critical times. Should not permit facilities near important habitat. Should apply IWMS to all activities.	Breeding and staging areas are maintained and remain in use.

2.5.3 Peregrine Falcon, anatum *subspecies*

Objectives	Management Direction	Outcomes
Habitat		
Identify Peregrine Falcon breeding sites.	MoE should search for active nests. Include active nest sites in regional database of raptor nests.	Improved knowledge of breeding range.
Population		
Determine if species breeds in the M-KMA.	Should search for breeding Peregrines. Should further assess and plan if nests are found.	Improved knowledge of breeding range.
Health		
None specific.		
Disturbance		
Maintain suitability of nesting and fledging areas.	MoE will identify nesting and fledging areas. MoE will provide guidelines. Apply appropriate guidelines. Track important habitat and distribution data. Should avoid major disturbance within 1.2 km of active nests. Should minimize physical disturbance of known nesting and fledging areas.	Breeding sites are identified and suitability is maintained.

2.5 4 Short-eared Owl

Objectives	Management Direction	Outcomes
Habitat		
Identify breeding sites.	MoE should search for active nests. Include active nest sites in regional database of raptor nests.	Improved knowledge of breeding range.
Population		
Determine numbers and distribution.	MoE should search for Short-eared Owls. MoE should further assess and plan if nests are found.	Improved knowledge of range.
Health		
None specific.		
Disturbance		
Maintain suitability of breeding and fledging areas.	MoE will identify breeding and fledging areas. MoE will provide guidelines. Should not burn potential habitat until August. Apply appropriate guidelines. Avoid major disturbance within 100 m of active nests. Should not permit facilities within 100 m of active nests. Should minimize physical disturbance of known nesting and fledging areas. Should track important habitat. Should apply IWMS to all activities.	Breeding sites are identified and suitability is maintained.

2.5.5 Cape May Warbler

Objectives	Management Direction	Outcomes
Habitat		
Maintain suitable breeding habitat.	MoE will develop M-KMA suitability indices. Maintain large patches of riparian mature and old forest. Minimize habitat fragmentation. Maintain mature and old-forest stand structure and connectivity.	Large patches of mature and old forest remain unfragmented and connected.
Population		
Determine numbers and distribution.	MoE should implement long-term inventory. MoE should develop new strategies with baseline information.	Improved knowledge of range.
Health		
Monitor population health.	MoE should establish baseline health parameters and monitor.	Baseline health parameters for Cape May Warbler are available.
Disturbance		
Minimize impacts due to natural resource use.	MoE will provide guidelines. Apply appropriate guidelines. Spatially locate OGMAs. Retain large patches in a connected landscape. Should maintain patches within natural range of variability. Should avoid high-potential habitat. Should restrict salvage and insecticides. Should apply IWMS to all activities. Should follow timing windows. Should track suitable habitat.	Impacts to important habitat are minimized.

2.5 6 Black-throated Green Warbler

Objectives	Management Direction	Outcomes
Habitat		
Maintain suitable breeding habitat.	MoE will develop M-KMA suitability indices. Maintain mature and old-forest connectivity. Minimise habitat fragmentation.	Large patches of mature and old forest remain unfragmented and connected.
Population		
Determine numbers and distribution.	MoE should implement long-term inventory. MoE will develop new strategies with baseline information.	Improved knowledge of range.
Health		
Monitor population health.	MoE should establish baseline health parameters and monitor.	Baseline health parameters for Black-throated Green Warbler are available.
Disturbance		
Minimize impacts due to natural resource use.	MoE will provide guidelines. Apply appropriate guidelines. Spatially locate OGMAs. Retain large patches in a connected landscape. Should maintain patches within natural range of variability. Should avoid high-potential habitat. Should restrict salvage and insecticides in suitable habitat. Should apply IWMS to all activities. Should follow timing windows. Should track suitable habitat.	Impacts to important habitat are minimized.

2.5.7 Connecticut Warbler

Objectives	Management Direction	Outcomes
Habitat		
Maintain suitable breeding habitat.	MoE will develop M-KMA suitability indices. MoE should apply prescribed fire for key habitats. MoE should opportunistically use wildfire. MoE should consider Connecticut Warbler in the M-KMA Fire Management Plan. Maintain forest stand structure and connectivity. Minimize habitat fragmentation.	Large patches of mature and old forest remain unfragmented and connected. Connecticut Warbler management is included in the M-KMA Fire Management Plan.
Population		
Determine numbers and distribution.	MoE should implement long-term inventory. MoE should develop new strategies with baseline information.	Improved knowledge of range.
Health		
Monitor population health.	MoE should establish baseline health parameters and monitor.	Baseline health parameters for Connecticut Warbler are available.
Disturbance		
Minimize impacts due to natural resource use.	MoE will provide guidelines. Apply appropriate guidelines. Spatially locate OGMAs. Retain large patches in a connected landscape. Should maintain patches within natural range of variability. Should avoid high-potential habitat. Should limit grazing to < 50% utilization. Should restrict salvage and insecticides in suitable habitat. Should apply IWMS to all activities. Should follow timing windows. Should track suitable habitat.	Impacts to important habitat are minimized.

2.6 Fish

Objectives	Management Direction	Outcomes
Habitat		
Maintain habitat quality, water quality, and hydrological conditions.	MoE should further refine habitat ratings tables. Maintain habitat and water quality, and hydrological conditions. Collect baseline information. Identify and map fish distributions and important habitat. Minimize habitat fragmentation and eliminate obstructions to maintain connectivity for fish. Should track connectivity.	Fish habitat remains suitable.
Population		
Determine species distribution and population parameters.	MoE should study and characterize priority species. MoE should monitor trends. MoE should develop and implement inventory and monitoring strategies.	Improved knowledge of fish populations.
Health		
Monitor population health.	MoE should establish baseline health parameters and monitor.	Baseline health parameters for fish are available.
Maintain genetic diversity of wild fish stocks.	MoE will seek to maintain genetic diversity of wild fish stocks MoE will follow established policies for fish transfers. MoE should establish a catalogue of wild fish stocks in the M-KMA. MoE should prevent stocking with non-indigenous species.	Genetic diversity is maintained.
Disturbance		

Objectives	Management Direction	Outcomes
Protection of important habitat.	MoE will provide guidelines in consultation with DFO. Provide known information. Apply provincial and federal guidelines. Provide inventory and impact assessment with development proposals. Obtain water licence, permit, or approval for water use. Identify volume, timing, and location of water withdrawal. Should not affect fish with water withdrawal. Apply IWMS to all activities. Should minimize impacts due to resource use and development. Should track important habitat.	Habitat use is not altered. Habitat suitability is not altered.
Minimize impacts due to access.	MoE will provide guidelines for crossings. Identify fisheries resources and sensitivities. Apply crossing guidelines. Plan, manage, and co-ordinate access. Use existing or historic access when appropriate. Should minimize density and temporal disturbance of access. Should assess effects of motorboat access.	Access is minimized, and well planned.
Harvest		
Maintain sustainable population levels.	MoE will manage fish more conservatively where population information is not known. MoE should use historical surveys as baselines. MoE should periodically analyze guided angling.	Fish populations are maintained at or above target levels.

2.7 Reptiles and Amphibians: Western Toad

Objectives	Management Direction	Outcomes
Habitat		
None specific.		
Population		
Determine species distribution and population parameters.	MoE should characterize populations, collect baseline information, and monitor. MoE should plan long-term inventory strategy, and assess management.	Improved knowledge of Western Toad populations.
Health		
None specific.		
Disturbance		
Minimize migration mortality.	Should provide inventory, assess impacts, and monitor use. Should identify and maintain migration corridors.	Migration corridors continue to be used successfully by Western Toads. Reduced mortality due to roaded access.
Avoid creating unsuitable pools.	Should ensure that created pools have suitable characteristics. Should maintain cover on natural pools. Should maintain a diversity of pools.	Reduced toad mortality.

2.8 Invertebrates

Objectives	Management Direction	Outcomes
Habitat		
Maintain habitat suitability.	Should minimize disturbance to sites with listed species. Should maintain habitat matrix. Should minimize disturbance to wetlands.	Habitat suitability is maintained for invertebrates.
Population		
Determine species distribution.	MoE should map and survey suitable habitat. MoE should collect baseline information. MoE should develop and implement long-term inventory strategy, and assess management. MoE should identify inventory requirements.	Improved knowledge of listed invertebrate populations.
Health		
None specific.		
Disturbance		
Minimize disturbance impacts.	MoE should provide known information. Should minimize use of pesticides, bacteriocides, and herbicides. Should avoid broadcast applications. Should avoid disturbing freshwater habitat.	Habitat suitability is maintained for invertebrates.

3.0 Non-indigenous Species

Objectives	Management Direction	Outcomes
3.1 Domestic Animals		
Prevent the introduction of disease.	MoE will assess exotic species before allowing access. MoE should provide guidelines. Should separate domestics from wild populations. Should not permit domestic goats within 15 km of wild populations. Should manage domestic animal waste.	Wild populations are kept disease-free.
Prevent negative impacts due to grazing.	Should conservatively allocate grazing. Should monitor grazing. Should select low-impact areas for grazing. Should use local, weed-free feed. Should remove feral horses. Should examine effects of grazing on other wildlife.	Impacts due to grazing are minimized.
Prevent harassment of wildlife.	Pets and other domestic animals must be kept under control. Pets must be prevented from chasing wildlife.	Pets are controlled, and do not harass wildlife.
3.2 Invasive Species		
Prevent and control invasive plants.	Control designated plants. Treat and re-seed disturbance. Should use local, invasive-free feed. Should apply controls regularly, and monitor. Should develop public education program.	The spread of invasive species is minimized.
Protect native species from introduced fish.	There must be no species of concern before introductions are allowed. MoE should not introduce fish where they do not occur naturally. MoE should not introduce fish where amphibians or invertebrates of concern occur. MoE should determine potential impacts before introductions. MoE should consider only closed systems.	Native species are protected from fish introductions.

4.0 Wildlife – Human Conflict

Objectives	Management Direction	Outcomes
4.1 Bear – Human Conflict		
Reduce negative interactions.	MoE should finalize Bear-Human conflict discussion paper. Store food and garbage such that these are unattainable. Should remove attractants. Should avoid developing prime bear habitat. Should review public education. Should specifically address hunting-related interactions. Should apply non-lethal responses, and review/improve effectiveness. Should review and evaluate incidents. Should monitor translocations.	Reduced bear – human conflict. Reduced bear mortality.
4.2 Wildlife Impact on Private Property		
Control or reduce impact on property.	MoE will follow provincial regulations and policy. MoE should apply non-lethal methods first. MoE should apply lethal methods only after consideration of conservation issues and local impacts. MoE should discourage methods with risk to non-target species.	Wildlife impact on private property is reduced, while minimizing risk to non-target species.
4.3 Domestic Livestock Control		
Reduce impacts of livestock on Crown land.	MoE and MAFF should control timing and distribution of access. MoE and MAFF should apply conservative stocking rates.	Forage availability.

5.0 Impacts and Mitigation Related to Industrial and Commercial Access and Development

Objectives	Management Direction	Outcomes
5.1 Mitigation of Impacts		
Identify and protect important habitat.	Identify important habitat in development or planning processes. Limit, restrict, or prohibit access to protect important habitat from unacceptable impact. Should identify alternative routes where possible. Minimize access-related disturbance to wildlife and habitat. Should not develop access to ungulate winter range in the winter.	Suitability of important habitat is maintained.
Maintain water quality and quantity.	Manage access within sensitive areas. Should determine baseline hydrologic characteristics.	Water quality is maintained.
Prevent vehicle-related impacts.	Should plan access and implement restrictions. Should prevent wildlife use of roads. Should develop a comprehensive tracking system.	Vehicle collisions with wildlife are minimized.
Co-ordinate access management planning.	Plan and manage access. Should co-operatively plan. Include certain elements in planning (see text).	Access is minimized in time and space through coordinated planning.
Return access to a vegetated state.	Return access to an appropriate vegetated state. Promptly and appropriately re-vegetate linear development. Should roll back trees and debris.	Access is minimized in time and space.

6.0 Management of Recreation Impacts on Wildlife

Objectives	Management Direction	Outcomes
Minimize negative effects of recreation.	Provide and apply appropriate guidelines, manage and monitor backcountry recreation. Identify and encourage minimum-impact behaviour. Should implement relevant plans and guidelines. Should provide guidelines, monitoring, and information support. Should include user groups in planning and assessment.	Wildlife populations in recreation and other areas follow similar trends.

7.0 Protection of Historical Vocations and Activities

Objectives	Management Direction	Outcomes
Maintain opportunities for historical vocations and activities.	Should identify and monitor uses and areas. Should consider suitable practices in planning.	Opportunities are available.

PART B-2: Technical Management Directions

Part B-2 (Technical Management Directions) provides comprehensive management directions for wildlife and wildlife habitat in the Muskwa-Kechika Management Area. **These technical management directions are details that support the achievement of the outcomes presented in the approved Strategic Document, which is Part A of this combined M-KWMP document. Part B-2 provides technical personnel with specific information intended to facilitate the achievement of the approved plan outcomes.**

In this Technical Manual, objectives and management directions are discussed in several categories, grouped under Habitat Considerations and under Wildlife Species Considerations. Prescribed directions and responsibilities in the Technical Manual are recommendations intended to facilitate achievement of the specified and approved wildlife management outcomes of the Strategic Document of the M-KWMP. It is strongly advised that these recommended prescriptions be applied unless an alternative strategy for achieving the outcomes has been recommended by a competent wildlife management professional. The use of the term "must" in this Technical Manual is only for emphasis of the importance of a recommended action.

The M-KMA is a large area, with much ecological variation. In order to provide a measure of fine-tuning, the M-KMA Landscape Units (LUs) are amalgamated into six broad Species Objectives/Strategies Units (SOUs) as per Table 1 and Figure 2, based on gross ecological similarity. The LUs themselves are derived from watershed boundaries.

TABLE 1. Species Objectives/Strategies Units for the Muskwa-Kechika Management Area

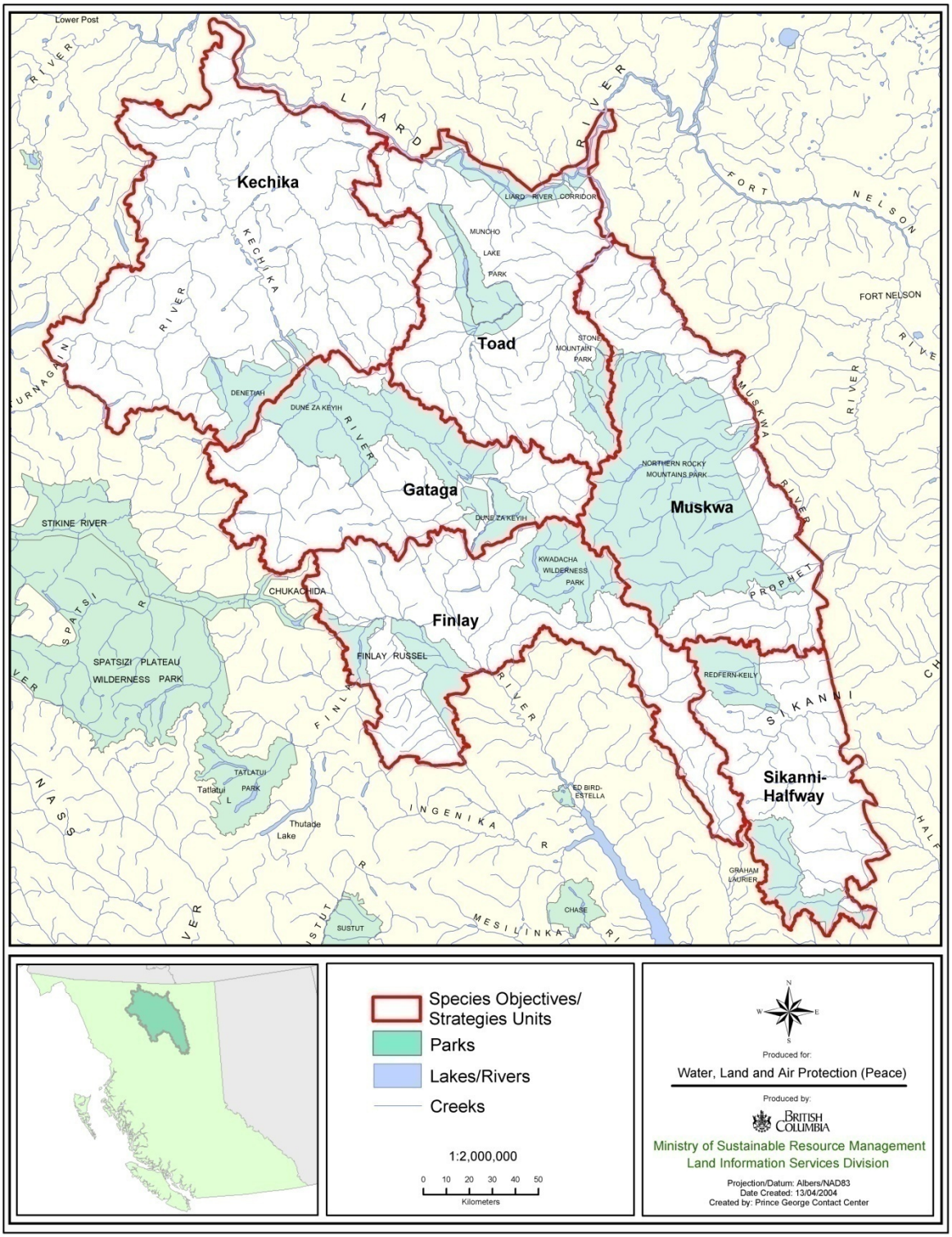
SOU	Approximate Area (km^2)
Kechika	16,600
Toad	11,100
Gataga	8,800
Muskwa	11,300
Finlay	9,500
Sikanni-Halfway	6,600
Total Area	**63,900**

These SOUs are depicted on Figure 2.

The main subject headings in the text of B-2 are:

1.0 Habitat Management
2.0 Wildlife Species Management
3.0 Non-Indigenous Species
4.0 Wildlife-Human Conflict Management
5.0 Impacts and Mitigation Relating to Industrial and Commercial Access and Development
6.0 Management of Recreation Impacts on Wildlife
7.0 Protection of Historical Vocations/Practices in the Muskwa-Kechika Management Area

Figure 2: Map of the Species Objectives/Strategies Units in the Muskwa-Kechika Management Area.



1.0 Habitat Management

In order to achieve the goals and outcomes of the Muskwa-Kechika Wildlife Management Plan, an ecosystem approach to wildlife management has been adopted. As a component of this approach, habitat considerations will be a primary concern. All wildlife have habitat requirements, and these can occur at a variety of spatial, temporal, and critical scales. For the purposes of the M-KWMP, wildlife habitat is defined as:

> *the air, soil, water, food and cover components of the environment on which wildlife depend directly or indirectly in order to carry out their life processes*.

The following sections provide direction for managing wildlife habitat in the Muskwa-Kechika Management Area.

1.1 General Habitat Direction

Provincial direction, land and resource management plans, park management plans, and the *Muskwa-Kechika Management Area Recreation Plan*[4] support an ecosystem approach to habitat management in the Muskwa-Kechika Management Area. Selected, important wildlife habitat should be managed at different scales relative to specific developments and planning processes. This approach follows the goals, guiding principles, foundations for management direction, and existing direction for the Muskwa-Kechika Wildlife Management Plan. As well, the approach benefits from existing programs and information, and follows principles of contemporary conservation biology.[5, 6, 7, 8, 9] The habitat management approach and associated objectives, management directions, indicators, implementation and/or monitoring actions and responsibilities, and potential research directions are described in the following sections, and summarized in Part B-1: Summary Objectives Tables.

Ecosystem Management

Any habitat management actions must consider conservation and/or maintaining biodiversity. Strategies that implement an ecosystem approach to management should be applied at different scales, including (but not limited to) the landscape and stand levels. Habitat should be managed to maintain a combination of scarce, representative, fragile, endangered, and threatened species and ecosystems, and important wildlife habitat for the wildlife species in this plan. Important wildlife habitat should be incorporated into agency maps and databases. Management actions should be designed for results within the natural range of variability and should maintain a mosaic of habitat types and seral stages such as would naturally occur. Implementation and monitoring responsibilities should be shared by the B.C. Ministries of Environment, Forests and Range, and Sustainable Resource Management as per their defined roles (refer to Appendix A-1) and the specifics of the following sections of this plan.

In addition to the management objectives presented in the M-KWMP, available guidelines and guidebooks, and other best management practices, should be applied to all projects where resource uses are planned and developed in the M-KMA, including, but not limited to, non-forestry-related development. For example, the Identified Wildlife Management Strategy

(IWMS) procedures and standards should be applied for all Identified Wildlife, whenever and wherever these occur, and to all activities within the M-KMA.[10] When relevant activities or developments are proposed, the *Biodiversity Guidebook*,[11] *Riparian Management Area Guidebook*,[12] and other appropriate forest practices guidebooks and guidelines should be applied. The *Guidelines for Evaluating, Avoiding and Mitigating Impacts of Major Development Projects on Wildlife in British Columbia*[13] and the *British Columbia Environmental Assessment Guidelines for Grizzly Bears and Black Bears*,[14] (both currently in draft) should be applied as interim best management practices, and the final versions completed and implemented as soon as possible. If available guidelines, guidebooks, or other best management practices are not applied, surrogate best management practices (i.e. interim measures to minimize the risk of reduction or loss of biological diversity, ecosystem function, or habitat suitability) should be developed and applied by relevant agencies and resource users.

Climate Change Management

Climate change is potentially one of the greatest long-term threats to biodiversity;[15] with respect to wildlife and wildlife management, the most important changes will be habitat related. Biomass and other ecological zones may shift dramatically. Generally speaking, models for mountainous areas predict that alpine zones will shrink, and other zones will shift to higher elevations. It is important that wildlife managers and statutory decision-makers consider options for wildlife species and habitats to respond to climate change. The first steps towards supporting such management will be to gather information on the potential effects of climate change that is specific to the Muskwa-Kechika Management Area. Tools such as the *Conservation Area Design for the Muskwa-Kechika Management Area*[16] can be used to evaluate options for climate change management (e.g., connectivity corridors and core areas of important wildlife populations); other tools and technologies should be developed to measure and mitigate the predicted or observed effects in the M-KMA.[17] From these predictive steps, monitoring plans should be specifically designed to detect the potential impacts of climate change on M-KMA wildlife as they occur. It is expected that future iterations of the M-KWMP will have increasingly developed climate change management direction, incorporating new information, innovative techniques, and approaches.

Cumulative Effects Management

A Cumulative Effects Assessment and Management Framework for Northeast British Columbia was been completed for the Muskwa-Kechika Management Area in 2003.[18] The two volume report includes detailed recommendations on implementation of cumulative effects management (CEM). The proposed framework, or a similar method of assessing and managing cumulative effects, should be implemented as soon as possible. The B.C. Ministry of Environment, in consultation with relevant agencies, should determine effects thresholds and together with the B.C. Integrated Land Management Agency should manage and evaluate cumulative effects against these thresholds. In the absence of specific, local effects thresholds, threshold estimates that minimize the risk of reduction or loss of biological diversity, ecosystem function, or habitat suitability should be used until better information is available. Cumulative Effects Management of development and public use in the M-KMA should consider migration habitat and the needs of the species that use such habitat. Future research may provide effects thresholds for the M-KWMP priority species to be used in the CEM process.

1.2 Landscape-level Habitat

Landscape ecology is the study of regional patterns of habitat types (ecosystems) and their influence on species distribution and ecosystem processes.[19] Many species are not confined to single habitat types. For these species, habitat patterns at the landscape level are important. In ecology, this is sometimes referred to as the beta diversity level.[20] Biosphere Reserves are an example of applied landscape ecology, and a potential model for the Muskwa-Kechika Management Area. These consist of a core area (e.g., Ecological Reserves) where biological communities and ecosystems are protected, a buffer zone where traditional human vocations and activities and non-destructive research may occur (e.g., Protected Areas), and a transitional zone in which sustainable activities, research, and limited natural resource extraction are allowed (e.g., Special Management Zones).[21] Similarly, Europe's "Ecological Networks" consider the concept of buffer zones around specifically protected areas, where a buffer zone is defined as "a zone peripheral to a national park/reserve where restrictions are placed upon resource use and special development measures are undertaken to enhance the conservation value of the area."[22] The Ecological Network approach also includes "corridors" and "stepping-stone habitat" to promote connectivity between buffered protected areas.

The objective of landscape-level habitat management is to ensure a continuous supply and availability of all habitats in associations, patch sizes, and distributions that would likely occur in the absence of human disturbance. The regular (or periodic) seral stage and ecosystem distributions should be documented and maintained. A clear and up-to-date description of the existing ecosystem distribution in the M-KMA should be produced and made available, including, but not limited to: forest cover; habitat capability and suitability for priority species; location of fragile, scarce, and representative ecosystems; old growth; and other landscape-level ecosystems that are used in management and planning. This information, combined with pre-disturbance and climate cycling data, can then be used to assess and determine disturbance patterns, so that management actions can occur within a perceived natural range of variability. The B.C. Ministry of Environment provides wildlife habitat information with respect to desired conditions. The B.C. Ministry of Forests and Range allocates tenure with respect to forest resources and therefore should participate in land use planning to maintain seral stage and ecosystem distributions within the natural range of variability. The B.C. Integrated Land Management Agency collects, stores, and disseminates the data for use in lower-level planning processes, such as pre-tenure plans.

Natural Disturbance

Thus far in the M-KMA, fire (wild and anthropogenic) is the dominant stand-initiating and stand-maintaining disturbance agent, although insects and fluvial processes also play a role. Recent work in the Northern Interior Forest Region has led to a delineation of Natural Disturbance Units (NDUs), which stratify the region into areas with similar patterns for stand-initiating disturbance.[23] Table 2 shows the NDUs that occur in the M-KMA and presents some basic characteristics of each unit. These NDU characteristics are broadly applicable to the units; however, there will be localized variability, such as arid south-facing slopes, which have a higher frequency of disturbance. Though not considered a stand-initiating or stand-maintaining disturbance, persistent use of an area by ungulates can lead to localized impacts; for example, if animals concentrate to use limited resources such as mineral licks, winter range, or burned areas, local vegetation communities can be disturbed, even transformed. Mass movements and forest gap dynamics will also act as disturbance agents in forest patches that escape fire, and can be

important to wildlife diversity in the M-KMA.[24] Where scattered trees and tree patches occur in open forests and shrub land, tree-island dynamics prevail.[25]

These, and other more detailed, disturbance characteristics and patterns, as available, should be considered in habitat management activities. The effects of natural disturbance on the size, frequency, and distribution of habitat types can be estimated, and should be used to plan desired future conditions. Management actions may include remediation and restoration, fire management (see section 1.6 Fire Management), or any other habitat manipulation designed for results within estimated natural ranges. Of interest are any significant changes in habitat composition or complexity that can result from ungulate populations. In order to minimize any negative effects, the monitoring program for the large-mammal system must pay special attention to this possibility (see section 4.4 Implementation and Monitoring).

TABLE 2. Natural Disturbance Units in the Muskwa-Kechika Management Area

Natural Disturbance Unit	Stand Replacement Disturbance Cycle (yrs)	Stand Replacement (% of disturbance area)	Gap Replacement (% of disturbance area)	Area in M-KMA (ha)
Boreal Foothills – Mountain	150	80	20	152,502
Boreal Foothills – Valley	120	90	10	15,485
Boreal Plains – Alluvial	200	80	20	98
Boreal Plains – Upland	100	98	2	3,934
Omineca – Mountain	300	70	30	147,693
Omineca – Valley	120	95	5	18,645
Northern Boreal Mountain	180	70	30	6,034,749

Landscape Connectivity

Landscape connectivity is a qualitative term describing the degree to which similar ecosystems (be they alpine, riparian, late-successional forests, grasslands, etc.) are linked to one another to form an interconnected network, or "the degree to which a landscape facilitates or impedes movement" of organisms.[26] The degree of interconnectedness and the characteristics of the linkages vary in natural landscapes based on topography, elevation, natural disturbance regimes, succession, and the organism(s) in question. Specific types of connectivity are defined below:

- core-corridor connectivity – describes the relative connectivity between core areas of habitat for a species utilizing discrete habitat patches or between areas of higher population density;

- general wildlife connectivity – describes the relative connectivity between different areas of contiguously occupied habitat in terms of likelihood of movement;
- species-specific connectivity – describes the relative connectivity from one area of occupied habitat to another in terms of habitat preference for movement;
- upland to upland connectivity – describes how well ecosystems in the upland portion of the landscape are linked over time;
- upland to stream connectivity – describes how well ecosystems on the upland and stream riparian portions of the landscape are linked over time;
- upland to wetland connectivity – describes how well ecosystems on the upland and wetland portions of the landscape are linked over time;
- glaciofluvial landforms connectivity – with open grassy/shrubby vegetation (similar to wetland complexes);
- cross-elevation connectivity – describes how well ecosystems from low-elevation valley bottoms and higher-elevation portions of the landscape are linked with each other over time;
- wetland complex frequency – a measure of how many wetland complexes are in a landscape relative to other landscapes;
- stream riparian frequency – a measure of how many streamside riparian areas are in a landscape relative to other landscapes;
- mean disturbance size – a measure of natural patch size in a landscape relative to other landscapes; and
- presence of island remnants – a measure of the importance of island remnants to landscape connectivity relative to other landscapes. Island remnants are spatial and vertical structures remaining after a stand-initiating disturbance.
  (Adapted from the *Biodiversity Guidebook*[27] J. Pojar[28] and F.L. Craighead[29])

Breaking of these linkages results in ecosystem fragmentation, which impedes dispersal and re-colonization.[30] Fragmentation and connectivity are relative terms and vary with the size and the mobility of the organism in question. A highway median can be an insurmountable obstacle to small terrestrial animals, dividing their habitat more effectively than a mountain range. Much of the literature on habitat connectivity relates to the use of corridors by mammals and birds. Other fauna might not respond to such corridors. Some amphibians, for instance, which migrate by compass direction rather than along leave strips, need both breeding habitat and non-breeding habitat interspersed along their chosen path, and will only disperse over several generations. Wetland density is important for local and meta-populations of amphibians, and should be considered when planning connectivity; wetlands as small as 0.2 ha can be very important to biodiversity, and should be protected.[31, 32, 33, 34, 35] Proposed and existing development should be assessed and managed by appropriate resource managers to fall within the natural variation of fragmentation resulting from natural disturbances. The development of new links and corridors not designed to function as part of a natural system should be minimized.

Landscape connectivity should be maintained for all species requiring genetic exchange and general movement, dispersal and migration habitat. Some of the connectivity corridors (e.g., forest ecosystem networks) must be large enough for wide-ranging wildlife (e.g., male Grizzly Bears) to live in with low risk of mortality.[36] Corridors, routes, and trails used by wildlife are often identifiable and should be included when mapping and planning connectivity. Major links,

corridors, routes, and trails must be identified at the landscape level. For example, mountain passes that link watersheds, and provide the only connection for terrestrial vertebrates, can be critical to the viability of neighbouring sub-populations.[37, 38, 39, 40] The ecological function of these and other connectivity pathways should be maintained over a landscape unit in the near term (4 - 20 years).

In order to manage and maintain connectivity and reduce habitat fragmentation, the B.C. Ministry of Environment is working with appropriate resource managers to ensure that suitable Old Growth Management Areas (OGMAs) and Wildlife Tree Patches (WTPs) are established. In the M-KMA, OGMAs must be spatially defined and large enough to maintain forest-interior conditions; suitability of OGMAs and WTPs must be assessed based on wildlife use, wind resistance, and their adequacy in terms of old-growth characteristics, size, and contribution towards minimizing disturbance impacts. The tenure holders and agency enforcement staff should monitor the establishment and use of OGMAs and WTPs by wildlife. Research into the use of these reserves by wildlife and the longevity of them may be a priority.

A list of important wildlife habitat is found in Technical Appendix 3. Some features (such as ungulate winter range, old-growth forests with interior conditions, migration routes, wetlands, and riparian zones) are typically extensive, and are best identified and mapped at the landscape level. Important wildlife habitat should be included in and used to establish forest ecosystem networks, connectivity corridors, and/or stepping-stone habitat to help maintain landscape connectivity, through the establishment of OGMAs, WTPs, and riparian, or other, reserves. In particular, the location and condition of critical habitat used by ungulates during different times of the year (e.g., late winter or calving season) should be mapped for the M-KMA. Critical ungulate range is necessary for the survival of discrete ungulate populations. When available, existing data on connectivity should be used to guide development activities. For example, the *Conservation Area Design for the Muskwa-Kechika Management Area,*[41] a project funded by the Muskwa-Kechika Trust Fund**,** should include a connectivity assessment. Management directions should include a consolidation of known information into accessible information sources and a prioritization of the populations for which critical range is most threatened.

To maintain landscape connectivity, developments (including, but not limited to, the placement of industrial and recreation access) must not negatively affect connectivity over the long term, and project proponents should identify connectivity features through the application of results-based habitat management principles (see section 1.8 Results-based Habitat Management). Important connectivity features must be incorporated into agency maps and databases. Digital maps and databases must be updated regularly and this updating will show both progress and gaps in information needs. Persistence of use by wildlife of the connectivity features would indicate success in achieving the objective. As available, important connectivity features should be incorporated into appropriate agency databases to ensure that these features are protected.

Riparian Areas

Fish, amphibians, mammals, and invertebrates of management concern require and depend on riparian areas. Functional riparian areas should be maintained. Riparian areas are those next to streams, lakes, and wetlands and include both the area dominated by continuous high moisture content and the adjacent upland vegetation that exerts an influence on it. Riparian vegetation

protects water quality, stabilizes banks, regulates temperatures, and provides woody debris. Most fish food organisms and primary nutrients come from riparian vegetation. Riparian areas provide critical habitats, home ranges, and travel corridors for wildlife. Stream-dwelling amphibians are more influenced by riparian and watershed features than by in-stream habitat.[42] These areas provide unique ecological linkages throughout the landscape.[43]

Research suggests that the type of riparian buffer commonly recommended to protect in-stream fish habitat is likely to be inadequate to protect riparian zones for some species (e.g., some small mammals and some amphibians). Managing terrestrial habitats to maintain existing habitat and processes (e.g., hydrology and fire), and maintaining undisturbed refuges in the riparian zone, is crucial. To maintain functional riparian areas, vegetative buffers surrounding riparian edges must be established and kept undisturbed. Buffers should be large; for example, at least 200 m wide for amphibians and Trumpeter Swans.[44, 45] For riparian areas with boat traffic, buffers should be 500 m wide or more to provide security cover for wildlife movement.[46] The ecological integrity of wetlands, ponds, lakes, and streams can be preserved through maintaining hydrological and drainage characteristics. Best management practices for sediment and erosion control must be applied in proximity to riparian areas, while operations in streams, lakes, wetlands, and pools that will alter riparian or hydrologic characteristics (such as, but not limited to, wetted area, vegetation, water quality, seasonal quantity, storm response, compaction, or substrate disturbance) should be avoided. Chemical use (such as, but not limited to, salt, dust suppressors, pesticides, and herbicides) near buffer zones, or near any ponds, pools, ditches, and streams, must be restricted.[47, 48, 49, 50, 51, 52, 53,54]

Known riparian area information should be provided to project proponents and tenure holders for development activities and planning processes. If no such information is available, project proponents and tenure holders must provide baseline habitat inventory information and assessment of potential impacts as part of development proposals, including, but not limited to, mechanical exploration activities.

