PEEL WATERSHED
PLANNING COMMISSION
TOGETHER FOR THE PEEL • CHUU TL'TI GEENJIT KHETOK

CONSERVATION PRIORITIES ASSESSMENT REPORT

September 2008

Donald Reid, Wildlife Conservation Society Canada, Whitehorse
Sam Skinner, Peel Watershed Planning Commission, Whitehorse

About the
Peel Watershed Planning Commission

The Peel Watershed Planning Commission is responsible for developing and recommending a regional land use plan for the Peel watershed planning region. The Commission is composed of six public members nominated by the Na-cho Nyak Dun, the Gwich'in Tribal Council, as a joint Yukon Government/Vuntut Gwitchin nominee, a joint Yukon Government/ Tr'ondëk Hwëch'in nominee and two Yukon Government nominees.

Office

Peel Watershed Planning Commission
201 – 307 Jarvis Street
Whitehorse, YT Y1A 2H3
Tel 867-667-2374 fax 867-667-4624
Email: info@planyukon.ca web: www.peel.planyukon.ca

Cover Photo

Aberdeen Canyon, Peel River. John Meikle, Environment Yukon.

Executive Summary

This report presents the principal results of the Conservation Priorities Assessment for the Peel watershed in north-central Yukon. Its purpose is to present data and interpretations regarding the distribution of the conservation indicators previously identified in the Conservation Priorities Assessment Criteria and Indicators Report (PWPC 2007).

The Conservation Technical Advisory Group worked with scientists and community experts to gather, map, and interpret information so as to assess ecosystem representation, areas where people harvest wildlife and plants, focal species distributions and habitats, and special features distributions. Our ultimate goal is to integrate this scientific, local and traditional information in the process of identifying high priority conservation areas. Ecosystem mapping relied on ecoregional classification, and a satellite-derived classification of ecological land classes. We derived distribution maps for focal species from previously mapped high quality areas (Wildlife Key Areas), and some radio-telemetry data sets. Habitat suitability maps were based on ratings for each ecological land class compiled by scientists and by community experts that used their traditional knowledge and experience on the land. Focal species or species groups included fish, caribou, moose, Dall's Sheep, marten, grizzly bears, Peregrine Falcon, waterbirds, breeding birds, birds of conservation concern, and rare or endemic plants. Special features were mapped from various sources including interviews with knowledgeable individuals and previous inventories. We also mapped the distribution of wilderness, and subsistence harvesting areas, as significant conservation values. This report includes background information regarding these data layers and their interpretation, and maps depicting their geographic distribution.

The upcoming Scenarios Methods Report (PWPC 2008b) will outline the steps and key questions of the Commission members and staff as they use findings in this report to produce a portfolio of high priority conservation areas. These areas will then be considered alongside the mapped distributions of other resources as well as existing and potential development (see the Resource Assessment Report, PWPC 2008a, for a description of these), to produce a series of regional land use scenarios. These scenarios will be described in the upcoming Scenario Options Discussion Paper (PWPC 2008b, as yet unpublished). Public consultation on these options will lead to the development of a set of land use zones and a final integrated regional land use plan.

Acknowledgements

The work reported here was designed and directed by The Peel Watershed Planning Commission's Conservation Technical Advisory Group (CTAG), consisting of the authors of this report, plus John Meikle, Cameron Eckert, and Mark O'Donoghue of Environment Yukon, and Graham Baird (Planning Technician until April 2007) and Brian Johnston (Senior Planner until September 2008) of the Peel Watershed Planning Commission. Many other biologists contributed significant experience and expertise to different sections of the report. They are acknowledged as the "domain experts" in each of the chapters. We thank Richard Vladars, GIS Specialist with the Peel Watershed Planning Commission, for his significant contribution to the gathering, storage, processing, and mapping of the data used in the report. John Ryder, Land Use Planner with the North Yukon and Peel Watershed Planning Commissions, was instrumental in getting much of the groundwork for this Conservation Assessment process in place before the CTAG took over responsibility and John took on responsibilities with the North Yukon Planning process in late 2006. Kathleen Zimmer assisted with logistics and administrative issues for the work. We thank the various experienced members of the three communities (Dawson City, Mayo and Fort McPherson) where we held workshops for contributing their knowledge to the process. They are identified in Table 1.

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List of Acronyms

CTAG – Conservation Technical Advisory Group
CWS – Canadian Wildlife Service
DEM – Digital Elevation Model
GIS – Geographic Information System

NTS – National Topographic Series
NTDB – National Topographic Data Base
PWPC – Peel Watershed Planning Commission
WKA – Wildlife Key Area

Glossary

Anadromous – a fish life cycle that includes time spent in salt ocean water as an adult, and freshwater spawning and early life stages.

Aufeis – a sheet of ice formed on a river flood plain when shallow areas are dammed or freeze solid, and ongoing water flow freezes widely over the flood plain. Ironically, aufeis, or "icings", tend to form where warmer groundwater discharges.

Biodiversity – the complete catalogue of species (including their genetic variability) which can occur in a region.

Coarse filter – an approach to conservation planning that works on the assumption that conserving representation of the full suite of ecosystems in a region will result in conservation of most species that rely on those ecosystems.

Digital elevation model – data that can take the place of traditional contour-based elevational data in a GIS.

Endemism – characteristic of a species whereby its distribution is restricted to a particular area.

Fine filter – an approach to conservation planning, complementary to the coarse filter, where species which are unlikely to be conserved by the coarse filter approach (notably rare species) are given specific attention.

Habitat suitability – the ability of a habitat, as it exists at present, to satisfy the life history needs of a particular species for a designated portion of the annual cycle.

Potadromous – a fish life cycle that includes migratory movements but where all stages exist in freshwater.

Wildlife Key Area – a site or area of very high value to a particular species in the most limiting season in its life cycle. Yukon Environment maintains a database of WKAs.

SECTION I: INTRODUCTION

This report presents the principal results of the Conservation Priorities Assessment for the Peel Watershed Planning process in north-central Yukon. Its purpose is to present data and interpretations regarding the distribution of conservation indicators identified in the Conservation Priorities Assessment Criteria and Indicators Report (PWPC 2007), so that Commission members, planners, government agencies, and the public can assess the spatial relationships among indicators over the planning region. The Criteria and Indicators Report explained how the conservation indicators were chosen, and this Report presents the information gathered for each indicator.

The PWPC's statement of intent begins with: "The goal of the Peel watershed land use plan is to ensure wilderness characteristics, wildlife and their habitats, cultural resources, and waters are maintained over time while managing resource use".
The General Terms of Reference for the PWPC (YLUPC 2004) sets a goal for the land use plan to "Take into account that the management of land, water and resources, including fish, wildlife, and their habitats, is to be integrated" (reference UFA 11.4.5.8)[1], while a number of the submissions from interest groups insist that these values be actively considered by the Commission. In doing so, it is assumed that the Commission should make recommendations regarding potential protected areas within the plan area, and regarding other management measures needed to deal with conservation values for landscapes outside proposed protected areas (PWPC 2005). The Conservation Priorities Assessment is the technical process of first gathering pertinent information regarding land, wildlife and fish resources; and then interpreting this information to identify areas of higher ecological value. Some of the technical work is summarized in other documents which are referred to in this Report. The Conservation Priorities Assessment is conducted independent of other resource assessments so that Commission members will have the best available information on conservation values to consider, alongside other values, when making their land use recommendations.

The Conservation Priorities Assessment process used, in roughly equal measures, both available scientific knowledge and traditional and local knowledge. Traditional and local knowledge contributed to not only the subsistence harvesting assessment, but also to most of the habitat suitability models. This combination of approaches not only satisfies a requirement of the Umbrella Final Agreement (reference UFA 11.1.1.4: "to utilize the knowledge and experience of Yukon Indian People in order to achieve effective land use planning"; DIAND 1993), but also creates a stronger document based on more experience on the land, and on more perspectives.

The Conservation Priorities Assessment is part of the information gathering stage of the PWPC planning process. Assessments of other key resource values in the watershed are happening parallel to the Conservation Assessment. The key information from all Assessments will be summarized in the Resource Assessment Report in fall 2008.

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1 These goals do not represent direct quotations of the UFA, but are derivations of the referenced clauses, as stated in the Commission's General Terms of Reference. See referenced clauses in the UFA for actual wording.

It is noteworthy that there is no current land use zoning for fish and wildlife conservation in the planning region; there are no protected areas, or parks (Map 1. Land Status). A few protected areas border the planning region, notably Tombstone Territorial Park (Yukon) on the southwest border (northern Ogilvie Mountains), and the James Creek / Vittrekwa River Conservation Zone (NWT: GLUPB 2003) to the north. The Tsiigehtshik Gwit'lit Special Management Zone (GLUPB 2003) borders the south-east. Within the planning region, there are a number of blocks of land owned by First Nations as a result of land claims (R-blocks). The Bonnet Plume River has been designated as a Canadian Heritage River by the Canadian Heritage River Board. This designation has government endorsement but offers no formal protection. However a management plan is part of the designation process, and needs to be formally considered by the Planning Commission. Generally speaking, the Conservation Priorities Assessment is starting from scratch in the search for high quality conservation lands.

Map 1: Land Status

Map 1: Land Status (reverse page)

SECTION II: PROCESS

Overview

Intrinsic and social values regarding land and resources in the planning region have been identified (PWPC 2005), and indicators have been chosen to best represent those values (criteria) spatially (PWPC 2007). The Conservation Priorities Assessment process then involves gathering data regarding the indicators, interpreting and mapping the data, and integrating the data from various indicators to identify areas of highest conservation value. The planning process then involves integrating the conservation values with other resource values in land use zoning and management recommendations within a land use plan. This report deals primarily with the data gathering, interpretation, and mapping phases of this process. The integration phases will follow, and we will describe our approaches to them in the Scenarios Methods Report (PWPC 2008b).

A Conservation Assessment for a large region with numerous wildlife and ecological resources ideally would use substantial and diverse sets of knowledge. However, the amount of ecological data previously gathered in this watershed has been patchy and generally sparse. Relatively few people know even portions of the ecological resources of this wilderness region intimately. Those who do are principally members of First Nations communities whose traditional territories and subsistence activities overlap the region, and biologists and guide-outfitters who have worked in the region. Consequently, these individuals are the experts, and the data, information and experiences they have collected are the focus of the data gathering phase of the work.

Water flow, quality, and quantity are integral parameters of many ecosystems. We do not explicitly deal with water resources in this Report, other than the fact that water acts as a habitat (as identified in the ecological land classification), and some of the focal species rely on this habitat. Water resources, and their management, are addressed in a separate resource report for the planning process.

Data Gathering and Mapping

In this section we outline the main ways in which information was acquired and analysed for mapping. This Conservation Priorities Assessment is coordinated by a team of biologists and planners from the Peel Watershed Planning Commission, the Yukon Department of Environment, and the non-government sector. This team (the Conservation Technical Advisory Group) has relied on a wide range of government and non-government experts to gather the relatively few scientific data, local knowledge, and First Nation traditional knowledge, and especially to interpret these sources of information so that they can be shown on maps. These experts are identified in the section of the Report where they had a role.

A Conservation Assessment generally includes three categories of mapped ecological information: distribution of ecosystems and biodiversity, distribution of focal or indicator species, locations of special elements or unique features (Groves 2003).

To map the distribution of ecosystems, staff of the Yukon Department of Environment and the Peel Watershed Planning Commission developed a categorization of ecological land classes based primarily on plant community characteristics as interpreted from satellite images, elevation, and topography (Meikle and Waterreus 2008). These land classes, meaningfully depicted at a scale of approximately 1:50,000, are a surrogate for ecosystems in this analysis. The spatial extent of these ecological land classes within each of the ecoregions in the Peel Watershed provides a measure of ecological “representation”, and a measure of relative abundance or rarity of these ecosystems. These land classes are also the habitat classes used for mapping suitability of habitat for focal species (see below). We refer to these ecological land classes as “habitats”, and the full map layer as the “biophysical habitat map”, through most of this Report.

To map the distribution of focal species, the team used two approaches: (i) mapped information on distribution derived either from radio-telemetry locations or direct observations of the focal species as interpreted in the Yukon Department of Environment’s Wildlife Key Areas (WKA) database: (http://www.environmentyukon.gov.yk.ca/geomatics/data/wildlife-key-area.html); (ii) expert opinion interpretations of the relative quality (under current conditions) of each of the mapped ecological land classes , or some other categorization of habitat types, as places for focal species to satisfy their key life requisites (e.g., food, shelter, nesting, and predator avoidance) in a particular season. The former approach allows direct mapping of distribution and relative intensity of use of different areas, but radio-telemetry data sets are rare for focal species, and WKAs are incompletely mapped in the region. Consequently we cannot use this approach as the primary way of mapping distributions for most species. The latter approach, habitat suitability mapping, assumes that animals distribute themselves in relation to habitat quality, with a higher density in high quality habitat than in low quality habitat. This is probably true for most species most of the time. However this approach requires that experts understand how well each of the habitats satisfies all food, den, shelter and safety requirements of the species in any one season, and it assumes that quality rankings for mapped habitats take into consideration all the features of the environment that might affect where an animal chooses to be. In some cases, some features of the environment may not be considered adequately; in these cases, mapped habitat suitability may not translate into habitat use. Despite these potential weaknesses of the habitat suitability mapping approach, we use it as the primary way to depict distribution for focal species because we can apply the approach to all focal species, and make a map for each species for the entire planning region. In doing so, we have also used radio-telemetry and WKA data, where available, to help direct the ranking of suitability for different habitats, and verify or test preliminary rankings.

The process of gathering expert opinion on the quality of habitats (i.e. ecological land classes) differed somewhat among focal species. In all cases at least one biologist with particular experience and knowledge of the species in the planning region was asked to tell which season(s) were most limiting for the species, to rank the suitability of all the habitats in the limiting season(s), and to indicate what factors influencing distribution might be missed by the habitat mapping. For ungulates and carnivores, we set up workshops in each of the three communities (Dawson City, Mayo, and Fort McPherson) whose members frequently use the planning region, and invited those community members who have had a lot of experience on the land to rank the quality of the habitats for those species they felt confident about (Table 1). For fish, birds and plants, we relied on groups of experts for detailed manipulation of data in a Geographic Information System (GIS) to derive habitat types and rankings. Where possible, we produced ratings on a four-point suitability scale: 0 (No habitat value), 1 (Low), 2 (Moderate), and 3 (High). Ratings were considered relative to the rest of the planning region, and not relative to other portions of the range of the species.

Interpreting and mapping the habitat rankings involved producing draft maps from draft models of ranked habitat quality, reviewing draft maps in relation to prior knowledge of focal species distribution (e.g. WKAs and expert knowledge) and possible additional factors affecting distribution, deriving revised models and rankings, and producing new sets of maps. This process was continued iteratively until experts were satisfied with the product. More detail regarding the process of deriving habitat suitability maps will be provided in a future report from Yukon Environment biologists (Meikle *et al*. 2008a).

To map special elements or unique features, the team relied heavily on interviews and anecdotal information from guide-outfitters and travelers with particular knowledge of portions of the region. These interviews were often conducted one-on-one, but information also came from workshop sessions.

Table 1: Timing, participants and species considered at the three community habitat suitability workshops

Community	Date	Species	Participants
Dawson	December 11 – 12, 2006	Moose, Woodland Caribou (Hart River Herd), Dall's Sheep, Marten, Grizzly Bear, Wolverine, Lynx	Citizens of Tr'ondëk Hwëch'in First Nation
Mayo	January 23, 2007	Moose, Woodland Caribou (Bonnet Plume Herd), Dall's Sheep	Pat Van Bibber, Jack Smith, Jimmy Johnny
Ft McPherson	February 22, 2007	Moose, Caribou (Porcupine Herd), Dall's Sheep, Marten	Robert Alexie, Thomas Koe, Maechal Pascal (citizens of TGFN)

SECTION III: BIOPHYSICAL SETTING

Location

The Peel River watershed lies largely within north-central Yukon, and its lower reaches are in the Northwest Territories where it joins the Mackenzie River draining to the Arctic Ocean. In Yukon, the watershed encompasses approximately 67,000 square kilometers of subarctic landscapes, representing around 14% of the Territory's area.

Physical Environment

Bedrock and surficial geologies, combined with drainage patterns, are relatively resistant to ecological or anthropogenic change. These "enduring features" are excellent foundations for conservation assessments. The information in this synopsis is largely taken from Smith *et al*. (2004). Mountain ranges described here are physiographic units as generally described on topographic maps, and are often different in spatial extent to the ecoregions that have similar names (see Ecosystems below, and Map 3)

The Ogilvie Mountains comprise the south-westerly sector of the planning region. These are moderately rugged, sedimentary ranges, consisting of limestones, dolostones, sandstones and shales. Glaciation was mostly limited to smaller alpine icefields, and much of the landscape is unglaciated ridges and pediments, with exposed bedrock very abundant. Parent materials for soils are mostly colluvium and glacial till. The Ogilvie, Blackstone and Hart Rivers drain north and east from these ranges. The Peel River results from the confluence of the first two of these tributaries when they reach the more subdued terrain of Eagle Plains. Headwater streams are generally steep with rapid flow following melt or precipitation. This area has continuous permafrost.

To the east of the Ogilvies, the Mackenzie Mountains extend the array of rugged alpine topography that dominates the southern third of the planning region, ranging from 600 m above sea level (asl) in the lower Bonnet Plume valley to 2740 m, the summit of Mt MacDonald. These are predominantly sedimentary ranges with numerous granitic and volcanogenic intrusions. Present landforms have been heavily influenced by alpine and cordilleran glaciations creating steep-walled alpine cirques and wide valleys, as well as the Wisconsinan Laurentide continental ice sheet which forced drainages to the west creating periglacial Lake Hughes. There are a few remnant cirque glaciers. Glacial tills and colluvium, resulting from mass wasting and slumping, are the most common surface layers. Large watersheds – the Wind, Bonnet Plume and Snake – drain from south to north, with numerous east-west trending tributaries. These are high energy systems fed by steep tributaries but forming braided gravel beds in the wide main-stem valleys, where they slow dramatically as they flow north onto the Peel plateau. Groundwater flow produces numerous seepages, creating widespread winter icing (aufeis) at some sites. Permafrost is continuous through most of these mountains within the planning region.

A small portion of the Eagle Plains forms the northern edge of the upper Peel drainage, a plateau-like area of subdued relief. This is an inter-montane basin of sedimentary rocks, with relatively rare outcrops in rapidly down-cutting river valleys. The area was generally not glaciated in the Pleistocene, but was the site of glacial Lake Hughes from which lake bed sediments still persist over parts of the upper Peel valley. After the retreat of the Laurentide ice sheet, drainages flowing north from the Ogilvie Mountains were recaptured by the current lower Peel drainage, and rapidly cut a deep passage for the current Peel River, including the prominent Aberdeen Canyon. Surficial deposits are a mix of glacial, fluvial and colluvial types, and permafrost is discontinuous throughout.

The heart of the planning region is the Peel Plateau, an extensive area of relatively flat terrain with a few hills and little exposed bedrock. This topographic feature extends through the Fort McPherson Plain to the northeast border of the region. A thick layer of glacio-lacustrine, glacio-fluvial, and till deposits cover most of the area, left behind by the Laurentide ice sheet and associated meltwaters. The Peel River cuts quite a deep but narrow valley through this mantle, first easterly, picking up much flow from its tributaries, the Wind, Bonnet Plume and Snake Rivers, then northerly towards the Mackenzie delta. Permafrost is continuous.

In the northern part of the planning region the Richardson Mountains form a subdued north to south pattern of ranges. These are mountains of sedimentary rocks (primarily limestones and sandstones) which were not affected by alpine glaciation in their upper elevations, but which were affected by the westward extension of the Laurentide ice sheet which pushed high into the valley bottoms. Surficial deposits reflect this pattern with extensive colluvium and solifluction debris on valley sides and lowland pediments, and glacial deposits in some of the valley floors. In the portion of the Richardson Mountains in the planning region, heavily incised streams (e.g., the Vittrekwa River) cut through the bedrock and the glacial deposits of the adjacent Peel Plateau on their way south and east to the Peel River. Permafrost is continuous.

Ecosystems

The planning region overlaps portions of two of Canada's terrestrial ecozones: the Taiga Cordillera and the Taiga Plain. Within the Peel drainage, the Taiga Cordillera ecozone includes portions of the Mackenzie Mountains, North Ogilvie Mountains, Eagle Plains and Richardson Mountains ecoregions. The Taiga Plains include the Peel River Plateau and the Fort McPherson Plain ecoregions. The Peel River, draining west to east through the centre of the region, bisects this mountain chain through the lower elevation Eagle Plains and Peel River Plateau ecoregions. Each of the ecoregions is also comprised of smaller ecodistricts, which in turn have varied coverage of the 31 ecological land classes mapped as part of this planning process (see Meikle *et al.* 2008b).

In the mountainous ecoregions, the wide range of elevations and diverse drainage patterns create the greatest diversity of plant communities and ecosystems. Exposed bedrock and alpine tundra vegetation are very extensive. Lichens are often primary colonizers on rock. *Dryas* and *Cassiope* heath communities intergrade with more productive forb-rich meadows and sedge-tussock tundra slopes. Below this zone, low shrub tundra, comprised of shrub birch and willows, is extensive. Tree line is often indistinct with black or white spruce occurring patchily through the shrub tundra, and through shrub-tussock tundra or sedge and cottongrass-tussock tundra on gentler pediment slopes. Southerly aspects support more extensive tree growth, but cold air drainage and poorly-drained flat valley floors can result in extensive valley bottom shrub tundra and shrub-tussock communities or, more rarely, wetlands. Lower elevation spruce forests also include white birch and aspen. Most productive growth is generally in white spruce-feathermoss forest on alluvial soils and riparian sites. In some areas, riparian forests also include balsam poplar and extensive willow and alder growth. Much of the Ogilvie and Richardson Mountains were part of the unglaciated Beringia refugium in the Pleistocene, and today support unusually high numbers of endemic and rare plants, especially in the unforested habitats. Wetlands are generally uncommon in these mountain ecoregions, especially the North Ogilvie and Richardson Mountains. The Mackenzie Mountains have a fair number of small alpine lakes, and larger valley floor lakes and fens, reflecting the more open and gentle gradients of these heavily glaciated valleys. Stand-replacing disturbances include forest fire and landslides. Numerous sites are affected by solifluction and frost churning that creates ongoing change in plant species composition.

In lower-elevation plateau ecoregions, plant communities are dominated by white and black spruce woodlands. At the higher elevations of the Eagle Plains, these spruce woodlands are frequently interspersed with patchy openings of willow, alder and shrub birch, cottongrass-tussock tundra, or lichen-moss. At lower elevations through the Peel plateau, larch is a common component with black spruce throughout the plateau woodlands, and white spruce is predominantly associated with rivers. These taiga plateau woodlands on permafrost have generally sparse tree cover, and are strongly affected by undulating ridges or hummocks of mineral soils separated by poorly drained troughs with organic soils. Hummocks support denser tree growth along with shrub birch, low-bush cranberry, and lichens. Troughs have more willow and Labrador tea growing on moss-rich substrates. Wetlands are relatively common in these plateau regions, though not so much on the Eagle Plains. Wetlands include peat bogs, cottongrass-tussock bogs, string fens, and treed swamps, often associated with small shallow lakes and ponds. The highest concentrations of large sized lakes (the Turner wetlands, and the Chappie Lakes complex) are on the Peel Plateau, but the Fort McPherson plain has a higher overall concentration of wetlands. The narrow riparian areas of major rivers, generally incised deep into the plateau, produce impressive stands of white spruce, balsam poplar, and willow, with extensive soapberry on well-drained slopes. Forest fire is the most common stand replacing disturbance, resulting in successional stands with high incidence of shrubs (alder and willow) and deciduous trees (paper birch and aspen).

Wildlife

The diversity of wildlife in the Peel watershed is remarkably high for a taiga region at these latitudes. This diversity results in part from a lack of glaciation over parts of the region, and therefore the presence today of species that probably persisted through the Pleistocene in the Beringian refugium. Examples include the arctic ground squirrel, the Ogilvie collared lemming, wandering tattler, and surfbird. The range of this lemming and the breeding range of the surfbird are almost exclusively within the Yukon. The wide range of elevations, and consequently habitat types, also contributes to present-day diversity. Some tundra and montane species (such as Dall’s Sheep, Willow Ptarmigan and Gyrfalcon) live in the same landscapes as more typical forested taiga residents (such as moose, Spruce Grouse and Merlin). Conservation in the Peel offers special opportunities to ensure a future for a unique assemblage of species, and for some species with limited distributions.

This large watershed is still mostly wilderness, and so it still supports the unimpeded, wide-ranging animal movements so characteristic of northern boreal and tundra ecosystems. Most notable are the caribou. The migratory Porcupine caribou herd winters over large areas of the Peel drainage. The Bonnet Plume caribou herd's annual movements are almost entirely within but cover approximately one-third of the planning region. Three other herds (a Boreal herd in the Peel Plateau, the Redstone, and the Hart River herds) spend portions, or the majority, of their time in the planning region. These herds persist in healthy predator-prey systems that require large space to function. Large spaces provide extensive habitat choices for animals facing declines in habitat quality elsewhere, following fires (e.g., caribou winter range) or the periodic fluctuations in abundance of prey (e.g., lynx and the snowshoe hare cycle). Large space is a necessity for these systems to work in a robust fashion.