1.3 Stand-level Habitat

At the stand level, habitat can be precisely measured and described. In ecology, this is sometimes referred to as the treatment (or alpha) diversity level.[55] The B.C. Ministry of Forests and Range has developed the Biogeoclimatic Ecosystem Classification (BEC) system. It classifies site series for most of the province and is presented in regional field guides.[56] In the BEC, the site series describe all land areas capable of supporting specific climax vegetation. In the Muskwa-Kechika Management Area, stand-level inventory has included Terrestrial and Predictive Ecosystem Mapping, Forest Cover, Vegetation Resource Inventory, and Satellite Imagery. Natural Disturbance Units have also been delineated. Data gaps should be identified and addressed.

Ecosystem Fragility, Scarcity, and Representation

Relatively scarce ecosystems are limited in distribution and possibly more vulnerable to significant impacts. Available information sources of habitat information should be analyzed to identify and map ecosystems that are scarce, relative to the rest of the M-KMA. Similarly, relatively fragile ecosystems should be identified and mapped. Relatively fragile or relatively scarce ecosystems must be conservatively managed, and must be maintained at the landscape level within the estimated natural range of variability. Section 2.5 (Red- and Blue-listed Plant

Species and Plant Communities[57]) provides additional direction for listed plants and plant communities. These listed groups are automatically considered scarce.

Analysis of habitat can also determine in what proportion each ecosystem occurs in the M-KMA. Representation of all naturally occurring ecosystems must be maintained in proportions within perceived natural conditions. This approach helps ensure that habitat features and characteristics with unknown importance remain available for those species that require them. Habitat redundancy should be incorporated to anticipate natural variability, the potential for habitat loss, and human ignorance of habitat needs. The B.C. Ministry of Environment is responsible for tracking ecosystem scarcity and representation in the M-KMA, and the B.C. Integrated Land Management Agency is responsible for managing the data. Although representation is mapped and considered at the landscape scale, the degree of representation should be evaluated at the stand level, or an equivalent substitute. Using available information, stand-level components of the landscape (or equivalent) should be mapped at an appropriate scale, and their size and distribution should be analyzed. This information should then be used in lower-level planning processes to answer the following questions:

- What ecosystems are potentially affected by the proposed development?
- Are any of the ecosystems fragile or scarce?
- What is the relative extent of impact to the affected ecosystems (i.e., how is representation affected)?

In turn, the frequency and distribution of fragile, scarce, and representative ecosystems should be used for the planning and implementation of other habitat objectives including, but not limited to, those for fire management and results-based habitat management (sections 1.7 Migration Habitat and 1.8 Results-based Habitat Management). Stand-level analysis can also be used to predict or determine the distribution of some important wildlife habitat, such as coarse woody debris and wildlife trees, as discussed in section 1.4 Species-specific Habitat.

This type of analysis is currently available for parks as the Protected Areas System Overview (PASO).[58] The PASO system should be applied to the M-KMA, by Landscape Unit or Resource Management Zone, and used to evaluate development proposals.

1.4 Species-specific Habitat

For each non-plant wildlife species, certain important wildlife habitat (e.g., coarse woody debris levels, understory composition, shade) can be identified and managed for. A working list of important wildlife habitat is presented in Technical Appendix 3 Important Wildlife Habitat. Management actions should be based on our best understanding of natural conditions for a particular site series. Sufficient important wildlife habitat for priority wildlife species must be maintained in the Muskwa-Kechika Management Area.

To achieve this objective, developments (including, but not limited to, the placement of industrial and recreation access) must not negatively affect important wildlife habitat over the long term, through the application of results-based habitat management principles (see section 1.8 Results-based Habitat Management). Important wildlife habitat must be incorporated into vegetation maps, habitat maps and agency maps and databases. Digital maps, and databases should be updated regularly, and projects should plan for database updating. Important wildlife

habitat should be included when planning for connectivity. Determining inventory and monitoring requirements and priorities is the responsibility of the B.C. Ministry of Environment and the B.C. Integrated Land Management Agency. Proposed development sites should be assessed as part of the access-permitting process**.** Unless otherwise available, project proponents and tenure holders should be required to provide site-specific site series inventory and species-specific habitat information when seeking operating permits. The intent is to ensure that proponents identify habitat, and particularly species-specific important habitat, before it is compromised. Ongoing monitoring of the occurrence and use of important wildlife habitat should be done by the tenure holder and by agency staff as each situation dictates. Research may focus on developing a better understanding of how the priority wildlife use available habitat, and on identifying important wildlife habitat. Some important wildlife habitat may be appropriately used to determine cumulative effects thresholds.

With the passing of the *Species at Risk Act*[59] recovery plans are now required by law for federally listed threatened and endangered species. In the M-KMA, these include Porsild's bryum (a rare moss), the Southern Mountain and Northern Mountain populations of Woodland Caribou (*Rangifer tarandus caribou*), Wood Bison (*Bison bison athabascae*), and Peregrine Falcon (*Falco peregrinus anatum*). Other species such as the Plains Bison (*Bison bison bison*) are expected to be added to the list. Recovery plans are in place for the Peregrine Falcon and the Wood Bison, and are in the draft stages for the Woodland Caribou. Management plans are a requirement for federally listed species of special concern, which include the northern population of Woodland Caribou, the Grizzly Bear (*Ursus arctos*), the Wolverine (*Gulo gulo*), the Short-eared Owl (*Asio flammeus*), and the Western Toad (*Bufo boreas*). The federal *Species at Risk Act* also forbids damage to the residences of threatened or endangered species, and protects their habitat. The provincial Identified Wildlife Management Strategy procedures and standards provide habitat management direction for several species that are of management priority in the M-KMA (see Table 3).[60] The Muskwa-Kechika Advisory Board has approved a *Conservation Area Design for the Muskwa-Kechika Management Area,*[61] which delineates and describes core areas and ecological corridors for several key species and major ecosystem processes in the M-KMA. All species-specific habitat management actions should be consistent with the above planning efforts.

Table 3. Muskwa-Kechika Management Area Identified Wildlife

Common Name	Scientific Name	Provincial Listing
Woodland Caribou	*Rangifer tarandus caribou*	Red/Blue
Grizzly Bear	*Ursus arctos*	Blue
Wolverine	*Gulo gulo*	Blue
Fisher	*Martes pennanti*	Blue
Lesser Sandhill Crane	*Grus canadensis canadensis*	Yellow
Peregrine Falcon, *anatum* subspecies	*Falco peregrinus anatum*	Red
Short-eared Owl	*Asio flammeus*	Blue
Cape May Warbler	*Dendroica tigrina*	Red
Black-throated Green Warbler	*Dendroica virens*	Blue
Connecticut Warbler	*Oporornis agilis*	Red
Bull Trout	*Salvelinus confluentus*	Blue

1.5 Red- and Blue-listed Plant Species and Communities

Vertebrate species cannot exist in the wild without sufficient, suitable habitat, including required vegetative cover. For this reason, as part of an ecosystem approach to wildlife management, our definition of wildlife includes plants. For the Muskwa-Kechika Wildlife Management Plan, plants and plant communities that are federally listed or provincially red- or blue-listed, and are known to occur or likely found in the Muskwa-Kechika Management Area, are found in Technical Appendix 4. Table 4 lists those plant species and plant communities from Technical Appendix 4 that should be considered for active management.

TABLE 4. Plant species and plant communities of concern known or suspected to occur in the Muskwa-Kechika Management Area

Common Name	Scientific Name	Provincial Listing
Raup's Willow	Salix raupii	Red
Porsild's Whitlow-grass	Draba porsildii	Blue
Porsild's Bryum	Haplodontium macrocarpum	Red
Arctic Rush – Nuttall's Alkaligrass – Seablite	Juncus arcticus – Puccinellia – nuttalliana – Suaeda calceoliformis	Red
Mat Muhly – Arctic Rush – Nevada Bluegrass	Muhlenbergia richardsonis – Juncus arcticus – Poa secunda spp. Juncifolia	Red
Black Spruce – Kinnikinnick – Reindeer Lichens	Picea mariana – Arctostaphylos uva ursi – Cladina spp.	Blue
Subalpine Fir – Alders – Horsetails	Abies lasiocarpa – Alnus spp. – Equisetum spp.	Blue
Slender Sedge – Common Hook-moss	Carex lasiocarpa – Drepanocladus aduncus	Blue
Glaucous Bluegrass – Herbaceous vegetation	Poa glauca ssp. rupicola – Herbaceous vegetation	Blue

The primary management objective for listed plants and plant communities is to maintain their distribution in the M-KMA. The distribution of Red and blue-listed plant species and plant communities should be determined by the appropriate resource management agencies, which should include analysis of existing information to date, followed by stratification of the M-KMA for field inventory. For a detailed example, see *Vegetation Inventory Analysis for Protected Areas in the Skeena Region*. A baseline inventory of plant species and plant communities should be prepared by the appropriate resource management agencies for the M-KMA, and should include development of a list of known ecosystems that are proposed to the provincial Conservation Data Centre (CDC) for tracking; the list may then be used by the CDC to prioritize conservation assessments and subsequent designation of plant species or plant communities that warrant management because of vulnerability, threats, or limited occurrence.[62] For example, Porsild's bryum (a rare moss that occurs in the M-KMA) was recently nationally listed as "threatened" by the Committee on the Status of Endangered Wildlife In Canada, and a national

recovery plan will be required before 2005.[63, 64] In addition, the Identified Wildlife Management Strategy includes guidelines and recommendations for certain plant species and plant communities; the procedures and standards should be applied by appropriate resource agencies for all Identified Plants and Plant Communities found within the M-KMA and to all activities, including, but not limited to, non-forestry-related development.[65] If available guidelines and guidebooks, or other best management practices, are not applied, surrogate best management practices must be developed and applied by appropriate resource agencies. The B.C. Conservation Data Centre (B.C. Integrated Land Management Agency) is responsible for establishing the Red and Blue lists for endangered, threatened, and vulnerable plant species and plant communities (with input from the B.C. Ministry of Environment and the B.C. Ministry of Forests and Range). Unless the information is otherwise available, project proponents and tenure holders should be required to determine the presence or absence of listed plant species; ongoing monitoring should be the responsibility of appropriate resource agencies.

1.6 Fire Management

While soil and climate are the primary determinants of the structure of plant and animal communities in the Muskwa-Kechika Management Area, a large role is played by fire.[66] Faunal succession follows plant succession; there are optimal combinations of habitats or seral stages for each animal species. As fire initiates and terminates succession, it exerts both long-term and short-term effects.[67] Fire can dramatically change the character of the plan area. In its absence, the M-KMA would tend towards increased vegetative uniformity, and, ultimately, biodiversity would be reduced. Altering vegetative cover can change habitat suitability. This typically would happen by maturation of a plant community (shift to a later seral stage) or the reverse: the rejuvenation of a plant community (shift to an earlier seral stage). For example, Caribou in the M-KMA tend to prefer mid- to older-aged conifer cover in the areas below alpine; Moose prefer young deciduous cover; and Bison, Short-eared Owls, and Upland Sandpipers prefer early seral grassland. Thus, in the absence of fire disturbance, Caribou habitat tends to get more abundant, Moose habitat slowly diminishes, and the habitat for many rarer species declines quite rapidly in certain portions of their range, particularly in the lower elevations. Although events such as avalanches or insect outbreaks can result in the creation of early-seral grassland, fire is the primary factor in producing this community (there are also arid sites with climax grassland). Table 5 gives the land cover found in the M-KMA.

Whether considering the use of wildfire or prescribed fire, management actions and planning should recognize the potential change in fire patterns that may result from climate change effects. If temperatures generally increase in the future, larger fires will likely occur more frequently, earlier and later than is presently observed. The extent of this change may depend to some degree on the fire management that is applied.[68, 69]

TABLE 5. Land cover in the Muskwa-Kechika Management Area (2004)[70]

Type	Area (% total)	Area (km^2)
Coniferous	43.2%	27,648
Deciduous	5.9%	3,776
Alpine	44.2%	28,288
Early seral	3.8%	2,432
Water	1.3%	832
Non-vegetated	0.5%	320
Swamp	0.5%	320
Miscellaneous	0.7%	448

All of these communities tend to be self-sustaining except the early-seral type, which diminishes relatively quickly, to be eventually recreated by fire. However, the wildlife diversity of the M-KMA depends on an array of seral stages with the extent and spatial distribution within the natural range of variability; the early seral component should be available on a continual basis to support the numerous species that require it.[71]

Natural fire disturbance regimes cannot be fully mimicked, but certain effects of fire may be imitated by management action, most notably fire size, shape, and fire skips, and to a lesser extent, fire intensity and residual material.[72] It is possible to manage fire to help meet habitat objectives for certain wildlife. There are likely several fire regimes in the M-KMA, depending on elevation, aspect, hydrology, slope, or other topographical features, as well as on vegetation, fuel loading, and fuel structures. To inform management decisions, research is needed to improve our understanding of the long-term fire history of the M-KMA and its role in maintaining ecosystems. Both the historic and current fire regime should be identified, described, and mapped with respect to fire frequency, severity, size, and spatial distribution so that a natural range of variability can be depicted. Natural variability of fire disturbances can be managed at either the landscape or stand level. Research may include developing a suitable method for estimating the fire regime.[73, 74, 75]

The fire regime and seral stage distribution for the M-KMA should be analyzed and the results applied as soon as possible. The recommendations on monitoring provided in *Monitoring Design for the Peace Sub-Region Prescribed Burn Program in the Fort St. John Forest District* should be followed and extended to the entire M-KMA.[76] Of particular importance is recommendation number 2:

> ***Initiate wildlife and vegetation inventories… A range survey would delineate areas of potential habitat overuse, and non target species inventories would aid in special relationship and usage data collection. Areas of critical habitat use and wildlife***

distributions… should be assessed, mapped, and documented. This would allow for prioritization of areas for early seral habitat maintenance and development.

Relevant and appropriate staff of the B.C. Ministry of Forests and Range and the B.C. Ministry of Environment should jointly produce a Fire Management Plan specific to the M-KMA. The Fire Management Plan should consolidate portions of existing Forest District and Provincial Park plans, prescribed burning plans, listed species occurrences, and wildlife habitat information to give direction for fire management priorities. Issues of property and resource protection should continue to play an important role in fire management planning.

Use of Wildfire

Wildfires in the M-KMA should be opportunistically managed to meet wildlife goals and outcomes of the Muskwa-Kechika Wildlife Management Plan. Managers select fire management options, such as fire suppression or "let-burn," by assessing the need for fire-maintained habitat and the risks as and when wildfires occur. In consultation with the B.C. Ministry of Forests and Range (Protection) and B.C. Ministry of Environment (Parks), prescribed natural fire ("let burn") areas should be established (for example) in some portions of some provincial forests or provincial parks.[77, 78] The focus of fire management objectives for wildlife should be on ensuring the continuation of natural ecological and evolutionary processes and floral and faunal species in the long term.

Use of Prescribed Fire

Prescribed fire (including First Nations use of fire) has been the most used habitat management tool in the M-KMA since the area was last glaciated.[79, 80] Prescribed fire is now commonly applied in wildland areas, including federal and provincial parks, for the creation of early-seral habitat types, to restore later-seral habitat types (e.g., ponderosa pine old growth), or to reduce fuel loading in forested areas.[81, 82] Prescribed fire may also be required to provide habitat for organisms that require burned dead trees, such as Black-backed Woodpeckers (*Picoides arcticus*) and other birds, and certain insects and fungi.[83, 84]

While wildfires have created some favourable areas for Bison, Short-eared Owls, and Upland Sandpipers, as well as all the other species that depend on this habitat type in the M-KMA, the fires tend to be extinguished for purposes of property protection or are too widely spaced in time for the maintenance of grassland range for those three species.

Wildfire should be managed to maintain half or more of the present amount of early-seral (< 10 years old) area, or approximately 1,200 km^2 (120,000 ha). A prescribed burning program should be undertaken to maintain the remaining fraction by burning small (50 - 1000 ha) patches on a 10-year rotation (approximately 10% being burned each year). Prescribed burning should be distributed across the M-KMA in approximately the proportion now found. The management units used should be Species Objectives/Strategies Units (SOUs), as shown in Table 6.

TABLE 6. Maintenance burning goals for the Muskwa-Kechika Management Area

SOU	SOU Area (km^2)	Area outside Parks		Area inside Parks	
		(km^2)	(%)	(km^2)	(%)
Kechika	16,600	150	0.9	25	0.2
Toad	11,100	200	1.8	10	0.1
Gataga	8,800	15	0.2	25	0.3
Muskwa	11,300	25	0.2	500	4.4
Finlay	9,500	10	0.1	5	0.1
Sikanni-Halfway	6,600	225	3.4	10	0.2
Total	63,900	625	1.0	575	0.9

Approximately half the prescribed burning should be in provincial parks and half outside provincial parks. This burning should target areas previously burned and beginning to convert to brush, provided that site-specific assessments are made for appropriate prescriptions. The area chosen is roughly based on existing grassland proportions in the M-KMA. The 1,200 $km^2$to be maintained in early-seral grassland represents about 2% of the M-KMA. Table 5 indicates the present forest cover in the M-KMA (from B.C. Ministry of Forests and Range data). All of the burn sites come from the early-seral category. The proposed program must be conducted within existing frameworks and procedures for prescribed burning in the Peace Region, including B.C. Ministry of Forests and Range referral and participation. Prescribed burning should include individual site prescriptions to ensure that sites do not become degraded from repeated fire damage.

1.7 Migration Habitat

Habitat for bird species that migrate through the Muskwa-Kechika Management Area that is not covered in other sections of the plan, but that should be considered as a priority for management, includes, but is not limited to, staging areas and other migration habitat used by migratory birds. Migrating birds can be extremely sensitive to impacts during critical staging and migrating periods. Typically, groups will be large, and can sometimes include substantial proportions of distinct populations. Any impacts during migration can significantly affect a species or groups of species. Recent evidence suggests that mortality during migration[85] is a significant cause of pronounced population declines of migratory landbirds observed over the past three decades.[86, 87] Studies in southern British Columbia have found more than 113 bird species foraging and/or resting in high-elevation habitats during fall migration; for North America, more than 200 species have been found to use alpine and subalpine habitats in late summer, suggesting that these are important staging areas for migrating shorebirds, raptors, and songbirds.[88, 89] Lowland riparian areas are also recognized as important habitat and staging areas for migrating songbirds. The Mackenzie Migration station, located on Mugaha Marsh at the south end of Williston Lake, has banded more than 37,000 individuals of 103 bird species during fall migration since 1995.[90] Golden Eagles fitted with satellite transmitters travelled from Alaska through northern British Columbia and from California to British Columbia to nest, including portions of the M-KMA.

Surveys have documented thousands of raptors, including 18 species, migrating through the Alberta Rockies. Similar migration numbers are expected in the Northern Rockies.[91] Even when important breeding areas and wintering grounds lie outside the M-KMA, population trends can sometimes be monitored more effectively in migration. An effective inventory plan of species in known migration habitat can help provide baseline data on the species.

Management of Migration Habitat

As a priority, specific habitat used in migration routes and important staging areas in the M-KMA should be identified. Information gathering should include the habitat needs, timing, and routes for the different species. Baseline inventory should be taken to determine and identify important staging areas and major/minor flyways. Public reporting of large concentrations of migrating wildlife can be used to identify staging areas and migration routes. Inventory should target the most likely habitat during the most likely time periods to search for and document significant concentrations of migrating species. For example, migratory bird banding stations should be operated at strategic locations in the M-KMA. Significant knowledge can be gained from increased communications and partnership between agencies (including, but not limited to, the B.C. Ministry of Environment, the Canadian Wildlife Service, the Geological Survey of Canada, Yukon Natural Resources, and the Canadian Migration Monitoring Network). Efforts should be made to join with several programs that are in place to monitor and manage migrating species, including the North American Bird Conservation Initiative and Partners in Flight.

Once information is collected on the locations and timing of important migration habitat, more detailed study should determine the migration habitat elements (e.g., staging areas and migration routes) that are required by the species, what known or potential threats exist, and how best to maintain habitat suitability. Important migration habitat should be regionally managed. Management effort should focus on maintaining the suitability of migration habitat, as determined by the B.C. Ministry of Environment. The B.C. Integrated Land Management Agency manages and disseminates migration habitat information. Appropriate resource agencies should plan to maintain the elements that make migration habitat suitable.

In the absence of detailed knowledge about migration routes, important habitat, staging areas, and timing, appropriate resource agencies and users should apply management strategies that minimize the risk of reduction or loss of biological diversity, ecosystem function, or habitat suitability in order to benefit migrating species. Alpine, mudflats, berry-producing, open water, riparian, and forested habitat along migration routes can be important to migrating birds. These habitats should be managed to maintain connectivity and to minimize fragmentation at all scales (see section 1.2 Landscape-level Habitat). Appropriate security cover should be retained adjacent to wetlands and water bodies to help maintain migration habitat for waterfowl and shorebirds. When important migration habitat is known, recreation and development activities should be restricted to avoid impacts (e.g., avoiding road/trail use and construction in potential staging areas during migration periods). Project proponents should provide baseline inventory information to identify known and potential staging areas and migration routes as part of development requirements.

1.8 Results-based Habitat Management

The intent of objectives and management directions in the Muskwa-Kechika Wildlife Management Plan is to improve the general status of all priority wildlife in the Muskwa-Kechika Management Area, in accordance with direction established under the Muskwa-Kechika Management Plan[92] and associated land and resource management plans (see section 1.4, Strategic Document, M-KWMP).[93, 94, 95, 96]

Before natural resource development and use (including, but not limited to, recreation, timber harvesting, guide outfitting, mining, and oil and gas mechanical exploration and development) are allowed within the M-KMA, appropriate site-locating, mitigation, and restoration measures to sustain the abundance and diversity of wildlife must be identified during the planning and approval phases of development.

Development must not reduce the suitability of habitat to support functionally significant and/or large wildlife populations, for at least the priority species. Commercial and/or industrial projects or activities in the M-KMA requiring provincial permits or approvals that could adversely affect wildlife and wildlife habitat must apply procedures for identifying, avoiding, and mitigating impacts to, and restoring, wildlife habitat in order to achieve desired wildlife habitat results.

Activities with potentially significant and/or widespread impacts on wildlife habitat (including, but not limited to, mineral and petroleum mechanical exploration, and forest harvest layout and design) must be considered within planning processes (e.g., park and protected area plans, pre-tenure plans, and landscape unit and/or sustainable forest management plans) that identify current wildlife habitat values and use, and desired wildlife habitat results (i.e., desired mix of habitat types and range of variation for a designated area within the M-KMA). Plans must provide a framework for avoiding and mitigating impacts, as well as a schedule and procedure for restoring wildlife habitat to desired conditions (i.e., desired results).

Project proponents should be provided with habitat management guidelines for higher-level planning (e.g., pre-tenure plans) including, but not limited to:

- desired wildlife habitat results (i.e., desired state and range of variability of wildlife habitat expected over a designated period of time consistent with M-KWMP objectives); and
- descriptions of the wildlife habitat for a specified area (e.g., protected area, pre-tenure planning area), including, but not limited to, vegetation communities, habitat classifications by species (as available), suitability, and species biodiversity.

Through the respective operational instruments, project proponents must be required to demonstrate how the habitat management guidelines should be met when planning, executing, and concluding a project, specifically addressing the following:

- identification and management of important wildlife habitat and/or areas (e.g., critical habitats, core habitats, corridor or linkage habitats) through planning and/or assessment processes; and
- how the project(s) should maintain habitat suitability to meet the desired wildlife habitat results over the development area, including, but not limited to, the tenure boundary,

potential access corridors, and, if necessary, portions of neighbouring zones, during and after the project.

A hierarchy of options must be used to protect wildlife habitat from adverse effects in accordance with the wildlife habitat objective (to manage the planning, development, and reclamation of natural resource use within the M-KMA in a manner that ensures, over time, that the functional role of habitat in supporting the abundance and diversity of wildlife is sustained, and, where needed, restored). The hierarchy of options is as follows (in order of decreasing preference):

- Relocation (physically moving a project or part of a project), to eliminate adverse impacts on wildlife habitat.
- Innovative redesign of a project so that it no longer has negative impacts on wildlife habitat.
- Compensatory mitigation of negative impacts (the replacement of unavoidably lost habitat suitability in cases where relocation and redesign are not possible, for the duration of the project and over time).
- Enhanced restoration if standard restoration/rehabilitation procedures will not suffice to restore the disturbed habitat to its original suitability over time.

In this hierarchy, the first mentioned options (relocation and redesign) are preferred, and should be exhausted before applying the subsequent options (mitigation and enhanced restoration). Mitigation and restoration activities should conform to guidelines provided by the Ministry of Environment. In practice, relocation, redesign, and mitigation may be used in combination to avoid harmful alteration, disruption, or destruction of wildlife habitat, and to ensure that projects comply with the objective. Some habitat is too important, and avoidance will be necessary. There is an underlying need for the improved identification of habitat use by wildlife species in the M-KMA. This has been identified as a major information deficiency and should be a high priority for funding support.

2.0 Wildlife Species Management

There are thousands of wildlife species in the Muskwa-Kechika Management Area, including:

- mammals (approximately 42 species);
- birds (approximately 230 species);
- reptiles (two known species);
- amphibians (five known species);
- fish (approximately 37 species);
- plants (unknown number of species); and
- invertebrates (unknown number of species).

It will not be possible to manage for each of these species. Relatively abundant species should not be subject to regular monitoring but rather should only receive attention when anecdotal, agency reporting, public, or other information suggests a significant change in status. It is hoped that by implementing the management directions proposed in the Technical Manual, Section 1.0, Habitat Management, suitable conditions should exist to sustain those wildlife species that are not of management priority. The risk in this approach is that a negative change in general status might not be detected until the problem is well advanced. The large protected area system within the M-KMA should provide a control for comparison if a negative change in general status is detected and adequately defined.

Furthermore, some climate change models show that minimum temperatures have warmed during the past century, particularly in the north; these models also predict that temperatures in British Columbia may rise by as much as 4°C in the next 100 years.[97] There may be species-level changes in numbers, distribution, life cycles, behaviour, and possibly genetic variation.[98] Decision-makers and wildlife managers are urged to factor climate change implications into decision-making when implementing the M-KWMP, and to consider that the potential for increased variability in ecosystem functions and processes may result in lower sustainable harvest rates and increased risks of population collapse.[99] For example, ungulates (and other herbivores) may time their reproductive cycles to coincide with emerging vegetation. Changing climate could result in a "trophic mismatch," and an associated decline in production of offspring.[100]

Wildlife species considered for active management were selected based on existing direction, ecosystem management principles, Advisory Group (refer to Acknowledgements page) discussion, and peer review. Table 7 lists these priority species. It is believed that these species represent a sufficient spectrum of the M-KMA wildlife that, if the objectives specified in the Technical Manual of Muskwa-Kechika Wildlife Management Plan for these species are being met, will meet the goals and outcomes of the plan.

TABLE 7. Muskwa-Kechika Wildlife Management Plan priority species

Common Name	Scientific Name	Provincial Listing
Stone's Sheep	*Ovis dalli stonei*	Yellow
Caribou, Woodland subspecies	*Rangifer tarandus caribou*	Red/Blue
Wood Bison	*Bison bison athabascae*	Red
Plains Bison	*Bison bison bison*	Red
Moose	*Alces alces*	Yellow
Mountain Goat	*Oreamnos americanus*	Yellow
Elk	*Cervus elaphus*	Yellow
Gray Wolf	*Canis lupus*	Yellow
Grizzly Bear	*Ursus arctos*	Blue
Wolverine	*Gulo gulo*	Blue
Fisher	*Martes pennanti*	Blue
Northern Myotis	*Myotis septentrionalis*	Blue
Lesser Sandhill Crane	*Grus canadensis canadensis*	Yellow
Peregrine Falcon, *anatum* subspecies	*Falco peregrinus anatum*	Red
Short-eared Owl	*Asio flammeus*	Blue
Cape May Warbler	*Dendroica tigrina*	Red
Black-throated Green Warbler	*Dendroica virens*	Blue
Connecticut Warbler	*Oporornis agilis*	Red
Bull Trout	*Salvelinus confluentus*	Blue
Lake Trout	*Salvelinus namaycush*	Yellow
Arctic Grayling	*Thymallus arcticus*	Red/Yellow
Rainbow Trout	*Oncorhynchus mykiss*	Yellow
Northern Pike	*Esox lucius*	Yellow
Western Toad	*Bufo boreas*	Yellow
Selected Invertebrates		
Selected Plant Species and Plant Communities		

The general intent of the management objectives and management directions is to improve the general status of all priority wildlife in the M-KMA. Three categories of population improvement should be targeted:

- The M-KMA does not contain sufficient habitat to ensure that all species are maintained at viable population levels. For such species (e.g., Peregrine Falcon and Wood Bison), active management should strive to define and improve their status (with a more specific target ultimately set) but should not apply extraordinary means.

- The M-KMA, with active management, could help to ensure the long-term viability of one or more populations of species by increasing population persistence. For such species (e.g., Short-eared Owl and Cape May Warbler), management activities should be applied once their life requisites and essential habitats have been identified.

- There are some species of high public interest and use (e.g., Elk and Moose) whose populations are currently secure. For such species, management should strive to maintain

functionally significant populations. Some of these species may be increased from current population levels, once numerical targets have been defined that are consistent with the broader goals for the M-KMA. Effort should be applied to determine general population objectives that reflect both habitat suitability and maintenance of ecosystem function.

Table 8 lists wildlife species that appear in the plan, but should not be considered for active management, unless anecdotal or other information suggests that greater attention is required. These are species that are hunted or trapped, and that the B.C. Ministry of Environment is required to manage, but that are not considered a priority at this time.

TABLE 8. Muskwa-Kechika Wildlife Management Plan non-priority species

Common Name	Scientific Name	Provincial Listing
Deer (White-tailed and Mule)	*Odocoileus* spp.	Yellow
Black Bear	*Ursus americanus*	Yellow
Coyote	*Canis latrans*	Yellow
Cougar	*Puma concolor*	Yellow
Lynx	*Lynx canadensis*	Yellow
Marten	*Martes americanus*	Yellow
River Otter	*Lontra canadensis*	Yellow
Beaver	*Castor canadensis*	Yellow

2.1 General Species Direction

The following broad categories of issues for management have been identified to facilitate organization of the plan:

- habitat;
- population;
- health;
- disturbance; and
- harvest (where relevant).

Associated with each of the above issue categories are objectives, management directions for achieving the objectives, potential indicators of the status of the implementation, implementation and/or monitoring actions and responsibilities, and research requirements. These are summarized in Part B-1: Summary Objectives Tables and listed in sections 2.2 through 2.7. The objectives and management directions that are described below apply to all species of management concern.

Habitat

The Muskwa-Kechika Wildlife Management Plan presents an ecosystem approach to wildlife management, and habitat considerations should be the primary management concern. The purpose of the habitat-related objectives and management directions is to maintain and restore wildlife habitat in the Muskwa-Kechika Management Area. Any habitat management must be for conservation and biodiversity first, and then for recreational opportunities. Important wildlife habitat should be regionally managed through the appropriate resource agencies. For more detailed habitat direction, see section 1.0 Habitat Management.

Populations

Populations should be managed to improve the status of priority wildlife within a sustainable, natural range of variability, as per the guiding principles of the M-KWMP (see Strategic Document, Section 2.3, Guiding Principles). Population targets should not be set at the maximum provided by habitat suitability or capability calculations, unless maximums are required to preserve a species from reaching an "at risk" level. General population objectives for species must be achievable, defensible, realistic, and within the range of natural variability. In order to conserve wildlife populations at a sustainable level, regular periodic population assessments should be done to detect local and regional changes in populations and composition. When possible, opportunities to co-operate with neighbouring jurisdictions should be maintained and encouraged.

In some cases, it may be necessary to control wildlife (either individuals or a discrete population) to conserve a population of species at risk or a red- or blue-listed priority species. For example, predation is or is suspected to be the limiting factor for several priority species in the M-KMA; predation alone, or sometimes combined with other stressors (such as human disturbance and habitat alienation), can lead to the reduction of local populations of prey to numbers below estimated minimum viable population levels. Wildlife control should be applied only to maintain or recover species at risk or a red- or blue-listed priority species that are or are likely to become reduced below minimum viable population levels, as estimated through contemporary science, and once other options (e.g., closure of hunting seasons, habitat management through prescribed burning) have been exhausted or shown to be insufficient. Examples of wildlife control may include (but are not limited to) the following:

- exclusion;
- deterrents;
- translocation;
- non-lethal population control;
- legal harvest; and
- lethal population control.

Non-lethal methods of wildlife control should be attempted before lethal methods are considered, except for non-indigenous species, for which lethal methods are preferred. When lethal control is determined to be necessary, hunting and harvest methods authorized by *British Columbia Wildlife Act*[101] regulation are preferred. Wildlife control should be planned in accordance with any relevant recovery plans that may be in place.

Health

The overarching animal health objective is to ensure that health issues do not threaten M-KMA priority wildlife species. This should be accomplished by enforcing existing environmental regulations to ensure that animal health is not compromised. Additional implementation strategies should be to manage potential disease vectors. Such strategies may include, but are not limited to, prohibiting high-risk exotic species and prohibiting game farms. A response plan should be developed for use in the event of a disease outbreak or other animal health issue. To determine an appropriate response, it is necessary to examine animal health indicators (e.g., the occurrence of various contagions and parasite loads) that remain within an estimate of the natural

range, and whether known vectors or other problem sources threaten M-KMA indigenous species.

Monitoring by government personnel and anecdotal information from M-KMA users is intended to help identify any animal health problems, such as environmental contamination and/or the presence of banned exotic species. All wildlife health monitoring activities should be monitored by the Provincial Wildlife Veterinarian. Sampling from harvested animals, road mortalities, and other sources should be used to establish and monitor baseline health information on the wildlife of the area; tissue and blood samples should be collected in a local registry. A specific volunteer program should be established. In some studies, researchers under permit should be required to take blood samples for analyses while doing inventories, to begin building a health and genetic inventory. Active research projects may focus on determining baseline animal health conditions.

Disturbance

The suitability of important wildlife habitat must be maintained. To this end, the management directions proposed in section 1.8 Results-based Habitat Management are required. In addition to the management objectives presented in the M-KWMP, available guidelines and guidebooks and other best management practices should be applied to all projects where resource uses are planned and developed in the M-KMA. For example, the Identified Wildlife Management Strategy (IWMS) is a comprehensive program designed to mitigate impacts to identified species; as such, the strategy should be applied whenever and wherever Identified Wildlife occurs. The IWMS procedures and standards should be applied for all Identified Wildlife and to all activities within the M-KMA, including, but not limited to, non-forestry-related development and mechanical exploration activities.[102] When relevant activities or developments are proposed, the *Biodiversity Guidebook,*[103] *Riparian Management Area Guidebook,*[104] and other appropriate Forest Practices Code guidebooks should be recognized as important sources of direction. The *Guidelines for Evaluating, Avoiding and Mitigating Impacts of Major Development Projects on Wildlife in British Columbia*[105] and the *British Columbia Environmental Assessment Guidelines for Grizzly Bears and Black Bears*[106] (both currently in draft) should be applied as interim best management practices, and the final versions completed and implemented as soon as possible. The impact thresholds and connectivity information found in the *Conservation Area Design for the Muskwa-Kechika Management Area*[107] should be applied to resource use and development. If available guidelines and guidebooks, or other best management practices, are not applied, surrogate best management practices must be developed and applied.