Typical of northern regions, much of the bird life in the Peel watershed is migratory. The lower elevation Peel plateau breaks the continuous northern sweep of the Mackenzie Mountains. With continuous forest and concentrated wetland complexes, this portion of the planning region provides an important route for waterfowl and other birds to break through the cordillera, in both directions. Migrants to and from the Old Crow flats, Mackenzie delta, or arctic stage and pass through, but many taiga species stop to nest. Wetlands, such as the Turner Lakes, provide a particularly valuable nesting and stop-over function for waterfowl.

Fish

The limited knowledge of fish resources in the Peel watershed has been summarized by Anderton (2006), from which most of the information in this synopsis is drawn. Being a tributary to the Mackenzie River, the Peel supports some Mackenzie fish species not found in the Yukon River watershed which drains much of Yukon. This makes the Peel's fish fauna especially notable in the Yukon context. These species include Pond Smelt, White Sucker, Ninespine Stickleback, Walleye, Spoonhead Sculpin, Flathead Chub, and Longnosed Dace (von Finster 2004, Anderton 2006). The Laurentide ice sheet forced the upper Peel to drain northwest into what is now the Porcupine system, tributary to the Yukon River. This division is maintained in recent geological history by an impassable barrier to fish on the middle Peel – Aberdeen Canyon. The watershed supports genetically distinct populations of Lake Whitefish from both Yukon and Mackenzie River lineages (Bodaly and Lindsey 1976), and may support different genetic lineages of other species, such as Round Whitefish, Long-nosed Sucker, Slimy Sculpin, Arctic Grayling and Burbot, above and below Aberdeen Canyon. This means that fish fauna above and below Aberdeen Canyon should not be considered substitutable, and are best considered separately for conservation.

Aberdeen Canyon marks the upstream extent of quite a few migratory species (e.g., Broad Whitefish, Inconnu) that move from the ocean or the lower Mackenzie to spawn in the Peel, and of species that are likely resident as well (e.g., Trout-perch, Flathead Chub, Longnosed Dace). This barrier, along with fast gradients and low winter flows in major tributaries below the Canyon (i.e., Snake and Bonnet Plume), makes the lower Peel by far the most species-rich portion of the planning region. It also means that this stretch of river has critical spawning habitat for the greatest diversity of species, and likely also provides over-wintering habitat for substantial portions of the fish populations (e.g. Arctic Grayling and Dolly Varden char) that spawn in headwater tributaries.

The fish fauna of Peel tributaries is much reduced in diversity and abundance, especially in headwater areas. However, many of these provide the critical spawning habitat for Arctic Grayling, and a few for Dolly Varden char (Millar 2006). Arctic grayling and slimy sculpin are the most frequent inhabitants of headwater tributaries, but probably move well downstream in winter.

Large lakes are uncommon in the region, but they generally support species not often found in streams (e.g., Lake Trout, Northern Pike, Lake Whitefish), along with some stream species. Lakes, consequently, deserve special conservation attention.

Human Ecology

Humans have been part of the Peel watershed's ecosystems for millennia, and continue to obtain a generally sustainable harvest of fish, wildlife and plant species from the land. This Conservation Assessment acknowledges that conserving such harvests, and the prime areas where such activities take place, attempts to address an aspect of a goal of the planning process: the recognition and promotion of the cultural values of affected First Nations and other affected Yukon Indian People (YLUPC 2004). Human harvesters include members of three First Nations who, for the most part, currently reside outside the planning region but continue to harvest within the region. These are the Nacho Nyak Dun (Mayo), the Tr'ondëk Hwëch'in (Dawson City), and the Teetł'it Gwich'in (Fort McPherson). Human harvesters also include big game hunting businesses and their clients, and subsistence hunting by the general public.

Currently the planning region receives relatively few visits from harvesters because there are few roads. The most heavily utilized areas are: the Dempster Highway corridor, where it passes through the northwest side of the region (in the Eagle Plains); the lower Peel River which gives ready access upstream at least to the confluence with the Snake for motorized boats or snowmobiles; and areas close to guide-outfitter base camps which are often on lakes where float planes can land. The Highway corridor is noteworthy for access to Porcupine caribou in fall. The Teetł'it Gwich'in primarily use the Peel River corridor for netting fish (mostly whitefish species), hunting moose and caribou, and fur-trapping. Seismic lines through the Peel Plateau, accessed from the Peel River valley, can enhance travel for hunting and trapping.

Extensive wild spaces and the experiences they provide are necessary for the sustenance and evolution of First Nations and Euro-centric cultures in Yukon and North America. The wilderness values of the Peel watershed are nationally and internationally renowned, and the need for their conservation is highlighted in the Planning Commission's Terms of Reference. Experience of wilderness is often part of the motivation for harvesters to visit the region, along with the desire to obtain sustenance. Wilderness experience is the primary motivation behind most backcountry visits by the general public, and even for many road travelers. People driving the Dempster Highway can reach wilderness areas within relatively easy hiking from the road in the Ogilvie and Richardson Mountains. Backcountry visitors generally access lakes or key sites by air. Many visitors to the backcountry travel down the Snake, Bonnet Plume, Wind, Hart or Blackstone Rivers to the Peel by canoe or raft, with frequent stops to hike and camp. Since a wilderness experience is clearly eroded by increasing levels of human activity and infrastructure, the conservation of the wilderness opportunity requires explicit management direction in a planning context.

Climate and Climate Change

The Peel watershed has a continental climate with intermittent maritime influences from both the south (Gulf of Alaska) and north (Beaufort Sea). It includes portions of three climate zones: Northern Mountains (in the British-Richardson Mountains ecoregion), Porcupine-Peel basin (through the Eagle Plains, Peel Plateau and Fort McPherson Plain ecoregions), and Ogilvie-Mackenzie Mountains in the south (Wahl 2004). There is strong seasonal variation in mean daily temperature at lower elevations, ranging from 10^0 to 15^0 C in July, to -20^0 to -30^0 C in January. It is noteworthy that winter temperatures are often colder at low elevations, with cold air sinking to valley floors and establishing a temperature inversion. Mean annual temperatures range from -4^0 to -8^0 C (Wahl 2004). Mean annual precipitation is low overall, ranging from 300 to 600 mm, and being heaviest in late summer, as rain. The Ogilvie and Mackenzie Mountains capture considerable moisture from the Pacific, especially on their southern flanks. Consequently this southern section of the planning region gets the highest precipitation in all seasons, with an increasing precipitation shadow further north to the Peel Plateau. There is moderate precipitation in the Richardson Mountains, and lowest precipitation in the Peel Plateau and northeast section of the planning region (Wahl 2004). Winds are a prominent climate feature in the Richardson Mountains where they are predominantly from east or west, frequently scouring the valleys and redistributing much of the snow.

Climates are changing, and globally one of the regions of fastest change is northwestern North America, including the subarctic Peel drainage (ACIA 2004, IPCC 2007). Recent and projected change generally includes warmer temperature regimes, especially in the late winter and spring (ACIA 2004). Some models also project more precipitation (ACIA 2004, IPCC 2007), though models have been less accurate in projecting precipitation patterns, often over-estimating the increase in Yukon (Bonsal and Prowse 2006). Change also means greater variability in temperature, precipitation, and wind conditions, both within and between years.

The conservation implications of climate change centre on the fact that many species will no longer experience their normal or desirable combination of living conditions where they now exist, because this combination may move in space or no longer exist at all. The application of a climate model to project the future locations of environmental "domains" (which are unique sets of topographic, soil, and climate conditions), indicates that many domains in northern Yukon will likely disappear, and the remainder will decrease in abundance (Saxon *et al.* 2005). This suggests that new combinations of soil, topography and climate are emerging in this region. These primarily reflect changes in soil (notably the decline in extent and duration of permafrost) and climate (particularly combinations of temperature and precipitation), because topography itself is relatively unchanging.

Such models suggest possible future patterns, but do not accurately predict future conditions. Current regional climate change models often deviate significantly from one another in their projections of possible trends, especially in precipitation (IPCC 2007). Planners cannot rely on any one model's results, but have to design protected areas and conservation strategies so as to enhance the ability of local species to adapt as best they can to ongoing change.

Many mobile bird, mammal and insect species are already adapting quickly to changing climates, by changing their distributions and their timing of key seasonal activities such as migration and reproduction (Parmesan 2006). Plants are least likely to move quickly. Some alpine species may be expanding their ranges as slowly as 0-4 m per decade, and not as fast as the changes in elevation of the mean annual temperature to which they are adapted (Grabherr *et al.* 1994). Yet plants may well be the most important ecologically, because plant communities are the main components of animal habitats. Studies of plant community changes since the Pleistocene glaciations indicate that from 17,000 to 7,000 years before today there was a great deal of change in distribution of species, and in the combinations of species making up each plant community, but that these changes slowed down and conditions were quite stable from 7,000 to 500 years before today (Williams *et al.* 2004). Many plant communities that are not seen today, existed during the period of change, and the changes were largely the result of the different abilities of individual species to disperse or be dispersed by seed-carrying animals (Williams *et al.* 2004). Now that we are in a period of change, we can expect the makeup of our plant communities to change. Some species may be able to adapt, where they are, to some of the temperature and precipitation changes. In general, however, we would expect to see plants spreading, to varying degrees, into new areas where growing conditions suffice at least for some period of time. Species unable to disperse will become rarer. Considering temperature regimes, this generally means dispersal movement to higher elevations in mountains, and from south to north (IPCC 2002). But movements will also depend on finding suitable moisture and soil conditions, so barriers will exist to upslope and northerly shifts. Although we can make educated guesses about the capability of individual plant species to spread, much depends on chance. When facing so much uncertainty, our best conservation strategies are likely: (i) to conserve the full diversity of plants by including the full range of topography, bedrock and soils (i.e. future growing conditions) within our natural areas; (ii) to help plant dispersal, upslope and from north to south, by keeping whole watersheds (valley floor to ridge top) as natural areas, and selecting watersheds with the best alignment for natural dispersal (e.g., north to south for temperature gradients, or in line with prevailing winds); (iii) to help plant dispersal by including as many elevational and latitudinal gradients in soil and moisture conditions all within the same natural area (see Halpin 1997, IPCC 2002).

SECTION IV: CONSERVATION VALUES

Introduction

The Criteria and Indicators Report (PWPC 2007) explained how conservation values were identified, and which indicators were chosen to represent each value in the conservation assessment. In this section we address each of these indicators. We give a brief conservation context for the indicator, explain what aspect of the indicator was chosen for mapping, and explain how information was gathered, analysed, and interpreted. We provide the key results of the work, including the maps showing the distribution of the indicator. In this section we also summarize and map two other key landscape processes which affect conservation planning: fire disturbance history and climate change. These are not indicators, but have an influence on the location, scale, and scope of conservation options.

Ecosystems or Habitats

Rationale: One principal goal of conservation planning is to ensure that each ecosystem in a region is represented in some form of protected area, and that rare ecosystems are identified. The Peel watershed includes significant portions of Beringia, with unique ecosystems and species, which require particular conservation attention.

Experts: John Meikle, Habitat Ecologist, Yukon Environment, Whitehorse
Marcus Waterreus, Geographic Information Specialist, Yukon Environment, Whitehorse.

Context: Climate and soils vary across the region and provide diverse sets of growing conditions for plants. The different plant communities that prosper in these different growing conditions are termed ecosystems. We need to conserve representative examples of each of these ecosystems. The biophysical map for the Peel watershed (Meikle and Waterreus 2008) portrays one classification of ecosystems, which we term habitats. The biophysical map can be used to quantify the spatial extent of habitats, as long as we acknowledge that a mapped habitat type in one ecoregion may differ somewhat from the habitat type with the same name in another ecoregion. This is because the biophysical map classifies habitats based on broad-scale differences in the energy reflected back from the earth to a satellite, and the same pattern of reflectance can happen with differing combinations of plants and soils. Ecodistrict and ecoregion mapping outlines approximate boundaries to areas with similar topography, soil, and climate, which are areas where a habitat type is likely to be quite similar from site to site. Consequently we can assess representation and rarity of ecosystems by comparing their relative spatial extent at an ecodistrict or eco-region level.