Important wildlife habitat must be avoided at sensitive times. Scheduling activities to minimize disturbance to wildlife is already common for many species, including game fish and ungulates, and should be expanded and developed for other relevant species of management concern. Success in achieving this objective should be measured by the persistent use of important wildlife habitat by wildlife of management concern. The proponent or tenure/permit holder should be required to provide an initial assessment of important wildlife habitat. Continued use of habitat and its suitability should be monitored (likely by government compliance and enforcement staff: e.g., conservation officers, oil and gas resource officers).

Access must be designed to minimize impacts to wildlife. This objective should be achieved through coordinated access management planning to address several problem areas. For

example, human access (design, management, and use) can affect predator effectiveness. Access to winter range should be avoided in the winter, because machine trails can provide a compact surface on which predators can travel, to ranges they would not normally be able to reach. Significant effects of access include impacts due to vehicle collisions. These can be reduced by road design and placement, and by implementing and monitoring/enforcing restrictions with respect to speed, season of use, and number of vehicles, where necessary. Reducing road salt in problem areas, combined with salting at sites suited to intercept or lure animals away, can be useful. Removing carcasses promptly can prevent injury/mortality to scavengers. Wildlife of management concern should be noted in a concerted effort to estimate mortalities due to collisions. Species of particular interest include ungulates, large carnivores, and furbearing species.

Research into the effects of recreation access on ungulates during critical seasons (e.g., winter) has shown that the effects range from disinterest to varying degrees of flight response, and that most negative reactions and impacts are primarily caused in winter or during calving/lambing periods.[108,109,110] Low-flying aircraft often elicit escape responses in ungulates, creating physiological stress and potential displacement from highly suitable, preferred habitat. The types of reactions caused by erratic, unpredictable encounters with industrial activity or recreationists (e.g., occasional hikers) can lead to severe energy costs for ungulates, which can be detrimental under certain circumstances. In addition to increasing energy costs for wintering animals, recreational activity often results in displacement of animals to less desirable habitat.[111] Predators will use trails and other routes to more effectively cover territories, and reach normally inaccessible areas (e.g., by using bridges or compacted snow trails).

The B.C. Ministry of Environment should provide access thresholds, based on the best available knowledge, for cumulative environmental impact assessments. See Technical Manual, sections 5.0 Impacts and Mitigation Related to Industrial and Commercial Development and 6.0 Management of Recreation Impacts on Wildlife for more direction. The B.C. Ministry of Environment should co-operate with all appropriate resource agencies to plan and manage access to minimize impacts on wildlife. Resource users, in co-operation with the B.C. Ministry of Environment and the B.C. Ministry of Transportation, should take steps to minimize vehicle collisions with wildlife and to implement traffic restrictions.

Harvest

Hunting and trapping are considered valid uses of many wildlife species that occur in the M-KMA. For these species, the objective is to maintain harvest at sustainable levels, within the bounds of provincial regulations and policy and in accordance with standards established by the provincial Wildlife Harvest Strategy.[112] The Ministry of Environment is responsible for monitoring harvest levels, and the Hunter Sample, Compulsory Inspections, Compulsory Reporting, Limited Entry, the Wild Fur Data System and enforcement staff in the field are used to this end. The Ministry of Environment is also responsible for directing population inventory and research, although many other organizations (including, but not limited to, tenure holders and resource users) may be involved. Measurement of age and sex composition of the harvest and the inventory data should be used to assess and monitor harvest impacts and population status. Harvest regulations may be reviewed annually in order to implement positive changes, and populations may be monitored as budgets permit.

To meet the objective, species that are hunted and trapped are managed to reflect conservation and biodiversity goals first, followed by First Nations priorities and opportunities for licensed hunters and trappers. The Province of British Columbia continues to expand co-operation with First Nations to improve harvest management. Sustainable harvests are achieved by modifying regulations as required to ensure that populations exceed functionally significant levels, or some other threshold density, as determined by the B.C. Ministry of Environment. Wildlife harvest and management objectives and practices are to be consistent with provincial policy.

2.2 Ungulates

Ungulates provide a significant percentage of all consumptive recreational opportunities in the Muskwa-Kechika Management Area. Ungulate (sub)species that must be considered as priority for management in the M-KMA include: Stone's Sheep, Woodland Caribou, Wood and Plains Bison, Moose, Mountain Goat, and Elk. White-tailed Deer and Mule Deer are included for information, but are not considered a management priority.

Ungulate populations can be limited by several environmental factors, including climate, vegetation cover, and availability of forage. However, predation is (in the broad picture) the primary limiting factor for the five priority ungulates in the M-KMA.[113, 114] While predators do kill adult ungulates, ungulate predation equilibria derive primarily from the high take of young ungulates by the predators. Activities that restore or maintain natural predator–prey dynamics (such as, but not limited to, providing large openings for Elk and maintaining ungulate escape terrain) should be encouraged. Activities that disrupt predator–prey dynamics (such as, but not limited to, trail creation to areas previously inaccessible to predators) should be discouraged.

*2.2.1 Stone's Sheep (*Ovis dalli stonei*)*

General[115, 116, 117]

Stone's Sheep are one of two subspecies of thinhorn sheep that occur in British Columbia, and are the only subspecies that occur in the M-KMA. Approximately 75% of the world population of Stone's Sheep inhabits the mountainous terrain of northern British Columbia, with the remainder found in south-central Yukon. This species was on British Columbia's Blue list of species at risk until 1997; however, it was removed to the Yellow list in 1998, because of the creation of several new protected areas that include some sheep range, and the creation of the M-KMA. There are development issues pending that have the possibility of negatively affecting the species, and it is important that their needs be addressed appropriately.

Stone's Sheep are widespread throughout the M-KMA. At present their distribution and abundance is limited primarily by predation and their restriction to available escape areas within a narrow range of suitable winter and spring habitats. They occur in the mountainous terrain from the Graham River north to the Liard River, and the western mountains surrounding the Kechika and Finlay Rivers. They are generally absent from the Lower Rabbit and the Upper Turnagain Rivers. The highest densities occur mostly in the rugged terrain surrounding Nevis Creek, Besa River, Prophet River, Muskwa River, Tetsa River, Toad River, Racing River, Gataga River, and the Denetiah and Moodie Creek drainages. Intensive inventories for the east-slope portion of the area (Fish and Wildlife Management Units 7-42 and 7-50), from the mid-

1980s to 1994, show that Stone's Sheep populations are substantially reduced from recent highs.[118] Generally, Stone's Sheep have shown a 50% decline in the last decade.[119]

Stone's Sheep occur above and below the treeline in the M-KMA and favour open areas with steep terrain and a wide field of view for early detection and avoidance of predators. Their diet consists primarily of grasses and forbs, including bluegrasses, fescues, rye grasses, sedges, and herbs such as locoweed, lupines, yarrow and pasture sedge, mosses and lichens, and the leaves of shrubby species such as willow. Seasonal movements are triggered primarily by reproductive cycles and snow depths. In the summer, Stone's Sheep are found throughout the open, rugged mountainous terrain feeding on a variety of grass, forb, sedge, and shrub species; summer escape terrain includes heavy timber in steep terrain. Due to their relatively short legs, Stone's Sheep are confined in winter to finding forage on treeless ranges with little or no snow cover in close proximity to escape terrain (cliffs). Winter range tends to occur on windswept ridges and steep south- and west-facing slopes, in the alpine from 1,500 to 2,200 m. Snow depth determines the size of the available winter range; during low-snow years, Stone's Sheep are able to occupy larger areas than in deeper-snow years. Additionally, Stone's Sheep make use of mineral licks in early spring and summer and will travel considerable distances away from escape terrain to reach them.

Habitat
This species makes substantial use of subalpine early-seral grassland. Availability of grassland habitat that is extensive (to allow for observing the approach of predators) and adjacent to terrain offering escape options is key to the success of this species. This kind of habitat, be it alpine or subalpine, should be a priority in habitat protection considerations for Stone's Sheep. A significant proportion of prescribed burning and/or the opportunistic use of wildfire should be directed towards maintaining habitat for this species. The B.C. Ministry of Environment is responsible for leading the prescribed burning program, and providing sheep habitat information and priorities for an M-KMA Fire Management Plan, to be implemented in co-operation with the B.C. Ministry of Forests and Range (see section 1.6 Fire Management).

Population
The general population objective for Stone's Sheep is to increase population persistence within the M-KMA by maintaining or increasing numbers of sheep. Managing human access can prevent excessive predation in areas that were previously inaccessible to predators. Creation of predator access (trails) to Stone's Sheep areas must be avoided. When necessary for the conservation of a specific population of sheep, predation may be limited through modification of hunting and trapping regulations, and trapper education. Because predation is selectively biased to lambs, yearling recruitment should be used to monitor annual changes between the minimum observed population estimate surveys every 6 years (one SOU per year). The performance measure that should be used to evaluate increasing population growth is greater than 30 nine month old juveniles per 100 ewes.[120, 121] The B.C. Ministry of Environment is the lead agency for sheep inventory and management.

Health
It is widely recognized that contagions are a serious issue in the health status of Bighorn Sheep. It is expected that these are also a significant threat to Stone's Sheep. Transmission from

domestic animals (especially domestic sheep and goats but possibly also Llamas and others) is the highest potential risk in this regard. To identify and avoid contagions, animals known to carry diseases potentially transmissible to wild sheep should be prohibited in the M-KMA through enforceable policy and/or regulation. The B.C. Ministry of Environment is working on establishing baselines for health parameters, contagions, parasite loads, glucocorticoid levels, or other appropriate physiological parameters, so that population health can be monitored. (An example would be the evaluation of stress and health through the use of glucocorticoid levels.)

Disturbance

Thinhorn sheep are generally more sensitive to intermittent or novel disturbances than are other wildlife. Stone's Sheep are particularly sensitive to disturbance in their natal and winter ranges. As a priority, disturbances due to industrial development and recreational use must be minimized. Disturbance types and levels should be identified and managed. This would include ground-based activities and also aircraft (especially helicopters) for which Stone's Sheep have a particular fear.[122] Flight guidelines are available through the B.C. Ministry of Environment and can be adapted to address the issue on an area-specific basis. Monitoring of aircraft activity is a function of enforcement staff, and public reporting may help identify compliance issues. Proponents should be required to monitor the impacts of their activities on sheep as a part of their permit conditions. A specific area of research interest may be the response of Stone's Sheep to helicopter activity and recreation encounters. The B.C. Ministry of Environment provides timing windows, and these must be applied to development activities in important Stone's Sheep range.

Harvest

The objective is to maintain a relatively conservative harvest approach, and regulations should be modified as required to achieve this objective. Existing restrictions in hunting regulations to protect ewes, lambs, and young mature rams should be retained. Seasons may be modified, or local areas closed, to appropriately deal with populations of concern. Indicators include the estimated age ratios of rams in the populations, and harvest numbers relative to population size. Compulsory inspection should remain a priority for hunter harvests to allow for a high level of monitoring and collection of biological information, which will be coordinated by the B.C. Ministry of Environment.

*2.2.2 Woodland Caribou (*Rangifer tarandus caribou*) (Red- and Blue-listed)*

General [123, 124, 125]

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC)[126] recognizes two populations of Woodland Caribou within the M-KMA: the Southern Mountain population (federally listed as "threatened") includes the Graham herd, while the remaining herds (Pink Mountain, Finlay, Gataga, Muskwa, Rabbit, and Liard Plateau herds) are included in the Northern Mountain population (federally listed as of "special concern"). Boreal Caribou (federally listed as "threatened") wander in and out of the M-KMA along portions of the western, eastern, and northern boundaries. The distinction is primarily the ecological adaptation to heavier snowpacks in the south (ESSF versus SWB biogeoclimatic zones). Caribou are included in the *Identified Wildlife Management Strategy Standards for Managing Identified Wildlife*.[127] Caribou are important to some First Nations in the exercise of their traditional rights.

Woodland Caribou are often considered indicators of wilderness characteristics due to their need for large, continuous mature/old forest stands and use of habitat corridors and linkages into alpine areas in order to minimize predation, while optimizing cover and food factors. In the M-KMA, Caribou are widely distributed and occur in all Species Objectives/Strategies Units. Caribou can be found at all elevations in the M-KMA. They use alpine tundra, subalpine forests, and lowland coniferous forests, including muskeg areas. Throughout the seasons, individuals and small bands of animals will range widely. Movement patterns are varied, and individuals or groups of Caribou are often classified as being migrators, non-migrators, or wanderers. Seasonal movement is dictated largely by snow depth and condition, and animals tend to move up and down in elevation in response to this. In early winter there is movement to lower-elevation forests, although not all Caribou will move in response to accumulating snow. Caribou show preference for slopes with northern exposure throughout the winter. When deeper snow covers the ground, they will often seek climax coniferous forests, although Caribou have exhibited a varied approach to foraging at all elevations.[128, 129, 130]

Habitat

This species makes substantial use of open-canopy mature forest. Much of that focus is towards lichen foraging; however, grasses, sedges, and horsetails are important elements of their forest diet. Habitat protection should focus on maintaining a supply of suitable important habitat, such as lichen-producing winter ranges[131] and mature coniferous forests. Because of Caribou's tendency to move a great deal, connectivity of extensive unfragmented mature stands of forest must be maintained. A factor in the magnitude of predation impact is the amount of fragmentation of the forested ranges. Forest patches must also be relatively large to remain suitable, and the landscapes must be connected for Caribou, particularly in the riparian areas. This should occur through fire protection and protection/maintenance of intact old forest structure and characteristics. The B.C. Ministry of Environment and the B.C. Integrated Land Management Agency should maintain an inventory of habitat linkages and movement corridors, large patches of the important habitats, and of Caribou use in them. Caribou habitat should be regularly assessed for suitability and landscape connectivity. The B.C. Ministry of Forests and Range, in co-operation with the B.C. Ministry of Environment, should consider Caribou in a Fire Management Plan for the M-KMA.

Population

The general population objective for Caribou is to increase population persistence within the M-KMA by maintaining or increasing numbers of Caribou. Predation is the primary limiting factor on the abundance of Caribou in the M-KMA.[132] Managing human access can prevent excessive predation in areas that were previously inaccessible to predators. Creation of predator access (trails) to Caribou areas must be avoided, and appropriate resource agencies are responsible for addressing human access management as part of their land use activities. When necessary for conservation of a specific population of Caribou, key predators may be limited through such methods as modification of hunting and trapping regulations, trapper education, and predator control. Because predation is selectively biased to calves, yearling recruitment should be used to monitor biannual changes. The performance measure that should be used to indicate population growth is a recruitment rate greater than 30 calves (9 months or older) per 100 cows (2 years or older).[133, 134]

Health
Imported domestic Reindeer along with some exotics are known to carry contagious diseases that might potentially threaten wild Caribou populations. Transmission from exotic domestic animals is the highest potential risk in this regard. To identify and avoid contagions, animals known to carry diseases potentially transmissible to Caribou should be prohibited in the M-KMA through enforceable policy and/or regulation. Likewise, game farming of Reindeer should not be allowed in private holdings in or near the M-KMA. The B.C. Ministry of Environment is working on establishing baselines for health parameters, contagions, parasite loads, glucocorticoid levels, or other appropriate physiological parameters, so that population health can be monitored. An example may be the evaluation of stress and health through the use of glucocorticoid levels.

Disturbance
Caribou are not notable for sensitivity to disturbance, except in calving and winter ranges. Management directions to avoid disturbance of Caribou calving and winter ranges must be applied. With development activities – such as forestry and oil and gas access – planning must address the maintenance of habitat connectivity between significant heavy-use habitat areas. As a priority, fragmentation must be minimized with better planning of development. Appropriate resource agencies should apply the Identified Wildlife Management Strategy procedures and standards for all activities that can potentially affect Caribou in the M-KMA. All resource agencies and users should plan and manage disturbance to minimize impacts on wildlife. The B.C. Ministry of Environment provides timing windows, and these must be applied to development activities in important Caribou range.

Harvest
In response to being nationally designated as "threatened" by COSEWIC for Caribou within the Southern Mountain National Ecological Area, the Graham herd was protected from hunting in 2003. This herd has been identified in a provincial Northern Caribou Recovery Strategy.[135] The other Caribou herds in the M-KMA are located in the Northern Mountain National Ecological Area, and are considered to be of "special concern" by COSEWIC. Under the conditions of the *National Accord for the Protection of Species at Risk*,[136] a Management Plan should be prepared for all Woodland Caribou herds in northern British Columbia (including the M-KMA) and the Yukon.

The objective is to maintain a conservative harvest approach, and regulations should be modified as required to achieve this objective. Harvest restrictions to protect calves, cows, and young mature bulls should be retained. Although populations are not at risk in most of the M-KMA, hunting seasons may be modified or local areas closed to appropriately deal with populations of concern. Indicators include the estimated sex ratios in the populations and harvest numbers relative to population size. For hunted herds, compulsory inspection should remain a priority for hunter harvests to allow for a high level of monitoring and collection of biological information, with co-ordination being the responsibility of the B.C. Ministry of Environment.

*2.2.3 Wood Bison (*Bos bison athabascae*) (Red-listed)*

General[137, 138, 139, 140]
Sometimes referred to as Mountain or Woodland Bison, Wood Bison were extirpated from the M-KMA at the turn of the century. This species is currently red-listed in British Columbia. This

subspecies was nationally listed as "threatened" by COSEWIC, and a national recovery plan is in place for this species.[141] Bison are also listed in the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES).[142] A herd of 50 animals was reintroduced to the Liard River Corridor at Nordquist Lake in 1997, in accordance with the Federal and Provincial Recovery Plan Initiative. All recovery activities, planning, etc. should be considered within the context of these planning processes. The current population numbers are stable. In the M-KMA, Wood Bison require specific management interventions to maintain populations (e.g., prescribed burns for forage, drift fencing to direct movement). Wood Bison are found only along the Liard River Corridor in the M-KMA. They also travel to the west of the M-KMA along the Liard River valley (Halkett herd).

Wood Bison are primarily grazers, eating sedges, grasses, rushes, and forbs in similar proportions to their occurrence. Shrubs are not common dietary items, but are occasionally eaten and can be important seasonally, especially under severe environmental conditions where herbaceous vegetation is less available. Prime Wood Bison habitat consists of extensive grassland or wet sedge meadows with spruce forests primarily for cover and an additional seasonal forage source. Wood Bison will develop wallows in dry ground, which can become several metres in diameter.

Habitat

This subspecies makes substantial use of early-seral grassland. A proportion of prescribed burning and/or the opportunistic use of wildfire should be directed towards maintaining habitat for them. To collect information on the seasonal distribution and habitat use of Wood Bison, proponents of developments in Bison range should participate in research and inventory. The B.C. Ministry of Forests and Range is the lead for range use management and should be involved with Plains Bison monitoring. Similarly, industry, parks, wildlife, and enforcement staff working in the area should be involved in reporting Bison locations. The B.C. Ministry of Environment leads the habitat program for Wood Bison, and provides Bison habitat information and priorities for an M-KMA Fire Management Plan, to be implemented in co-operation with the B.C. Ministry of Forests and Range (see section 1.6 Fire Management).

Population

The general population objective for Wood Bison is to improve their status within the M-KMA without using extraordinary means. The intent is to maintain or increase numbers of Wood Bison. Population management is restricted to the Liard corridor area, where Wood Bison were introduced in 1995. Ideally, the herd will expand its range over time and connect with other herds being re-established in northeast British Columbia and those present along the Liard River in the Northwest Territories. The performance measure that should be used to evaluate increasing population growth is greater than 30 nine month old juveniles per 100 cows.[143]

This population has failed to grow for many years. Several animals have been observed killed by Wolves. A large pack denned in the middle of the main Bison summer range in 1996 and Bison hair was observed in the Wolf scats. Moose numbers are presently low and the current population of fifty Bison likely represents a high proportion of the available ungulate prey base in the area of the herd. Initially, the Bison remained in the original release area. Calf survival was low to nil each year, and the herd declined. Later, the herd moved to the highway corridor where

traffic discourages Wolf activity. Calf survival has improved to a level adequate to replace adult Bison lost to Wolves and traffic.[144] When necessary for conservation, key predators may be limited through modification of hunting and trapping regulations, trapper education, and predator control, as determined by the recovery team. Predation is selectively biased to calves, and yearling recruitment should be used to monitor biannual changes. As these animals are relatively observable, the B.C. Ministry of Environment should monitor their status in conjunction with other activities in the area. The public is encouraged to report sightings, and the observations can be used to establish recruitment levels. The B.C. Ministry of Environment should attempt to conduct an absolute abundance inventory every 2 years.

Health

The Halkett herd Wood Bison is free from bovine tuberculosis and brucellosis. Domestic Bison could potentially transmit these and a variety of other contagions to the wild Bison. To maintain the disease-free condition of the population, contact with other Bison, domestic or wild, must be prevented.

There are two genetic issues of note around these Bison. Firstly, the genetic base for the entire Canadian Wood Bison herd is limited because of the small size of the starting population following near-extirpation. National efforts are now under way to expand that herd with new stock from Hook Lake, Northwest Territories. If successful, a few new animals from that herd may be introduced to the Halkett herd. Secondly, to avoid genetic dilution with wild Plains Bison (nearest herd, 300 mountainous kilometres distant) or feral farm Bison (nearest herd, 200 roaded flatland kilometres distant), contact with other Bison, domestic or wild, must be prevented. Planning for this subspecies should include measures to maintain genetic diversity in Bison.

The B.C. Ministry of Environment should attempt to establish baselines for health parameters, contagions, parasite loads, glucocorticoid levels, or other appropriate physiological parameters, so that population health can be monitored. The B.C. Ministry of Environment should attempt to monitor the health of the herd by sampling incidental mortalities for presence of disease carried by Bison.

Disturbance

Wood Bison generally have a high tolerance for disturbance. However, calving is a time when disturbance must be minimized by scheduling activities outside of timing windows, which are provided by the B.C. Ministry of Environment.

Most Wood Bison in the M-KMA are currently selecting the immediate vicinity of the Alaska Highway for year-round residence. While this presents a tremendous tourism opportunity, it does put the animals and the public at risk, and there are several mortalities each year from vehicle collisions. To minimize vehicle collisions with Wood Bison, grassland to the east of the highway should be retained or improved for Wood Bison. Other measures such as maintaining salting areas and building a drift fence to discourage movement back to the highway corridor should be applied. Resource users and tenure holders may be recruited to monitor Bison presence and movement, and road traffic. The B.C. Ministry of Environment is responsible for managing habitat to minimize Bison use of the Alaska Highway corridor. All mortalities and other observed impacts in a tenure holder's area should be reported. The B.C. Ministry of

Transportation tracks vehicle collisions with wildlife. Collisions with wood Bison should be specifically noted. The vehicle collision issue is also addressed in section 2.1 General Species Direction. A vehicle collision strategy is needed to minimize the Bison collision rates. This strategy is being developed between all the agencies concerned.

Harvest
Wood Bison is federally listed as "threatened," and appears in Part 3 of Schedule 1 of the *Species at Risk Act*,[145] and therefore is not harvested. Harvest restrictions (no harvest) must be retained at least until a minimum sustainable population is attained. Due to conservation concerns, this subspecies is not available for harvest by First Nations at this time. In the longer term, however, any potential for harvest would consider the conservation of the population as the first priority.

*2.2.4 Plains Bison (*Bos bison bison*) (Red-listed)*

General[146, 147]
Plains Bison are similar in appearance and habits to Wood Bison, but are currently considered a distinct subspecies. The only free-ranging herd in British Columbia was established when 50 or so individuals from the wild Plains Bison herd at Elk Island National Park, purchased by a farmer, escaped in the Pink Mountain area of the M-KMA in the 1970s. This introduced herd has grown to become the largest disease-free herd of Plains Bison in the world, and the population has local, national, and international significance to the conservation of the wild genotype. Plains Bison are found in the Sikanni River and upper Halfway River valleys in the M-KMA. Though not native to the area, these animals are closely peripheral to historic range. There are no options for introductions to other areas due to the potential for land use conflict. The status of this subspecies is presently being reviewed by COSEWIC, and changes in proposed management could result based on federal designation.

Bison change location in response to seasonal changes in weather and food sources and in avoidance of some types of disturbances. In boreal areas, grasses and grass-like plants comprise over 85% of their diet. The Bison's unusual body shape is at least partly an adaptation to the need to forage through snow, and they can exist in areas where snow cover is too deep for most other ungulates. Bison also utilize well-beaten trails to travel between forest stands for shelter and meadows for feeding. They use sandy ridges and other dry ground for wallowing.

Habitat
Wood Bison make substantial use of early-seral grassland. Bison benefit from prescribed fire, which provides attractive early seral sites. A proportion of prescribed burning and/or the opportunistic use of wildfire should be directed towards maintaining habitat for this subspecies. To collect information on the seasonal distribution and habitat use of Wood Bison, proponents of developments and tenure holders in Bison range should participate in research and inventory and may be required to monitor Bison presence and movement, and road traffic. The B.C. Ministry of Forests and Range is the lead for range use management and can be involved with Plains Bison monitoring. Similarly, industry, parks, wildlife, and enforcement staff working in the area should be involved in reporting Bison locations. The B.C. Ministry of Environment leads the habitat program for Wood Bison and provides Bison habitat information and priorities for an M-KMA Fire Management Plan, to be implemented in co-operation with the B.C. Ministry of Forests and Range (see section 1.6 Fire Management).

Population
The general population objective for Plains Bison is to increase persistence of the established population within the M-KMA. This means maintaining or increasing the Plains Bison population. Periodic Plains Bison surveys indicate that the population grew substantially from the mid 1970s to the early 1990s. However, based on observations made from conducting aerial inventory for other subspecies, radio telemetry, and other work in the area, the population likely declined during the mid to late 1990s. A survey in 2003 counted 877 animals, which exceeds the count in 1992 (648 animals), indicating overall positive growth. In the last 10 years, Plains Bison recruitment has lowered, and it has been observed that Wolves kill Bison, which was considered unusual in past years. Currently, the herd is stable (to slightly increasing).[148] The B.C. Ministry of Environment should attempt to inventory Plains Bison every 6 years. Recruitment is measured by estimating age/sex ratios during the intervening years to assess the status of the population. The performance measure that should be used to evaluate increasing population growth is greater than 30 nine month old juveniles per 100 cows.[149]

Health
The M-KMA Plains Bison are free from bovine tuberculosis and brucellosis. Domestic Bison could transmit a variety of contagions to these wild Bison. To maintain the disease-free condition of the population, contact with other Bison, domestic or wild, must be prevented.

To avoid genetic dilution from feral farm Bison (the nearest domestic herd is currently about 100 km down the Halfway River valley through parkland habitat) or the wild Wood Bison (nearest herd about 200 km through muskeg), contact with other Bison, domestic or wild, must be prevented. Planning for Plains Bison should include measures to maintain genetic diversity in Bison. Industrial access has created a movement corridor for Bison. It has been necessary to construct a drift fence at the foot of the valley (outside the M-KMA) to restrict movement and prevent conflict with land users. Maintenance of this fence is a responsibility of the B.C. Ministry of Environment. Evaluation and monitoring the risk potential of this aspect should involve ongoing public and agency reporting of distribution/occurrences.

The B.C. Ministry of Environment should attempt to establish baselines for health parameters, contagions, parasite loads, glucocorticoid levels, or other appropriate physiological parameters, so that population health can be monitored. The Ministry should monitor the health of the herd by sampling hunter-killed and incidental mortalities for presence of disease carried by Bison.

Disturbance
Plains Bison are generally tolerate of most disturbance. However, calving is a time when disturbance must be minimized. The B.C. Ministry of Environment is responsible for providing timing windows for scheduling activities.

Vehicle traffic can cause mortality, and Bison can be displaced to areas with heavier snowpack areas. Minimizing vehicle traffic on a per-unit as well as on a time/seasonal basis may mitigate this impact. To minimize vehicle collisions with Plains Bison, speed restrictions and gating on industrial roads are necessary. All mortalities in a tenure holder's area should be reported, along with other observed impacts. The B.C. Ministry of Transportation tracks vehicle collisions with

wildlife on public roads, and Plains Bison should be specifically noted. Appropriate resource agencies should implement traffic restrictions. The vehicle collision issue is also addressed in section 2.1 General Species Direction. The B.C. Ministry of Environment should manage habitat and apply measures to control bison movement, such as baiting the animals away from road access areas with salt.

Harvest
The high level of interest and public support for viewing and hunting these animals is partly reflected by the limited-entry hunter licence subscription rate (more than 100 hunters typically apply for each permit available). The regulated harvest is for any Bison for most of the season. A limited-entry cow season is in effect due to existing land use conflicts.

*2.2.5 Moose (*Alces alces*)*

General[150, 151]
Abundant winter browse, shallow snow depths, and frequent warm winds in the winter promote high Moose densities in the M-KMA in comparison to most of the remainder of the province. Moose were historically a priority species and are still important, particularly to First Nations, and Moose is the most important species for human food consumption in the M-KMA.

Moose are widespread throughout the M-KMA. They occur year-round from valley bottom to alpine. The highest remaining population density is found in the Sikanni-Halfway SOU. While they are not at risk, Moose numbers have generally undergone very substantial declines over the last two to three decades.[152]

As they are primarily browsers, Moose are able to obtain the bulk of their food requirements from shrubs and young deciduous trees found in recently burned areas, in young forests, along river valleys, in avalanche chutes, where seasonal disturbances create a mixture of both young and old forest stands, and in subalpine areas with shrub species. In winter, Moose commonly forage on trembling aspen, paper birch, red-osier dogwood, alder, and willows, with the latter being the most important winter food. For most of the M-KMA, snow depth does not appear to limit winter distribution or movement. Throughout the M-KMA, mature forests provide important thermal habitat during summer months. In the summer, Moose forage on the new leaves and growing shoots of browse species, a variety of plant species, and aquatic vegetation. In general, they tend to move to lower elevations during summer months, and many are attracted to bottomland areas along rivers, lakes, swamps, and ponds to feed on the nutrient-rich vegetation where predators cannot readily kill them or their young. Still others disperse widely over many habitats, mostly as part of a predator avoidance strategy. In the fall, as other plant species die, Moose once again forage almost exclusively on deciduous browse until spring.

Habitat
This species makes substantial use of early-seral shrubland in smaller patches. Where appropriate, wildfires should not be restricted in order to allow for creation of this habitat type, as per section 1.0 Habitat Management. To retain Moose forage, the use of herbicides when re-vegetating disturbed areas should be minimal or prohibited. The B.C. Ministry of Environment should provide Moose habitat information and priorities for an M-KMA Fire Management Plan,

to be implemented in co-operation with the B.C. Ministry of Forests and Range (see section 1.6 Fire Management).

Population
The general population objective for Moose is to maintain functionally significant populations throughout the M-KMA. The intent is to maintain or increase populations, through the habitat management directions outlined above. The B.C. Ministry of Environment should attempt to obtain an absolute abundance estimate every 6 years (inventory one SOU each year). Predation is the primary limiting factor on the abundance of Moose in the M-KMA.[153] Moose density can be locally depressed. For example, in the last 10 years, a 45% decline in Moose due to predation impacts has been documented in the Sikanni River area.[154] Yearling recruitment should be used to monitor annual changes (between the 6-year population counts). More than 30 nine month old juveniles per 100 cows are required for population growth.[155, 156]

Health
Winter ticks are recognized as the most widespread health factor for Moose in western North America. The northern locale and generally higher elevations reduce the importance of this in the M-KMA. However, it is desirable to monitor parasite loads within populations. The B.C. Ministry of Environment is working toward establishing baselines for health parameters, particularly parasite loads, or other appropriate physiological parameters, so that population health can be monitored. The B.C. Ministry of Environment should attempt to monitor Moose health by sampling hunter-killed and/or incidental mortalities. Public and agency staff reporting of observed anomalies should be used to assess other potential Moose health issues.

Disturbance
Moose are moderately susceptible to novel disturbance.[157] It can be a major causal factor in moving animals from prime winter ranges or disrupting natal activities, and thereby reducing animal fitness and, potentially, juvenile survival. The B.C. Ministry of Environment will provide timing windows for application to development activities in known important Moose habitat.

Harvest
At present, Moose populations are at very low numbers in some areas of the M-KMA.[158] Harvests have been restricted to males only and further restricted with respect to middle-aged males. Female harvest through unregulated hunting can be a significant source of mortality and should continue to be addressed on an annual basis. Where conservation concerns are not addressed, more restrictive regulations may be implemented. The B.C. Ministry of Environment will continue to monitor the harvest through random inspections, hunter surveys, and public reporting.

*2.2.6 Mountain Goat (*Oreamnos americanus*)*

General[159, 160, 161]
Of the estimated number of Mountain Goats in North America, more than half occur in British Columbia. Mountain Goats occur throughout the M-KMA, wherever suitable habitat is found, and they often inhabit some of the roughest possible terrain in the mountain ranges. They predominantly use steep, rocky, forested outcroppings where their agility allows them to effectively escape from predators. Mountain Goats are generally considered to be non-migratory

animals; however, significant movement is known to occur, usually in response to snow depth. They are often observed on high-elevation, steep, windswept ridge crests during winter. Mountain Goats are able to survive on a variety of plant foods, including lichens, ferns, forbs, grasses, and most shrubs and woody browse. Generally, these ungulates will move to lower elevations in the winter, unless suitable forage can be found on windswept ridges and south- or west-facing slopes. In the M-KMA, Mountain Goats may travel long distances to make use of mineral licks. Goat populations can be relatively slow to recover, because only up to 40% of mature females give birth (usually to just one kid); only about 50% will survive their first winter.

Habitat

As a priority, habitat connectivity for Mountain Goats must be maintained. Mineral licks hold a special attraction for goats, and they will move a considerable distance from security cover to reach important licks, often using forested cover to travel between important habitats. This must be considered in development planning. The B.C. Ministry of Environment provides connectivity information for Mountain Goats, and the B.C. Integrated Land Management Agency manages the data. Mineral and other licks and the impacts of human activities on Mountain Goats may be a focus for research.

Population

The general population objective for Mountain Goat is to increase population persistence within the M-KMA. The intent is to maintain or increase populations. Managing human access can prevent excessive predation in areas that were previously inaccessible to predators. Creation of predator access (trails) to Mountain Goat areas must be avoided. The B.C. Ministry of Environment should attempt to obtain an absolute population estimate every 6 years (inventory one SOU each year). Predation is believed to be the primary limiting factor on the abundance of Mountain Goat in the M-KMA.[162] Yearling recruitment should be used to monitor annual changes (between the 6-year population counts).