Much of northern and western Yukon was an ice-free refugium, called Beringia, during the most recent glaciations of the Pleistocene. Numerous species survived and evolved in this area, and are unique today compared to species that survived and evolved in ice-free areas (refugia) further south. The Peel watershed includes significant portions of Beringia, as well as areas that were ice-covered and have been colonized from other areas. The separate origins of plants, insects and animals from different refugia means that a habitat in a Beringian portion of the watershed could have a substantially different mix of species than the same habitat elsewhere in the watershed. This is particularly true for plants in tundra habitats. A full suite of conservation options ideally should search for representation of habitats from both Beringian and non-Beringian zones.

Methods: We overlaid the biophysical map of habitats (ecosystems) on the map of ecoregions to quantify the area occupied by each habitat in each ecoregion. We consulted the existing, well documented map of the extent of Pleistocene glaciation (Duk-Rodkin 1999) to tell us which ecoregions had substantial areas in Beringia.

Results: Table 2 summarizes the absolute and relative (%) extent of each habitat and glacial history in each ecoregion. Habitats are considered rare if they occur in an ecoregion, yet occupy less than 1% of it. These habitats are shown in Map 2 (Habitats: Ecological Land Classification), while ecodistricts within their respective ecoregions are shown in Map 3 (Regional Ecosystems: Ecoregions and ecodistricts). Four of the six ecoregions present in the planning region, including all those in the Taiga Cordillera ecozone, contain significant portions of Beringian terrain, with nearly all of the North Ogilvie Mountains ecoregion being Beringian. The ecoregions of the Taiga Plain ecozone (Fort McPherson Plain and Peel River Plateau) are almost completely non-Beringian. These overlaps are shown in Map 4 (Glacial Extents and Ecoregions).

Table 2: Absolute (km^2) and relative (% in brackets) extent of each habitat from the biophysical map and glacial history within each of the ecoregions in the planning region. Rare habitats are highlighted. However, all cases with 0% representation were ignored because the particular habitat is not anticipated to occur in the ecoregion. Beringian extents within each ecoregion are shown at bottom of table. **FMP**=Fort McPherson Plain, **PRP**=Peel River Plateau; **BRM**=British-Richardson Mountains; **EP**=Eagle Plains; **NOM**=Northern Ogilvie Mountains; **MM**=Mackenzie Mountains.

High Elevation Coniferous Forest	193.14 (1.18%)	0 (0.00%)	156.94 (4.63%)	199.46 (1.17%)	51.68 (1.54%)	822.35 (3.30%)
Low-Mid Elevation Exposed Rock/Rubble	99.46 (0.61%)	4.75 (0.21%)	25.37 (0.75%)	368.18 (2.16%)	13.97 (0.42%)	179.94 (0.72%)
Low-Mid Elevation Wet Herb	784.43 (4.79%)	90.98 (4.00%)	49.99 (1.47%)	909.29 (5.33%)	340.67 (10.18%)	142.74 (0.57%)
Low-Mid Elevation Wet Shrub	3137.82 (19.16%)	1194.26 (52.52%)	141.99 (4.19%)	1300.68 (7.62%)	710.83 (21.24%)	807.78 (3.24%)
Low-Mid Elevation Wet Mixedwood/Broadleaf Forest	87.19 (0.53%)	10.61 (0.47%)	1.97 (0.06%)	2.31 (0.01%)	26.17 (0.78%)	1.99 (0.01%)
Low-Mid Elevation Wet Coniferous Forest	3820.13 (23.33%)	549.69 (24.17%)	0 (0.00%)	0 (0.00%)	273.7 (8.18%)	0 (0.00%)
Low-Mid Elevation Moist Herb	85.06 (0.52%)	1.28 (0.06%)	22.09 (0.65%)	222.65 (1.30%)	0.84 (0.03%)	38.84 (0.16%)
Low-Mid Elevation Moist Shrub	182.39 (1.11%)	6.54 (0.29%)	61.46 (1.81%)	388.23 (2.27%)	2.35 (0.07%)	138.71 (0.56%)
Low-Mid Elevation Moist Mixedwood/Broadleaf Forest	67.62 (0.41%)	1.9 (0.08%)	2.54 (0.07%)	4.67 (0.03%)	0.26 (0.01%)	1.81 (0.01%)
Low-Mid Elevation Moist Coniferous Forest	156.06 (0.95%)	11.31 (0.50%)	41.19 (1.21%)	167.56 (0.98%)	2.21 (0.07%)	103.17 (0.41%)
Low-Mid Elevation Dry Herb	507.58 (3.10%)	5.07 (0.22%)	154.07 (4.54%)	1601.36 (9.38%)	336.7 (10.06%)	234.52 (0.94%)
Low-Mid Elevation Dry Shrub	1582.77 (9.66%)	48.09 (2.11%)	325.91 (9.61%)	2798.14 (16.39%)	669.82 (20.01%)	1606.24 (6.45%)
Low-Mid Elevation Dry Mixedwood/Broadleaft	251.31 (1.53%)	6.61 (0.29%)	8.71 (0.26%)	15.55 (0.09%)	49.95 (1.49%)	8.44 (0.03%)
Low-Mid Elevation Dry Coniferous Forest	1939.78 (11.84%)	70.24 (3.09%)	316.93 (9.34%)	1337.69 (7.83%)	351.09 (10.49%)	1471.99 (5.91%)
Low-Mid Elevation Lichen	204.46 (1.25%)	87.83 (3.86%)	17.9 (0.53%)	141.68 (0.83%)	4.05 (0.12%)	95.13 (0.38%)
Gravel-Sand Bars	138.83	0.06	9.72	88.18	8.63	207.48

HABITAT (continued)	ECOREGION					
	PRP	FMP	BRM	NOM	EP	MM
Gravel-Sand Bars	138.83 (0.85%)	0.06 (0.00%)	9.72 (0.29%)	88.18 (0.52%)	8.63 (0.26%)	207.48 (0.83%)
Riparian Herb Marsh	228.52 (1.40%)	0.9 (0.04%)	25.62 (0.76%)	251.64 (1.47%)	59.32 (1.77%)	239.37 (0.96%)
Riparian Shrub	349.78 (2.14%)	1.82 (0.08%)	32.13 (0.95%)	420.8 (2.46%)	106.28 (3.18%)	389.07 (1.56%)
Riparian Mixedwood/Broadleaf Forest	50.79 (0.31%)	0.35 (0.02%)	1.94 (0.06%)	7.07 (0.04%)	7.85 (0.23%)	2.66 (0.01%)
Riparian Spruce Forest	380.55 (2.32%)	5.1 (0.22%)	33.38 (0.98%)	205.42 (1.20%)	63.83 (1.91%)	385.57 (1.55%)
Wetland Herb	216.07 (1.32%)	61.92 (2.72%)	5.55 (0.16%)	21.75 (0.13%)	7.9 (0.24%)	15.55 (0.06%)
Wetland Shrub	44.08 (0.27%)	24.99 (1.10%)	0.18 (0.01%)	22.06 (0.13%)	10.56 (0.32%)	6.65 (0.03%)
Wetland Forest	36.62 (0.22%)	13.12 (0.58%)	0.14 (0.00%)	3.91 (0.02%)	5.81 (0.17%)	2.49 (0.01%)
Open Water	205.74 (1.26%)	76.53 (3.36%)	3.06 (0.09%)	6.44 (0.04%)	7.59 (0.23%)	33.46 (0.13%)
Flowing Water	236.46 (1.44%)	0.05 (0.00%)	1.23 (0.04%)	50.07 (0.29%)	30.07 (0.90%)	49.33 (0.20%)
Snow/Ice	1.02 (0.01%)	0.01 (0.00%)	6.14 (0.18%)	14.22 (0.08%)	0 (0.00%)	489.89 (1.97%)
Beringian	22653.4 (1.38%)	0 (0.00%)	171085.09 (50.45%)	1686877.9 (98.80%)	227260.23 (67.92%)	761371.81 (30.56%)
Non-Beringian	1614982.78 (98.62%)	227401.19 (100.00%)	168044.16 (49.55%)	20574.06 (1.20%)	107344.23 (32.08%)	1730125.61 (69.44%)
Totals	16377.41 (100.00%)	2275 (100.00%)	3392.3 (100.00%)	17075.46 (100.00%)	3347.1 (100.00%)	24916.08 (100.00%)

Map 2: Habitats – Ecological Land Classification

Map 2: Habitats – Ecological Land Classification (reverse page)

Map 3: Regional Ecosystems – Ecoregions and Ecodistricts

Map 3: Regional Ecosystems – Ecoregions and Ecodistricts (reverse page)

Map 4: Glacial Extents and Ecoregions

Map 4: Glacial Extents and Ecoregions (reverse page)

Fish

Rationale: Fish are our primary indicator of the state of aquatic ecosystems. The fish fauna of the Peel River watershed is unique in Yukon as it includes Mackenzie River drainage species. Various fish (notably whitefish, Arctic Grayling, Lake Trout and Dolly Varden char) have high subsistence and sport fish value in local economies.

Experts: Susan Thompson, Fisheries Biologist, Yukon Environment, Whitehorse
Al von Finster, Fish Habitat Biologist, Fisheries and Oceans Canada, Whitehorse
Nick de Graff, Fish Biologist, Can-nic-a-nick Consulting, Whitehorse
Dick Mahoney, Fish and Wildlife Manager, Nacho Nyak Dun First Nation, Mayo.
Richard Vladars, GIS specialist, Peel Watershed Planning Commission

Context: Anderton (2006) summarized knowledge of the distribution and ecological conditions of fish in the Peel watershed. Fish habitat is still quite pristine throughout, thanks to the scarcity of human developments. Fish harvesting has been fairly high on some lakes and on stocks of whitefish and salmonid species in the lower Peel, but generally appears sustainable. However, knowledge on the distribution of various species is still patchy and incomplete. In particular there is a dearth of information on locations of spawning and over-wintering habitats, which could be critical for conservation of certain species. The main-stem of the Peel River below Aberdeen Canyon (impassable to fish) has the highest species diversity, and a number of known and suspected spawning and wintering areas for various species. It should be considered of special habitat management importance.

Portions of the drainage flowed into the Yukon River drainage when it drained Beringia. One lake whitefish stock (Margaret Lake) is genetically of Beringian origin (Bodaly and Lindsay 1976), and there may be stocks of other species residing upstream of Aberdeen Canyon that are genetically separate from the Mackenzie drainage stocks of the lower Peel.

Methods: Without detailed mapping of fish distribution, stream morphologies, and water quantity, we were unable to comprehensively identify reaches of high habitat value for various species, or develop a detailed habitat suitability map for one or more species. Instead we developed three maps that, respectively, convey: (i) known locations of spawning, occupancy, and traditional use; (ii) the likely maximum extent of any species of high subsistence and sport fish value; (iii) the features likely to have high localized value.

Known locations of spawning, occupancy, and traditional use:
While sparse, there are several sources of fish occupancy data that should be considered for land-use planning in the Peel watershed. In addition to Anderton's (2006) summary, we also considered and used fish occupancy data collected in the summer of 2007 by Yukon Environment (unpublished data), as well as those documented in CPAWS (2004) and Elson (1974). Locations and areas of traditional fish distribution and harvesting, provided by three First Nations in Dawson, Mayo and Fort McPherson workshops, were also included.

While the amount of data presented in the spawning, occupancy, and traditional use map may at first glance be impressive, it is clear that large portions of the planning region have not been sampled or described adequately. Therefore, data on fish occupancy alone are not sufficient for planning decisions, and are best suited for showing general patterns and testing habitat models. Similarly, not all spawning habitat in the planning region has been documented conclusively (Anderton 2006). However, given the localized nature of spawning habitat and its critical importance, known spawning locations should be given adequate consideration.

Likely maximum extent of any fish species:
There are large expanses of the Peel Watershed without any occupancy data, yet most are likely occupied by several fish species. To fill these data gaps, we modelled the maximum extent of fish occupancy. The maximum extent of the distribution for most species occurs in the summer and fall when water flow is sufficient for fish to move well upstream in tributaries. Research in Alaska indicated that landscape factors could be used to model fish distribution (Hershey *et al*. 2006), however it was not clear whether the same factors were applicable in the Peel watershed. With this in mind, Yukon Environment personnel conducted fieldwork in the Peel watershed during the summer of 2007 to help quantify landscape factors that affect summer fish distribution. Though many years of data would be required to reach the same detail of conclusions reached by Hershey *et al*. (2006), this limited field sampling determined that, in general, no fish are able to disperse upstream of a stream reach of gradient 20-22%. Biologists also found that only Dolly Varden char were able to move up gradients approaching this limit.

We modelled the maximum extent of fish distribution (i.e., Dolly Varden char) using a GIS. Water features mapped at a scale of 1:50,000 in the National Topographic Database (NTDB) were compared against a slope map (derived from a Digital Elevation Model (DEM)). Due to unavoidable mapping inaccuracies, water features that were obviously of low gradient (e.g., a lake, a meandering stream) that lie near steep topography were often shown to have gradients over 20%. To reduce this type of error, water features within an extended "riparian" buffer or within ecodistricts with topography unlikely to contain barriers to fish (Jackfish Lake Wetland, Tabor Lakes, Peel Plateau North, Lower Peel River, Turner Lakes Wetlands), were considered to be occupied by fish, regardless of the mapped gradient. The extended "riparian" buffer was created by buffering both the riparian classes of the biophysical habitat map, and polygonal water features (e.g., lakes, wide or braided streams, sand bars), by 75 meters. Watersheds upstream of steep water features (e.g., those mapped to have a gradient >= 20%), and outside of this buffered area, were then considered not occupied by fish. The result was then scrutinized and compared to known fish locations. Obvious errors were corrected by manually adjusting the buffered area and re-running the model. This model cannot be considered accurate at a local operational level, however, we feel that it is a reasonable regional portrayal of the maximum distribution of fish. Further fieldwork, especially in the ecodistricts assumed to have no barriers (listed above), could be used to refine this model further.

Features likely to have high localized value for fish:
There are five anadromous (or sea-running) coregonid species (Whitefish, Herrings/Ciscos, and Inconnu), and one anadromous salmonid (Dolly Varden char), that spawn in the Peel Watershed (Anderton 2006). All of these species, especially Broad Whitefish, are of

immense current and historical importance as subsistence food to communities in the Mackenzie Delta, owing to their historical abundance and predictable seasonal concentrations. Population size is most likely limited by spawning habitat. As such, special attention must be paid to known and likely spawning grounds for these species. Spawning habitat has been confirmed for only one Dolly Varden char population, - on Ne'edilee Ck, tributary to the Vittrekwa (Millar 2006), while Broad Whitefish spawn at the mouth of the Trail River (Chang-Kue & Jessop 1997) and near the mouth of the Caribou River (MDBSRLUPC 1991). Ciscos and inconnu spawn near the mouth of the Snake River (MDBSRLUPC 1991, Elson 1974). It is likely that other spawning grounds for coregonids exist at similar sites, characterized by channel complexity and gravel deposition. Therefore the Peel main stem from Aberdeen Canyon downstream to the Trail River should be considered to be of regional and trans-boundary importance for spawning.

Potadromous fish populations (or those that are not sea-running) in far northern drainages tend to be more limited by suitable over-wintering habitat than by spawning habitat. However, there have been few studies documenting locations and importance of these over-wintering areas in the Peel watershed. Many good over-wintering areas are associated with surface groundwater, owing to its relatively high concentration of dissolved oxygen and warmer temperature. Therefore, we mapped sites likely associated with groundwater sources, including previously recorded overflow, open water, and aufeis. We supplemented these observations with region-wide mapping of aufeis, alluvial fans, and major stretches of braided streams, based on satellite imagery. Major confluences were also identified as often being excellent over-wintering habitat. Using the confluence of North Cache Creek with the Blackstone River as an example of the smallest "major" confluence with known over-wintering fish, we plotted the locations of all the confluences of two streams with equal or larger catchments than North Cache Creek. The Peel main stem, downstream of Aberdeen Canyon, rates as high quality over-wintering habitat for many species. Finally, lakes were identified as usually being over-wintering habitat. These were divided into Beringian and non-Beringian lakes to better account for their different genetic lineages and species compositions. As with the map of maximum extent of fish distribution, this collection of features may not accurately reflect the location and extent of all over-wintering and spawning locations, especially at a local or operational scale. However, we feel that it is a reasonable regional portrayal of over-wintering habitat.

<u>Results:</u> We present three maps: Fish: spawning, occupancy, and traditional use (Map 5); Fish: summer habitat distribution (Map 6); Fish – high quality habitats (Map 7).

Map 5: Fish – Spawning, Occupancy, and Traditional Use

Map 5: Fish – Spawning, Occupancy, and Traditional Use (reverse page)

Map6: Fish – Summer Habitat Distribution

Map 6: Fish – Summer Habitat Distribution (reverse page)

Map 7: Fish – High Quality Habitats

Map 7: Fish – High Quality Habitats (reverse page)

Caribou

Rationale: Caribou are a primary subsistence food for First Nations communities with traditional territories overlapping the planning region. They are vulnerable to human activities, and iconic of northern wilderness.

Experts: Rick Farnell, caribou biologist, formerly of Yukon Environment, Whitehorse;
Community members who attended workshops (Table 1).
Mark O'Donoghue, Regional Biologist - Mayo, Yukon Environment.

Context: The planning region overlaps parts of the ranges of the barren-ground ecotype Porcupine caribou herd (PCH), a Boreal ecotype caribou herd (BCH), and 3 northern mountain ecotype herds, the Bonnet Plume (BPCH), the Hart River (HRCH), and the Redstone (RCH). The winter range of the barren-ground PCH is largely within the planning region, but the herd moves north for other seasons. Some animals in the largely non-migratory Boreal herd move into the northeast part of the planning region from the taiga plains in the Northwest Territories, even crossing the Peel River. The Bonnet Plume herd resides almost entirely within the planning region, with only a part of its winter range to the east in the Northwest Territories. The Hart River herd spends much of its annual cycle, including winter, in the south-west section of the planning region. Only a small part of the Redstone herd's range is in the planning region, but this includes some winter range at the head of the Bonnet Plume drainage. Herds use large portions of the planning region exclusively, though there is some overlap among herds. The range of one other northern mountain ecotype herds, the Clear Creek herd, only slightly overlaps the planning region, and was therefore not considered in the habitat suitability analysis.

The status of most of these herds is not well known, because inventories of all but the Hart River herd have not been possible in recent years. Caribou are directly and indirectly susceptible to human activities and infrastructure. Hunting mortality is probably additive to mortality from other predators, and total mortality can exceed annual recruitment in some years. Linear corridors, such as roads and seismic lines, allow predators (notably wolves and people) to more easily locate caribou, and consequently kill caribou more often (Johnson 1985; McLoughlin *et al.* 2003). These features are often avoided by caribou (Dyer *et al*. 2001). Human activity and noise along such linear corridors force caribou to use more energy by moving to avoid the disturbance, by foraging more often in poorer quality habitats, and by having to avoid use of some high quality security habitats (Bradshaw *et al.* 1997; Dyer *et al.* 2001). Higher energy use can result in poorer calf condition, or even failure to bring a foetus to term. Winter is generally thought to be the critical season for caribou because of the reduced availability of foods under snow, and the restricted seasonal ranges of some herds at this time of year.

Biologists have gathered radio-telemetry data for all herds except the Redstone, and these data plus aerial surveys have allowed biologists to extensively map Wildlife Key Areas for this species. Enough data have been collected for the PCH to allow mapping of core areas (i.e. kernels) of winter use – areas where radio-collared caribou were most frequently located (Ryder *et al.* 2006).

Methods: For each caribou herd, we mapped distribution in winter both as a map of core areas of use or WKA polygons, and as a map of winter habitat suitability. We took the former approach with this species because we have relatively high amounts of data, fairly evenly distributed through the plan area. This approach produces a map with two types of land designation – areas of high density, and areas of lesser density – or, in the case of the Porcupine caribou herd, areas of low, moderate, and high density.

To produce a winter habitat suitability map, we had to recognize that our experts were knowledgeable about the habitat choices of caribou only in certain portions of the region (therefore only one or two of the herds), and that herds might differ in their response to a certain habitat type. So we had to decide which experts' ratings applied to which herd, and also where herd boundaries lay.

Using satellite or radio collar locations, aerial survey data and personal experiences, we delineated herd boundaries using linework from ecodistrict boundaries (Yukon Environment), regional terrain mapping (Yukon Environment), and watercourses (NTDB 1:50,000). The Porcupine herd boundary also was delineated using interpreted line work from historical observations (Russell *et al.* 1992). While delineating these boundaries, we ensured that adjacent herd ranges either overlap or line up in order for the entire planning region to be represented by a caribou habitat suitability map. As such, herd ranges used in this analysis are only approximate.

Rick Farnell rated the winter suitability of the habitats on the biophysical map, herd by herd, first in autumn 2006, and then re-visited some of these ratings at subsequent meetings. Community members rated herds they were most familiar with: Dawson (HRCH, PCH); Mayo (HRCH, BPCH); Fort McPherson (PCH, BPCH, and possibly BCH). The RCH range was so poorly known and small, that we did not rate it separately, but gave it the ratings for the BPCH. Fort McPherson hunters were not aware that the BCH moved so far into the Peel Plateau ecoregion from the Fort McPherson Plain ecoregion, and didn't want to rate BCH habitats differently from PCH habitats. The various sets of ratings were quite similar but did differ in some important ways. We made choices about which ones to use for each habitat suitability map as follows: PCH (Dawson (south portion of range) & Fort McPherson (north portion of range)); BCH (Rick Farnell); BPCH and RCH (Mayo); HRCH (Rick Farnell).

Deep snow can reduce the animals' ability to find forest floor foods, and forces them to abandon some range. Rick Farnell thought that 50 cm was sufficient to start this process, while other studies of both the Bonnet Plume and the Porcupine herds suggested a depth of 75 cm was sufficient to change caribou behaviour (Farnell & Russell 1984; McNeil *et al*. 2005). We judged that an intermediate depth of 65 cm would reduce habitat suitability significantly, so we decreased by one point the ratings for all areas receiving 65 cm or more based on a snow depth map interpolated from snow depth data points collected in and around the study area in March 2007 (an "average" snow year).

Results: The ratings for each habitat, by herd, are listed in **Table 3**. We also present maps of herd range and winter core areas or Wildlife Key Areas for each herd, and winter habitat suitability for each herd (Maps 8 – 15).

Table 3: Habitat suitability ratings used for final mapping of caribou winter habitat suitability (0=Nil; 1=Low; 2=Moderate; 3=High).

COMMUNITY:	Mayo	Dawson	Ft McPherson	Rick Farnell	Rick Farnell
HERD:	Bonnet Plume	Porcupine	Porcupine	Hart River	Boreal
HABITAT TYPE					
High Elevation Rock/Exposed	0	1	1	0	0
High Elevation Dry Sparse Herb	0	1	1	0	0
High Elevation Bryoid	1	1	1	1	0
High Elevation Dryas/Dwarf Shrub	0	3	0	0	0
Sub-alpine Shrub	1	1	0	0	0
High Elevation Coniferous Forest	2	3	2	2	0
Low-Mid Elevation Exposed Rock/Rubble	0	0	0	0	0
Low-Mid Elevation Wet Herb	1	2	2	3	2
Low-Mid Elevation Wet Shrub	1	2	1	3	2
Low-Mid Elevation Wet Mixedwood/ Broadleaf Forest	0	0	0	0	0
Low-Mid Elevation Wet Coniferous Forest	3	2	2	2	3
Low-Mid Elevation Moist Herb	2	2	1	0	0
Low-Mid Elevation Moist Shrub	2	2	1	0	0
Low-Mid Elevation Moist Mixedwood/Broadleaf Forest	0	0	0	0	0
Low-Mid Elevation Moist Coniferous Forest	3	2	3	3	2
Low-Mid Elevation Dry Herb	0	0	0	0	0
Low-Mid Elevation Dry Shrub	0	2	0	0	0
Low-Mid Elevation Dry Mixedwood/Broadleaft	0	1	0	0	0
Low-Mid Elevation Dry Coniferous Forest	2	2	3	3	0
Low-Mid Elevation Lichen	1	2	3	0	3
Gravel-Sand Bars	0	1	1	0	0
Riparian Herb Marsh	2	2	1	0	0
Riparian Shrub	2	2	0	0	0
Riparian Mixedwood/Broadleaf Forest	0	2	1	0	0
Riparian Spruce Forest	3	2	1	0	0
Wetland Herb	2	2	3	3	3
Wetland Shrub	1	2	0	0	0
Wetland Forest	2	2	0	0	2
Open Water	1	2	2	3	3
Flowing Water	1	2	0	0	0
Snow/Ice	0	0	0	0	0

Map 8: Porcupine Caribou Herd – Range and Concentration of Locations

Map 8: Porcupine Caribou Herd – Range and Concentration of Locations (reverse page)

Map 9: Porcupine Caribou Herd – Winter Habitat Suitability

Map 9: Porcupine Caribou Herd – Winter Habitat Suitability (reverse page)

Map 10: Boreal Caribou Herd – Range and Locations

Map 10:Boreal Caribou Herd – Range and Locations (reverse page)

Map 11: Boreal Caribou Herd – Winter Habitat Suitability

Map 11: Boreal Caribou Herd – Winter Habitat Suitability (reverse page)

Map 12: Hart River Caribou Herd – Range, Locations, and Key Areas

Map 12: Hart River Caribou Herd – Range, Locations, and Key Areas (reverse page)

Map 13: Hart River Caribou Herd – Winter Habitat Suitability

Map 13: Hart River Caribou Herd – Winter Habitat Suitability (reverse page)

Map 14: Bonnet Plume Caribou Herd – Range, Locations, and Key Areas

Map 14: Bonnet Plume Caribou Herd – Range, Locations, and Key Areas (reverse page)

Map 15: Bonnet Plume Caribou Herd – Winter Habitat Suitability

Map 15: Bonnet Plume Caribou Herd – Winter Habitat Suitability (reverse page)

Moose

Rationale: Moose are an important subsistence food species for local communities. They are also a prominent indicator species for the health of riparian habitats.