Health

Contagious diseases can be a serious threat to the health of Mountain Goat populations. Transmission from exotic domestic animals has the highest potential risk in this regard. To identify and avoid contagions, animals known to carry diseases potentially transmissible to wild Mountain Goats should be prohibited from the M-KMA through enforceable policy and/or regulation. The B.C. Ministry of Environment should attempt to establish baselines for health parameters, contagions, parasite loads, glucocorticoid levels or other appropriate physiological parameters, so that population health can be monitored. An example may be the evaluation of stress and health through the use of glucocorticoid levels.

Disturbance

The Mountain Goat is considered more sensitive to novel disturbance than most other large mammals, and its escape response causes significant risk for individuals, particularly young goats. This sensitivity to disturbance includes both ground-based activities and aircraft, especially helicopters.[163] Disturbance due to industrial development must be minimized. Flight guidelines and significant buffer zones will be required for commercial and industrial operations in or near important goat habitat. The impacts of aircraft activity as a stress factor for Mountain Goats using known background glucocorticoid levels or a similar study may be a priority

research focus. The B.C. Ministry of Environment and the Oil and Gas Commission should monitor flight guideline compliance, and reporting from this should be used to improve permit management, if necessary. The B.C. Ministry of Environment will provide timing windows for application to development activities in important Mountain Goat range.

Harvest

Mountain Goats are sensitive to over-harvest, largely due to the difficulty of distinguishing females from males in the field. Controls on hunting have led to a recovery of Mountain Goat over the last two decades. A conservative harvest should be maintained, with limited-entry hunting in areas of significant hunter access, total protection of nanny–kid and mineral lick areas, and adherence to any other regulations as deemed appropriate by provincial policy. Educational material, contact with the hunting public, as well as the annual public harvest allocation review process should be used to stress the negative impact of female Mountain Goat harvest and to implement management actions (e.g., quotas for guide outfitters). The B.C. Ministry of Environment leads harvest monitoring, and compulsory inspection should continue. The proportion of females taken must be carefully considered so that harvest levels can be modified appropriately if required. Considering the difficulty in their inventory and the need for a closely monitored harvest, it is critical that management be both conservative and science-based.

*2.2.7 Elk (*Cervus elaphus*)*

General[164, 165, 166, 167, 168]

Elk is the second-largest member of the deer (Cervidae) family. Portions of the M-KMA were refugia during the Wisconsin glaciation (and the mini-glaciation of the late 1800s) and were key areas in maintaining Elk in British Columbia. Elk winter in both the insular and outer foothills of the relatively snow-free Rocky Mountains, as well as in the parkland of the Liard Plain Ecosection in the northern Rocky Mountain Trench of the M-KMA**.** Elk feed primarily on ferns, grasses, sedges, and other ground vegetation supplemented by browse from willows, rose, and other shrubs. Elk in the northern M-KMA require large contiguous areas of open grassland and shrub habitat (early seral) to allow for winter snow removal and to reduce predation. Elk are typically found on the south-facing grassland habitat, or in subalpine and alpine ranges. Elk are also strongly associated with aspen forests.

Habitat

This species makes substantial use of subalpine early-seral grassland; the availability of extensive grassland habitat (to allow for observing the approach of predators) is key to the success of this species. The primary habitat objective for Elk is the maintenance of this habitat. A significant proportion of prescribed burning and/or the opportunistic use of wildfire should be directed towards maintaining habitat for this species. Prescribed burning should be aimed at yielding larger openings, which retain less snow and allow for improved predator detection. Progress measurements include: the area treated using prescribed fire per year and the opening size for important habitats. The B.C. Ministry of Environment leads the prescribed burning program and should provide Elk habitat information and priorities for an M-KMA Fire Management Plan (see section 1.6 Fire Management).

Population
The general population objective for Elk is to maintain functionally significant populations throughout the M-KMA. The intent is to maintain or increase populations. Predation is the primary limiting factor on this species.[169] Managing human access can prevent excessive predation in areas that were previously inaccessible to predators. Creation of predator access (trails) to Elk areas must be avoided. Since predation is biased to calves, yearling recruitment should be used to monitor annual changes. The performance measure for inferring population growth may be more than 30 nine month old juveniles per 100 cows 2 years or older.[170, 171] The B.C. Ministry of Environment should obtain an absolute population estimate every 6 years (inventory one SOU each year), and recruitment may be estimated from herd composition surveys for each SOU every 2 years.

Health
Contagious diseases can be a serious threat to Elk populations. Transmission from exotic domestic animals has the highest potential risk in this regard. To identify and avoid contagions, animals known to carry diseases potentially transmissible to wild Elk should be banned from the M-KMA through enforceable policy and/or regulation. The B.C. Ministry of Environment should establish baselines for health parameters, contagions, parasite loads, glucocorticoid levels, or other appropriate physiological parameters, so that population health can be monitored. An example is the evaluation of stress and health through the use of glucocorticoid levels. Although of relatively low priority, a possible research focus may be the measure of various stressors and their impact on Elk, with an emphasis on helicopter activity.

Disturbance
Elk are moderately sensitive to disturbance, particularly on calving areas and winter range.[172] The B.C. Ministry of Environment will provide timing windows for application to development activities in important Elk range.

Harvest
The greatest protection through regulation is needed in those Species Objectives/Strategies Units (SOUs) other than the Muskwa. Female Elk hunting in SOUs other than the Muskwa is discouraged and may be eliminated through hunting regulations if required; an overall conservative strategy should be maintained with annual reviews of harvest statistics (Summary Statistics Database). Where conservation concerns are not addressed, more restrictive regulations may be implemented. The B.C. Ministry of Environment monitors harvest through random inspections, hunter surveys, and public reporting.

*2.2.8 Mule and White-tailed Deer (*Odocoileus hemionus *and* O. virginianus*)*

General[173, 174, 175]
These species are not a priority for active management in the M-KMA. Mule and White-tailed Deer occur at low densities (hundreds to low thousands) in the M-KMA relative to the Peace River area and the southern half of British Columbia. Both species are widely distributed in North America and the M-KMA is near the northern extent of both of their ranges. These are species of concern because of their consumptive and non-consumptive uses. Both species are found across the M-KMA but tend to be more abundant on the east-slope foothills and the northern trench parkland.

Mule and White-tailed Deer are limited by snow depths greater than 30 cm in the winter months and are restricted to low-elevation mature forests associated with moderate to steep, warm-aspect parkland slopes where snow accumulation is low. Deer will forage on a variety of grasses, herbs, and leaves of deciduous shrubs in the summer, and rely on browse from shrubs such as rose, saskatoon, and red-osier dogwood in the winter. Winter range in combination with predation and severe winter weather limit the distribution and density of Mule and White-tailed Deer in the M-KMA.[176]

Habitat
No specific habitat objectives for deer are recommended at this time; implementing the objectives and management directions outlined in section 1.0 Habitat Management is considered sufficient.

Population
The general population objective for deer is to retain sufficient numbers to prevent extirpation from the M-KMA. The intent is to maintain existing numbers. Predation is suspected to be the primary limiting factor on these species;[177] however, in some years, winter conditions alone are limiting. Even with record mild winters since 1997 to present, numbers have increased only very moderately, which is possibly due to predation impacts.[178] The B.C. Ministry of Environment is responsible for tracking population status through incidental observations and hunter surveys. The performance measure that should be used to evaluate increasing population growth is greater than 30 nine month old juveniles per 100 does.[179]

Health
No specific health objectives are recommended. The B.C. Ministry of Environment should opportunistically track deer health through public and other anecdotal reports.

Disturbance
Deer are moderately sensitive to disturbance. Wintering areas should receive added protection from disturbance when planning developments. Disturbance impacts to deer are generally addressed in section 1.0 Habitat Management, section 5.0 Impacts and Mitigation Related to Industrial and Commercial Access, and section 6.0 Management of Recreation Impacts on Wildlife.

Harvest
There are limited harvest options for these species and regulations should remain conservative. The B.C. Ministry of Environment is responsible for monitoring harvest through random inspections, hunter surveys, and public reporting.

2.3 Large Carnivores

The number of Gray Wolves, and to some extent Grizzly Bears, is dependent upon ungulate numbers, and so their population will reflect changes in the abundance of ungulates. Grizzlies could survive at moderate numbers in the Muskwa-Kechika Management Area in the absence of ungulate food sources. The relation between Wolf numbers and the ungulate prey base is well known.[180] In key Wood Bison and Caribou areas, predator control may be applied for conservation purposes.

*2.3.1 Gray Wolf (*Canis lupus*)*

General[181, 182, 183]

The Gray Wolf is Yellow-listed provincially, and populations are at moderate to high levels throughout the north and central interior of British Columbia. The northern Gray Wolf (*Canis lupus occidentalis*) is listed in CITES.[184] Wolves are carnivores, preying mainly on adult ungulates, ungulate juveniles, and Beavers. To a lesser extent, they will also eat hares, small rodents such as mice and voles, and occasionally birds. The Wolf's role as a top predator of ungulates often leads to human–wildlife conflicts. Past predator control programs directed at Wolves have been controversial and, regardless of changes in management approaches, continued high public interest in this subject is anticipated.

Wolves occur throughout the M-KMA in most habitats and at all elevations, with their abundance being correlated with ungulate biomass. They are adaptable to almost any landscape, and habitat utilization is primarily influenced by the availability of prey species.

In the summer, Wolves show a degree of fidelity to denning sites, and although there is variation in this behaviour, a pack might use the same maternity dens each year. In winter, Wolves tend to be found in areas associated with ungulate winter range,[185] and often use frozen waterways as travel corridors; when snow accumulation is less under conifer canopies, Wolves often favour travelling there. Their use patterns within territories are greatly influenced by physiography. They tend to travel where it is easiest, and so will readily adapt to using new trails developed by humans, thus leading them to prey that might not otherwise have been encountered. Wolves routinely patrol their territories, scent-marking the peripheries, making their presence known to adjacent packs.[186] Extraterritorial movements and dispersal by pack members can occur throughout the year, but are most commonly observed in February and early March (coinciding with the breeding season), and during the summer (coinciding with whelping).

Habitat

There are no habitat objectives specifically for Wolves. General objectives and management directions, such as identifying and managing important habitat elements, are addressed in section 1.0 Habitat Management.

Population

The general population objective for Gray Wolf is to maintain functionally significant populations throughout the M-KMA. In the M-KMA, Wolf populations are dependent on the abundance of large ungulates.[187] The approach will be to maintain or increase populations of Wolves by maintaining large ungulate populations. Monitoring of the Wolf populations should

be conducted through inventories of the large ungulates and by assessing Wolf density and recruitment levels. An absolute population estimate should be completed at the rate of half an SOU per year.

When Wolf predation is of conservation concern for a specific population of Caribou or Wood Bison, it may be necessary to control local Wolf populations or discrete packs. Predation may be limited through modification of hunting and trapping regulations, trapper education, or predator control. The research focus may be to study the impact of sterilization on social behaviour, and to continue to document inter-pack movement using genetic and GPS radio-collaring methods. The B.C. Ministry of Environment leads predator control.

Health
The B.C. Ministry of Environment should establish baselines for appropriate health parameters, so that population health can be monitored. The B.C. Ministry of Environment should continue to monitor Wolf health by sampling harvested and captured animals.

Disturbance
Wolves are not particularly sensitive to human activities, except in natal areas. Denning areas can be abandoned because of disturbance; known dens should be avoided by development activities, including, but not limited to, access. Research conducted in recent years also indicates that there are many other reasons for den abandonment. To prevent den abandonment, the B.C. Ministry of Environment should locate dens, identify use patterns, and develop and provide management guidelines for known denning sites, which should be applied in development activities by the applicable resource agencies and users. A regional database of known den sites should be maintained by the B.C. Integrated Land Management Agency to ensure that they are formally included in planning processes.

Harvest
High productivity and low hunter and trapper success, combined with relative inaccessibility, result in little harvest pressure on this species in the M-KMA. The objective is to maintain harvest opportunities for Wolf, within provincial policy and regulations. Hunting and trapping may be modified for conservation/protection of threatened prey populations of Stone's Sheep, Caribou, and/or Wood Bison. The B.C. Ministry of Environment is responsible for regulating the Wolf harvest.

*2.3.2 Grizzly Bear (*Ursus arctos*) (Blue-listed)*

General[188,189, 190, 191]
The Grizzly Bear is currently blue-listed provincially, and there is a conservation strategy in place to direct management of this species, as well as a draft recovery plan for the North Cascades Population Unit. The B.C. Ministry of Environment has a draft of the *British Columbia Environmental Assessment Guidelines for Grizzly Bears and Black Bears*.[192] Grizzly are included in the provincial *Identified Wildlife Management Strategy Standards for Managing Identified Wildlife*.[193] This species was nationally listed of "special concern" by COSEWIC.[194] Grizzly are listed in CITES.[195] All recovery activities, planning, etc. should be considered within the context of these planning efforts.

Grizzly Bears occur throughout the M-KMA at all elevations. They are most abundant in rich ungulate areas and some of the wetter forest areas. Grizzly Bears are often involved in negative interactions with humans that result in the death of the bears. This species, formerly wide ranging over continental North America, has significant cultural importance for some First Nations and a high public profile, both provincially and internationally. The Grizzly Bear is the "top" predator in the M-KMA, and therefore an important component of the large-mammal system. Grizzly numbers in the M-KMA result partially from the amount of prey available (especially ungulates); populations of Grizzly Bears are also affected by intra-specific predation and human-caused mortality[196]. The number of Grizzly maintained will depend to some degree upon success in achieving ungulate objectives,[197] on harvest regulations, and in management of bear–human encounters.

Habitat

Landscape connectivity must be maintained for Grizzly Bears. Connectivity must be considered in development planning. It should include regularly used denning sites, trails, foraging areas, and any other important Grizzly Bear habitat. Section 1.2 Landscape-level Habitat and section 1.4 Species-specific Habitat include several objectives and management directions that should benefit Grizzly Bears. The B.C. Ministry of Environment is responsible for continuing to provide connectivity information, and the B.C. Integrated Land Management Agency is responsible for managing the data.

Population

The general population objective for Grizzly Bear is to maintain functionally significant populations within the M-KMA. The intent is to maintain or increase their numbers. To achieve this, cost-effective yet meaningful population estimates should be developed. The B.C. Ministry of Environment leads population assessments, and should obtain an absolute estimate for the M-KMA every 12 years (1/2 SOU per year).

Health

The B.C. Ministry of Environment should establish baselines for appropriate health parameters, so that population health can be monitored. The B.C. Ministry of Environment should continue to monitor Grizzly health by sampling harvested and/or captured animals.

Disturbance

Den sites are generally in relatively predictable habitats, as indicated by ongoing GPS radio telemetry.[198] To prevent den abandonment, active dens and denning areas (and other important habitat) must be protected from disturbance during the appropriate period. When an active den is identified through development or tenured activities, it must be reported to the B.C. Ministry of Environment. Appropriate resource agencies should apply the Identified Wildlife Management Strategy procedures and standards for all activities that potentially affect Grizzly Bears in the M-KMA. Active dens and known denning areas should be regionally monitored. The B.C. Ministry of Environment is responsible for providing guidelines including, but not limited to, timing windows, locations of important habitat features, and best management practices. Guidelines for working near denning sites must be applied. The B.C. Integrated Land Management Agency should provide map information to project proponents or tenure holders for use in planning their

developments. Objectives and management directions with respect to bear–human conflict and safety issues can be found in section 4.1 Bear–Human Conflicts.

Harvest
The objective is to maintain a relatively conservative harvest approach. The hunting of Grizzly Bears should remain as a limited entry and quota system as per provincial policy. Sows should be given extra protection in order to discourage their harvest, by means of hunter education and a restriction on hunting bears that are observed in a family unit. Hunting seasons may be modified or local areas closed to appropriately deal with populations of concern. Compulsory inspection should remain a priority for hunter harvests to allow for a high level of monitoring and collection of biological information, to be coordinated by the B.C. Ministry of Environment.

*2.3.3 Black Bear (*Ursus americanus*)*

General[199]
This species is not a priority for active management in the M-KMA. The Black Bear is listed in CITES.[200] Black Bears occur throughout the M-KMA, and have been noted at all elevations, but tend to favour burned areas, also frequenting areas near streams, meadows, and openings. Feeding habits are up to 95% vegetarian, and normally consist of flowers, buds, leaves, fruit, roots, and berries, although this opportunistic omnivore will also eat insects, fish, carrion, smaller vertebrates, or young ungulates.[201] However, it has been suggested that boar Black Bears in the M-KMA are relatively more predatory than Black Bears elsewhere in the province, possibly due to the higher densities of prey.

Habitat
No specific habitat objectives for Black Bears are recommended at this time; implementing the objectives and management directions outlined in section 1.0 Habitat Management is considered sufficient.

Population
The general population objective for Black Bears is to maintain functionally significant populations throughout the M-KMA. There are no specific population objectives for Black Bears at this time.

Health
The B.C. Ministry of Environment should establish baselines for health parameters, contagions, parasite loads, glucocorticoid levels, or other appropriate physiological parameters, so that population health can be monitored. The B.C. Ministry of Environment should continue to monitor Black Bear health by sampling harvested animals.

Disturbance
Black Bears are not overly sensitive to disturbance, and are likely to persist in disturbed areas.[202] Objectives and management directions with respect to bear-human conflict and safety issues can be found in section 4.1 Bear–Human Conflicts.

Harvest

High productivity, low hunter and trapper participation, and inaccessibility result in there being relatively little harvest pressure on this species in the M-KMA. There are no harvest objectives for Black Bears beyond those recommended in section.2.1 General Species Direction.

*2.3.4 Coyote (*Canis latrans*)*

General[203, 204, 205]

This species is not a priority for active management in the M-KMA. Since colonial times, Coyotes in North America have steadily expanded their range, likely as a result of forest clearing and local extirpations of Gray Wolf populations, their primary predator. Coyotes occur throughout the M-KMA, and have been noted at all elevations. They are most common in "parkland" areas. Coyotes breed at an early age, produce many young, have a varied diet, and thus adapt well to change. Coyotes normally hunt alone, and also form small packs to chase down ungulates. Coyotes may limit other medium-sized carnivores and omnivores, with associated increased abundance of the smaller prey (e.g., increased nesting success).[206] This has been observed in February and March in the M-KMA, where Coyotes are successful predators of Elk during these periods.[207]

Habitat

No specific habitat objectives for Coyotes are recommended at this time; implementing the objectives and management directions outlined in section 1.0 Habitat Management is considered sufficient.

Population

The general population objective for Coyotes is to maintain their presence in the M-KMA in sufficient numbers to prevent extirpation. The B.C. Ministry of Environment should opportunistically monitor Coyote populations. Some Stone's Sheep herds are subject to substantial predation pressure from Coyotes.[208] When Coyote predation is of conservation concern for a specific population of Caribou or Wood Bison, it may be necessary to control local Coyote populations or discrete packs. Predation may be limited through modification of hunting and trapping regulations, trapper education, and/or predator control. The B.C. Ministry of Environment leads predator control.

Health

The B.C. Ministry of Environment should establish baselines for health parameters, contagions, parasite loads, glucocorticoid levels, or other appropriate physiological parameters, so that population health can be monitored. The Ministry should opportunistically monitor Coyote health by sampling harvested animals.

Disturbance

Coyotes are not overly sensitive to disturbance and are likely to persist in disturbed areas. There are no specific disturbance objectives for Coyotes.

Harvest

This species is not a priority for active management, and numbers are currently expanding in the M-KMA.[209] Coyote harvest has been relatively low in the M-KMA. As they do threaten recovery of a few sheep populations (notably populations that prefer lower-elevation ranges),

hunting and trapping may be modified for conservation/protection of threatened populations of Stone's Sheep.

*2.3.5 Cougar (*Felis concolor*)*

General[210]

This species is not a priority for active management in the M-KMA. Cougars are listed in CITES.[211] Cougars have been on the increase in the M-KMA, although their stealth and low population density result in few recorded observations. In the plan area they primarily feed on Stone's Sheep and Mountain Goat but also commonly take deer and Elk. Cougars can have a local impact on certain prey species, particularly at points of prey concentration (e.g., mineral licks or bedding areas for sheep).[212] They are most commonly seen where people are most common (e.g., in the Graham and Toad River areas)[213] and are also likely to be prevalent in less frequented areas in association with available prey.

Habitat

There are no habitat objectives specifically for Cougars. General objectives and management directions (such as to identify and manage important habitat elements) are addressed in section 1.0 Habitat Management.

Population

The general population objective for Cougars is to maintain their presence in the M-KMA in sufficient numbers to prevent extirpation. The B.C. Ministry of Environment should opportunistically monitor Cougar populations. When Cougar predation is of conservation concern for a specific population of Caribou or Wood Bison, it may be necessary to control local Cougar populations. Predation may be limited through modification of hunting and trapping regulations, trapper education, and/or predator control. The B.C. Ministry of Environment leads predator control.

Health

The B.C. Ministry of Environment should establish baselines for health parameters, contagions, parasite loads, glucocorticoid levels, or other appropriate physiological parameters, so that population health can be monitored. The Ministry should opportunistically monitor Cougar health by sampling harvested animals.

Disturbance

Cougars are not overly sensitive to disturbance and are likely to persist in disturbed areas. There are no disturbance objectives for Cougars.

Harvest

Cougar harvest is extremely low in the M-KMA. The harvest option should be retained to facilitate resolution of problem Cougar issues. Hunting and trapping may be modified for conservation/protection of threatened prey populations or in areas of conflict.

2.4 Furbearing Animals

In British Columbia, the registered trapline system is the primary tool for managing furbearing animals. There are approximately 44 registered traplines in the Muskwa-Kechika Management Area. Trappers must successfully complete approved education courses before being allowed to trap. Furbearing species that must be considered as priority for management in the M-KMA include: Wolverines, Lynx, Marten, Fisher, River Otters, and Beavers. *Management Guidelines For Trappers* are available for each of these species, and can be found on the internet.[214] These publications, combined with the Trapper Education Program, help ensure humane and sustainable trapping.[215]

2.4.1 Wolverine, luscus *subspecies (*Gulo gulo luscus*) (Blue-listed)*

General[216, 217, 218, 219]

Wolverines, long associated with wilderness, have large home ranges and typically occur at low densities. Wolverines have important cultural significance to some First Nations and continue to be trapped for fur. Wolverines are generalist omnivores and will hunt anything they can, including ungulates, ptarmigan, hare, and marmots. Predation of sheep and goats by Wolverines has been observed in the plan area. It is widely held that the density of ungulates is a significant factor in maintaining Wolverine numbers, because they provide direct prey and carrion food sources. The Wolverines in the M-KMA are blue-listed provincially.[220] Wolverines are included in the provincial *Identified Wildlife Management Strategy Standards for Managing Identified Wildlife*.[221] This species was listed of "special concern" nationally by COSEWIC,[222] and all recovery activities, planning, etc. should be considered within the context of this plan. Wolverines are sensitive to loss of extensive wilderness (through incursion of human development and activities), and individuals are very sensitive to human disturbance during denning.

Wolverines are found throughout the M-KMA and forage widely within large territories. There is documented variation of home range size depending on sex and age class. Territories of adult females in the Omineca Ranges of Northeastern British Columbia were found to average 400 km^2. Wolverines are found from valley bottoms to the alpine: they tend to occupy higher-elevation alpine and subalpine areas in the summer and will move to lower-elevation forests in the winter.

Habitat

Landscape connectivity should be maintained for Wolverines. Landscape connectivity for Wolverines should include regularly used denning sites, trails, foraging areas, and any other important Wolverine habitat. Section 1.2 Landscape-level Habitat and section 1.4 Species-specific Habitat include several objectives and management directions that benefit Wolverines. The B.C. Ministry of Environment is responsible for collecting habitat information, and the B.C. Integrated Land Management Agency maintains the data and provides them to resource agencies and users. Further research may be directed at identifying important habitat features in the M-KMA.

Population

The general population objective for Wolverines is to maintain functionally significant populations throughout the M-KMA. The population management intent is to maintain or

increase their numbers. To achieve this, cost-effective yet meaningful population estimates should be developed, and risks to Wolverines should be identified. The number of Wolverines maintained depends in some measure upon the success in achieving ungulate objectives and healthy Wolf populations, as much of the food that Wolverines consume during winter months is carrion from Wolf-killed ungulates.[223] The B.C. Ministry of Environment has developed guidelines to address Wolverine management and should attempt to obtain an absolute estimate for the M-KMA every 12 years (1/2 SOU per year).

Health
The B.C. Ministry of Environment should establish baselines for appropriate health parameters, so that population health can be monitored. The Ministry should opportunistically monitor Wolverine health by sampling harvested animals.

Disturbance
In order to prevent den abandonment, identified denning areas must be protected from disturbance from mid February to mid June.[224, 225] When an active den is identified through development or tenured activities, it must be reported to the B.C. Ministry of Environment. Known den sites should be regionally monitored. Guidelines for working near identified denning areas must be applied; for example, all access within 2 km of active dens should be avoided. Development of facilities and high levels of human activity in identified high-use habitats should be avoided at all other times of year. Appropriate resource agencies should apply the Identified Wildlife Management Strategy procedures and standards for all activities that potentially affect Wolverines in the M-KMA. The B.C. Ministry of Environment is responsible for providing guidelines including, but not limited to, timing windows and best management practices to protect and maintain Wolverine presence, for use in planning developments and tenured activities, and for use when denning areas are identified. The B.C. Ministry of Environment and resource users should monitor den use and denning areas. Appropriate resource agencies should track important Wolverine habitat to provide such information to project proponents or tenure holders for use in planning their developments. A potential research area to be established is to determine the level of fidelity exhibited by Wolverines to previously active denning areas.

Harvest
The objective is to maintain a conservative harvest approach, and regulations should be modified as required to achieve this objective. The two recommended approaches are trapper education and encouraging the use of trapping methods that exclude Wolverines. Though populations are not at risk in most of the M-KMA, trapping seasons may be modified or local areas closed to appropriately deal with populations of concern. Indicators include the estimated age ratios in the populations and harvest numbers relative to population size. The B.C. Ministry of Environment is responsible for reviewing Wolverine regulations annually.

*2.4.2 Lynx (*Lynx canadensis*)*

General[226, 227, 228, 229, 230]
This species is not a priority for active management in the M-KMA. Lynx are listed in CITES.[231] Lynx are commonly associated with the boreal forests of Alaska and Canada. In the M-KMA, Lynx distribution is widespread in forested habitat, with fewer occurrences in the alpine and subalpine areas. Densities of Lynx are lower than those found in the boreal forests of the Taiga

Plains and Boreal Plains ecoprovinces to the east of the M-KMA. This results from the generally lower levels of their principal foods (hares and grouse). Lynx numbers fluctuate considerably with the cyclic changes in those prey species.

The distribution of Lynx coincides with the availability of suitable prey habitat, primarily that of the Snowshoe Hare, which comprises 60% of their winter diet. Lynx are so dependent on Snowshoe Hares that their density roughly follows the hare population cycle. In general, Lynx require a mosaic of forest conditions, such as young forests (early-seral stages) that support a variety of prey species for foraging, and mature forests for denning and resting (security/thermal) habitat. Recent burns offer little habitat value to Snowshoe Hares and Lynx, but, as is often the case with timber removal by logging, result in good habitat 15–20 years post-fire. In Alaska, parts of the Yukon, and the Northwest Territories, alpine shrub thickets serve as food refuges for Lynx during lows in the hare cycle; in these areas, adjacent mature forested habitat is still required and used for other activities such as cover and denning. This phenomenon, although largely undocumented in the literature, has been observed in a more subjective manner for the plan area as well.

For natal dens, female Lynx select dense, mature forest habitats that contain large woody debris to provide security and thermal cover for kittens. Other important features of denning sites are a high density of downed trees, minimal human disturbance, proximity to feeding habitat, and stands that are at least 1 ha in area.[232] Maternal dens do sometimes occur in younger regenerating forests that contain a high density of blowdown and structures such as roots and dense vegetation. Therefore, understorey structure is an important habitat component for maternal dens. Resting sites are also found in young to mature forest habitats and are important as refuge from inclement winter weather or drought.

Habitat
No specific habitat objectives for Lynx are recommended at this time; implementing the objectives and management directions outlined in section 1.0 Habitat Management is considered sufficient.

Population
The general population objective for Lynx is to maintain functionally significant populations throughout the M-KMA. The intent is to maintain or increase Lynx numbers. The B.C. Ministry of Environment should continue to follow trends by monitoring the trapper return system, distinguishing adult vs. kitten harvest through pelt measurements, and conducting an annual trapper survey.

Health
The B.C. Ministry of Environment should establish baselines for health parameters, contagions, parasite loads, glucocorticoid levels, or other appropriate physiological parameters, so that population health can be monitored. The Ministry should opportunistically monitor Lynx health by sampling harvested animals.

Disturbance
In order to prevent abandonment of active Lynx dens, identified denning areas should be protected from disturbance during use. When an active den is identified through development or tenured activities, it should be reported to the B.C. Ministry of Environment. The Ministry is responsible for providing timing windows and best management practices to project proponents or tenure holders for use in planning their developments, and for use when active dens are found. Proponents should monitor den use. The B.C. Integrated Land Management Agency should establish and maintain a database of important Lynx habitat.

Harvest
There are no specific harvest objectives for Lynx. Commercial harvest may continue according to provincial policy and regulations.

*2.4.3 Marten (*Martes americana*)*

General[233, 234, 235, 236]
This species is not a priority for active management in the M-KMA, although Marten are the most economically important furbearing animal species. As one of the top predators of small mammals, they are often considered indicators of ecosystem health. Marten are most successful in old coniferous and mixed forests, and this habitat requirement makes this species sensitive to forest practices and the effects of habitat alteration at the landscape level. While this species is normally associated with uneven-aged old-growth coniferous and mixed forests, it will occur wherever there is sufficient prey (small mammals such as mice, voles, and squirrels), along with accessible areas underneath snow cover in winter. A key element of suitable Marten habitat is structural complexity at ground level (e.g., coarse woody debris), which provides security cover, denning and resting sites, and access to subnivean prey. In the M-KMA, only the alpine and non-forested habitats are unlikely to support Marten.

Marten are capable of adapting to changing situations. The highest density (and trapper harvest) in the province has been in some of the large wildfire areas along the Liard River, some 5–10 years post-fire. This latter situation was obviously related to post-fire structural conditions and improved winter access under the snow cover offered by extensive downed timber. Marten numbers will fluctuate as cyclic prey (such as voles, hare, and grouse) or prey food (such as spruce cones) is abundant or scarce. The main focus for management should be to maintain sufficient numbers for consumptive and non-consumptive use. Marten are widespread throughout the M-KMA, and occur in all Landscape Units. Their numbers in the M-KMA would be most threatened by large-scale logging of mesic conifer stands.

Habitat
Maintaining important habitat features at the stand level is the habitat objective for Marten. Retaining large-diameter coarse woody debris (CWD) at naturally occurring levels and volumes, promoting alternative methods that maintain structural complexity, and maintaining stand-level connectivity by restricting opening sizes and amount of timber removed are examples of methods to mitigate stand-level development impacts on Marten. The B.C. Ministry of Environment is responsible for providing guidelines for habitat management for Marten. The research focus for this species may be to determine suitable, local CWD characteristics.

Population
The general population objective for Marten is to maintain functionally significant populations throughout the M-KMA. The main intent is to maintain or increase Marten numbers. The B.C. Ministry of Environment should monitor population trends through trapper returns and an annual trapper survey.

Health
The B.C. Ministry of Environment should establish baselines for health parameters, contagions, parasite loads, glucocorticoid levels, or other appropriate physiological parameters, so that population health can be monitored. The Ministry should opportunistically monitor Marten health by sampling harvested animals.

Disturbance
There are no disturbance objectives for Marten beyond those recommended in section 2.1 General Species Direction.

Harvest
There are no specific harvest objectives for Marten. Commercial harvest may continue according to provincial policy and regulations.

*2.4.4 Fisher (*Martes pennanti*) (Blue-listed)*

General[237, 238, 239, 240]
Fisher are far-ranging carnivores associated with late-succession forests and riparian areas. Resting and maternal dens are most often found in large, mature and declining cottonwood. Like Marten, Fisher are strongly associated with coarse woody debris (CWD). These animals are generalist predators, and will hunt any small mammal. Fisher will also eat carrion. Fisher are adept at hunting Porcupine and are the primary predator of that species. The Fisher is blue-listed provincially because populations are believed to have declined recently over much of their range, and a 25–50% decline due to habitat loss is predicted over the long term. Fisher are included in the provincial *Identified Wildlife Management Strategy Standards for Managing Identified Wildlife*. Populations are sensitive to over-harvest by trapping and are particularly susceptible to habitat change (notably forest harvesting). Fisher have relatively large home ranges; 600 km^2 has been suggested as a minimum area necessary to manage for viable populations. Availability of suitable den sites is possibly a limiting factor. Fisher numbers fluctuate considerably with the cyclic changes in primary prey (hare, Porcupine, and grouse) numbers. Fisher are widespread throughout the M-KMA and occur in all Landscape Units, although there are restrictions in elevation that limit their habitat use. Fisher will be actively managed for in all Species Objectives/Strategies Units.

While Fisher will forage within many structural stages, most habitat use is associated with mature and old riparian forest where late-succession structural characteristics are most developed. Resting and maternal denning habitat is typically associated with older forests. Suitable habitat is characterized by shrub cover, coniferous canopy cover of mature and old forest,[241, 242] sub-hygric or wetter moisture regime, patches of large, declining trees (particularly black cottonwood), and greater than average amounts of CWD for the zone (> 200 m^3/ha), and have greater than 30% canopy closure. Fisher will use small cutblocks but also require larger

habitat areas. Over the long term, larger cutblocks will develop into larger habitat areas. Large-diameter spruce (> 40 cm dbh), cottonwood (> 75 cm dbh), or fir in decay classes 2 and 3 are preferred. Trees with cavities, broom rust, or witches broom are selected for denning and resting. Population cycles of major prey species can also determine Fisher use. Riparian–riparian and riparian–upland connectivity is also important.

Habitat
Important habitat for Fisher should be managed at the landscape and stand levels. To achieve this objective, available guidelines for Fisher habitat should be followed. For example, stand retention should be windfirm, and should be 2 ha or larger to provide denning and resting habitat. Streamside retention in Special Management Zones should exceed streamside retention in General Resource Management Zones. The B.C. Ministry of Environment is responsible for providing guidelines for habitat management for Fisher. Appropriate resource agencies should participate in tracking important Fisher habitat data.

Population
The general population objective for Fisher is to maintain functionally significant populations within the Muskwa-Kechika Management Area. The intent is to maintain or increase their numbers. To achieve this, cost-effective yet meaningful population estimates should be developed and the current distribution of Fisher should be determined. The B.C. Ministry of Environment should lead population assessments.

Health
The B.C. Ministry of Environment should establish baselines for health parameters, contagions, parasite loads, glucocorticoid levels, or other appropriate physiological parameters, so that population health can be monitored. The Ministry should opportunistically monitor Fisher health by sampling incidentally harvested animals.

Disturbance
In order to prevent abandonment of Fisher dens, identified denning areas must be protected from disturbance during use. When an active den is identified through development or tenured activities, it must be reported to the B.C. Ministry of Environment, and should be regionally managed. The Ministry provides habitat information and develops guidelines, including, but not limited to, timing windows and best management practices for use in planning developments and tenured activities, and for use when active dens are found. The B.C. Ministry of Environment, proponents, and tenure holders, when possible or applicable, should monitor den use and denning areas. Appropriate resource agencies should apply the Identified Wildlife Management Strategy procedures and standards for all activities that potentially affect Fisher in the M-KMA. Appropriate resource agencies should participate in establishing and maintaining a database of locations of important habitat for Fisher. A potential research area to be established is to determine the level of fidelity exhibited by Fisher to previously active denning areas.

Harvest
Fisher has been closed to harvest, a reflection of its status as a red-listed species in British Columbia. Any Fisher accidentally caught must be reported to the Ministry of Environment for compulsory inspection. Reducing accidental kills from Marten traps is the only harvest objective

for Fisher. The B.C. Ministry of Environment monitors accidental kills, provides trapper education, and encourages use of Marten trapping methods that exclude Fisher. Developing and testing Marten trapping methods to exclude Fisher may be research priorities.

*2.4.5 River Otter (*Lontra canadensis*)*

General[243, 244, 245, 246]

The River Otter is not a priority for active management in the M-KMA. The River Otter is listed in CITES.[247] The Otter is closely associated with riparian areas and is most often seen in the water, but will use Beaver lodges, dams, bank dens, log jams, and CWD for resting and maternal dens. River Otters are strongly associated with slow-moving, fish-bearing water, with diverse shorelines that provide hiding places, although this species may travel considerable distances through upland areas to reach preferred habitat. These furbearing animals are primarily non-game-fish–eaters and are also known to consume invertebrates (insects, molluscs, and crayfish), birds, amphibians, and, occasionally, reptiles, Muskrats, and Beavers. River Otters travel relatively large home ranges, up to 50 km along linear travel routes for males. Population density is related to habitat and food availability and is reported at one Otter per 4–17 km of waterway. Populations are susceptible to over-harvest by trapping and are sensitive to habitat change. The Gray Wolf is the main predator and mortality factor for River Otters in the M-KMA. River Otters are widespread throughout the M-KMA, occurring in all Landscape Units, although there are restrictions in elevation that limit their habitat use.

Habitat

This species is associated with riparian habitat and the distribution of fish, their main prey. The habitat objective for River Otter is to maintain riparian habitat suitability. Disturbance in riparian areas must be minimized, and fish and their habitat must be maintained. Appropriate resource agencies should apply riparian management guidelines (such as the *Riparian Management Area Guidebook*[248]) to all activities (including, but not limited to, mechanical exploration) in riparian zones in the M-KMA. The B.C. Ministry of Environment provides habitat suitability and development guidelines.

Population

The general population objective for the River Otter is to maintain functionally significant populations within the M-KMA. The intent is to maintain or increase their numbers. To achieve this, cost-effective yet meaningful population estimates should be developed, and their current distribution should be determined. The B.C. Ministry of Environment leads population assessments.

Health

The B.C. Ministry of Environment should establish baselines for health parameters, contagions, parasite loads, glucocorticoid levels, or other appropriate physiological parameters, so that population health can be monitored. The Ministry should opportunistically monitor River Otter health by sampling harvested animals.

Disturbance
River Otter have been found to be sensitive to human activity and development.[249] Disturbance to riparian areas should be minimized. These animals tend to follow regular movement patterns along riparian habitat, and the trails should be marked and mapped prior to natural resource development.[250] In order to prevent abandonment of Otter dens, identified denning areas must be protected from disturbance during use. When an active den is identified through development or tenured activities, it must be reported to the B.C. Ministry of Environment. The Ministry provides habitat information and develops guidelines, including, but not limited to, timing windows and best management practices for use in planning developments and tenured activities in known denning areas, and for use when active dens are found. The B.C. Ministry of Environment, proponents, and tenure holders, when possible or applicable, should monitor den use and denning areas. Appropriate resource agencies are responsible for applying appropriate guidelines for all activities that potentially affect River Otter in the M-KMA. Appropriate resource agencies should track important habitat for Otter, including, but not limited to, denning areas. A potential research area to be established is to determine the level of fidelity exhibited by Otter to previously active denning areas.

Semi-aquatic wildlife (specifically Beaver, Muskrat, and Otter) can be adversely affected by increased water-related recreational activities such as boating. The effects reported include increased pollution, contaminant suspension, and increased turbidity. Effects can be direct (e.g., mortality) or indirect (e.g., food-chain effects). Increased motorboat activity has led to increased rates of bank erosion, increased levels of contaminants in the water, and a decline of overall water quality, all of which can influence the reproduction and survival of bank-dwelling mammals. To maintain riparian habitat suitability, motorboat access should be managed for Otter. In addition, industry use of Beaver ponds as a source of water for ice roads can have a negative impact on important food sources for Otter. Water use should not be from ponds with fish or from ponds with signs of Otter use, and should be monitored by the appropriate resource agencies).

Harvest
The harvest objective for River Otter is to maintain a conservative approach, a reflection of our lack of population information and extremely low historic presence in the fur harvest relative to observations in the plan area. Trappers should continue to be educated to concentrate efforts in early spring (March and April), and early winter (mid-October and November) to target young transients, and to record and report trapper effort. The B.C. Ministry of Environment reviews trapping regulations annually.

*2.4.6 Beaver (*Castor canadensis*)*

General[251]
Beavers are widespread throughout the M-KMA and occur in all Landscape Units. This species is not a priority for active management. Beavers are restricted to slower-moving water and ponds and lakes with an accessible supply of hardwood/mixedwood forest. Fire has in many cases improved the availability of food for the Beaver, as regenerating deciduous stands provide productive habitat. Beavers will eat a variety of plants during the summer, including grasses, forbs, leaves of shrubs, and aquatic plants. In the winter, Beavers will rely more heavily on the bark and twigs of deciduous trees and shrubs (mostly aspen and willow) stored in food caches.

Beaver ponds may also be critical habitat for many other species, including fish, Otter, songbirds, waterfowl, amphibians, and invertebrates.

Habitat
No specific habitat objectives for Beavers are recommended at this time; implementing the objectives and management directions outlined in section 1.0 Habitat Management is considered sufficient.

Population
The general population objective for Beavers is to maintain functionally significant populations throughout the M-KMA. No specific initiatives are proposed.

Health
The B.C. Ministry of Environment should establish baselines for health parameters, contagions, parasite loads, glucocorticoid levels, or other appropriate physiological parameters, so that population health can be monitored. The Ministry should opportunistically monitor Beaver health by sampling harvested animals.

Disturbance
To minimize impacts of development, Beaver dams and lodges should be protected. Resource users must evaluate alternatives to destruction of Beaver lodges and dams when conflict situations arise. Industry use of Beaver ponds as a source of water for ice roads can have a negative impact on Beavers. To maintain winter ponds, water should not be removed from active Beaver ponds and this should be monitored by the appropriate resource agencies).

Harvest
Part of the harvest strategy should be directed trapping of Beavers when conflict arises. Trails and/or access roads located in riparian areas are often flooded through the activity of Beavers. The decision to permit the removal of the dam and trap the Beavers is made on a case-by-case basis and should be applied more conservatively in the M-KMA.

2.5 Red- and Blue-listed Vertebrate Species

Provincially red- and blue-listed species not discussed elsewhere in this plan that must be considered for management in the Muskwa-Kechika Management Area include Northern Myotis, Sandhill Crane, Peregrine Falcon, Short-eared Owl, Cape May Warbler, Black-throated Green Warbler, and Connecticut Warbler. It is assumed that the remaining red- and blue-listed vertebrate species (see Technical Appendix 4) will be addressed through objectives and management directions for species with similar requirements.[252] There exist few reported occurrences of red- and blue-listed species because most of the area has not been directly surveyed. Therefore, a priority is to establish baseline inventories.

For all the red- and blue-listed species of management priority, habitat requirements are a primary consideration. Loss of habitat through various means, cumulative effects, and increasing use of natural resources have been major factors in placing these species on the Red and Blue lists. The general objective for red- and blue-listed species is to maintain important wildlife habitat. First, baseline inventory must be conducted to determine distribution of species and their

important habitat. Known habitat and distribution information for project areas must be provided to project proponents and tenure holders for development and/or planning processes, when possible. If no such information is available, appropriate resource agencies are responsible for providing sufficient information to assess potential impacts as part of development proposals, including, but not limited to, mechanical exploration activities. Red- and blue-listed species data must be delivered to the Conservation Data Centre, the M-KMA Program Manager, and the regional B.C. Ministry of Environment office. To minimize the risk of reduction or loss of biological diversity, ecosystem function, or habitat suitability, the B.C. Ministry of Environment is responsible for providing conservative guidelines for important red- and blue-listed species habitat, and the appropriate resource agencies are responsible for applying appropriate guidelines. Such guidelines should also apply to management of habitat with high potential for identified red- and blue-listed species whose presence in the area is yet to be determined or described, but is possible. Listed species are potential indicators of ecosystem health. To assess management effectiveness, the B.C. Ministry of Environment may monitor their status. Adaptive management must consider the effects on red- and blue-listed species, in particular those effects resulting from active management of the large-mammal system and the effects, positive or negative, from resource use. Recovery plans are anticipated for all provincial red-listed species and will help direct management of red-listed species within the M-KMA.[253]

Long-term recovery plans should be developed for red-listed species. Management plans should be developed for blue-listed species. To implement the recovery plans and to assess management actions, baseline data on species, numbers, and distribution in the Muskwa-Kechika Management Area should be collected. Habitat data should be analyzed to help identify potential high-value habitat. The public should be encouraged to submit information. Potential stressors and risks to the populations should be included and addressed in regional land use planning processes. Appropriate resource agencies should provide baseline habitat inventory information and assessment of impacts to red- and blue-listed species and should participate in monitoring continued use of important habitat as part of development. The B.C. Ministry of Environment leads recovery planning, with participation from appropriate resource agencies.

*2.5.1 Northern Myotis (*Myotis septentrionalis*) (Blue-listed)*

General[254, 255, 256, 257, 258, 259, 260, 261]

The Northern Myotis is currently a blue-listed species in British Columbia. Very little is known of this nocturnal mammal, and only a few records exist for the province. Recent surveys have documented roosting Northern Myotis bats in northeastern British Columbia, including the Liard River area of the Muskwa-Kechika Management Area. This species emerges from roosts at dusk to hunt for invertebrates (such as moths, beetles, and caddisflies) over small ponds and forest clearings. The Northern Myotis does not migrate; it hibernates individually or in small groups in crevices where temperatures may fall to 1.6ºC. Suitable habitat includes open mature cottonwood or structurally equivalent forest adjacent to lakes, ponds, and large rivers at low elevation (e.g., in the Liard River Corridor).

In northern British Columbia, six roost trees were identified (two were visually confirmed), and all were either old balsam poplar or aspen. Roosts were either holes or cracks in trees at least 5 m above the forest floor. In the West Arm Demonstration Forest near Nelson, British Columbia, four species of bats roosted selectively in tall trees with relatively open canopies that were close

to nearby Wildlife Trees. In addition, studies found that Big Brown Bats (*Eptesicus fuscus*) and Silver Haired Bats (*Lasionycteris noctivagans*) preferred large trees (either in diameter or height) that were relatively uncluttered by surrounding trees, and both bat species strongly preferred trembling aspen. Results from a pilot study into roosting behaviour of the Northern Myotis indicate similar results to other studies from southern British Columbia. A bat colony will often roost among several trees, associating with different groupings of the colony night by night. Colonies likely occupy multiple trees, colonies are larger than the numbers of bats in any given tree, and bats mix and match, maintaining contact with other colony members as they move among roosts. This would suggest that, in forests, a functional bat roost can consist of many trees, which needs to be considered when setting aside roosting habitat (as well as future recruitment). Roosting bats show some overlap with habitat models for Fisher and are most likely found in mature deciduous or deciduous-leading riparian forests, although they are not restricted to these habitats. Although limited surveys have not found any bats roosting in caves, there is significant potential for wintering bat populations (hibernacula) in cave and karst formations in the M-KMA, particularly deep caves with a temperature of 3–4ºC and 100% relative humidity. In the M-KMA their distribution is unknown, except for the Liard River Corridor Protected Area.

Studies in recent years have reported the following effects of recreational activities on small mammals: direct mortality, population reduction, increased energy expenditure, displacement, habitat modification, forage removal, and cover removal. Harvesting of older mixedwood forests has an impact on these bats, because this habitat seems to be preferred for roosting during reproduction. Northern Myotis appear to avoid clearcuts. Studies have also found that this species is sensitive to impacts during critical winter hibernation and birthing/rearing periods. The timing of development and effects of microclimate conditions on habitat are critical.

Habitat

The habitat objective for the Northern Myotis is to identify and protect important habitat. In the M-KMA, roosts of any bat species are potentially important for the Northern Myotis, because multiple species can use the same roost. Recent work has identified potential cave and karst features in the M-KMA, some of which are potentially used for hibernacula. Potential roosting habitat – such as caves, bridges, abandoned cabins and other old buildings, and low-elevation old forests – should be examined for use. Suitability of important Northern Myotis habitat must be maintained. Since known sites are scarce, the B.C. Integrated Land Management Agency should regionally manage these known roosts and hibernacula. The B.C. Ministry of Environment should attempt to develop/refine habitat ratings for the Northern Myotis in the M-KMA. Research may focus on the potential for artificial rearing houses.

Population

The general population objective for Northern Myotis is to improve their status without using extraordinary means. The initial population objective is to determine whether this species breeds in the area. To achieve this, potential breeding habitat should be searched. The B.C. Ministry of Environment leads inventory efforts.

Health
There are no specific health objectives for the Northern Myotis at this time.

Disturbance
In order to prevent roost abandonment, identified roosts and roosting areas should be protected from disturbance. When a roost is identified through development or tenured activities, the proponent must report this information to the B.C. Ministry of Environment. When a hibernaculum (winter roost) is discovered, appropriate resource agencies are responsible for preventing disturbance from managed human activities. Resource use and recreation activities should be restricted around or in caves known to be used or potentially used for hibernating, roosting, or maternal sites. Prior to permitting commercial recreational caving, surveys for use must be completed, during appropriate times of the year. The B.C. Ministry of Environment is responsible for providing guidelines, including, but not limited to, timing windows and best management practices, for use in planning developments and tenured activities, and for use when roost areas and hibernacula are found. Appropriate guidelines must be applied to any hibernacula and any species of bat. Appropriate resource agencies should track important bat habitat (including, but not limited to, resting, nursery, maternal, breeding, and hibernacula) to provide to project proponents or tenure holders for use in planning their developments.

2.5.2 Sandhill Crane, canadensis *subspecies (*Grus canadensis canadensis*) (Yellow-listed)*

General [262, 263, 264]
Three subspecies of Sandhill Crane occur in British Columbia. The Lesser Sandhill Cranes are the most likely to be found in the M-KMA and are known to breed primarily in the Northwest Territories, the Yukon, Alaska, and the northern portions of the Prairie Provinces. Sandhill Cranes are included in the provincial *Identified Wildlife Management Strategy Standards for Managing Identified Wildlife*.[265] Thousands of cranes migrate through the M-KMA in the spring and fall, and there are some records of Sandhill Cranes breeding in the northeast corner of the province. Breeding season generally occurs from April to August; however, times possibly vary by location in the M-KMA. There are no confirmed breeding records of Sandhill Cranes in the M-KMA, although anecdotal information suggests nesting activity north of Fort Ware.[266] Sandhill Cranes nest in isolated bogs, marshes, swamps, and meadows as well as along the shores of ponds, rivers, and lagoons. This species requires thick shrubs or emergent vegetation, including *Salix, Ledum, Scirpus,* and *Carex,* for nest construction and concealment.

Habitat
Important habitat for Sandhill Cranes should be identified and protected. In the M-KMA, the most important habitats are breeding and migration staging areas. Potential habitat, such as wetlands and grasslands should be searched for use. The B.C. Ministry of Environment leads inventory efforts and develops/refines habitat ratings for Sandhill Cranes in the M-KMA. Appropriate resource agencies should regionally track known breeding and staging information. Research may focus on the habitat characteristics of breeding areas.

Population
The general population objective for Sandhill Cranes is to improve their status without using extraordinary means. The initial population objective is to determine whether this species breeds in the area. To achieve this, potential breeding habitat should be actively searched for nesting pairs. The B.C. Ministry of Environment leads inventory efforts.

Health
There are no specific health objectives for Sandhill Cranes at this time.

Disturbance
In order to maintain the suitability of breeding and staging areas, these areas must first be identified. Guidelines must be applied to minimize disturbance of known or potential breeding and staging areas. For example, disturbance activity (such as, but not limited to, grazing) must be avoided during critical times in potential breeding and staging areas. The construction of facilities in areas surrounding identified or potential breeding and staging areas should not be permitted. Appropriate resource agencies should apply the Identified Wildlife Management Strategy procedures and standards for all activities that potentially affect Sandhill Cranes in the M-KMA.[267] The B.C. Ministry of Environment is responsible for preparing guidelines for tenured and development-related activities in identified or potential Sandhill Crane habitat. Appropriate resource agencies are responsible for tracking known habitat and distribution information and this information is to be provided to proponents for planning processes.

2.5.3 Peregrine Falcon, anatum *subspecies (*Falco peregrinus anatum*) (Red-listed)*

General [268, 269]
This species has been a focus of interest for many years. There are only two known possible nest sites in the M-KMA.[270] Peregrine Falcons are known to breed further north, and the M-KMA is a migratory route. The *anatum* Peregrine Falcons are listed in CITES.[271] Interim management measures outlined below do not address migration and staging habitat for Peregrine Falcons. This species is nationally listed as "threatened" by COSEWIC.[272] A national recovery plan is in place for this species, and all recovery activities, planning, etc. should be considered within the context of this plan.[273] The two recovery plan priorities that apply most to the M-KMA include population monitoring and habitat preservation.

Peregrine Falcons breed most often on dry cliff ledges, between 12 and 338 metres above the ground. In all cases, Peregrines choose a site that has an isolated protected spot for nesting near good hunting grounds, usually a cliff or rocky outcrop. They prefer ledges 15–60 m above ground, with a southern exposure, some vegetation on the ledge, and a protective overhang above. However, other forms of nesting habitat have also been utilized, such as river cutbanks, river canyon walls, cliffs above lakes, tall trees, and even human-made structures in urban areas. Occasionally Peregrines nest in other habitat types including tundra, savanna, and high mountainous areas.

Habitat
Preserving habitat is part of the second priority of the national recovery plan for this species. The preliminary habitat management objective for this species is to identify nest sites. To achieve this, high-potential habitat should be searched for active nests. No active nests for Peregrine

Falcons are known in the M-KMA at this time. If found, active nest sites must be identified in a regional database of raptor nests. The B.C. Ministry of Environment leads inventory for this species. The B.C. Integrated Land Management Agency manages the raptor nest database.

Population
The general population objective for Peregrine Falcons is to improve their status without using extraordinary means. There are no current nesting records of Peregrine Falcons in the M-KMA; therefore, determining whether this species breeds in the area should be the initial population objective. The B.C. Ministry of Environment should search for breeding falcons, with an emphasis on areas of likely habitat, or areas indicated in anecdotal information or historical reports. If active nests are found, further assessment and planning should be required.

Health
There are no specific health objectives for Peregrine Falcons at this time.

Disturbance
In order to maintain the suitability of nesting and fledging areas, these areas first need to be identified. Peregrine Falcons are particularly sensitive to impacts during nesting and fledging periods. To prevent negative effects, major disturbance activities should be avoided within 1.2 km of known nests during these critical times; some activities must be avoided within a closer radius.[274, 275] Appropriate resource agencies should minimize physical disturbance of known nesting and fledging areas. The construction of facilities within 1.2 km of known nesting and fledging areas should be avoided. The B.C. Ministry of Environment is responsible for preparing guidelines for tenured and development-related activities in identified Peregrine Falcon habitat. Appropriate resource agencies are responsible for applying appropriate guidelines and tracking known habitat and distribution information to provide to proponents for planning processes.

*2.5.4 Short-eared Owl (*Asio flammeus*) (Blue-listed)*

General [276, 277, 278, 279, 280]
This species is declining in some parts of British Columbia. Although no official nesting records exist, individuals were observed in the M-KMA in recent summers.[281] The Committee on the Status of Endangered Wildlife in Canada listed this species as of "special concern" nationally.[282] Short-eared Owls are included in the provincial *Identified Wildlife Management Strategy Standards for Managing Identified Wildlife*.[283] The Short-eared Owl is listed in CITES.[284] All recovery activities, planning, etc. should be considered within the context of these planning processes.

Short-eared Owls nest in open areas, such as dry marshes, grasslands, alpine tundra, and forest openings. They build their own shallow scrapes on the ground, often hidden by vegetation. These owls hunt at low elevations over fields, marshes, and open areas, preying on small mammals (usually rodents) and, occasionally, birds and insects. Short-eared Owls may become locally abundant in response to prey cycling, and likely migrate to more southern parts of the province during the winter, although this has not been confirmed.

Habitat
The preliminary habitat management objective for this species is to identify nest sites. To achieve this, high-potential habitat should be searched for active nests. When found, active nest sites must be identified in a regional database of raptor nests. The B.C. Ministry of Environment leads inventory for this species. Appropriate resource agencies should participate in maintaining the database. The use of prescribed fire to promote habitat for Short-eared Owls may be studied.

Population
The general population objective for Short-eared Owls is to improve their status without using extraordinary means. The immediate objective is to determine population numbers and distribution. There is only one current nesting record of Short-eared Owls in the M-KMA. The initial population objective should be to determine the distribution of this species in the area. If active nests are found, further assessment and planning should be required. The B.C. Ministry of Environment leads inventory efforts.

Health
There are no specific health objectives for Short-eared Owls at this time.

Disturbance
To maintain the suitability of nesting and fledging areas, these areas first need to be identified. In the M-KMA, Short-eared Owls are particularly sensitive to impacts during critical nesting and fledging periods (late March to early August). To prevent negative effects, disruptive activities must be avoided within 100 m of known nests during these critical times. To protect eggs and unfledged young, potential nesting and fledging areas should not be burned until August. The construction of facilities within 100 m of known nesting and fledging areas should not be permitted, and physical disturbance of these areas should be minimized. The Identified Wildlife Management Strategy procedures and standards for this species should be applied to all activities within the M-KMA, whenever and wherever Short-eared Owls occur.[285] The B.C. Ministry of Environment prepares guidelines for tenured and development-related activities in identified Short-eared Owl habitat. Appropriate resource agencies are responsible for applying appropriate guidelines and should track known habitat and distribution information to provide to proponents for planning processes.

*2.5.5 Cape May Warbler (*Dendroica tigrina*) (Red-listed)*

General [286, 287, 288, 289]
Cape May Warblers are included in the provincial *Identified Wildlife Management Strategy Standards for Managing Identified Wildlife*.[290] Current distribution of Cape May Warblers in the M-KMA is yet to be determined. This species breeds in mature coniferous forests along major river drainages and low-elevation plateaus. It also inhabits mixedwood forests and black spruce bogs. Fairly dense, mature and old-growth spruce forest with numerous openings and a poorly to moderately developed shrub layer typifies breeding habitat. The deciduous component of these stands is generally poplar, willow, and alder. Breeding habitat for this species is strongly correlated with the white spruce–currant–horsetail site series of the Boreal White and Black Spruce biogeoclimatic zone. Within this habitat, tall spruce that extend above the main canopy are used by singing males and appear to be an important habitat element. Despite its dependence on mature and old-growth coniferous forests, this species can occasionally be found in open,

selectively logged sites, indicating that it possibly tolerates such conditions. The species is more typical of edge habitat than of the forest interior.

Habitat
The habitat objective is to maintain suitable breeding habitat. Potential breeding areas in the M-KMA include old-growth, large-diameter white spruce–dominated forests. Therefore, large patches of suitable riparian forest must be maintained. Habitat fragmentation must be minimized. Stand structure and mature and old-forest connectivity is important, particularly along riparian systems, and must be maintained. The B.C. Ministry of Environment is developing suitability indices for warbler habitat. The research focus for this species may be on confirmation of habitat requirements and distribution in the M-KMA, through inventory and refinement of habitat suitability indices.

Population
The general population objective for Cape May Warblers is to increase population persistence within the M-KMA. The immediate objective is to determine population numbers and distribution. Baseline data on the species, numbers, and distribution is required and should be obtained through long-term inventory. Once baseline information is obtained, new strategies should be formulated to achieve the population objective. The B.C. Ministry of Environment leads inventory efforts. A potential research subject is examination of clutch survival relative to forest characteristics such as patch size and species composition.

Health
The B.C. Ministry of Environment should attempt to establish baselines for health parameters, contagions, parasite loads, glucocorticoid levels, or other appropriate physiological parameters, so that population health can be monitored. Research may be directed to study potential effects of oil and gas well emissions on the reproductive success of neotropical migratory birds.

Disturbance
The objective is to minimize impacts due to natural resource use. Warblers are sensitive to disturbance during the nesting season (May to late July). To minimize the negative impacts of resource use and development, habitat with high potential for Cape May Warbler breeding and rearing should be avoided. If high-potential habitat cannot be avoided, the scheduling of disturbance in such habitat should follow conservative timing windows. To mitigate impacts due to forest harvesting, Old Growth Management Areas must be spatially located to include high-potential breeding habitat, patch sizes and distributions should be maintained within the natural range of variability, and large Wildlife Tree patches must be retained in a connected landscape. Silviculture activities that restore structural diversity of mature and old stands and regenerate cut areas with spruce-dominated mixedwood stands can provide breeding and rearing habitat for this species. Salvage harvesting of insect-infested timber and the use of insecticides should be restricted in suitable Cape May Warbler habitat. The Identified Wildlife Management Strategy procedures and standards for this species should be applied to all activities within the M-KMA.[291] The B.C. Ministry of Environment is responsible for providing guidelines for managing disturbance effects on warblers. Appropriate resource agencies should track the availability of forest habitat suited to breeding Cape May Warblers.

*2.5.6 Black-throated Green Warbler (*Dendroica virens*) (Blue-listed)*

General [292, 293, 294, 295]

Black-throated Green Warblers are included in the provincial *Identified Wildlife Management Strategy Standards for Managing Identified Wildlife*.[296] Current distribution of the Black-throated Green Warbler in the M-KMA is yet to be determined. This species is generally associated with mature mixedwood forests throughout its range but is also occasionally found in pure coniferous forests and very rarely in deciduous woodlands. Typical breeding habitat is spruce-aspen-poplar forest with an understorey composed of willow, rose, baneberry, highbush-cranberry, cow-parsnip, bunchberry, horsetail, fireweed, kinnikinnick, peavine, and vetch. The shrub layer is typically well developed. Forest openings are important because of increased light penetration in the understorey and thus increased vegetation and subsequently prey diversity. This species is more often found around the edges of such openings, often within a matrix of denser forest.

Habitat

The habitat objective is to maintain suitable breeding habitat. Potential breeding areas in the M-KMA include late-seral, mixedwood forests. Habitat fragmentation must be minimized. Stand structure and mature- and old-forest connectivity is important, particularly along riparian systems, and must be maintained. The B.C. Ministry of Environment should develop suitability indices for warbler habitat. The research focus for this species may be on confirmation of habitat requirements and distribution in the M-KMA, through inventory and refinement of habitat suitability indices.

Population

The general population objective for Black-throated Green Warblers is to increase population persistence within the M-KMA. The immediate objective is to determine population numbers and distribution. Baseline data on the species, numbers, and distribution are required, and should be obtained through long-term inventory. Once baseline information is obtained, new strategies should be formulated to achieve the population objective. The B.C. Ministry of Environment leads inventory efforts. A potential research subject is examination of clutch survival relative to forest characteristics such as patch size and species composition.

Health

The B.C. Ministry of Environment should attempt to establish baselines for health parameters, contagions, parasite loads, glucocorticoid levels, or other appropriate physiological parameters, so that population health can be monitored. Research may be directed to study potential effects of oil and gas well emissions on the reproductive success of neotropical migratory birds.

Disturbance

The objective is to minimize impacts due to natural resource use. Warblers are sensitive to disturbance during the nesting season (May to late July). To minimize the negative impacts of resource use and development, habitat with high potential for Black-throated Green Warbler breeding and rearing should be avoided. If high-potential habitat cannot be avoided, the scheduling of disturbance in such habitat should follow conservative timing windows. To mitigate impacts due to forest harvesting, Old Growth Management Areas must be spatially located to include high-potential breeding habitat, patch sizes and distributions should be

maintained within the natural range of variability, and large Wildlife Tree patches must be retained in a connected landscape. Silviculture activities that restore structural diversity of mature and old stands can provide breeding and rearing habitat for this species. Salvage harvesting of insect-infested timber and the use of insecticides should be restricted in suitable Black-throated Green Warbler habitat. The Identified Wildlife Management Strategy procedures and standards for this species should be applied to all activities within the M-KMA.[297] The B.C. Ministry of Environment is responsible for providing guidelines for managing disturbance effects on warblers. Appropriate resource agencies should track availability of forest habitat suited to breeding Black-throated Green Warblers.

*2.5.7 Connecticut Warbler (*Oporornis agilis*) (Red-listed)*

General [298, 299, 300, 301, 302]

Connecticut Warblers are included in the provincial *Identified Wildlife Management Strategy Standards for Managing Identified Wildlife*.[303] Current distribution of Connecticut Warbler in the M-KMA is yet to be determined. This species is frequently associated with mature or old aspen forests or poplar woodlands and occasionally also with younger stands of aspen, aspen-poplar, or pure aspen on slightly drier ridges. Pole-stage aspen (25–45 years old) with a sparse shrub layer and a strongly developed herbaceous layer is also often used as breeding habitat. The understorey vegetation is generally low (< 3 m) and composed of rose, willow, bunchberry, fireweed, paintbrush, peavine, and white geranium. Suitable forests generally occur on flat to gently sloping hillsides or on dry ridges. This species avoids edge habitats and is more restricted to the interior of the forest. The Connecticut Warbler nests on the ground, and herbaceous and shrub layers are potentially the most important features.

Habitat

The habitat objective is to maintain suitable breeding habitat. Potential breeding areas in the M-KMA include pole/sapling to mature deciduous stands, and mixedwood stands. Habitat fragmentation must be minimized. Stand structure and forest connectivity is important, and must be maintained. Wildfires should be managed across the landscape to maintain natural stands of deciduous species. Conversion burns of pure deciduous stands older than 30 years should be avoided. Low-intensity burns in middle-age to old aspen forest and regenerating cut areas with deciduous stands can provide breeding and rearing habitat for this species. The B.C. Ministry of Environment leads the prescribed burning program and should provide Connecticut Warbler habitat information and priorities for an M-KMA Fire Management Plan, to be implemented in co-operation with the B.C. Ministry of Forests and Range (see section 1.6 Fire Management). The B.C. Ministry of Environment is developing suitability indices for warbler habitat. The research focus for this species may be on confirmation of habitat requirements and distribution in the M-KMA, through inventory and refinement of habitat suitability indices.

Population

The general population objective for Connecticut Warblers is to increase population persistence within the M-KMA. The immediate objective is to determine population numbers and distribution. Baseline data on the species, numbers, and distribution is required and should be obtained through long-term inventory. Once baseline information is obtained, new strategies should be formulated to achieve the population objective. The B.C. Ministry of Environment

leads inventory efforts. A potential research subject is examination of clutch survival relative to forest characteristics such as patch size and species composition.

Health
The B.C. Ministry of Environment should attempt to establish baselines for health parameters, contagions, parasite loads, glucocorticoid levels, or other appropriate physiological parameters, so that population health can be monitored. Research may be directed to study potential effects of oil and gas well emissions on the reproductive success of neotropical migratory birds.

Disturbance
The objective is to minimize impacts due to natural resource use. Warblers are sensitive to disturbance during the nesting season (May to late July). To minimize the negative impacts of resource use and development, habitat with high potential for Connecticut Warbler breeding and rearing should be avoided. If high-potential habitat cannot be avoided, the scheduling of disturbance in such habitat should follow conservative timing windows. Recreational and commercial grazing in high-potential breeding and rearing habitat should also be avoided, and should be limited during breeding and rearing periods to maintain the desired plant community, including both species composition as well as structural characteristics; at any time, there should be no more than 50% utilization of herbs and forbs. To mitigate impacts due to forest harvesting, Old Growth Management Areas must be spatially located to include high-potential breeding habitat, patch sizes and distributions should be maintained within the natural range of variability, and large Wildlife Tree patches must be retained in a connected landscape. Breeding and rearing habitat for this species can be improved through silviculture activities that restore structural diversity of the shrub and herbaceous layer in deciduous stands and regenerate cut areas with primarily deciduous, possibly mixedwood stands. Salvage harvesting of insect-infested timber and the use of insecticides should be restricted in suitable Connecticut Warbler habitat. The Identified Wildlife Management Strategy procedures and standards for this species should be applied to all activities within the M-KMA.[304] The B.C. Ministry of Environment is responsible for providing guidelines for managing disturbance effects on warblers. Appropriate resource agencies should track availability of forest habitat suited to breeding warblers.

2.6 Fish

General
Fish and fish habitat in the Muskwa-Kechika Management Area, as in all of British Columbia, is managed and protected by a variety of federal and provincial legislation. These include, but are not limited to, the Federal *Fisheries Act,*[305] the *Canadian Environmental Assessment Act,*[306] the *British Columbia Water Act*,[307] the *British Columbia Wildlife Act,*[308] and the *Forest Practices Code of British Columbia Act*.[309] The purpose of this section is to identify species or situations for which a higher level of protection and/or management must be undertaken so as to maintain the aquatic resource values of the M-KMA. This is referred to as "enhanced" management.

Fish species considered for enhanced management in the M-KMA include: Bull Trout (*Salvelinus confluentus*), Lake Trout (*S. namaycush*), Arctic Grayling (*Thymallus arcticus*), Rainbow Trout (*Oncorhynchus mykiss*), notable populations of Northern Pike (*Esox lucius*), and populations of red- or blue-listed species (as listed by the British Columbia Conservation Data Centre[310]). Areas that are demonstrated to have high biodiversity values may also be candidates

for enhanced management and protection. Inconnu (*Stenodus leucichthys*) are currently being studied and may be considered for enhanced management if new information shows their distribution more significantly within the M-KMA. The following management objectives and directions apply to all fish or areas of enhanced management consideration.

Habitat
Appropriate resource agencies are responsible for ensuring maintenance of habitat quality, water quality, and hydrological conditions (adequate water quantities, flow rates, storm response, seeps, springs, etc.), as well as for collecting baseline information on these conditions. Identifying and mapping existing fish distributions and important habitat features, including, but not limited to, migration patterns and timing, productivity, spawning, over-wintering, and rearing areas must continue; see Technical Appendix 3 for a list of fish-related important habitat. This information should be used to further develop/refine habitat ratings tables for fish in the M-KMA. Habitat connectivity is very important to fish for migration, dispersal, and gene flow. Appropriate resource agencies are responsible for tracking the maintenance of connectivity in relation to resource activities. Habitat fragmentation must be minimized and anthropogenic obstructions to movements must be eliminated (e.g., designing stream crossings for fish passage at all flows). The B.C. Ministry of Environment will track fish inventory and habitat in cooperation with other appropriate resource agencies.