Experts: Rick Ward, Moose Biologist, Yukon Environment, Whitehorse
Community members who attended workshops (Table 1).
Mark O'Donoghue, Regional Biologist – Mayo, Yukon Environment.

Context: There have been no telemetry studies and few population surveys for moose in the study area, so the WKA data set is incomplete and we have to rely on habitat suitability mapping. Moose are fairly common in the planning region. In the mountainous ecoregions they largely inhabit riparian zones of valley bottoms, even to quite high elevations. In the lower elevation, forested ecoregions, they are more widespread. The moose population or populations are probably quite healthy overall. Late winter is generally thought to be the most critical season for moose, because food choices become limited to woody browse, and snow can impede movements and increase predation risk.

Methods: Rick Ward rated the habitats on the biophysical map in autumn 2006, but noted that he had relatively little direct experience of the planning region. Community members rated habitats at the workshops. We divided the region into three sections so as to apply community members' ratings to the portion of the planning region they best knew. The overview flights of March 2007 allowed Yukon Environment to map moose concentrations as new WKAs, and thereby refine the ratings provided by community members. At that time, we noted that habitat suitability attributed to the gently sloping tussocky pediment in the Blackstone River Uplands ecodistrict appeared to be inaccurate; a specific modification to the Dawson habitat suitability index was applied there. Rick Ward agreed to the final ratings in fall 2007.

Results: Moose WKAs, locations, historical survey extents, and community knowledge are shown on Map 16 (Moose: Locations and Key Areas). The final habitat ratings are listed in Table 4. Ratings apply specifically to the zone within the study area where the community had most experience, and these zones are outlined on Map 17 (Moose: Late Winter Habitat Suitability) .This map shows that high quality habitats are mainly in valley bottoms throughout the planning region, but include more widespread shrub communities in some of the higher elevation plateaus in the North Ogilvie Mountains and Eagle Plains ecoregions. The forested ecoregions have a more even distribution of moderate and high quality habitats, with extensive wetland complexes providing food and shelter throughout.

Table 4: Habitat suitability ratings used for final mapping of moose late winter habitat suitability (0=Nil; 1=Low; 2=Moderate; 3=High).

HABITAT TYPE	Ogilvie Pediment	Dawson	Ft McPherson	Mayo
High Elevation Rock/Exposed	0	0	0	0
High Elevation Dry Sparse Herb	0	0	0	0
High Elevation Bryoid	0	0	0	0
High Elevation Dryas/Dwarf Shrub	0	0	0	0
Sub-alpine Shrub	1	3	1	1
High Elevation Coniferous Forest	2	2	1	0
Low-Mid Elevation Exposed Rock/Rubble	0	0	0	0
Low-Mid Elevation Wet Herb	1	1	2	2
Low-Mid Elevation Wet Shrub	0	0	2	2
Low-Mid Elevation Wet Mixedwood/Broadleaf Forest	1	1	0	1
Low-Mid Elevation Wet Coniferous Forest	1	1	1	2
Low-Mid Elevation Moist Herb	0	0	0	1
Low-Mid Elevation Moist Shrub	0	0	1	0
Low-Mid Elevation Moist Mixedwood/Broadleaf Forest	1	1	0	1
Low-Mid Elevation Moist Coniferous Forest	1	1	1	2
Low-Mid Elevation Dry Herb	1	1	0	0
Low-Mid Elevation Dry Shrub	0	0	0	0
Low-Mid Elevation Dry Mixedwood/Broadleaft	2	2	3	2
Low-Mid Elevation Dry Coniferous Forest	2	2	0	1
Low-Mid Elevation Lichen	1	1	0	0
Gravel-Sand Bars	0	0	1	2
Riparian Herb Marsh	3	3	1	2
Riparian Shrub	3	3	3	3
Riparian Mixedwood/Broadleaf Forest	3	3	3	3
Riparian Spruce Forest	3	3	3	3
Wetland Herb	0	0	2	2
Wetland Shrub	3	3	3	2
Wetland Forest	2	2	2	2
Open Water	0	0	1	1
Flowing Water	0	0	1	1

Map 16: Moose – Locations and Key Areas

Map 16: Moose – Locations and Key Areas (reverse page)

Map 17: Moose – Late Winter Habitat Suitability

Map 17: Moose – Late Winter Habitat Suitability (reverse page)

Dall's Sheep

Rationale: Guide-outfitting is one of the existing economic contributors in the PWPR today. The existing guide-outfitting industry in the Peel relies heavily on hunting Dall's Sheep, so planning for sheep habitat conservation is required. Sheep are also a primary indicator of the complex of alpine habitats characteristic of much of the planning region.

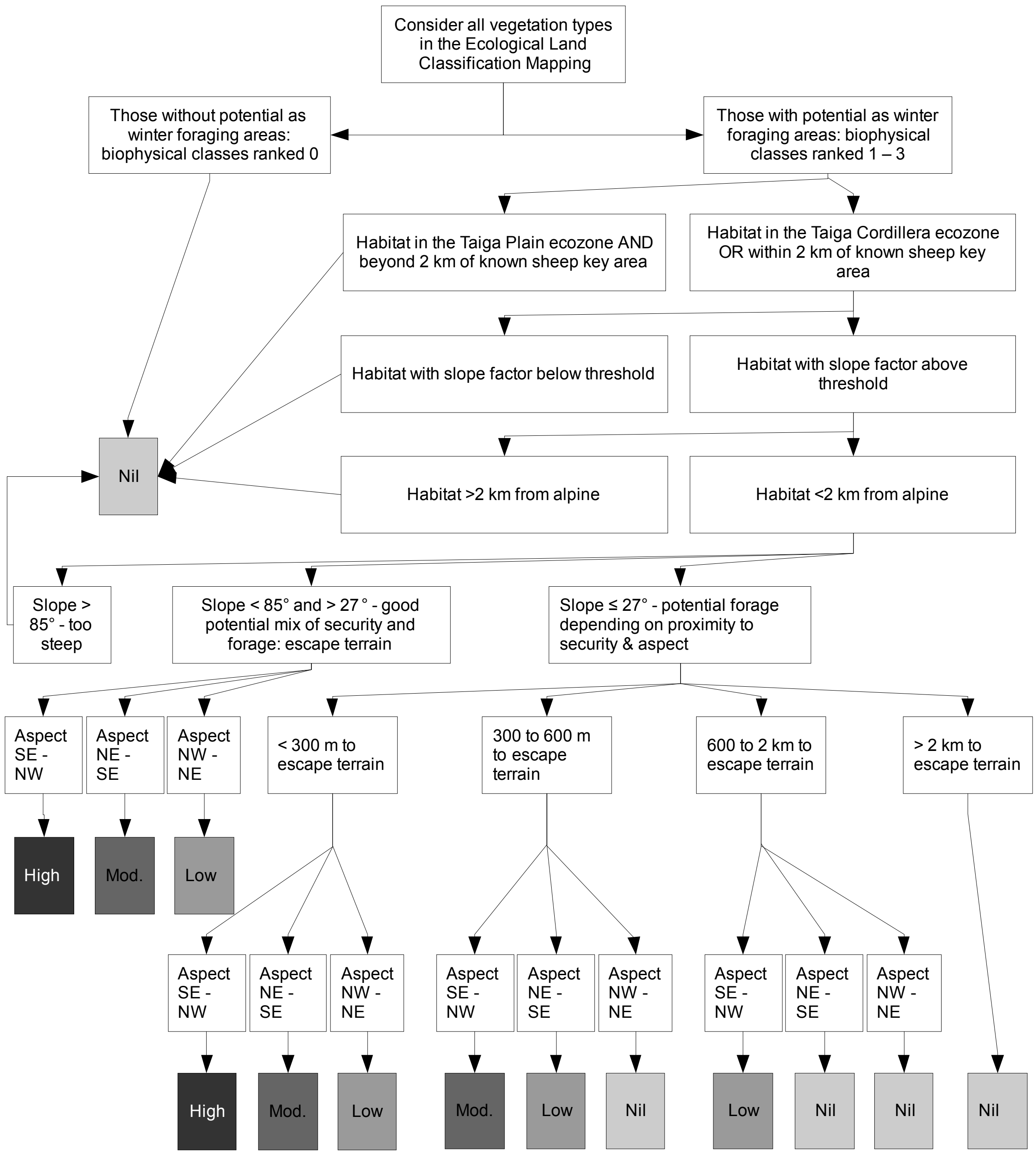
Expert: Jean Carey, Sheep Biologist, Yukon Environment, Whitehorse.
Community members who attended workshops (Table 1).
Mark O'Donoghue, Regional Biologist – Mayo, Yukon Environment.

Context: Sheep are widespread in suitable habitat in the Mackenzie, Ogilvie and Richardson Mountains. The few population surveys in the region, and other general observations, have resulted in mapping of some Wildlife Key Areas for sheep, but such mapping is incomplete and cannot be relied on to show all areas of high importance to sheep especially in winter. Winter is generally considered to be the critical season for this species, because snow limits access to alpine tundra foods, with potential effects on current year survival and subsequent reproductive output (Demarchi and Hartwig 2004, Nichols 1978). Consequently, sheep select alpine tundra and meadows where snow depth is reduced by wind scouring and/or strong sunshine, and these sites primarily provide graminoid foods (Simmons 1982). Without strong wind scouring, sheep may suffer food shortages (Burles and Hoefs 1984). Predator avoidance is also a key aspect of sheep behaviour in all seasons, and they rely on cliffs as escape terrain and rarely forage more than 300 m from such steep slopes (Risenhoover and Bailey 1985, Demarchi and Hartwig 2004). Forested habitats may be used for shelter, and when accessing mineral licks. Licks are perennially used and provide critical nutrients especially in spring and early summer, so require site-specific conservation attention (see Special Elements Indicator).

Methods: Jean Carey, our sheep expert, agreed that winter is the critical season for sheep, and that an attempt at mapping winter habitat suitability was necessary given that Wildlife Key Area mapping is incomplete. She rated the winter suitability of the habitat types from the biophysical map based on their potential to provide food, noting that suitability also depends on proximity to escape terrain and on exposure of slopes to wind and sun. We also asked the First Nations participants at workshops in Dawson, Mayo and Fort McPherson to rate habitats for sheep. Participants stressed the issue of proximity to escape terrain and noted that their experience was limited in winter. Ratings were based on the four point scale (Nil, Low, Moderate, High).

We developed a model of winter habitat suitability starting with the premise that few habitat types overall would be used by sheep in winter, in particular those given any rating greater than Nil by Jean Carey (Table 5), and the remainder should be rated Nil. First Nations experts agreed with this list of potential winter habitats. We incorporated slope angle and aspect into the model as illustrated in Figure 1. Slopes greater than 27^{o} and less than 85^{o} were considered potential escape terrain (Dicus 1992), and areas within 300 m of such escape terrain were considered potentially suitable (Demarchi and Hartwig 2004). Areas within two ranges of distance from escape terrain (300 – 600 m and 600 – 2000 m) were considered incrementally less suitable. We considered the warmer and more windswept aspects at higher latitudes to be south and west (from 135° to 315°), with less suitable aspect being east (45° to 134°), and the least suitable being north (316° to 44°). We verified the map with historical observations of sheep locations in winter (mostly March), and found good correspondence between observations and mapped moderate to high quality sites, but also noted very large areas of mapped high quality habitat where no sheep had been observed. The model produced a map with very liberal amounts of high quality habitat. We judged that (i) some escape terrain was unrealistically far from good foraging; (ii) in many valleys wind would not be strong enough to remove much snow; (iii) the part of the planning region with highest snowfall had very little winter sheep use as might be expected. To make the model more conservative we applied a mask that removed any potential escape terrain more than 2 km from alpine habitats in the ecological land classification, and we developed a slope factor relating the difference in elevation between the mountain slope and the nearest big water body or river (as indicated on 1:1,000,000 topographic maps) to the horizontal distance between the two sites. The slope factor is an index of wind exposure, with large water bodies representing relatively wide and open valleys. At a fixed distance between a slope and a water body, the greater the difference in elevation the more wind exposure the slope will receive. Slopes only received a rating if their slope factor was greater than 1.0 in the Richardson Mountains, and greater than 1.2 elsewhere. We also reduced the suitability ratings by one point for that part of the planning region with snowfall > 60 cm (i.e. the southern portions of the Ogilvie and Mackenzie Mountains from the Hart all the way east to Snake Rivers). Finally, we set the habitat suitability to nil in the Taiga Plain ecozone except for features within a 2 km buffer of identified sheep key areas (Yukon Environment WKA or TGFN wildlife areas). See Figure 1 for a graphical representation of this modeling process.