Population
The general population objective for fish species is to enhance population persistence and, where applicable, to maintain functionally significant populations in the M-KMA. The immediate objective is to determine species distribution and population parameters. For many populations of game fish in the M-KMA, there is a lack of reliable inventory, stock assessment, and harvest information. Appropriate inventory, assessment, and surveys should be applied to distinct populations of the managed species. Populations should be characterized across their distributional ranges to determine variations in life history and population parameters, and population trends should be monitored. An overall strategy should be developed to fill in the basic inventory data gaps through systematic collection of data over time, thereby creating a true inventory of the aquatic resource. Once baseline information is obtained, new strategies should be formulated to achieve the population objective.

Health
Baseline parameters for physiological and genetic status of populations and sub-populations are generally lacking. To monitor fish population health, this information should be gathered through blood and tissue samples from harvests, approved/permitted research collections, and incidental mortalities. The B.C. Ministry of Environment should continue to monitor fish health.

As with all wildlife in the M-KMA, the genetic diversity of wild populations must be conserved and maintained. To this end, a catalogue of wild fish stocks should be established. Non-indigenous species should not be stocked in the M-KMA. Any transfers of indigenous species or use of non-indigenous species for stocking purposes must follow provincial and federal introductions and transfers policies, including the Wild Indigenous Fish Policy (1993), and the Fish and Aquatic Invertebrate Transplant and Introduction Policy (1994).[311, 312]

Disturbance

Important habitat for priority fish species must be protected (see Technical Appendix 3). The Identified Wildlife Management Strategy procedures and standards for Bull Trout should be applied to all activities within the M-KMA, including, but not limited to, non-forestry-related development and mechanical exploration activities.[313] For example, Wildlife Habitat Areas (WHAs) around important Bull Trout habitat features may be established; similarly, important habitat for the fish species listed above should be regionally tracked. The B.C. Ministry of Environment is responsible for tracking important fish habitat and establishing WHAs, based on proposals from any source. Tracking the status of proposed, candidate, and approved WHAs is the responsibility of the Identified Wildlife Management Strategy data coordinator in Victoria.

Fish can be sensitive to disturbances caused by resource use and development, and these impacts should be minimized. Disturbance should be managed at both the landscape and stand levels. Food and habitat requirements of fish change on a seasonal basis and over the course of their life; so too does their sensitivity to disturbance. Guidelines to avoid and mitigate effects of in-stream activities in and near important fish habitat are provided by the B.C. Ministry of Environment, and must be applied by appropriate resource agencies. These guidelines should include conservative timing windows, measures to prevent sediment delivery, measures to maintain water quantity, quality, and hydrological characteristics, and any other recommendations that potentially minimize impacts due to resource use and development.

Procedures and principles as outlined in the Policy for the Management of Fish Habitat,[314] as well as other federal fish management guidelines, must also be applied to mitigate disturbance impacts. An important aspect of disturbance management is the control and mitigation of water withdrawal. Any development requiring water must obtain a water licence, permit, or approval as per the *British Columbia Water Act*.[315] The volume, timing, and location of water extraction must be identified and should not result in impacts to fish. Draft standards for in-stream fish flows and information requirements are being prepared by the B.C. Ministry of Environment and Land and Water British Columbia Inc. Known habitat and distribution information for project areas will be provided to project proponents and tenure holders for development and/or planning processes. In the absence of such information, project proponents and tenure holders will be responsible for providing standard species and habitat inventory information[316]and assessment of potential impacts as part of development proposals, including, but not limited to, mechanical exploration activities. Research may focus on assessing and mitigating impacts from resource use and development.

Key concerns are the direct and indirect effects of access development on fish and fish habitat (roads, trails, mechanical exploration, etc.). For example, the effects of both legal and illegal fishing (poaching) can increase following access development. To minimize anticipated access impacts, in advance of access development appropriate resource agencies are responsible for identifying fisheries resources and sensitivities. Existing guidelines must be applied to fish-stream crossings. Where species or areas of enhanced management concern are involved, efforts should be made to minimize the density and temporal disturbance of access corridors. Access must be planned, managed, and coordinated. Whenever possible and appropriate, existing or historical access must be used in order to reduce the creation of new access and thereby reduce cumulative impacts. The B.C. Ministry of Environment provides guidelines for fish-stream

crossings. The effect of motorized boat access on fish, fish behaviour, and fish habitat should be further assessed. The increasing use of jet boats in the M-KMA can result in direct and indirect impacts to fish, fish behaviour, and fish habitat in some systems, notably the Muskwa and Tuchodi Rivers. A recent study indicates that adult Bull Trout in migration to spawning areas are the most susceptible to impacts from motorboat use in the Muskwa and Tuchodi Rivers, and future research may look at the role of specific habitat features, flow stages, and movement patterns in reducing recreational use impacts on migrating or staging Bull Trout.[317]

Harvest

Fish harvest is managed as required to maintain sustainable population levels. Populations for which few data exist are managed more conservatively, to minimize risk. Each of the game fish species considered for enhanced management is vulnerable to both growth and recruitment overfishing; for example, Lake Trout are long-lived and slow-growing, have a relatively low reproductive potential, and are extremely sensitive to over-harvest. Some of these species are top predators with a significant influence on other trophic levels in the ecosystem. Many of them have naturally low reproduction rates, and most occur in relatively unproductive waters as a result of high latitudes and/or altitudes. Through a combination of field surveys, aerial surveys, and co-operative data collection, the angling effort and distribution can be determined, as well as areas of sustenance fishing. Historical fisheries surveys should be used as baselines for future comparative studies. Impacts from guided angling activities should be periodically analyzed. The B.C. Ministry of Environment reviews fishing regulations annually, based on appropriate surveys and information.

2.7 Reptiles and Amphibians

Reptiles, amphibians, and their habitat are not well known in the Muskwa-Kechika Management Area. Reptile and amphibian species known or likely to occur in the M-KMA are listed in Table 9.

No red- or blue-listed reptiles or amphibians are thought to occur in the M-KMA. Habitat considerations are the primary reptile and amphibian management direction. No specific habitat objectives are recommended at this time; implementing the objectives and management directions outlined in section 1.0 Habitat Management is considered sufficient.

TABLE 9. Reptiles and amphibians known or likely to occur in the Muskwa-Kechika Management Area

Common Name	Scientific Name	Provincial Listing
Boreal Chorus Frog	*Pseudacris triseriata*	Yellow
Columbia Spotted Frog	*Rana luteiventris*	Yellow
Wood Frog	*Rana sylvatica*	Yellow
Western Toad	*Bufo boreas*	Yellow
Long-toed Salamander	*Ambystoma macrodactylum*	Yellow
Red-sided Garter Snake	*Thamnophis sirtalis*	Yellow
Western Terrestrial Garter Snake	*Thamnophis elegans*	Yellow

Western Toad (*Bufo boreas*)

General[318, 319, 320, 321, 322, 323]

The only reptile or amphibian considered for active management is the Western Toad, which is nationally listed of "special concern" by COSEWIC. This species is widely distributed, but is experiencing population declines in the southern portions of its range, including British Columbia, and is red-listed by the World Conservation Union. Population declines can be due to many factors such as habitat loss, habitat fragmentation, and disease (toads are susceptible to chytridiomycosis). The Western Toad is found in a variety of habitats, and needs water to breed, laying eggs in ponds with sandy bottoms less than 50 cm deep. Adults are mostly terrestrial outside the breeding period, normally live underground, and hibernate underground, but they can be found in or near water during dry periods.

Habitat

Habitat alienation is likely the most important cause of population decline for the Western Toad.[324] No habitat objectives or management directions specific to Western Toads are recommended at this time. It is expected that maintaining the integrity of wetland complexes in the M-KMA will ensure sufficient habitat for the Western Toad (see section 1.2 Landscape-level Habita**t**).

Population

The general population objective for Western Toads is to enhance population persistence. Where applicable, maintaining functionally significant populations is also desired. Determining the species distribution and population parameters in the area is the initial population objective. Populations should be characterized across their distributional ranges to determine variations in life history and population parameters, and population trends should be monitored. If breeding areas are found, baseline data on the species' ecology, natural history, and meta-population dynamics should be collected, [325] and long-term inventory and management assessment should be planned.

Health

There are no specific health objectives for Western Toads at this time.

Disturbance

Western Toads sometimes move well into the upland outside the breeding season and are particularly sensitive during migration. Typically, hundreds or even thousands of individuals will travel along a single path from the rearing ponds. Migrating toadlets can experience heavy mortality crossing roads. If migration corridors are known in an area where road construction is proposed, then road design and location need to be sensitive to this migration, including altering road locations and installing amphibian underpasses – such as modified culverts (also known as toad tunnels) – in order to maintain the suitability of the migration corridors. Known habitat and distribution information for Western Toads should be provided to project proponents and tenure holders for development and/or planning processes. If no such information is available, project proponents and tenure holders should be responsible for providing baseline amphibian habitat inventory information and assessment of potential impacts as part of development proposals including, but not limited to, mechanical exploration activities.

To avoid the creation of unsuitable pools that will act as ecological traps for breeding amphibians, human-made pools should have characteristics required by amphibians, such as suitable depth, temperature, and cover. Cover should be maintained on natural pools, and a diversity of pools and wetlands should remain available on the landscape.[326, 327] The B.C. Ministry of Environment may provide guidelines for pool characteristics for amphibians.

2.8 Invertebrates

Invertebrates and their habitat are not well known in the Muskwa-Kechika Management Area. Owing to the lack of general inventory information, the priority groups for invertebrate management are the lepidopterans (butterflies and moths), the odonates (dragonflies and damselflies), and the molluscs (slugs, snails, and freshwater shellfish). Additional invertebrates (outside of these three groups) may be added as inventory information becomes available. Invertebrate species considered for management in the M-KMA are listed in Table 10.[328, 329, 330, 331, 332]

Butterflies and moths require specific host plants at the various stages of their life history. Generally, the adult butterfly lays eggs on a specific host plant, on which the larvae feed after hatching. Following pupation, the adult butterfly will use different host plants for their nectar source. There are no host plant species considered for active management at this time. For many species, the larval and nectar food plants are known, although knowledge of the distribution and abundance of both is lacking.

Dragonflies and damselflies begin life in an aquatic environment, sometimes spending up to 3 years as a naiad. Eventually the adults emerge to spend the remaining part of their life in the terrestrial environment. Habitat for both the aquatic and terrestrial life stages is vital to Odonata persistence.

Gastropods (slugs and snails) are terrestrial and require microsite suitability in order to exist in a given area. Little is known of the ecology and life history of gastropods in the M-KMA. Gastropods are hermaphroditic, lay eggs, and may be slow-maturing and long-lived. Their dispersal ability is probably poor, based on the fact that distribution patterns are usually scattered. The surface activity of gastropods appears to peak in spring and early summer, coinciding with mating and oviposition. There is also activity in the fall or when the environment becomes moist again with precipitation. The list of gastropods in the M-KMA is incomplete at this time.

TABLE 10. Muskwa-Kechika Management Area priority invertebrate species (March 2009)

Common Name	Scientific Name	Provincial Listing
Butterflies and Moths (Lepidopterans)		
Arctic Blue, *lacustris* subspecies	*Agriades glandon lacustris*	Blue
Alberta Arctic	*Oeneis alberta*	Red
White-veined Arctic, *edwardsi* subspecies	*Oeneis bore edwardsi*	Blue
Philip's Arctic	*Oeneis philipi*	Red
Uhler's Arctic	*Oeneis uhleri*	Blue
Baird's Swallowtail, *pikei* subspecies	*Papillio bairdii pikei*	Blue
Old World Swallowtail	*Papilio machaon hudsonianus*	Red
Tawny Crescent	*Phyciodes batesii*	Blue
Checkered Skipper	*Pyrgus communis*	Blue
Striped Hairstreak	*Satyrium liparops*	Red
Coral Hairstreak, *titus* subspecies	*Satyrium titus titus*	Red
Aphrodite Fritillary, *manitoba* subspecies	*Speyeria aphrodite manitoba*	Blue
Great Spangled Fritillary, *pseudocarpenteri* subspecies1	*Speyeria cybele pseudocarpenteri*	Red
Mt. McKinley Alpine	*Eribia mackinleyensis*	Red
Magdalena Alpine	*Eribia Magdalena*	Red
Dragonflies and Damselflies (Odonates)		
Kennedy's Emerald	*Somatochlora kennedyi*	Blue
Plains Forktail	*Ischnura damula*	Red
Beaverpond Baskettail	*Epitheca canis*	Blue
Quebec Emerald	*Somatochlora brevicincta*	Blue
Forcipate Emerald	*Somatochloa forcipata*	Blue
Hagen's Bluet	*Enallagma hageni*	Blue
Slugs, Snails, and Freshwater Shellfish (Molluscs)		
Rocky Mountain Capshell	*Acroloxus coloradensis*	Blue
Thicklip Rams-horn	*Planorbula armigera*	Blue
Crestless Column	*Pupilla hebes*	Blue
Callused Vertigo	*Vertigo arthuri*	Blue

Freshwater shellfish are filter-feeders and require an aquatic environment free from continual substrate disturbances. In general, most freshwater molluscs are essentially immobile and thus sensitive to environmental changes and negatively affected by heavy metals, transition elements, and eutrophication. In North America, the aquatic molluscs lack a true siphon (tube) for water intake. Thus, most species can burrow only as deep as their shells, and lie partially exposed and susceptible to predators, desiccation, and temperature fluctuations.

Habitat
To maintain habitat suitability for invertebrates, appropriate resource agencies should ensure that disturbances to sites with populations of listed invertebrates are minimized, and they should maintain the habitat matrix necessary to support present populations. Where Odonates and freshwater molluscs are present, riparian protection practices should be implemented to minimize disturbances to wetlands, as discussed in section 1.0 Habitat Management.

Population
The general population objective for invertebrates is to maintain their presence in the M-KMA in sufficient numbers to prevent extirpation. Determining the distribution of priority invertebrates is the initial population objective. To achieve this, suitable habitat should be mapped and surveyed. If areas of high abundance and/or breeding areas are found, baseline data on the species, numbers, and distribution should be collected. Long-term inventory should be planned, and management effects should be assessed. The B.C. Ministry of Environment leads inventory efforts, and the B.C. Integrated Land Management Agency maintains the distribution database. As data become available, inventory requirements should be identified.

Health
There are no specific health objectives for invertebrates at this time.

Disturbance
In order to minimize impacts to invertebrates due to disturbance, the use of generalized pesticides, bacteriocides and herbicides should be extremely limited to minimize detrimental effects to non-target lepidopterans or their host plants. Broadcast aerial spraying should be completely avoided in favour of spot treatments.

Disturbance of freshwater habitat can be detrimental to dragonflies/damselflies and molluscs. The following disturbances should be avoided:

- use of chemicals such as pesticides and herbicides in the riparian areas adjacent to waterbodies;
- draining and filling of marshes, peatlands, bogs, and fens;
- alteration of the natural flow regime of waterways;
- flooding of peatlands, ponds, slow streams, and shallow lakes, and the creation of large lake habitats that support predatory species;
- destruction of wetland shores due to recreational and boating activities;
- livestock use of riparian areas;
- recreational use of hot springs; and
- activities that reduce water quality.

Known habitat and distribution information for invertebrates should be provided to project proponents and tenure holders for development and/or planning processes, when possible. If no such information is available, project proponents and tenure holders may be required to provide baseline invertebrate habitat inventory information for priority species, and assessment of potential impacts as part of development proposals, including, but not limited to, mechanical exploration activities.

3.0 Non-indigenous Species

There is a concern that the use of non-indigenous species for recreational and/or domestic purposes can pose a significant threat to native populations of wild animals. Non-indigenous species might be used for transporting goods, as pets, or for farming. Some non-indigenous animal species can be responsible for impacts on native wildlife, including displacement, harassment, mortality, potential transfer of disease, and competition for habitat resources. Non-indigenous species can invade natural communities and displace native species important to healthy intact ecosystems. In order to maintain natural and native habitats and wildlife populations, it may be necessary to manage our activities to prevent problems associated with non-indigenous plant and animal species.

3.1 Domestic Animals

Domestic animals are used throughout the Muskwa-Kechika Management Area and throughout all habitats. As a result, they are potential vectors for introducing disease and non-indigenous plants. Most domestic animals are brought in as pack animals, although there is concern about the risk of disease transmission from domestic livestock living on private property in the M-KMA. There is good evidence that domestic sheep and goats can transmit disease to wild sheep and goats. This is less clear for camelids. Species such as Stone's Sheep, considered to be particularly sensitive to disease and with no previous contact with domestic species, are most at risk. The main objective is to prevent the introduction of disease from domestic to wild animals. No presence or access of domestic animals should be allowed in areas where there is a likelihood of contact with sensitive species or their habitats, until such time as the risk is determined to be acceptable.[333] Exotics, such as goats, Llamas, Alpacas, and other camelids are not allowed in the M-KMA. Before exotics or domestic sheep are allowed they must have undergone an appropriate risk assessment[334] (which sheep and goats have failed). Goats should not be housed or farmed within at least 15 km of wild ungulate populations, unless a significant geographical barrier exists. Domestic animal waste should be managed to prevent contact with wild populations. The B.C. Ministry of Environment should provide guidelines for domestic species in the M-KMA, including species that are allowed as pack animals, and guidelines for waste management practices. The B.C. Ministry of Environment may also lead an education program, in co-operation with Land and Water British Columbia Inc, to sensitize land owners and resource users to this issue.

Domestic or feral horses can have significant grazing impacts. Guide-outfitting operations in the past often turned horses out to winter in the mountains. As a result, numerous feral horses persist in certain areas: there are approximately 15–20 individuals in the Fort St. John Forest District, and there were up to 500 wild or abandoned (trespass) horses in the Fort Nelson Forest District.[335] Possible effects on local wildlife and habitat of grazing domesticated or feral animals include reduced available forage, impacts to riparian areas, reduced stand complexity, and physical disturbance. In order to prevent negative impacts, available range should be closely monitored and conservatively allocated. Areas for grazing should be selected for minimizing impacts, avoiding riparian areas. Feed used should be locally grown, and weed-free. The B.C. Ministry of Forests and Range is responsible for managing the Crown range resource, in consultation with the B.C. Ministry of Environment. The B.C. Ministry of Forests and Range and the Guide-outfitters Association of B.C. is currently in the process of removing the feral horses

(recent efforts to remove individuals have had some success – approximately 30–50 animals have been removed to date). Effects of non-indigenous grazing on other wildlife and their habitat should be examined, with particular attention to red- and blue-listed species.

Domestic pets can have a significant impact on local wildlife if they are left loose and unattended in the wild. Cats and dogs will often chase and sometimes kill birds, small mammals, and other smaller vertebrate species. In order to prevent the harassment of wildlife by domestic animals in the M-KMA, all pets should be kept under control, by means of a leash or other restraint method. Pets and other domestic animals in the M-KMA must always be under their owners' control and must not be permitted to chase any wild species, except in accordance with the *British Columbia Wildlife Act* regulations. The B.C. Ministry of Environment is responsible for enforcing the *British Columbia Wildlife Act*. [336]

3.2 Invasive Species

Invasive (non-indigenous) species are usually non-native plants or animals that have been introduced to an area without the controlling agents that restrict their distribution in native habitats (such as insect predators and plant pathogens). These species tend to be found where human development and access occurs. Invasive species are aggressive competitors and have a high potential of extending their ranges. In some cases, these species are so successful that native species are overtaken and become threatened and endangered. Invasive species can upset ecosystem relationships by altering community compositions. Typical invasive species are quick to colonize, tolerate a wide range of conditions, and are difficult to control once established.[337]

Invasive Plant Species

In spring and summer, some wildlife (e.g., ungulates) typically rely on important features of their habitats such as seeps, mineral licks, and wet areas to provide nutrient-rich foods to replace weight that was lost during winter. The earliest green-up sites are considered critical, and the spread and establishment of invasive species (e.g., certain knapweed species on drier sites) can degrade these sites. Such invasive plants could affect the quality of spring and summer habitats and could force some wildlife to increase their energy expenditure in search of a suitable food source. Invasive plant species are often found in disturbed areas, even on poorer-quality soils; however, these plants have the capability to spread throughout an area, even among trees. Annual invasives are not as competitive if the ground is not disturbed annually. Invasive plant species that are a potential concern in the Muskwa-Kechika Management Area are listed in Appendix 5. According to the *British Columbia Weed Control Act*[338] all land occupiers must control designated noxious plants, and government-appointed inspectors can require landowners to control identified noxious weeds; each of the invasive plant species listed in Appendix 5, except for Rush Skeletonweed (*Chondrea juncea*), are currently designated as "noxious weeds" under the Act, for the Peace River, Northern Rockies, and Stikine Regional Districts.[339]

Several strategies can be implemented to prevent and control the spread of invasive plant species. Early identification and control, before a plant is able to establish colonies, is extremely important in remote areas.[340] Control should be applied on a regular basis to be effective, and regularly monitored for effectiveness. Soil disturbances must be treated and reseeded with ecologically suitable species (e.g., mixes of native plants, free of invasive species) within 2 years.[341] Feed for livestock should be local and free of invasive species. Public agencies and M-

KMA users should be sensitized to the concern through an education initiative so that any problems can be detected early. The B.C. Ministry of Forests and Range and the B.C. Ministry of Agriculture and Lands are responsible for initiatives for controlling and preventing the spread of invasive plants. The Northeast Invasive Plant Committee has been formed to co-operatively manage invasive species in the region. The committee maintains a reporting and monitoring program for invasive plants and provides a forum for the development of management directions.[342]

Invasive Fish Species

Amphibians and invertebrates can be adversely affected by the introduction of predatory, sport fish or non-native fish into wetland ecosystems.[343, 344, 345] Fish prey on invertebrates and amphibian species and can cause declines in populations or local extinctions. In addition, fish introductions can alter nutrient cycles and algal production in mountain lakes.[346] In order to protect native species from the effects of introducing fish, fish should not be introduced into ponds, lakes, or streams where they do not naturally occur, or where amphibians and invertebrates of concern are found. Before introducing fish, inventory for native species (including, but not limited to, amphibian and invertebrates) must show that there are no potential species of concern. If species of concern or suitable habitat for species of concern are detected, potential impacts should be determined. Introductions should be considered only for systems that are not connected to other systems at any time of the year (closed, isolated systems). The B.C. Ministry of Environment is responsible for inventory and assessment related to fish introduction.

4.0 Wildlife-Human Conflict Management

The issue of wildlife–human conflict has received much attention in the literature.[347,348, 349] There are several types of wildlife–human conflict where management principles or policies are useful:

- when wildlife–human interactions negatively threaten one or both involved (e.g., bears and humans);
- when wildlife affect agricultural enterprises (e.g., Elk grazing on haystacks);
- when wildlife (Bears, Wolves, Foxes, Coyotes, Raccoons, European Starlings, etc.) prey on domestic livestock or damage property;[350]
- when domestic animals disturb wildlife and/or wildlife habitat;[351]
- when wildlife viewing leads to wildlife harassment;
- when livestock compete with wildlife for resources on Crown land;
- when wildlife are illegally killed; and
- when wildlife and vehicles collide.

There are wildlife–human conflict regulations and policies currently in effect that apply in the Muskwa-Kechika Management Area.[352, 353] This section addresses only negative interactions that are most likely applicable to the M-KMA, and that are not already covered by existing provincial regulations and/or policy.

4.1 Bear–Human Conflicts

A bear–human conflict is said to occur when a bear charges people, people have to flee from a bear, people have to use a deterrent on a bear, there is damage or loss of property from a bear, or a bear makes physical contact with a person.[354] When bears and humans conflict, the results can lead to death: of the human, of the bear, or both. The 1996 draft discussion paper developed by the B.C. Ministry of Environment, Lands and Parks lists several recommendations for reducing and managing human–bear conflicts for both Black and Grizzly Bears; these should be finalized by the B.C. Ministry of Environment, and followed by appropriate resource agencies.[355] Although bear attacks are relatively rare, learning how to safeguard property and people from unnecessary conflicts with bears is critical to ensuring minimal interaction and continued healthy bear populations.

To avoid or reduce negative bear–human interactions, development planning should avoid prime bear habitat, where bear densities are likely to be higher. Damage to camps and other property is seen to be a growing problem in the backcountry. Camp cleanliness is the most important factor to reduce loss and damage caused by bears. It is considered an offence for people in British Columbia to attract dangerous wildlife (including Bears, Wolves, Cougars, and Coyotes). Conservation Officers may issue a written order that requires "the removal or containment of compost, food, food waste or domestic garbage."[356, 357] All bear attractants, especially waste and food products, should be removed from an area. Where human presence is established for a period of time, food material and garbage must be stored so as to be unattainable by bears. Technological advances have recently made electric fencing much more practical in remote locations. Education is the key element to reduce and defuse bear–human encounters, and non-lethal responses should be applied when possible. Bear safety information is currently available from a wide variety of sources and internet sites.[358]

An important issue in the Muskwa-Kechika Management Area is the high risk of conflict between Grizzly Bears and hunters. Many of the Grizzlies in the M-KMA are ungulate predators. This prey focus, combined with a natural tendency to use threat to deal with close human encounters, leads to incidents that may result in the death of the bear, the human, or both. Poor practices with respect to meat storage and bear-proofing hunting camps lead to bear mortalities, hunter discomfort, and economic losses, which should be avoided with improved facilities and modest prevention measures.[359, 360] Continued public education is critical, and extension activities should be reviewed to ensure that the information reaches the audience targeted. In order to assess progress in this regard, the number and nature of reported bear-people incidents should be reviewed annually.

Where there is a history of problems with bears, aversive conditioning may be a reasonable solution, provided that attractants have been previously removed. Where aversive conditioning is not practical or is unsuccessful, removal of the offending bear may be necessary. A database of human–bear interactions, translocations, and problem bear control mortalities is currently maintained by the B.C. Ministry of Environment. The effectiveness of translocations should be reviewed and evaluated through monitoring, and critical factors associated with successful translocations noted. Animal destruction may be warranted in the event that none of the other

options presents a viable solution. The circumstances surrounding animal destruction should be reviewed to determine how best to approach each situation.

The B.C. Ministry of Environment is responsible for leading management of bear–human conflict and continues to provide resources and expertise to this end.

4.2 Wildlife Impact on Private Property

Wildlife can disrupt, damage, and harm agricultural crops and livestock, the land they are raised on, and the infrastructure and equipment needed to raise them. Problem wildlife can also spread undesirable insects, invasive plant species, and diseases. To control or reduce wildlife impact on private property, non-lethal methods are preferred, and should be applied first. Numerous non-lethal methods are available to control or reduce the impact of wildlife on agricultural enterprises. These may include:

- fencing (including electric fencing);
- netting;
- scare tactics;
- repellents;
- translocation;
- cultivation of unattractive plants; and
- habitat modification and cultural management.

Sometimes it is necessary to use lethal control methods for certain wildlife individuals that are doing too much damage to private property, or posing a physical risk to humans. Preferred lethal control methods may include trapping and/or hunting, possibly under special permits. Within the Muskwa-Kechika Management Area, lethal control methods should be rarely applied, and only after careful consideration of conservation issues and local impacts. Control methods permitted must follow provincial regulations and policy. Methods with greater risk to non-target species (e.g., poisons) should be discouraged. The B.C. Ministry of Environment is the lead resource for controlling wildlife impact on private property. In many cases, it is left to the property owner to implement the control action.

4.3 Domestic Livestock on Crown Land

Livestock can have a significant effect on wildlife and wildlife habitat on Crown land. Impacts include alteration of vegetation communities, introduction of invasive species, physical disturbance to wildlife and habitat, effects on water quality, competition for forage, and displacement of wildlife. There are various options to reduce these effects. The distribution of domestic animals should be controlled to minimize or prevent use of sensitive areas (e.g., riparian areas, ground nesting habitat, rare plant occurrences), and to appropriately distribute impacts. The timing of access should be controlled to prevent animals from grazing and browsing when soils, plants, or wildlife are most vulnerable; animals should be removed from the range early, so that there is late summer and fall recovery of the plants. Vegetation should be allowed adequate rest from grazing for recovery before it is grazed and browsed again. The intensity of grazing should be controlled by setting conservative stocking rates.[361, 362] The B.C. Ministry of Forests and Range and the B.C. Ministry of Agriculture and Lands are responsible for managing domestic grazing on Crown land. Potential research may include vegetation community responses to domestic grazing and what is necessary for recovery.

5.0 Impacts and Mitigation Related to Industrial and Commercial Access Development

The study of the impacts on wildlife and wildlife habitats caused by industrial and commercial access development has received much attention.[363] The effects of industrial access or development on wildlife may include the following:

- direct mortality from vehicle collisions;
- direct mortality from poaching;
- changes in predator–prey relationships;
- energetic costs associated with disturbance;
- barrier effects;
- displacement and avoidance;
- changes in abundance;
- disruption of normal behaviour;
- alteration of habitats;
- disruption of social systems; and
- increased mortality rates.

In this section, the objectives and management directions apply to all linear access, including (but not limited to) all types of roads, trails, railways, seismic lines, pipelines, and electricity transmission lines.

5.1 Mitigation of Impacts

When access is required, there are mitigation options available to reduce negative impacts on wildlife and wildlife habitat. The first objective is to identify and protect important wildlife habitat. More detailed planning processes must identify important wildlife habitat, either as part of the development process, or as part of regional planning processes including (but not limited to) the *Conservation Area Design for the Muskwa-Kechika Management Area*.[364] Where appropriate resource agencies determine that the risk of significant negative impact is high, permanent or temporary access must be limited, restricted, or, on a site-specific basis, prohibited to protect known important wildlife habitat. However, where an access route is prohibited, alternative routes should be identified where possible. Access development, maintenance, and upgrading activities must be planned and conducted to minimize disturbance to wildlife and wildlife habitat. Security cover is an important wildlife habitat to manage for when planning access. For example, access (including, but not limited to, seismic lines) to ungulate winter range should not be developed in the winter, because machine trails provide a compact surface on which predators can travel, facilitating movement to ranges that they would not normally be able to reach.

To maintain water quality and quantity, baseline hydrologic characteristics (including, but not limited to, in-stream flow requirements, lake volumes and stages, seasonal water levels, and water quality) for streams, rivers, groundwater, seeps, springs, lakes, and wetlands should be determined by the appropriate resource agencies. Resource users will be required to minimize negative effects on water quality and quantity within areas of sensitive hydrology.

Significant effects of access include impacts due to vehicle collisions. These should be prevented by road design and placement, and by implementing and monitoring/enforcing restrictions with respect to speed, season of use, and number of vehicles, where necessary. Collisions should also be prevented by addressing the reasons for which wildlife are struck by vehicles. For example: animals can be lured away from high-use areas, wildlife can be provided with alternative paths, and removing carcasses promptly can prevent injury/mortality to scavengers. Reporting of collisions is also discussed in section 2.1 General Species Direction.

Impacts to wildlife and their habitat due to access should also be minimized through coordinated management planning by appropriate resource agencies, with leadership from the B.C. Integrated Land Management Agency. As an implementation priority, detailed access management plans that reflect Land and Resource Management Plan direction must be developed. Appropriate resource agencies should co-operatively plan access to minimize impacts. Models currently exist for access planning among several tenure holders.[365, 366] A similar system should be designed and implemented for the M-KMA. Elements of the system must include (but are not limited to):

- early communication with/among proponents and regulatory agencies;
- using historical and/or existing routes;
- sharing access information and costs;
- universally applied mitigation measures, including (but not limited to) thresholds;
- sequential development of watersheds/areas (e.g., one watershed at a time, on one side of the watershed only);
- minimizing the period, frequency, and volume of use; and
- restoration/reclamation of all access to desired conditions within a pre-determined period, including (but not limited to) mechanical exploration–related activities.

Upon cessation of activities, access routes must be restored to a vegetated state using reclamation, rehabilitation, re-contouring, and other techniques that, over time, will approximate the desired conditions. There should be a complete rollback of trees and debris upon the termination of access, including (but not limited to) mechanical exploration activities. As well, linear corridors must be promptly re-vegetated with the desired community type, including, where appropriate for desired future conditions, native tree species. See section 1.8 Results-based Habitat Management.

The B.C. Ministry of Environment continues to provide guidelines and best management practices for mitigating the impacts of access on important wildlife habitat, and on water quality and quantity, including access thresholds based on the best available knowledge. Appropriate resource agencies should apply cumulative environmental impact assessments to ensure that thresholds are not exceeded. Land and Water British Columbia Inc. is responsible for assessing potential environmental impacts when licensing Crown water resources and land use. The B.C. Integrated Land Management Agency is responsible for maintaining and delivering integrated land, resource, and geographic information, including (but not limited to) important wildlife habitat, water quality, and water quantity information. The B.C. Ministry of Environment works with all resource agencies to plan and manage access to minimize impacts on wildlife.

6.0 Management of Recreation Impacts on Wildlife

Recreational activities can disturb wildlife, which may result in increased energy costs, changes in behaviour, reduced fitness, avoidance of preferred habitat, and wildlife mortality.[367, 368, 369] Recreationists can also affect important habitat during the time of year when a species is considered to be most at risk (e.g., boaters disturbing nesting waterfowl). Any type of recreational activity or development, when uninformed, underplanned, under-designed, inappropriately located, or unmanaged can result in substantial detrimental effects to natural resources, including wildlife.[370] In a study of 640 trail users, half of survey respondents did not feel that recreation had a negative effect on wildlife, and respondents generally thought that wildlife could be approached more closely than wildlife actually will allow.[371] While the Muskwa-Kechika Management Area Recreation Management Plan is the primary vehicle for managing recreation use in the area, this section is intended to describe and address some specific concerns identified for wildlife and wildlife habitat in the Muskwa-Kechika Management Area. Table 11 describes some of the potential effects on wildlife from specific recreation activities.

It is important to recognize the following generalizations:[372]

- Reactions by wildlife depend upon type, intensity, duration, timing, predictability, and location of human activity.
- Reactions by wildlife can be immediate, delayed, direct, or indirect.
- Most animals can become habituated to some form of human activity, but not all animals can become habituated to all forms of human activity.
- Habituation imposes energy costs on animals even though they seem undisturbed by human activity.

Susceptibility to negative impacts from recreation use varies among wildlife species and different environments. In general, vulnerability is greatest at key locations (e.g., breeding, spawning, feeding, birthing, and watering areas), during periods of harsh weather, and during unproductive years. Riparian areas are critical for many species.

The objective is that commercial and non-commercial recreation access and activities be managed to minimize negative effects on wildlife and wildlife habitat in the M-KMA. The appropriate recreation managers and users should implement the Muskwa-Kechika Management Area Recreation Management Plan (including the Monitoring Plan), the *Wildlife Guidelines for Backcountry Tourism/Commercial Recreation,*[373] and related Parks and Protected Areas Management Plans. Recreation user groups should be included in the management planning and the assessment of cumulative effects. Appropriate minimum-impact recreation behaviours on wildlife and important wildlife habitat in the M-KMA must be identified and encouraged. The B.C. Ministry of Environment provides guidelines, monitoring, and information support for backcountry recreation management. Land and Water British Columbia Inc. is the lead agency for managing commercial backcountry recreation outside of parks and protected areas. B.C. Ministry of Environment and Land and Water British Columbia Inc. conduct enforcement patrols and M-KMA users will continue to report evidence of disturbance due to recreation. The B.C. Ministry of Forests and Range is responsible for managing public recreation on forest lands (i.e., outside parks), including a number of recreation trails and recreation sites in the M-KMA. The

B.C. Integrated Land Management Agency continues to implement the Muskwa-Kechika Management Area Recreation Management Plan.[374]

TABLE 11. Recreation activities and their effects on wildlife[375]

Recreation Activity	Potential Effects on Wildlife
1. Hunting	Alteration of sex and age composition, behaviour, reproduction (e.g., date of conception in Elk[376] and distribution), overall reduction in population size,[377] disturbance, redistribution, wildlife–human conflict. [378]
2. Viewing	Disturbance as a result of close encounters can alter behaviour, cause unnecessary energy expenditure, alter nest placement, and reduce survival of young (via abandonment).
3. Backpacking/hiking/cross-country skiing/horseback riding	Flight and/or elevated heart rates, displacement.
4. Rock climbing	Disturbance of preferred raptor perching and nesting sites during the breeding season, displacement.
5. Spelunking	Disturbance or abandonment of bat roosting and maternity sites. Spelunking is implicated in the decline of certain bat populations.
6. Pets (dogs)	Provoke more of a predator alarm response than a person unaccompanied by a dog; harassment and energy expenditure, direct mortality.
7. Boating/personal watercraft	Can disturb fish and fish habitat; can deprive waterfowl, wading birds, and raptors of roosting or foraging habitats; flushing of birds from nests can result in egg breakage; changes to riparian vegetation, bank stability, and water quality can affect semi-aquatic mammals; potential release of toxin by-products from combustion into water; boats may temporarily or permanently displace large mammals from riparian corridors and waterways (redistribution of wildlife movement).
8. All-terrain vehicles and mountain bicycles	Can cause disturbance, flight, and habitat deterioration.
9. Snowmobiles	Can cause disturbance (flight or stress), redistribution, and habitat deterioration.
10. Aircraft (primarily fly-in fishing and hunting but also wildlife research)	Can cause disturbance, including panic flights, which can result in the abandonment or loss of young or in altered activity levels [379, 380, 381]

7.0 Protection of Historical Vocations/Practices in the Muskwa-Kechika Management Area

There is a long history of use of the Muskwa-Kechika Management Area's wildlife resources. Historical vocations and practices include trapping, hunting, fishing, guiding, and outfitting, and are listed in Technical Appendix 6. The Land and Resource Management Plan processes in the M-KMA acknowledged these historical vocations and recommended objectives and management directions to protect their continued practice. The *Muskwa-Kechika Management Area Act* recognizes that:

> "…wildlife and its habitat is critical to the social and cultural well-being of First Nations and other people in the plan area…" (Preamble to the *Muskwa-Kechika Management Area Act*[382]).

Contents of the Wildlife Plan and any recommendations with respect to historical vocations/ practices in the
M-KMA are distinct from existing and/or claimed aboriginal rights and title, and are for management purposes only.

The objective is that opportunities for historical vocations and activities in the M-KMA be maintained, within conservation constraints and in support of the outcomes of the strategic M-KWMP. This may be achieved by first identifying the various vocations and activities, and the traditional areas where these are or were practiced. These should then be evaluated against the goals, objectives, and outcomes of the Muskwa-Kechika Wildlife Management Plan, to determine their consistency. Suitable vocations and activities should be monitored and considered in appropriate planning processes. The B.C. Ministry of Environment, the B.C. Ministry of Forests and Range, the B.C. Integrated Land Management Agency, and Land and Water British Columbia Inc. are the lead agencies for managing and maintaining opportunities for historical vocations and activities, in cooperation with resource users. Future research may catalogue known historical vocations and activities, indicating (where possible) the locations and scale of practices.

8.0 Research/Information Needs

Several research and information needs are noted in Technical Appendix 8. These are linked to specific objectives for the plan. Many objectives in the B-1 tables do not have associated research needs, which is a reflection of regional and provincial priorities. All recommended research and information needs will not be achieved in the short term (1–4years)**.** Priority should be given to those areas that can be grouped under core services and the legislated mandate of the B.C. Ministry of Environment, and those areas for which funding is available. Periodically, staff of the regional B.C. Ministry of Environment Environmental Stewardship Branch and members of the Muskwa-Kechika Wildlife Management Plan Implementation Committee should meet to discuss research needs, and to set priorities. These can then be communicated to various funding agencies (e.g., the Muskwa-Kechika Management Area Trust Fund) and institutions (e.g., the University of Northern British Columbia).

Technical Appendix 1: Recreation Planning and Management Principles

(From the Muskwa-Kechika Recreation Plan[383])

Recreation planning and management is complex, particularly in an area as large, diverse, and environmentally sensitive as the M-KMA. It is, therefore, important that a decision-making rationale produce solutions that are compatible with the values for which the area was given special status. The adoption of a set of management principles for the area can help bring a high degree of consistency to this decision-making process.

Each of the line agencies responsible for different aspects of recreation management within the M-KMA has its own set of principles to guide their various recreation management programs. Most of these principles have been approved at the Cabinet level and include: "Guiding Principles for Protected Area Management," British Columbia Assets and Land Corporation (BCALC)'s CR Policy "Strategic Principles," and the B.C. Ministry of Forests and Range "Wilderness Management Principles." While each set of principles was developed to guide specific agency mandates, they are, in many respects, very similar.

The following principles or fundamental assumptions have been adopted by the various agencies in an attempt to: (1) help both managers and users of the M-KMA make decisions that are consistent with the objectives and management directions of the Muskwa-Kechika Management Plan; (2) integrate and co-ordinate their local strategic recreation planning efforts and management activities; and (3) provide guidance in developing effective and workable recreation plans. The first set of principles (1─8) guide decision-making related to technical aspects of recreation planning and management. Principles 9─12 refer more to administrative procedures or how decisions are made.

Principle 1: Environmental Stewardship

Maintaining and conserving essential ecological processes and variety in nature (biological diversity) is a vital contribution to provincial, national, and global conservation efforts. The M-KMA should be managed in a manner that respects natural ecological systems and maintains wilderness characteristics, wildlife, fish, and their habitats.

Principle 2: The Non-degradation Concept

This principle recognizes that conditions of naturalness and solitude vary between Resource Management Zones (RMZs) within the M-KMA. The objective is to prevent degradation of naturalness and solitude in the area and restore substandard settings to minimum acceptable levels, rather than letting all areas deteriorate to a minimum standard.

To a degree, under this principle, the conditions prevailing in each zone when it was designated establish the benchmark of naturalness to be sought by management. However, the management

of conditions of naturalness and solitude in a particular RMZ must be consistent with objectives and management directions as identified in the Muskwa-Kechika Management Plan.

Principle 3: Manage Human Influences

A primary goal of management in the M-KMA is the maintenance of ecological processes. Thus, management is, to a large extent, concerned with the management of human use and influences to conserve ecological processes. Human influences include recreational activities, which can affect biophysical and social conditions. Therefore, recreation management's intent is to guide, modify, and, if necessary, directly control recreation facility development and use to minimize their impact on natural ecological processes.

Principle 4: Guide Management with Objectives for Specific Areas

Recreation management in the M-KMA should be guided by formal plans that state goals and objectives and explain in detail how they will be achieved. Without such clear prescriptions, management can become uncoordinated and even counterproductive to the goals for which the area was designated. Local natural resource agencies and recreation users of the area need recreation management plans to consider whether strategies and actions are appropriate for specific areas and are consistent with the Muskwa-Kechika Management Plan.

Recreation management objectives ought to be clear statements of desired future conditions, and proposed management actions must be evaluated for their potential contribution to a specific objective. Objectives are also essential to monitoring progress and evaluating the success of recreation management. Because the goals of the M-KMA are diverse, it is difficult to write clear objectives for the various aspects of recreation management. However, it is crucial to develop, through an orderly planning process, the clearest and most specific objectives possible and to use them as constant guides to management.

Principle 5: Determine Acceptable Activities and Developments

Recognition and special consideration should be given to existing tenures, licences, authorizations, and public and commercial recreation use, where those uses are compatible with the management objectives and directions in the Muskwa-Kechika Management Plan. Uses that have been approved for continuation should be fully respected.

Appropriate recreation activities should include those that are directed toward appreciation of the natural, cultural, and recreation values of the area. All recreation activities should be assessed in regard to their impact on the ecological systems and the key natural, cultural, and recreation values of the particular Resource Management Zones (RMZ) within the M-KMA. Developments should directly complement the management objectives and directions recommended for particular Resource Management Zones within the area.

Recreation planning must also consider the implications and potential impacts from recreation development and use on other resource management goals and activities such as natural resource extraction or First Nations use.

Principle 6: Zoning

A diversity of physical and biological features and recreation experiences can be found in the M-KMA. To maintain this diversity in the future, a variety of management actions are needed. Zoning is a useful tool that can help provide for a diversity of biophysical and social settings and help achieve clearly defined objectives for different areas. In addition, use of the concept of zoning can potentially reduce the conflicts among incompatible values (e.g., motorized vs. non-motorized use) and permit retention of values voiced by different segments of the recreating public.

An acceptable recreation activity may not be appropriate in all RMZs or in all parts of a particular zone in the M-KMA. Zones within the area may range from areas that accommodate and/or enhance intensive recreation opportunities (e.g., guide/outfitting base camps) to areas that exclude public access to protect fragile and vulnerable ecosystems and sensitive, rare, threatened, or endangered species (e.g., within Ecological Reserves).

Principle 7: Determine the Limits of Acceptable Change

The M-KMA has limited capacity to absorb the impacts of recreation use and still retain its wilderness character, wildlife, and habitat. As use increases, or as damaging patterns of use develop at specific places, or during particular times, wilderness qualities may disappear, either gradually or rapidly. Determining the limits of acceptable change that an area can tolerate without unacceptable impacts offers a framework for managing recreation use to protect wilderness qualities, such as the opportunity to enjoy a broad spectrum of recreation experiences and outstanding opportunities for solitude.

Principle 8: Monitor Area Conditions and Experience Opportunities

Any recreation management plan or program needs a monitoring system to evaluate progress toward stated objectives, and to guide the long-term revision, adjustment, and refinement of the plan. Devising monitoring plans remains one of the major challenges for advancing recreation management consistent with current adaptive management models. A good plan describes the desired future conditions to be achieved, and sets them out in the form of management objectives. Only through monitoring (i.e., the systematic gathering, comparing, and evaluation of data) can one tell whether those objectives are being realized.

Because biological, physical, and social conditions can be influenced by recreation use, all need to be monitored by measuring and evaluating suitable indicators of change in conditions.

Principle 9: Partnerships in Planning and Management

The M-KMA is a public trust, and opportunities for First Nations and the public to provide input into the planning and management of the area must not be neglected. Recreation planning and management should ensure that all interests are involved in decision-making by using a fair, open, and consultative process that takes into account provincially, regionally, and locally

established priorities and public interests. Mutual learning and understanding is a key benefit in public participation for both managers and interested stakeholders alike.

Principle 10: Relationship with First Nations

Recreation planning and management activities within the M-KMA should respect First Nations traditional harvesting, cultural activities, and other aboriginal or treaty rights and interests. Opportunities for meaningful consultation with First Nations in recreation planning and management activities are required.

Principle 11: Co-ordination with Adjacent Areas and Uses

The M-KMA and adjacent lands should be managed in relation to one another. Human activities on lands adjacent to the M-KMA can have substantial impacts inside the boundary and vice-versa. Recreation planning and management decisions inside and outside of particular Resource Management Zones and inside and outside the M-KMA should be coordinated and integrated to the greatest extent possible.

Principle 12: Co-operation and Co-ordination between Agencies

As the recreation resource can be influenced by many human activities (including, but not limited to, both industrial and amenity uses) and because local strategic recreation planning and management within the
M-KMA is a shared responsibility between various government agencies, the co-ordination of recreation planning and management activities is necessary. Therefore, recreation planning and management should be conducted in an integrated, co-operative, collaborative, and open manner, with provincial government agencies and the Muskwa-Kechika Advisory Board acting as partners in the process.

Technical Appendix 2: Adaptive Management

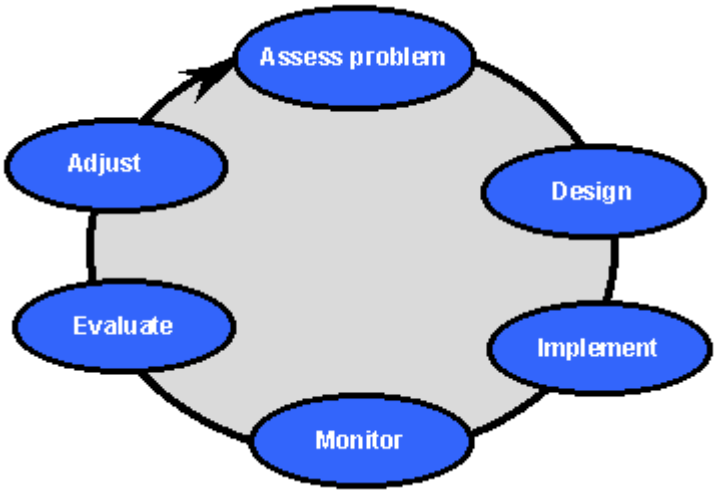
(Forests Practices Branch[384])

DEFINITIONS OF ADAPTIVE MANAGEMENT

Adaptive management has been defined in various ways since its development in the early 1970s. We recognize that different people and organizations continue to have somewhat differing views of the best definition for their purposes. In order to bring some consistency and clarity to what we in the BC Forest Service mean when we say "adaptive management," we have decided to use a standard working definition for the term, as follows:

Adaptive management is a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. Its most effective form–"active" adaptive management–employs management programs that are designed to experimentally compare selected policies or practices, by evaluating alternative hypotheses about the system being managed.

We often portray the adaptive management process a six-step cycle, and emphasize that successful adaptive management requires managers to complete all six steps:



Some of the differentiating characteristics of adaptive management are:

1. acknowledgement of uncertainty about what policy or practice is "best" for the particular management issue,
2. thoughtful selection of the policies or practices to be applied (the assessment and design stages of the cycle),
3. careful implementation of a plan of action designed to reveal the critical knowledge that is currently lacking,
4. monitoring of key response indicators,
5. analysis of the management outcomes in consideration of the original objectives, and
6. incorporation of the results into future decisions.

Some other definitions

Bormann et al. 1994, p. 1: "...is 'learning to manage by managing to learn'..."

Halbert, C.L. 1993, p. 261–262: "...is an innovative technique that uses scientific information to help formulate management strategies in order to 'learn' from programs so that subsequent improvements

can be made in formulating both successful policy and improved management programs."

Lee, K.N., 1993, p. 9: adaptive management..."...embodies a simple imperative: policies are experiments; *learn from them*." (Italics are the author's).

Lee K.N. and J. Lawrence, 1986, p 435: "...is a policy framework that recognizes biological uncertainty, while accepting the congressional mandate to proceed on the basis of the 'best *available* scientific knowledge'. An adaptive policy treats the program as a set of experiments designed to test and extend the scientific basis of fish and wildlife management."

Scientific Panel for Sustainable Forest Practices in Clayoquot Sound, 1995, p. 271: "The rigorous combination of management, research, and monitoring so that credible information is gained and management activities can be modified by experience. Adaptive policy acknowledges institutional barriers to change and designs means to overcome them."

Sources

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Technical Appendix 3: Important Wildlife Habitat

Here are some examples of important wildlife habitat that should be mapped and described in pre-development assessments:

Terrestrial

- winter range and over-wintering areas
- denning sites for Bears, Cougar, Lynx, Wolves, and Wolverines
- breeding sites (e.g. licks, leks, rutting arenas, wallows)
- birthing sites (e.g. calving)
- rearing sites
- south- and/or west-facing slopes
- colonies, rookeries
- mineral licks
- wildlife trails
- rubbing and scent posts/points
- travel and escape routes
- seeps, springs
- wetlands
- riparian islands
- avalanche chutes
- snags and coarse woody debris
- old growth, and Old Growth Management Areas
- forests with interior conditions
- Wildlife Tree patches
- riparian zones
- open meadows
- nesting sites
- hibernacula
- talus slopes
- caves
- cover; and
- cliffs

Aquatic

- main channel pools (including, but not limited to, depth, flow, and volume characteristics), especially those on the downstream edge of large boulders or those downstream of stable, large woody debris
- riffle-pool junctions, especially under the cover of banks
- water flow – volume, seasonal variation (especially along dammed rivers/streams)
- off-channel pools near woody debris or overhanging banks
- channel structure
- spawning habitat
- rearing habitat
- undercut banks

- large woody debris
- logjam pools
- thermal pools
- early (spring) open water
- riparian islands
- riparian zones
- groundwater flow, seeps, springs
- substrate
- wetlands; and
- water temperature

Many of these features can be found on TRIM or forest cover maps, or through air photo interpretation. Others would require field assessments and local/anecdotal information. Site-specific prescriptions can be agreed to by parties involved during pre-development consultation and referral.

If a person carrying out development finds important wildlife habitat that was not identified on an approved development plan or permit, the person carrying out the practice must:

1. modify or stop any activity that is in the immediate vicinity of the previously unidentified habitat to the extent necessary to refrain from threatening it; and

2. promptly advise the appropriate managers and district environment official of the existence and location of the important wildlife habitat.

Technical Appendix 4: Red- and Blue-listed Species

(That May Occur in the Muskwa-Kechika Management Area – August 2009*)

Scientific name	Common name	Global Rank	Prov. Rank	Prov. List
Freshwater Fish				
Hiodon alosoides	Goldeye	G5	S3S4	Blue
Coregonus artedi	Cisco	G5	S1	Red
Coregonus autumnalis	Arctic Cisco	G5	S2	Red
Salvelinus confluentus	Bull Trout	G3	S3	Blue
Salvelinus malma	Dolly Varden	G5	S3S4	Blue
Thymallus arcticus population 1	Arctic Grayling, Williston Watershed population	G5T1Q	S1	Red
Stenodus leucichthys	Inconnu	G5	S3	Blue
Margariscus margarita	Pearl Dace	G5	S3	Blue
Notropis atherinoides	Emerald Shiner	G5	S1	Red
Notropis hudsonius	Spottail Shiner	G5	S1S2SE	Red
Pungitius pungitius	Ninespine Stickleback	G5	S1	Red
Birds				
Botaurus lentiginosus	American Bittern	G4	S3B,SZN	Blue
Melanitta perspicillata	Surf Scoter	G5	S3B,S4N	Blue
Buteo platypterus	Broad-winged Hawk	G5	S3B	Blue
Falco peregrinus anatum	Peregrine Falcon, *anatum* subspecies	G4T4	S2B	Red
Pluvialis dominica	American Golden-plover	G5	S3S4B,SZN	Blue
Bartramia longicauda	Upland Sandpiper	G5	S1S2B,SZN	Red
Asio flammeus	Short-eared Owl	G5	S3B,S2N	Blue
Contopus cooperi	Olive-sided Flycatcher	G4	S3S4B	Blue
Hirundo rustica	Barn Swallow	G5	S3S4B	Blue
Vireo philadelphicus	Philadelphia Vireo	G5	S3S4B	Blue
Dendroica tigrina	Cape May Warbler	G5	S2B	Red
Dendroica virens	Black-throated Green Warbler	G5	S3B	Blue
Dendroica castanea	Bay-breasted Warbler	G5	S2B	Red
Oporornis agilis	Connecticut Warbler	G4	S2B	Red
Wilsonia canadensis	Canada Warbler	G5	S3S4B	Blue
Ammodramus leconteii	Le Conte's Sparrow	G4	S3S4B	Blue
Ammodramus nelsoni	Nelson's Sharp-tailed Sparrow	G5	S2B	Red
Euphagus carolinus	Rusty Blackbird	G4	S3S4B	Blue
Mammals				
Myotis septentrionalis	Northern Myotis	G4	S2S3	Blue
Ursus arctos	Grizzly Bear	G4	S3	Blue
Martes pennanti	Fisher	G5	S2S3	Blue
Gulo gulo luscus	Wolverine, *luscus* subspecies	G4T4	S3	Blue
Rangifer tarandus population 14	Caribou, Boreal population	G5TNR	S2	Red
Rangifer tarandus population 15	Caribou, Northern population	G5T4Q	S3S4	Blue
Bos bison athabascae	Wood Bison	G4T2Q	S1	Red
Bos bison bison	Plains Bison	G4TU	SX	Red
Invertebrates				
Acroloxus coloradensis	Rocky Mountain Capshell	G3	S3	Blue
Agriades glandon lacustris	Arctic Blue, *lacustris* subspecies	G5TNR	S3	Blue
Oeneis alberta	Alberta Arctic	G4	S2	Red
Oeneis bore edwardsi	White-veined Arctic, *edwardsi* subspecies	G5T3	S3	Blue
Oeneis philipi	Philip's Arctic	G3G5	S1S3	Red

Oeneis uhleri	Uhler's Arctic	G5	S3	Blue
Papilio bairdii pikei	Baird's Swallowtail, *pikei* subspecies	G5T3	S3	Blue
Papilio machaon hudsonianus	Old World Swallowtail	G5T4	S1S3	Red
Phyciodes batesii	Tawny Crescent	G4	S3	Blue
Planorbula armigera	Thicklip Rams-horn	G5	S2S4	Blue
Pupilla hebes	Crestless Column	G5	S3S4	Blue
Pyrgus communis	Checkered Skipper	G5	S3	Blue
Satyrium liparops	Striped Hairstreak	G5	S2	Red
Satyrium titus titus	Coral Hairstreak, *titus* subspecies	G5T5	S2	Red
Speyeria aphrodite manitoba	Aphrodite Fritillary, *manitoba* subspecies	G5T5	S3	Blue
Speyeria cybele pseudocarpenteri	Great Spangled Fritillary, *pseudocarpenteri* subspecies	G5T5	S2	Red
Enallagma hageni	Hagen's Bluet	G5	S3S4	Blue
Epitheca canis	Beaverpond Baskettail	G5	S3	Blue
Erebia mackinleyensis	Mt. McKinley Alpine	G4	S1S3	Red
Erebia Magdalena	Magdalena Alpine	G5	S1S3	Red
Ischnura damula	Plains Forktail	G5	S1	Red
Leucorrhinia patricia	Canada Whiteface	G4	S3	Blue
Somatochlora brevicincta	Quebec Emerald	G3	S2S3	Blue
Somatochlora forcipata	Forcipate Emerald	G5	S2S3	Blue
Somatochlora kennedyi	Kennedy's Emerald	G5	S1S2	Red
Somatochlora septentrionalis	Muskeg Emerald	G5	S3	Blue
Vertigo arthuri	Callused Vertigo	G3Q	S3	Blue
Plants				
Alopecurus alpinus	alpine meadow-foxtail	G5	S2S3	Blue
Androsace chamaejasme ssp. *lehmanniana*	sweet-flowered fairy-candelabra	G5T5	S2S3	Blue
Anemone virginiana var. *cylindroidea*	riverbank anemone	G5TNR	S1	Red
Aphragmus eschscholtzianus	Eschscholtz's little nightmare	G3	S2S3	Blue
Apocynum x *floribundum*	western dogbane	G4G5	S2S3	Blue
Arabis lignifera	woody-branched rockcress	G5	S2S3	Blue
Arctophila fulva	pendantgrass	G5	S2S3	Blue
Arnica chamissonis ssp. *incana*	meadow arnica	G5TNR	S2S3	Blue
Artemisia furcata var. *heterophylla*	three-forked mugwort	G4TNR	S2S3	Blue
Aster puniceus var. *puniceus*	purple-stemmed aster	G5T5	S1	Red
Aster radulinus	rough-leaved aster	G4G5	S1	Red
Astragalus umbellatus	tundra milk-vetch	G4	S2S3	Blue
Botrychium crenulatum	dainty moonwort	G3	S2S3	Blue
Braya purpurescens	purple braya	G4G5Q	S2S3	Blue
Carex bicolor	two-coloured sedge	G5	S2S3	Blue
Carex incurviformis var. *incurviformis*	curve-spiked sedge	G4G5T4T5	S2S3	Blue
Carex heleonastes	Hudson Bay sedge	G4	S2S3	Blue
Carex lenticularis var. *dolia*	Enander's sedge	G5T3	S2S3	Blue
Carex membranacea	fragile sedge	G5	S2S3	Blue
Carex misandra	short-leaved sedge	G5	S2S3	Blue
Carex petricosa	rock-dwelling sedge	G4	S2S3	Blue
Carex rostrata	swollen beaked sedge	G5	S2S3	Blue
Carex rupestris ssp. *rupestris*	curly sedge	G5TNR	S2S3	Blue
Carex tenera	tender sedge	G5	S2S3	Blue
Castilleja hyperborea	northern paintbrush	G4	S2S3	Blue
Chamaerhodos erecta ssp. *nuttallii*	American chamaerhodos	G5T5	S2S3	Blue
Chrysosplenium wrightii	Wright's golden-saxifrage	G5?	S2S3	Blue
Cicuta virosa	European water hemlock	G4G5	S2S3	Blue
Claytonia tuberosa	tuberous springbeauty	G4	S2S3	Blue
Cnidium cnidiifolium	northern hemlock-parsley	G5	S2S3	Blue
Cornus suecica	dwarf bog bunchberry	G5	S2S3	Blue

Descurainia sophioides	northern tansy mustard	G5	S2S3	Blue
Diapensia lapponica ssp. *obovata*	diapensia	G5T5	S2S3	Blue
Douglasia alaskana	Alaskan fairy-candelabra	G2G3	S1	Red
Douglasia gormanii	Gorman's douglasia	G3	S2S3	Blue
Draba alpina	alpine draba	G4G5	S2S3	Blue
Draba corymbosa	Baffin Bay draba	G4G5	S2S3	Blue
Draba cinerea	gray-leaved draba	G5	S2S3	Blue
Draba fladnizensis	Austrian draba	G4	S2S3	Blue
Draba glabella var. *glabella*	smooth draba	G4G5T4	S2S3	Blue
Draba lactea	milky draba	G4	S2S3	Blue
Draba lonchocarpa var. *thompsonii*	lance-fruited draba	G4T3T4	S2S3	Blue
Draba palanderiana	Palander's draba	G4G5	S2S3	Blue
Draba porsildii	Porsild's draba	G3G4	S2S3	Blue
Draba ruaxes	coast mountain draba	G3	S2S3	Blue
Draba stenopetala	star-flowered draba	G3	S1	Red
Draba ventosa	Wind River draba	G3	S2S3	Blue
Elymus calderi	Calder's wildrye	GNR	S2S3	Blue
Elymus sibiricus	Siberian wildrye	GNR	S2S3	Blue
Epilobium davuricum	northern swamp willowherb	G5	S2S3	Blue
Epilobium halleanum	Hall's willowherb	G5	S2S3	Blue
Epilobium hornemannii ssp. *behringianum*	Hornemann's willowherb	G5T4	S2S3	Blue
Epilobium leptocarpum	small-fruited willowherb	G5	S2S3	Blue
Erigeron uniflorus ssp. *eriocephalus*	northern daisy	G5T4	S2S3	Blue
Eriophorum vaginatum ssp. *vaginatum*	sheathed cotton-grass	G5TNR	S3	Blue
Erysimum pallasii	Pallas' wallflower	G4	S2S3	Blue
Eutrema edwardsii	Edwards' wallflower	G4	S2S3	Blue
Festuca minutiflora	little fescue	G5	S2S3	Blue
Galium labradoricum	northern bog bedstraw	G5	S2S3	Blue
Gentianella tenella ssp. *tenella*	slender gentian	G4G5T4	S2S3	Blue
Geum rossii var. *rossii*	Ross' avens	G5T5	S2S3	Blue
Glyceria pulchella	slender mannagrass	G5	S2S3	Blue
Gymnocarpium jessoense ssp. *parvulum*	Nahanni oak fern	G5T4	S2S3	Blue
Haplodontium macrocarpum	Porsild's bryum	G2G3	S1	Red
Helictotrichon hookeri	spike-oat	G5	S2S3	Blue
Juncus arcticus ssp. *alaskanus*	arctic rush	G5T?	S2S3	Blue
Impatiens aurella	orange touch-me-not	G4?	S2S3	Blue
Juncus albescens	whitish rush	G5	S2S3	Blue
Juncus stygius	bog rush	G5	S2S3	Blue
Kobresia sibirica	Siberian kobresia	G5	S2S3	Blue
Koenigia islandica	Iceland koenigia	G4	S2S3	Blue
Lesquerella arctica var. *arctica*	arctic bladderpod	G4T4	S2S3	Blue
Leucanthemum integrifolium	entire-leaved daisy	G5	S2S3	Blue
Lomatogonium rotatum	marsh felwort	G5	S2S3	Blue
Lupinus kuschei	Yukon lupine	G3	S2S3	Blue
Luzula confusa	northern wood-rush	G5	S2S3	Blue
Luzula groenlandica	Greenland wood-rush	G4	S2S3	Blue
Luzula kjellmaniana	Kjellman's wood-rush	GNR	S2S3	Blue
Luzula nivalis	arctic wood-rush	G5	S2S3	Blue
Luzula rufescens	rusty wood-rush	G5	S2S3	Blue
Malaxis brachypoda	white adder's-mouth orchid	G4	S2S3	Blue
Minuartia austromontana	Rocky Mountain sandwort	G4	S2S3	Blue
Minuartia elegans	northern sandwort	G4G5	S2S3	Blue
Minuartia macrocarpa	large-fruited sandwort	G4	S2S3	Blue
Minuartia stricta	rock sandwort	G5	S2S3	Blue
Minuartia yukonensis	Yukon sandwort	G3G4	S2S3	Blue

Montia bostockii	Bostock's montia	G3	S2S3	Blue
Muhlenbergia glomerata	marsh muhly	G5	S3	Blue
Nymphaea leibergii	small white waterlily	G5	S2S3	Blue
Oxytropis campestris var. *davisii*	Davis' locoweed	G5T3	S3	Blue
Oxytropis campestris var. *jordalii*	Jordal's locoweed	G4T4	S2S3	Blue
Oxytropis maydelliana	Maydell's locoweed	G5	S2S3	Blue
Oxytropis scammaniana	Scamman's locoweed	G3G4	S2S3	Blue
Papaver alboroseum	pale poppy	G3G4	S2S3	Blue
Parrya nudicaulis	northern parrya	G5	SH	Red
Pedicularis parviflora ssp. *parviflora*	small-flowered lousewort	G4T4	S3	Blue
Pedicularis verticillata	whorled lousewort	G4	S2S3	Blue
Penstemon gormanii	Gorman's penstemon	G4	S2S3	Blue
Phacelia mollis	MacBryde's phacelia	G3	S1	Red
Pinguicula villosa	hairy butterwort	G4	S2S3	Blue
Pinus banksiana	jack pine	G5	S2S3	Blue
Plantago eriopoda	alkali plantain	G5	S1	Red
Poa abbreviata ssp. *pattersonii*	abbreviated bluegrass	G5T5	S2S3	Blue
Poa pseudoabbreviata	polar bluegrass	G4	S2S3	Blue
Polemonium boreale	northern Jacob's-ladder	G5	S2S3	Blue
Polemonium occidentale ssp. *occidentale*	western Jacob's-ladder	G5?T5?	S2S3	Blue
Polygala senega	Seneca-snakeroot	G4G5	S1	Red
Polygonum bistorta ssp. *plumosum*	meadow bistort	G5T5	S2S3	Blue
Polypodium sibiricum	Siberian polypody	G5?	SH	Red
Polystichum kruckebergii	Kruckeberg's holly fern	G4	S2S3	Blue
Potamogeton perfoliatus	perfoliate pondweed	G5		
Potentilla biflora	two-flowered cinquefoil	G4G5		
Potentilla elegans	elegant cinquefoil	G4	S2S3	Blue
Potentilla nivea var. *pentaphylla*	five-leaved cinquefoil	G5T4	S2S3	Blue
Primula cuneifolia ssp. *saxifragifolia*	wedge-leaf primrose	G5TNR	S2S3	Blue
Primula nutans	Siberian primrose	G5	SH	Red
Ranunculus pedatifidus ssp. *affinis*	birdfoot buttercup	G5T5	S2S3	Blue
Rumex arcticus	arctic dock	G5	S3	Blue
Salix raupii	Raup's willow	G2	S1	Red
Saxifraga nelsoniana ssp. *carlottae*	dotted saxifrage	G5T2	S2	Red
Senecio sheldonensis	Mount Sheldon butterweed	G5	S2S3	Blue
Silene involucrata ssp. *involucrata*	arctic campion	G5	S2S3	Blue
Silene repens	pink campion	G5	S1S3	Blue
Silene taimyrensis	Taimyr campion	G4?	S2S3	Blue
Sphenopholis intermedia	slender wedgegrass	G5	S3	Red
Tofieldia coccinea	northern false asphodel	G5	S2S3	Blue
Trichophorum pumilum	dwarf clubrush	G5	S2S3	Blue
Utricularia ochroleuca	ochroleucous bladderwort	G4?	S2S3	Red
Woodsia alpina	alpine cliff fern	G4	S2S3	Blue

*For the most current list of species at risk in British Columbia, refer to the B.C. Ministry of Environment Species and Ecosystems Explorer tool: http://a100.gov.bc.ca/pub/eswp/

Technical Appendix 5: Invasive Plant Species

Several invasive plant species already exist within the boundaries of the Muskwa-Kechika Management Area, or have the potential of spreading to the area. The following species are of management concern, and are the focus of the objectives and management directions in section 3.2 Invasive Plant Species.

- annual sowthistle (*Sonchus oleraceus*)
- Canada thistle (*Cirsium arvense*)
- cleavers (*Galium aparine*)
- crupina (*Crupina vulgaris*)
- Dalmatian toadflax (*Linaria dalmatica*)
- diffuse knapweed (*Centaurea diffusa*)
- dodder (*Cuscuta spp.*)
- gorse (*Ulex europaeus*)
- green foxtail (*Setaria viridis*)
- hound's-tongue (*Cynoglossum officinale*)
- jointed goatgrass (*Aegilops cylindrica*)
- kochia (*Kochia scoparia*)
- leafy spurge (*Euphorbia esula*)
- night-flowering catchfly (*Silene noctiflora*)
- orange hawkweed (*Hieracium aurantiacum*)
- oxeye daisy (*Chrysanthemum leucanthemum*)
- perennial sowthistle (*Sonchus arvensis*)
- purple nutsedge (*Cyperus rotundus*)
- quackgrass (*Agropyron repens*)
- rush skeletonweed (*Chondrilla juncea*)
- Russian thistle (*Salsola kali*)
- scentless chamomile (*Matricaria maritima*)
- spotted knapweed (*Centaurea maculosa*)
- tansy ragwort (*Senecio jacobaea*)
- Tartary buckwheat (*Fagopyrum tataricum)*
- velvetleaf (*Abutilon theophrasti*)
- white cockle (*Lychnis alba*)
- wild mustard (*Sinapsis arvensis*)
- wild oats (*Avena fatuaa*)
- yellow nutsedge (*Cyperus esculentus*)
- yellow starthistle (*Centaurea solstitialis*)
- yellow toadflax (*Linaria vulgaris*)

Source http://www.agf.gov.bc.ca/cropprot/weedguid/weedindx.htm (March 15, 2002)

Technical Appendix 6: Historical Vocations and Activities

Historical vocations and activities that are recognized for the purpose of the Muskwa-Kechika Wildlife Management Plan are limited to the following:

- aviation
- riding and packing using horses, mules, and dogs
- hunting
- fishing
- trapping
- hiking
- cross-country skiing
- cross-country snowmobiling
- wilderness appreciation
- wildlife viewing
- camping
- photography
- rafting (limited)
- snowshoeing
- wildlife management
- wildlife habitat management and enhancement (including, but not limited to, burning)
- guide outfitting; and
- plant harvesting (berry/mushroom picking)

Technical Appendix 7: Glossary of Selected Terms

Active Management: management that involves a planned effort with goals and objectives, and management directions (strategies) designed to achieve them.