Figure 1: Sheep habitat suitability model that ascribes suitability ratings (shaded boxes) by considering vegetation types, slope, aspect, and distance from major waterbodies in the Peel watershed planning region.



Results: The final sheep habitat suitability map (Map 19. Dall's Sheep: Winter habitat suitability and winter key areas) shows that moderate to high suitability habitats are widespread in the Mackenzie, Ogilvie and southern Richardson Mountains, corresponding well to the mapped distribution of Wildlife Key Areas for this species and to the known winter distribution of sheep (Map 18. Dall's Sheep: Key areas and local knowledge). The habitat map probably still identifies considerable habitat that is not used by sheep in any one winter, but that may be used in some winters. More detailed knowledge of the patterns of wind in diverse drainages would probably help refine the map.

Table 5: Habitat suitability ratings used for initial stage of modeling of sheep winter habitat suitability (0=Nil; 1=Low; 2=Moderate; 3=High).

HABITAT TYPE	Jean Carey – winter
High Elevation Rock/Exposed	1
High Elevation Dry Sparse Herb	1
High Elevation Bryoid	1
High Elevation Dryas/Dwarf Shrub	1
Sub-alpine Shrub	2
High Elevation Coniferous Forest	2
Low-Mid Elevation Exposed Rock/Rubble	3
Low-Mid Elevation Wet Herb	0
Low-Mid Elevation Wet Shrub	0
Low-Mid Elevation Wet Mixedwood/Broadleaf Forest	0
Low-Mid Elevation Wet Coniferous Forest	1
Low-Mid Elevation Moist Herb	0
Low-Mid Elevation Moist Shrub	0
Low-Mid Elevation Moist Mixedwood/Broadleaf Forest	0
Low-Mid Elevation Moist Coniferous Forest	1
Low-Mid Elevation Dry Herb	0
Low-Mid Elevation Dry Shrub	2
Low-Mid Elevation Dry Mixedwood/Broadleaft	0
Low-Mid Elevation Dry Coniferous Forest	2
Low-Mid Elevation Lichen	0
Gravel-Sand Bars	0
Riparian Herb Marsh	0
Riparian Shrub	1
Riparian Mixedwood/Broadleaf Forest	0
Riparian Spruce Forest	0
Wetland Herb	0
Wetland Shrub	0
Wetland Forest	0
Open Water	0
Flowing Water	0
Snow/Ice	1

Map 18: Dall's Sheep – Key Areas and Local Knowledge

Map 18: Dall's Sheep – Key Areas and Local Knowledge (reverse page)

Map 19: Dall's Sheep – Winter Habitat Suitability and Winter Key Areas

Map 19: Dall's Sheep – Winter Habitat Suitability and Winter Key Areas (reverse page)

Grizzly Bear

Rationale: Grizzly bears were selected as a focal species requiring management and protection in the Issues and Interests Report (PWPC 2005). Grizzly bear population status is a good measure of how healthy large wilderness areas remain because bears require diverse habitats dispersed over large areas, and they are susceptible to disturbance by humans.

Experts: Grant MacHutchon, Consulting bear biologist, Comox, BC
Dr. Ramona Maraj, Carnivore Biologist, Yukon Environment, Whitehorse, YT

Current Status: No population estimates exist for grizzly bears in the Peel watershed. There is a past history of high harvest of grizzly bears in some parts of the drainage, with some guide-outfitters having taken more than their quota of females. The population may be below carrying capacity in these areas. Biologists have not studied grizzly bears in detail in the Peel watershed. The most intensive work was led by Grant MacHutchon in 1996 and 1997 (MacHutchon 1997a & b). Working with a different land cover class map than that used in this planning process, he rated the suitability of cover classes ("habitats") in the Snake and Bonnet Plume drainages, with some work near the Peel River downstream of these tributaries. His work focused more on higher elevation and mountain riparian habitats of the Mackenzie Mountains ecoregion, and not so much in the Peel Plateau, or other ecoregions. There is a good deal of information available on grizzly bears in other portions of boreal cordilleran and taiga cordilleran ecozones, and this provides a solid understanding of the key seasonal foods for bears, and an increased understanding of how social ecology influences habitat use (Mattson *et al*. 1987; MacHutchon and Wellwood 2003; Maraj 2007). Bears make habitat choices largely on the availability of high quality foods. It is also clear that adult females with cubs often avoid habitats used heavily by adult males, and so end up using habitats that might not be quite so high in food value but that offer more security (e.g., subalpine shrub habitats in spring). Unfortunately we know little about grizzly bear denning ecology in these northern areas. Traditional knowledge interviews in Fort McPherson (GRRB study) did not identify any habitat correlates of den site choice.

Methods: At a workshop in February 2007, the experts agreed that: (i) habitat suitability mapping is the best method we have for estimating distribution of grizzly bears; (ii) we can justifiably rate habitat quality based on plant food availability and relative levels of security for females and young, in ecological land classes on the biophysical map; (iii) we cannot rate habitat suitability for denning at this time; (iv) we do not need to consider reductions in habitat suitability as a result of human activity (i.e. habitat effectiveness), since roads and settlements are virtually absent; (v) we can divide the annual cycle into four periods, providing ratings for spring (den emergence to June – root diet), summer (June to late July – herbs), and fall (late July to denning – roots and berries), but not winter; (vi) we should use a four-point rating scale (Nil, Low, Medium and High qualities); (vii) no single season is critical, or more important than another, so a map should produce a synthesis of seasons. Of particular concern was the potential difference in foods available within a habitat depending on whether that habitat was in the mountains or on the taiga plains. Without detailed plant community composition data from each ecozone to address this question, we agreed to apply the habitat ratings uniformly across the planning region. At that workshop we finalized ratings tables for three seasons, partly by cross-walking ratings from the habitat classes described by MacHutchon (1997 a & b) to the habitat types in the Peel biophysical map (Meikle and Waterreus 2008), and partly by reviewing pictures of the Peel biophysical map classes. The resulting map showed heavy association of high quality habitats with riparian areas, especially in the mountains. The general distribution of high quality habitats was fairly even over the plan area, suggesting that there was not one ecoregion or ecodistrict that had particularly high value for grizzly bears. This then suggested a potential problem given that grizzly bears seem to be more heavily associated with the mountainous parts of the region. We noted that ratings did not take into account potential animal foods (e.g., ground squirrels and ungulates) because we were not sure of the availability and use of these foods across habitats.

At a workshop in October 2007, without Grant MacHutchon, we agreed that the best map would display the highest rating each habitat had across all seasons. We agreed to deal with the excessively high ratings through the non-mountainous ecodistricts of the Taiga Plains by dropping the ratings by one class in all habitats in the following ecodistricts: Jackfish Lake Wetland, Tabor Lakes, Peel Plateau North, Lower Peel Plateau, and Turner Lake Wetlands.

<u>Results:</u> The final suitability ratings are in Table 6, and they are pictured on Map 20 (Grizzly Bear: Habitat suitability and key areas). Grizzly bear habitat quality is highest in riparian areas, especially in the mountains. However, moderate to high quality habitats are widespread. One caveat is our inability to rate availability of animal foods. The net effect of heavy use of animals by bears would probably be to increase the quality of some of the alpine and sub-alpine herb and shrub communities (ground squirrels, moose and caribou available), and some of the riparian areas (moose available).

Table 6: Habitat suitability ratings for grizzly bears for each habitat in each season, and the maximum value in any season (0=Nil; 1=Low; 2=Moderate; 3=High).

HABITAT TYPE	SPRING	SUMMER	FALL	MAXIMUM VALUE
High Elevation Rock/Exposed	0	0	0	0
High Elevation Dry Sparse Herb	0	0	0	0
High Elevation Bryoid	1	0	1	1
High Elevation Dryas/Dwarf Shrub	2	1	1	2
Sub-alpine Shrub	3	2	1	3
High Elevation Coniferous Forest	2	1	2	2
Low-Mid Elevation Exposed Rock/Rubble	1	0	0	0
Low-Mid Elevation Wet Herb	2	2	2	2
Low-Mid Elevation Wet Shrub	1	2	2	2
Low-Mid Elevation Wet Mixedwood/ Broadleaf Forest	1	2	2	2
Low-Mid Elevation Wet Coniferous Forest	1	1	1	1
Low-Mid Elevation Moist Herb	1	1	2	2
Low-Mid Elevation Moist Shrub	2	3	2	3
Low-Mid Elevation Moist Mixedwood/Broadleaf Forest	2	1	2	2
Low-Mid Elevation Moist Coniferous Forest	1	1	2	2
Low-Mid Elevation Dry Herb	2	1	2	2
Low-Mid Elevation Dry Shrub	2	1	2	2
Low-Mid Elevation Dry Mixedwood/Broadleaft	1	1	2	2
Low-Mid Elevation Dry Coniferous Forest	2	1	3	3
Low-Mid Elevation Lichen	2	1	1	2
Gravel-Sand Bars	1	1	1	1
Riparian Herb Marsh	2	2	2	2
Riparian Shrub	3	2	3	3
Riparian Mixedwood/Broadleaf Forest	2	2	2	2
Riparian Spruce Forest	3	3	3	3
Wetland Herb	2	2	1	2
Wetland Shrub	2	3	1	3
Wetland Forest	1	1	1	1
Open Water	1	1	1	1
Flowing Water	0	0	0	0
Snow/Ice	0	0	0	0

Map 20: Grizzly Bear – Habitat Suitability and Key Areas

Map 20: Grizzly Bear – Habitat Suitability and Key Areas (reverse page)

Marten

Rationale: Fur trapping is an important part of the cash economy of communities close to the planning region, and marten is one of the most valuable species trapped. It is also an indicator of the health of mature forest ecosystems.

Experts: Community members with a history of trapping.

Current Status: There are no inventory data for marten populations in the region, and quantitative knowledge of marten distribution is best described by community members and travelers who visit the region in the winter when marten sign is most evident. The population is generally thought to be healthy and quite stable, though recent forest fires have removed high quality habitat from large areas. If the number and extent of fires increase with global warming, the marten population may well decline.

Methods: Community members, especially those with winter experience on the land, have the most intimate and detailed knowledge of the general distribution and habitat choices of marten. No biologist has that level of experience in this part of the Yukon. Community knowledge is generally patchy, however, so the best way to map it throughout the planning region was by building a habitat suitability map using ratings supplied by community members. Habitat suitability rankings were agreed to at workshops in Dawson and Ft McPherson. For each habitat type, the highest value from either workshop was used to represent the habitat suitability in the map.

Results: The habitat suitability rating for each habitat is listed in Table 7, and depicted in Map 21 (Marten: Winter habitat suitability). There was agreement that winter is probably the most demanding season for marten. Habitat suitability ratings from the two workshops were remarkably similar, and this similarity could be an indication of high reliability of workshop data.

Table 7: Winter habitat suitability ratings for marten as provided by two communities, and the maximum value (0=Nil; 1=Low; 2=Moderate; 3=High).

HABITAT TYPE	DAWSON	FT MC PHERSON	MAXIMUM VALUE
High Elevation Rock/Exposed	0	0	0
High Elevation Dry Sparse Herb	0	0	0
High Elevation Bryoid	0	0	0
High Elevation Dryas/Dwarf Shrub	0	0	0
Sub-alpine Shrub	1	0	1
High Elevation Coniferous Forest	2	2	2
Low-Mid Elevation Exposed Rock/Rubble	0	0	0
Low-Mid Elevation Wet Herb	2	2	2
Low-Mid Elevation Wet Shrub	2	2	2
Low-Mid Elevation Wet Mixedwood/Broadleaf Forest	0	0	0
Low-Mid Elevation Wet Coniferous Forest	2	3	3
Low-Mid Elevation Moist Herb	0	0	0
Low-Mid Elevation Moist Shrub	0	0	0
Low-Mid Elevation Moist Mixedwood/Broadleaf Forest	0	0	0
Low-Mid Elevation Moist Coniferous Forest	2	3	3
Low-Mid Elevation Dry Herb	0	0	0
Low-Mid Elevation Dry Shrub	0	0	0
Low-Mid Elevation Dry Mixedwood/Broadleaft	2	2	2
Low-Mid Elevation Dry Coniferous Forest	2	3	3
Low-Mid Elevation Lichen	0	1	1
Gravel-Sand Bars	1	0	1
Riparian Herb Marsh	1	0	1
Riparian Shrub	1	1	1
Riparian Mixedwood/Broadleaf Forest	2	2	2
Riparian Spruce Forest	2	3	3
Wetland Herb	1	2	2
Wetland Shrub	1	1	1
Wetland Forest	0	3	3
Open Water	1	0	1
Flowing Water	1	0	1
Snow/Ice	0	0	0

Map 21: Marten – Winter Habitat Suitability

Map 21: Marten – Winter Habitat Suitability (reverse page)

Peregrine Falcon

Rationale: In taiga regions Peregrine Falcons prey mainly on wetland birds, so can be considered an indicator of wetland ecosystem health. This is also a threatened species under the federal Species at Risk Act (SARA), and therefore requires explicit attention.