Adaptive Management: a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. Its most effective form – "active" adaptive management – employs management programs that are designed to experimentally compare selected policies or practices, by evaluating alternative hypotheses about the system being managed (see Technical Appendix 2).

Address: to direct specific efforts towards.

Appropriate: suitable and fitting for a particular place or condition.

Appropriate Resource Management Agencies: used to refer generally to agencies and ministries of the provincial government, each of which have specific resource management responsibilities, including issuance and monitoring of specific types of resource tenures. In any given situation, the "appropriate" agencies are those with prescribed tenure responsibilities (through issuance of various operational instruments) and monitoring responsibilities.

Assess: to determine the importance, size, or value.

Attempt to: to make a planned, directed effort to achieve the outcome specified in the direction statement; to try. Magnitude of effort depends on available personnel and resources.

Avoid: to prevent the occurrence of.

Baseline: a standard or existing condition by which things are measured or compared.

Best Management Practices: approaches based on known science that, if followed, should allow the client to meet the required standard(s) or achieve the desired objective(s).

Biodiversity: the diversity of plants, animals, and other living organisms in all their forms and levels of organization, including the diversity of genes, species, and ecosystems, as well as the evolutionary and functional processes that link them.

Biogeoclimatic Zone: a geographic area having similar patterns of energy flow, vegetation, and soils as a result of a broadly homogeneous macro-climate.

Biosphere Reserves: areas of terrestrial and coastal ecosystems promoting solutions to reconcile the conservation of biodiversity with its sustainable use. They are internationally recognized, nominated by national governments, and remain under sovereign jurisdiction of the states where they are located. Biosphere reserves serve in some ways as living laboratories for testing and demonstrating integrated management of land, water, and biodiversity.

Blue-listed: includes any indigenous species or subspecies considered to be Vulnerable in British Columbia. Vulnerable taxa are of special concern because of characteristics that make them particularly sensitive to human activities or natural events. Blue-listed taxa are at risk, but are not Extirpated, Endangered, or Threatened.

Camelid: any member of the Camelidae family being ruminant and artiodactyl (hoofed mammals of the order Artiodactyla, which have an even number of toes) and having two toes and a three-chambered stomach. Examples are Llamas and Alpacas, Bactrian and Dromedary Camels, Guinacos, and Vicunas.

Capability (Habitat): the ability of the habitat, under the optimal natural (seral) conditions for a species, to provide its life requisites, irrespective of the current condition of the habitat. It is an estimate of the highest potential value of a particular habitat for a particular species and is useful in providing predictive scenarios for various habitat management options. Capability assumes non-intensive management and does not apply where the inherent soil characteristics and productivity have been artificially improved, as commonly occurs with irrigation or fertilization. The capability classification of these areas is based on what the ecosystems would be like if they reverted from their present state back to a non-intensive management state.

Carnivore: an animal that eats only (or almost only) meat.

CDC: Conservation Data Centre (British Columbia).

CITES: the Convention on International Trade in Endangered Species of Wild Flora and Fauna. An international convention on sustainable management of natural resources, including over 155 international parties; regulates international trade and movement of animal and plant species that have been or may be threatened. In Canada, the Canadian Wildlife Service leads the implementation of the convention.

Connectivity: a qualitative term describing the degree to which similar ecosystems (be they alpine, riparian, late-successional forests, grasslands, etc.) are linked to one another to form an interconnected network.

Conservation: the act or result of maintaining, managing, preserving, or protecting something; especially planned management of a natural resource with the intention of sustaining that resource over the long term, usually through a combination of protecting and mitigating measures to respond to various human activities that have the potential to diminish that resource.

Consider: to think about carefully, weigh, take into account.

Consistent: compatible or in harmony with; follows set principles, intent, and specific direction; permissible. Its meaning can be better understood in context with and in contrast to the related term “inconsistent.”

Coordinate: to bring the different elements of [a complex activity or organization] into a harmonious or efficient relationship.

Coordinated Access Management Plan(ning): integrated resources management tool to reduce impacts due to access by multi-stakeholder planning and management of access.

Corridor: habitat used by wildlife for dispersal, migration, and/or general movement.

COSEWIC: the Committee on the Status of Endangered Wildlife In Canada. A federal committee made up of 29 voting members, including experts from each province and territory and federal agencies. COSEWIC

assesses and determines the national status of wildlife species, subspecies, and populations in Canada, based on scientific and traditional ecosystem knowledge.

Three lists are maintained:

1. **Species at Risk**: species designated in the Extinct, Extirpated, Endangered, Threatened, or Special Concern categories;
2. **Not at Risk**: species that have been evaluated and found to be not at risk; and
3. **Data Deficient**: species for which there is insufficient scientific information to support a risk or not at risk designation.

Creel Surveys: most creel surveys take the form of a series of angler interviews conducted on randomly chosen days over a specific period; however, they can also be done by aerial survey, or by using indexing methods such as instantaneous ground boat counts. These latter surveys provide a relative index of angler use, and are used to attain a broad measure of angler distribution across a large geographic area, or to assess long-term trends in angling activity.

Critical Habitat: habitat that is vital to the health and maintenance of one or a variety of species for a range of activities, such as nesting, denning, feeding, breeding, etc.

Critical Wildlife Habitat Feature: a discrete element (feature) of the habitat that is vital to the health and maintenance of one or a variety of species for a range of activities, such as nesting, denning, feeding, breeding, etc.

CWD: coarse woody debris.

Determine: to fix in scope, fix the boundaries of; fix with certainty, usually by making an inquiry or other effort.

Develop: to generate gradually.

DFO: Federal Department of Fisheries and Oceans, Canada.

Discourage: to try to prevent; show opposition to.

Document: to record in detail.

Domesticated Animal: a vertebrate that has adapted to life in association with man.

Early Seral: the first stage in ecological succession characterized by a greater number of plant species than later stages. These plant species have high population growth rates, short generation times, abundant seed production, and efficient seed dispersal (grasses and forbs).

Ecological Integrity: a condition where the structures and functions of an ecosystem are unimpaired by stresses induced by humans and are likely to remain so.

Ecology: the study of patterns of relations between living organisms and their environment.

Ecoprovince: an area with consistent climatic processes or oceanography, and relief, defined at the sub-continental level.

Ecosection: an area with minor physiographic and macroclimatic or oceanographic variation, defined at the sub-regional level.

Ecosystem: a functional unit consisting of all the living organisms (plants, animals, and microbes) in a given area, and all the non-living physical and chemical factors of their environment, linked together through nutrient cycling and energy flow. An ecosystem can be of any size–a log, pond, field, forest, or the earth's biosphere–but it always functions as a whole unit. Ecosystems are commonly described according to the major type of vegetation; for example, forest ecosystem, old-growth ecosystem, or range ecosystem.

Ecosystem Approach: integrating scientific knowledge and socioeconomic values to manage for biological diversity and ecological integrity as well as natural resources use over the long term.

Encourage: to contribute to the progress or growth of.

Endangered (Species): an indigenous species, subspecies, or geographically separate population that is threatened with imminent extirpation or extinction throughout all or a significant portion of its range.

Endemic: native to a particular area; not introduced.

Enhanced: relatively improved, greater (in value, complexity, or desirability).

Enhanced Management: a relatively higher level of protection and/or management required to maintain the resource values.

Enhanced Restoration: requires a level of effort and value relatively greater than current, standard restoration/rehabilitation procedures.

Ensure: to make certain that something will occur or be so, to be careful or certain to do something.

Establish: to set up, found, lay the groundwork for.

Extirpated (Species): species that were once part of the natural fauna but no longer occur; they may occur in the wild elsewhere.

Extraordinary Means: notably exceptional or unusual measures above and beyond routine management, which typically would require an inordinate expenditure of resources (including time, budget, and effort).

Feral (Animal): a domestic animal that has adapted to and lives in the wild.

Focus: to attach special emphasis to.

Forb: a broad-leaved herb other than a grass, especially one growing in a field, prairie, or meadow.

Forest Ecosystem Network: a contiguous network of representative old-growth and mature forests (some of which provide forest interior habitat conditions), and/or other important wildlife habitat, delineated in a

managed landscape. Not only does a FEN aim to meet the needs of native species and ecological processes, it also serves to maintain or restore the natural connectivity within a landscape unit.

Fragmentation (Habitat): is a qualitative term describing the degree to which similar habitats (be they alpine, riparian, late-successional forests, grasslands, etc.) are separate from one another. Reduction in the total area of the habitat can be from increase of edge, decrease of interior habitat, isolation of a fragment from other areas, breaking up of one patch into smaller patches, or decrease in the size of patches.

Functionally Significant (Population): a population that is not at risk (i.e., not considered to be Vulnerable, Threatened, or Endangered) and is able to maintain its natural role in ecosystem function. Functionally significant populations can be achieved within a single population, or within a meta-population.

GIS: Geographic Information System. A configuration of computer hardware and software that captures, stores, analyzes, and displays geographic information.

Glucocorticoid: a group of steroid hormones secreted by the adrenal cortex, which can be used as indicators of stress.

Goal: broad statement that describes a future vision with respect to a particular subject.

Guidelines: approaches based on known science that, if followed, should allow the client to meet the required standard(s) or achieve the desired objective(s).

Habitat: the air, soil, water, food, and cover components of the environment on which wildlife depend directly or indirectly in order to carry out their life processes.

Harass: includes worry, exhaust, fatigue, annoy, plague, pester, tease, or torment, but does not include the lawful hunting, trapping, or capturing of wildlife.

Herbivore: an animal that eats only (or almost only) plants.

Hibernaculum (a): any over-wintering site used by hibernating bats. Bats in hibernacula are particularly vulnerable to human disturbance.

Historical Vocations and Activities: include those professions and activities as listed in Technical Appendix 6.

Identified Wildlife: a species classified as Identified Wildlife under section 70 of the *Forest and Range Practices Act of British Columbia*. Identified Wildlife will be managed through a higher-level plan, wildlife habitat area, general wildlife measure, or combination of these.

Identified Wildlife Management Strategy (IWMS): two documents outlining the necessary information, procedures, and provisions to promote conservation of Identified Wildlife under the *Forest and Range Practices Act of British Columbia*. The first document describes procedures for establishing, modifying, and removing a Wildlife Habitat Area and implementing strategic and landscape-level planning recommendations for Identified Wildlife, and provides direction to government planners, foresters, and wildlife managers. The second document summarizes the status, life history, distribution, and habitats of Identified Wildlife and outlines specific prescriptions for management of their habitats. This document is a resource document for government planners, foresters, and wildlife managers, and for those interested in the life history of Identified Wildlife.

Identify: to establish, determine.

ILMA: British Columbia Integrated Land Management Agency

Implement: to pursue to a conclusion or bring to a successful issue.

Indicator: a parameter that can be measured, observed, or derived, and that provides information about patterns or trends in the environment. There are many different kinds of indicators, including both qualitative and quantitative information (e.g., percentage of protected areas, seral stage distribution, number of endangered species, single-species distribution changes). Even quantitative indicators are often not free of qualitative judgements. In many cases, qualitative information may provide adequate support for trend analysis. Any data uncertainty should be explicitly recognized.

Indigenous: a species native to British Columbia.

Integrity: the condition of being sound, complete, intact, or whole.

Interior Forest Conditions: conditions achieved at a point where edge effects no longer influence environmental conditions within a patch of forest. The effects usually involve light intensity, temperature, wind, relative humidity, and snow accumulation and melt.

IWMS: Identified Wildlife Management Strategy.

Known: a feature, objective, or other thing that is generally available and contained in information sources provided by the government.

Land and Resource Management Plan (LRMP): in British Columbia, a local strategic plan for the purpose of natural resources management. General management direction, objectives, and strategies are provided for Resource Management Zones, by Forest District. Local and provincial organizations, agencies, and stakeholders participate in the preparation of LRMPs.

Landscape: a watershed or series of similar and interacting watersheds, usually between 10 000 and 100 000 ha in area.

Landscape Unit (LU): a planning area, generally up to about 100 000 ha in area, delineated according to topographic or geographic features such as a watershed or series of watersheds. It is established by the District Manager.

Lead: to act as the proponent, be in charge of, preside over.

Limit: to confine, restrict.

Local: of regional or sub-regional provenance.

Low Abundance: towards the lower end on a scale of natural variability; the low end of the cycle for populations that follow cyclic abundance patterns.

LRMP: Land and Resource Management Plan.

LU: Landscape Unit.

Maintain: to keep in an existing state; to sustain or conserve; to keep in safety and protect from harm, decay, loss, or destruction.

MAL: British Columbia Ministry of Agriculture and Lands

Manage: to exercise executive, administrative, and supervisory direction of; administer and regulate disposition of; to guide use and regulate availability.

Management Directions: includes strategies, targets, and actions that are the responsibility of appropriate agencies of the British Columbia government to implement or to ensure are implemented by other parties.

May: an auxiliary to introduce examples that are viable, or likely, and that are possibly subject to unspecified conditions. Does not imply a requirement.

Meta-population: a group of two or more interacting but separated (sub)populations occupying discrete habitat patches, connected by immigrating and emigrating individuals. Meta-population is most often a result of spatially discontinuous habitat due to natural heterogeneity or habitat fragmentation. Subpopulations can go extinct without the meta-population going extinct.

Mitigation: natural resource management practices targeted at improving the compatibility between natural resource uses. Mitigation strategies include efforts to avoid, minimize, rectify, reduce, or compensate for the impact of one resource use on another.

Minimize: to make a planned, stated, and directed effort to reduce to a reasonable minimum. For example, to minimize the impacts of road development to wildlife and wildlife habitat, the potential wildlife species and habitat values would be determined beforehand, alternative access methods would be developed, potential impacts (worst- and best-case scenarios) of each alternative would be identified, and the option with the likelihood for the least impact to wildlife and wildlife habitat would be selected.

Minimum Viable Population (MVP): a population with the minimum number of individuals theoretically needed to form a viable population. Minimum population viability is estimated using contemporary, provincially recognized scientific methodology, when available.

M-KMA: Muskwa-Kechika Management Area.

M-KWMP: Muskwa-Kechika Wildlife Management Plan.

MFR: British Columbia Ministry of Forests and Range.

Monitor: to evaluate progress toward stated objectives and guide the long term revision, adjustment and refinement of the plan; the systematic measuring, comparing, and evaluation of suitable indicators of change in conditions.

MoT: British Columbia Ministry of Transportation.

Must: : an auxiliary used in Part A (Strategic Document) to express a mandatory requirement, obligation, or necessity for a decision-maker; can be used as a test for consistency with the plan. When used in Part B (Technical Manual), this auxiliary verb is used for emphasis of the importance of an action or actions.

MVP: minimum viable population.

MoE: British Columbia Ministry of Environment.

Natural (Conditions): determined by nature; environmental conditions within the range of historic variability prior to European settlement. In most cases, "natural conditions" should be described in terms of a long term average or norm, with accompanying ranges for specified conditions (e.g., mean seasonal stream flows with historic maximum and minimums; peak flows with mean return intervals).

Natural Range of Variability: the range of variability in ecological conditions that occurred before European settlement.

Natural Resource: land, water, and atmosphere; their mineral, vegetable, and other components; and the flora and fauna on or in them.

Natural Resource Development: management and use of natural resources to satisfy human needs. Includes all planning, mechanical exploration, extraction, rehabilitation, remediation, mitigation, etc. activities.

Negatively Affect: to affect in a manner involving disadvantage or harm.

Niche: the status of an organism within its environment and community (affecting its survival as a species).

No Net Loss: a working principle that strives to balance unavoidable habitat losses with habitat replacement on a project-by-project basis so that further reductions to fisheries resources due to habitat loss or damage may be prevented.

Objective: a concise, measurable statement of a desirable future condition for a natural resource or natural resource use that is attainable through management action.

Old Growth Management Area (OGMA): an area established under the *Forest Practices Code of British Columbia Act* that contains, or is managed to replace, old-growth attributes.

Omnivore: an animal that eats both meat and plants.

Operational Instrument: a plan, allocation, tenure, disposition, licence, or any other instrument or document affecting or respecting Crown land or a natural resource that is enacted or authorized under an enactment; a broad definition, meant to cover all forms of specific permission given by the Provincial Government. Examples include permissions to explore for and extract natural resources, permissions to occupy or use Crown land on a temporary or long-term basis, transfers of Crown land, permissions to build and use roads, permissions under the *Wildlife Act,* permissions to use water and to alter water bodies, permissions to release waste into the environment, and permissions to use pesticides; describes permissions given in the exercise of administrative or judicial discretion, rather than permissions given on a legislative basis.

Opportunistic(ally): when a favourable combination of circumstances, time, place, and resources permit.

Parkland: an intermingling of forest and grassland. Thus, spruce parkland is comprised of open groves of white spruce, balsam fir, and aspen mixed with tundra and grasslands; aspen parkland is comprised of a mosaic of grassland and aspen woodland.

Population: a group of individuals from the same species that are genetically, demographically, or spatially separated from other groups of individuals. The Committee on the Status of Endangered Wildlife in Canada defines a population as "a geographically or otherwise distinct group (a portion of the total population) that has little demographic or genetic exchange with other such groups (populations) – typically one successful migrant individual or gamete per year or less."

Population Control (Wildlife): to actively limit or reduce the population of a species through means other than legal harvest. Population control can be lethal (i.e., aimed at causing direct mortality), or non-lethal (i.e., aimed at indirectly limiting or reducing a population).

Population Monitoring: the process of collecting and analyzing demographic information to evaluate population status and trends.

Population Persistence: when quantified, the probability that a population will maintain itself at or above a threshold number (or density) for a specific period of time.

Precautionary Principle: where there is a threat of significant reduction or loss of biological diversity, ecosystem function, or habitat suitability, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize a threat.

Predator Control: to manage the effects of individuals or populations of wildlife that, through predation, represent a threat to the viability of, or impede the recovery of, a prey population. The preference is, where practical, for techniques that target individuals that are known or suspected to be causing the impacts. Non-lethal techniques of management are preferred over lethal techniques where practical except in the case of non-indigenous species, where lethal techniques are preferred. Lethal techniques of predator population control will not be used for other species-at-risk that are known or suspected to be causing impacts. Where legal harvest of species that are not at risk can effectively be used, this should be preferred over other lethal techniques.

Predictive Ecosystem Mapping (PEM): a computer-, GIS-, and knowledge-based method of stratifying landscapes into ecologically oriented map units based on the overlaying of existing mapped themes and the processing of the resultant attributes by normally automated "inferencing" software with a formalized knowledge base comprising ecological–landscape relationships.

Prescribed Fire: the knowledgeable application of fire to a specific land area to accomplish predetermined forest management or other land use objectives.

Prescribed Natural Fire: a habitat management tool where naturally occurring fire is allowed to burn, usually in designated areas and under predetermined conditions.

Prevent: to keep from happening or arising.

Priority Wildlife Species: species of special management interest in the Muskwa-Kechika Area because they are red- or blue-listed, or because their M-K populations are a substantial proportion of the total population, or because their populations or habitats are particularly sensitive to human activities. These species are also important for First Nations, guide outfitters, and the public.

(Project) Proponent: an individual or group of individuals, company, agency, or organization that is proposing or applying for some form or component of resource use and development.

Protect: to shield from injury, destruction or damage.

Provide: to make a preparation to meet a need; to supply or make available.

Recognize: to acknowledge or take notice of in some definite way.

Red-listed: includes any indigenous species or subspecies that have, or are candidates for, Extirpated, Endangered, or Threatened status in British Columbia. Extirpated taxa no longer exist in the wild in British Columbia, but do occur elsewhere. Endangered taxa are facing imminent extirpation or extinction. Threatened taxa are likely to become Endangered if limiting factors are not reversed. Not all red-listed taxa should become formally designated. Placing taxa on these lists flags them as being at risk and requiring investigation.

Representative Ecosystem: an ecosystem (e.g., site series) that is typical of the landscape and region, whether common or not.

Require: to demand as necessary or essential.

Resource Management Zone (RMZ): a geographic area within the larger planning area that is distinct from other geographic areas with respect to biophysical characteristics, resource issues, or resource management direction. RMZs are normally delineated, and corresponding resource management objectives and strategies defined, as a consequence of a regional or sub-regional planning process. RMZs are planning units that may be established under the *Forest Practices Code of British Columbia Act*.

Restrict: to place limits or specific conditions on; in some cases, prohibit.

Results-based Habitat Management: management actions concurrent with natural resource development and use (including, but not limited to, recreation, timber harvesting, mineral mechanical exploration and mining, and oil and gas mechanical exploration and development) with the objective of maintaining local habitat suitability.

Riparian: refers to the area next to streams, lakes, and wetlands and includes both the area dominated by continuous high moisture content and the adjacent upland vegetation that exerts an influence on it.

Risk Assessment: the process of identifying a hazard and characterizing or estimating the risk presented by that hazard, in qualitative or quantitative terms.

RMZ: Resource Management Zone.

Roost: any site used by wildlife for rest, sleep, torpor, food digestion, shelter, etc. For many wildlife species, a distinction can be made between day and night roosts.

Scarce: limited in distribution, relatively rare, in short supply.

Seral Stages: sequence of communities during ecological succession, the communities generally merging from one into another; the different stages of forest development.

Shared Stewardship: the notion that environmental sustainability depends on the collective knowledge, commitment, and actions of individuals, organizations, communities, industries, and all levels of government as a whole, and that caring for the environment is a responsibility shared among all sectors of society.

Should: an auxiliary used to express a recommendation to a decision-maker to consider the advice, guidance, or direction proposed, but that is not mandatory and cannot result in an inconsistency.

Significant: important; having or likely to have a major effect; of consequence; fairly large in amount or quantity.

Site Series: sites capable of producing the same late seral or climax plant communities within a biogeoclimatic subzone or variant.

SOU: Species Objectives Unit.

Spatially Locate: to identify and record the location and boundary.

Species: a group of individuals that have their major characteristics in common and are potentially interfertile.

Species Objectives/Strategies Unit (SOU): a planning unit for the purposes of the Muskwa-Kechika Wildlife Management Plan comprised of amalgamations of Resource Management Zones with gross ecological similarity.

Stand Level: the level of forest management at which a relatively homogeneous land unit can be managed under a single prescription, or set of treatments, to meet well-defined objectives.

Stewardship: the ethic and practice of careful and responsible management of resources and amenities for the benefit of present and future generations.

Strategy: a means of achieving a resource objective.

Subnivean: situated or occurring under the snow.

Subspecies: a subset of a species occupying a particular geographic area or, less commonly, a distinct habitat; capable of interbreeding with other members of the same species.

Suitable: relevant, appropriate, and achievable for a condition or occasion.

Suitability (Habitat): the ability of the habitat in its current condition to provide the life requisites of a species. It is an estimate of how well current habitat conditions provide the specified life requisite(s) of the species being considered. The suitability of the land is frequently less than the capability because of unfavourable seral conditions.

Summary Statistics Database: provides summary statistics for big-game species (and limited information for a few game birds). The database incorporates data from compulsory reporting (for big-game animals), from guide outfitter summaries, hunter sample questionnaires, limited-entry hunting, problem wildlife reports, and tooth returns.

Sustain: to support, maintain.

Sustainable (Development): The Bruntland Commission defined sustainable development as "the management of the human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining the potential to meet the needs and aspirations of future generations." For natural resources development to be sustainable, it must take account of economic, social, and ecological factors of the living and non-living natural resource base, and of the long-term (> 100 years) and short-term (1–4 years) advantages and disadvantages of alternative actions.

Target: a reference point to work towards.

Terrestrial Ecosystem Mapping (TEM): the stratification of a landscape into map units, according to a combination of ecological features, primarily climate, physiography, surficial material, bedrock geology, soil, and vegetation.

Threat: likely to cause negative impact.

Threatened (Population): a geographically separate population of an indigenous species likely to become endangered if the factors affecting its vulnerability are not reversed.

Threatened (Species): an indigenous species, subspecies, or geographically separate population likely to become endangered if the factors affecting its vulnerability are not reversed.

Thresholds (Ecological): a point on an environmental or ecological gradient that produces a significant population response. For example, number of linear disturbances per square kilometre, and effects on wildlife population dynamics such as (but not limited to) presence/absence, density, distribution, and population estimates. A threshold should be science-based, and measurable.

Track: to record and monitor.

Traditional Ecological Knowledge (TEK): a cumulative and adaptive body of knowledge, usually associated with indigenous peoples (First Nations), and closely associated with sustenance and survival; the ability of indigenous peoples to comprehend local ecosystem interrelationships and to achieve sustainable levels of natural resource use with no or minimum disruptions to ecosystem functions.

Undertake: to commit to and begin, for example, an implementation action or strategy.

Unduly: to an excessive, improper, or unjustifiable degree.

Viable Population: a population in a state that maintains its vigour and its potential for evolutionary adaptation. This requires that the population be naturally regulated and subject to selective pressures. Over the

medium (20–100 years) to long-term (> 100 years) a viable population should exhibit a stable growth rate and a stable age distribution.

Vulnerable (Species): an indigenous species, subspecies, or geographically separate population particularly at risk because of low or declining numbers, small range (limited habitat), or some other reason, but not a Threatened species.

WHA: Wildlife Habitat Area.

Wild Fur Data System: licensed fur-traders (persons legally able to buy and sell furs) are required to submit monthly tallies. These fur reports have been organized into a computerized system known as the Wild Fur Data System (WFDS) since 1982 but are considered almost 100% complete only since 1988. The WFDS allows for harvest summaries of the province, or by administrative region, wildlife Management Unit (MU), and trapline.

Wildlife: vertebrates (mammals, birds, reptiles, amphibians, and fish), invertebrates, and plants; includes the eggs and juvenile stages of these vertebrates, invertebrates, and plants.

Wildlife Habitat Area: areas of limiting habitat that are mapped and approved by the Chief Forester and Deputy Minister of Environment. Wildlife Habitat Areas are managed according to specific management practices, known as General Wildlife Measures (GWMs). General wildlife measures may limit forest or range management practices partially or entirely.

Wildlife Management: the application of scientific and technical principles to wildlife populations and habitats to produce a desired effect (direct or indirect) on the abundance, dynamics, distribution, diversity, and species composition of wildlife, including plants and invertebrates. Wildlife management can be applied through legislation, policies, or procedures.

Wildlife Tree: a standing live or dead tree with special characteristics that provides important habitat for wildlife.

Wildlife Tree Patch (WTP): an area specifically identified for the retention and recruitment of suitable Wildlife Trees.

Technical Appendix 8: Summary of Research Needs

Objectives	Research Needs
General Habitat	
Ecosystem approach to habitat management	Establish natural range of variability for ecosystems
Cumulative Effects Management	Effects thresholds should be determined for the priority species
Landscape-level Habitat	
Natural range of seral-stage and ecosystem distributions	Natural disturbance patterns and effects on habitat
Connectivity of habitats	Determining where and how connectivity occurs under natural disturbance processes
Functional riparian areas	Continued research on developing effective management
Species-specific Habitat	
Maintaining important wildlife habitat for priority species	Determine habitat use and define niches in the M-KMA Cumulative effects assessment modeling to determine effects thresholds
Fire Management	
Manage fire to meet habitat objectives, within the natural range of variability	Better understanding of long-term fire history and role of fire in the M-KMA Better understanding of the use of prescribed fire to maintain natural range of variability Cumulative effects assessment modeling to determine acceptable limits of change
Migration Habitat	
Maintain important migration habitat	Determine important elements in migration habitat Determine threats to migration habitat Cumulative effects assessment modeling to determine acceptable limits of change
Results-based Habitat Management	
Ensure that developments do not reduce habitat stability	Improved identification of habitat use. Cumulative effects assessment modeling to determine acceptable limits of change

Objectives	Research Needs
Species - General	
Ensure that health issues do not threaten priority species	Establish baseline animal health data
Minimize impacts due to access	Methods of managing access to limit predation Develop access thresholds
Maintain sustainable harvests as per provincial policy	Develop First Nations co-management
Stone's Sheep	
Maintain adequate early-seral grass–shrub areas	Cumulative effects assessment modeling to determine acceptable limits of change
Identify and avoid contagions	Establish baseline health indicators
Minimize disturbance	Impacts of aircraft and recreation encounters on stress levels
Woodland Caribou	
Maintain large patches of suitable habitat	Development of a suitability model
Maintain or increase Caribou numbers	Neonatal calf mortality
Identify and avoid contagions	Establish baseline health indicators
Wood Bison	
Provide/maintain adequate early-seral habitat	Cumulative effects assessment modeling to determine acceptable limits of change
Maintain disease-free condition of population	Establish baseline health indicators
Plains Bison	
Provide/maintain adequate early-seral habitat	Cumulative effects assessment modeling to determine acceptable limits of change
Maintain disease-free condition of population	Establish baseline health indicators
Moose	
Create/retain early-seral shrub land	Cumulative effects assessment modeling to determine acceptable limits of change
Monitor parasite loads	Establish baseline health indicators
Mountain Goat	
Maintain habitat connectivity	Importance and use of licks
Identify and avoid contagions	Establish baseline health indicators
Minimize disturbance	Impacts of aircraft on stress levels
Elk	
Maintain large early-seral grassland areas	Cumulative effects assessment modeling to determine acceptable limits of change
Identify and avoid contagions	Establish baseline health indicators
Gray Wolf	
Control when necessary for conservation of species at risk or red- or blue-listed priority species	Impacts of sterilization and inter-pack movement
Monitor population health	Establish baseline health indicators
Grizzly Bear	
Monitor population health	Establish baseline health indicators

Objectives	Research Needs
Black Bear	
Monitor population health	Establish baseline health indicators
Maintain harvest	Maintain a conservative harvest
Coyote	
Control when necessary for conservation of species at risk or red- or blue-listed priority species	Impacts of sterilization and inter-pack movement
Monitor population health	Establish baseline health indicators
Cougar	
Control when necessary for conservation of species at risk or red- or blue-listed priority species	Impacts of sterilization and inter-pack movement
Monitor population health	Establish baseline health indicators
Wolverine, *luscus* subspecies	
Maintain landscape connectivity	Important wolverine habitat in the M-KMA
Monitor population health	Establish baseline health indicators
Prevent abandonment of dens	Level of fidelity to denning areas
Lynx	
Monitor population health	Establish baseline health indicators
Marten	
Manage for important habitat at the stand level	Determine suitable, local CWD characteristics
Monitor population health	Establish baseline health indicators
Fisher	
Manage for important habitat at the landscape and stand levels	Determine suitable characteristics and volumes of CWD for Fisher in the M-KMA
Monitor population health	Establish baseline health indicators
Prevent abandonment of dens	Level of fidelity to denning areas
Reduce accidental kills	Effective exclusion of Fisher from Marten sets
River Otter	
Monitor population health	Establish baseline health indicators
Minimize riparian disturbance	Level of fidelity to denning areas
Prevent abandonment of dens	Level of fidelity to denning areas
Beaver	
Monitor population health	Establish baseline health indicators
Northern Myotis	
Identify and protect important habitat	Explore potential for artificial rearing houses
Sandhill Crane	
Identify and protect important habitat	Habitat characteristics of breeding areas
Peregrine Falcon, *anatum* subspecies	
Determine if species breeds in the M-KMA	Feasibility of releases
Short-eared Owl	
Identify breeding areas	Use of prescribed fire to promote habitat
Cape May Warbler	
Maintain suitable breeding habitat	Confirmation of habitat requirements
Determine numbers and distribution	Evaluation of clutch survival relative to forest

Objectives	Research Needs
	characteristics
Monitor population health	Impact of oil and gas well emissions on reproduction
Black-throated Green Warbler	
Maintain suitable breeding habitat	Confirmation of habitat requirements
Determine numbers and distribution	Evaluation of clutch survival relative to forest characteristics
Monitor population health	Impact of oil and gas well emissions on reproduction
Connecticut Warbler	
Maintain suitable breeding habitat	Confirmation of habitat requirements
Determine numbers and distribution	Evaluation of clutch survival relative to forest characteristics
Monitor population health	Impact of oil and gas well emissions on reproduction
Fish	
Maintain habitat quality, water quality, and hydrological conditions	Developing/refining habitat ratings tables
Determine species distribution and population parameters	Characterize populations across their distributional range
Protect important habitat	Assessing and mitigating impacts
Minimize impacts due to access	Assessing impacts of motorized boat access
Maintain sustainable population levels	Compare current conditions with historical surveys Analyze impacts from guided activities
Reptiles and Amphibians: Western Toad	
Determine species distribution and population parameters	Characterize populations across range
Invertebrates	
Maintain habitat suitability	Refer to General Habitat above
Determine species distribution	Map suitable habitat
Non-indigenous Species	
Prevent negative impacts due to grazing	Effects of grazing on wildlife and habitat
Wildlife–Human Conflict	
Reduce negative interactions	Effectiveness of translocations, and critical factors of success
Reduce impacts of livestock on Crown land	Vegetation responses to and recovery from grazing
Industrial/Commercial Access and Development	
Co-ordinate access management planning	Cumulative Effects Assessment to determine acceptable limits of change
Recreation Impacts on Wildlife	
Minimize negative effects of recreation	Cumulative Effects Assessment to determine acceptable limits of change

Objectives	Research Needs
Historical Vocations and Activities	
Maintain opportunities	Compendium of historical vocations and activities

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Red listed species include any indigenous species or subspecies that have, or are candidates for Extirpated, Endangered, or Threatened status in British Columbia. Extirpated taxa no longer exist in the wild in British Columbia, but do occur elsewhere. Endangered taxa are facing imminent extirpation or extinction. Threatened taxa are likely to become endangered if limiting factors are not reversed. Not all Red-listed taxa will necessarily become formally designated. Placing taxa on these lists flags them as being at risk and requiring investigation.
Blue Listed species at risk include any indigenous species or subspecies considered to be Vulnerable in British Columbia. Vulnerable taxa are of special concern because of characteristics that make them particularly sensitive to human activities or natural events.
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Three lists are maintained:

1. Species at Risk: species designated in the extinct, extirpated, endangered, threatened, or special concern categories;
2. Not at Risk: species that have been evaluated and found to be not at risk; and,
3. Data Deficient: species for which there is insufficient scientific information to support a risk or not at risk designation.

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