Expert: David Mossop, Raptor Biologist, Yukon College, Whitehorse
Cameron Eckert, Conservation Biologist, Yukon Environment, Whitehorse
Pamela Sinclair, Wildlife Biologist, Canadian Wildlife Service, Whitehorse

Context: The Peregrine Falcon is a migratory raptor which nests and raises young in the planning region. Peregrine falcon populations in North America were endangered in the latter half of the twentieth century. Conservation actions, including the banning of certain pesticides, have allowed Peregrine Falcon populations to increase through most of western and arctic North America. The species is no longer considered endangered, but is rated instead as threatened. This general situation probably holds for the Peel planning region, where inventories are conducted on some drainages every 5 years, and the population has been growing.

When nesting and raising young, taiga Peregrines generally catch shorebirds and waterfowl, so population status also depends on the abundance and productivity of these wetland birds, and their local habitat quality (Hunter *et al.* 1988). Peregrines nest on cliffs, generally near water bodies (Mossop 1979, 2005).

Methods: We decided that a map of Peregrine Falcon habitat suitability, during the nesting season, would include areas with a high likelihood of nests, buffered by an area within which adult birds were most likely to forage. A number of nest sites have already been mapped, some recently discovered, but the entire region has not been searched. Before building a predictive model of high suitability Peregrine nesting habitat, D. Mossop delineated a polygon representing suitable foraging habitats for these falcons. This polygon encompasses riparian habitat and suitable habitat for waterbird prey species, and mostly excludes higher elevation topography. Next, we modeled high suitability peregrine nesting habitat in a GIS by identifying cliffs, (i.e. slopes of $>40^{o}$ on a 16m DEM – Yukon Environment) within both the suitable foraging polygon and existing riparian corridor polygons (Yukon Environment). We then buffered this habitat by 2 km to yield the final polygons representing suitable nesting habitat for Peregrine Falcons. This buffer is based on the area around the nest which peregrines defend and within which they are sensitive to disturbance.

Results: Map 22 (Peregrine Falcon: Nesting and foraging habitat) shows that this raptor is mostly associated with the well-incised stretches of the major drainages, where cliffs close to water provide nesting habitat, and nearby plateau country supports numerous wetlands.

Map 22: Peregrine Falcon – Nesting and Foraging Habitat

Map 22: Peregrine Falcon – Nesting and Foraging Habitat (reverse page)

Waterbirds

Rationale: Waterbirds (ducks, geese, swans, loons, and grebes) are an indicator of the health of taiga lakes and wetlands. These ecosystems support numerous species not found elsewhere on the land base, and provide valuable migratory habitats in a broader regional context. They are also key sites for human activity that can easily disrupt waterbird occupancy and habitat quality.

Experts: Amy Leach, Waterfowl Biologist, Ducks Unlimited, Whitehorse
James Kenyon, Waterfowl Biologist, Ducks Unlimited, Whitehorse
Jim Hawkings, Wildlife Biologist, Canadian Wildlife Service, Whitehorse

Context: Lakes and associated wetlands are fairly uncommon elements in this generally mountainous region, so provide locally important habitats for numerous plants, insects, birds and mammals that depend on such ecosystems, and surrounding riparian habitats, for at least a portion of their life cycle. These ecosystems contribute enormously to the total biodiversity of the region because of their productivity and unique growing conditions. Waterbirds are central players in these ecosystems, relying on all ecosystem components – open water, vegetated wetlands and riparian areas – for feeding, nesting, raising young, and moulting. They also use the lakes in migration. This function is particularly valuable in the larger regional context. The Peel River drainage breaks the long spine of the northern cordillera, creating a migratory pathway for numerous birds traveling east or west between Yukon and Mackenzie River basins. Many of the region's wetlands sit in this break, on the Peel Plateau, and so provide valuable staging and stop-over sites for waterfowl.

Many waterfowl species are declining in western North America (Afton and Anderson 2001, Traylor *et al.* 2004). Inventories in the Peel have focused mostly on nesting and staging counts on the Turner Lakes wetlands and surrounding areas (Mossop 2001 & 2002, Eckert *et al.* 2003, Spiewak and Leach 2005 & 2006, Kenyon and Spiewak 2008), and knowledge of the rest of the region is incomplete. Peel lakes and wetlands themselves are largely pristine at present, so habitat suitability has not been widely compromised. Water, however, is a necessary resource for most human activity. These kinds of ecosystems attract activity, yet are easily destabilized by human use of water and shorelines, including changes to flow regimes of tributary areas (dams, blockages, diversion, clearing vegetation), water uptake and use (pumping, wells), pollution (spills, runoff, effluent, injections into the water table), fishing (angling, netting), and disturbance (noise, displacement). It is largely because water is so valuable to people, and these ecosystems are so easily disrupted, that they require special conservation action.

Methods: Experts agreed that a habitat suitability mapping approach was necessary because of the lack of detailed knowledge of waterbird distribution, and that we should produce a map of nesting habitat suitability. This nesting suitability map would function comprehensively for all waterbird species, by focusing on identification of the full range of wetlands and the associated riparian areas within which nesting by any species was most likely to occur. We agreed that this mapping should be done separately for flowing water (streams and rivers) and standing water (lakes, ponds, flooded areas). Before doing this habitat suitability mapping, the original biophysical map was improved by correcting water pixels that were incorrectly classified as standing water.

For standing water we recognized two suitability classes: high and low. High suitability includes all open water polygons on the NTDB map layer (1:50,000) plus any other open water polygons identified on the biophysical map that were either within NTDB wetland polygons, or were larger and in the Peel Plateau, all buffered by 250 m. These same water bodies were buffered a further 250m to denote a zone of low suitability. This 500 m total buffer is the distance from open water within which 95% of nests of prominent taiga waterfowl are likely to occur, based on data from the white-winged scoter which on average nests further from water than other species (Traylor *et al.* 2004, Safine 2005). Low suitability also includes all NTDB wetland polygons lacking open water, without a buffer. These areas may have ephemeral open water, may include nesting habitat, and are likely brood-rearing habitat. For flowing water, we consider only one suitability class, high, which includes the water course and all associated riparian habitats on the biophysical map (without buffer). The riparian zone is generally wide enough to include the nest sites of the relatively few species (e.g., harlequin ducks and mergansers) associated with these aquatic habitats.

<u>Results:</u> High quality waterfowl nesting habitat is much more widespread and prominent on the Peel Plateau and Fort McPherson Plain than other ecoregions, where it is clearly associated with mountain valley bottoms and scattered lakes and ponds (Map 23. Waterbirds: Key areas and traditional knowledge; Map 24. Waterbirds: Nesting habitat suitability). This conservation value will frequently be at risk from human activity without active protection through parts of the planning region, and focused management actions elsewhere.

Map 23: Waterbirds – Key Areas and Traditional Knowledge

Map 23: Waterbirds – Key Areas and Traditional Knowledge (reverse page)

Map 24: Waterbirds – Habitat Suitability

Map 24: Waterbirds – Habitat Suitability (reverse page)

Breeding Birds

Rationale: One or more bird species occupies virtually every mapped habitat, and experts have good knowledge of the habitat choices of breeding birds. Bird species richness within each habitat is our best available indicator for mapping the general patterns of biodiversity across the region

Experts: Pamela Sinclair, Wildlife Biologist, Canadian Wildlife Service, Whitehorse
Cameron Eckert, Conservation Biologist, Yukon Environment, Whitehorse

Context: Conservation planning ideally seeks to secure a future for all ecosystems, and the full range of species, by providing representative areas for each in the land base set aside for conservation (i.e. coarse filter representation). It also includes securing a future for ecosystems or species which are particularly valuable or unique, but which might not be included in lands assigned to conservation by the coarse-filter approach (i.e. fine filter approach). Most of our wildlife indicators are fine-filter focal species, and only our Habitat indicator addresses the coarse filter. We include Breeding Birds as an indicator so as to expand the coarse filter. This assumes that the number of species (species richness) of breeding birds in each habitat reasonably represents the species richness of all biodiversity (plants, mammals, insects, etc) in each habitat. Birds are the only group for which we could attempt to portray the general distribution of species richness across the region. Nearly every habitat has been colonized by one or more species. Also, birds are conspicuous and mobile enough that we have a solid understanding of their ranges and their likely habitat choices, even though we might not have detailed information from all parts of the planning region.

Methods**:** We compiled a list of bird species that have been recorded in the Peel Watershed, using the Birds of the Yukon Database (CWS, Whitehorse) and defining the Peel Watershed as including the following NTS mapsheets: 116A/5-16, 116B/14-16, 116G/1-9, 116H/1-12,14-16, 116I/1-2, 106B/5-6, 106C/6-16,106D/5,8-16, 106E, 106F, 106K, and 106L. From this list of 139 species, we excluded those which only migrate through the area, and those which do not occur regularly (i.e. vagrants). This left 113 species which regularly breed in the Peel Watershed Planning Area. We excluded ducks, geese, swans, loons and grebes, plus Peregrine Falcons (27 species), because these are focal species for other indicators. This left 86 species for this analysis.

We created a spreadsheet of bird species presence/absence for each habitat on the biophysical map, where presence means the bird is likely to regularly use the habitat in the breeding season. We determined presence/absence from our knowledge of habitat use by birds in some portions of the Peel watershed and more generally in Yukon, along with brief descriptions, photos, and a map of the habitat classes. (This process included slight modifications to the biophysical map to include vegetation succession from herb to shrub categories in burns of the 2000-2004 fire seasons.). For each habitat we added up the number of species rated as present. To map these totals across the planning region, we divided habitats into four classes depending on the number of species likely to be present. These are:
Class 1: 0-10 of the 113 species regularly use these habitats
Class 2: 11-20 of the 113 species regularly use these habitats

Class 3: 21-30 of the 113 species regularly use these habitats
Class 4: 31-50 of the 113 species regularly use these habitats

Results**:** The number of species thought to use each habitat is summarized in Table 8, and pictured on Map 25 (Breeding Birds: Species richness). These numbers ranged from zero to fifty, with a median value of 17 species. Habitats predicted to host few breeding bird species were generally restricted to poorly vegetated terrain at higher elevations, while those predicted to host the most species were in wetlands, in wet or riparian forests, or, to a lesser degree, in shrubby areas at all elevations. Consequently, mountainous areas host either very few or many species. Higher, rockier mountains, such as the Wernecke and Selwyn Mountains contained fewer areas with high numbers of breeding birds (i.e. fewer of Classes 3 and 4), while lower, more vegetated mountains, including the Richardson, Trevor, Knorr, and Ogilvie Mountains, contained a higher density of these classes. Other areas of concentrated high species numbers include: the Ogilvie pediments, Edigii Hill, wetlands, and wet or riparian forests.

Experts have a number of caveats or concerns about the use of this indicator.

1. These habitats do not correspond neatly with habitat selection by bird species, so it was not straightforward to assign habitat classes to bird species. For example, a bird species may use only part of a habitat, or it may use a habitat only under certain conditions (e.g. when it is adjacent to a second habitat). Alternatively, a habitat may be used by a species for nest placement but not foraging; or the species may use it at very low densities, but a different habitat at high densities. The presence/absence scores were not ground-truthed, and no bird surveys were conducted with prior knowledge of the biophysical habitats. Consequently there may be errors in assignment of species to habitat.
2. Simple Species Richness (number of species) by habitat is not necessarily a good measure of the ecological value of a habitat. For example, a habitat that supports many generalist species (species which can use a variety of other habitats) may be far less valuable ecologically than a habitat that supports a few specialist species (species which cannot use other habitats).
3. The species richness of a habitat depends on how the habitat is defined. For example, a broadly defined habitat such as “wetland” would tend to have more species than a more narrowly defined habitat such as “low elevation riparian white spruce”. One habitat as defined in the biophysical mapping may represent several bird communities, each using some subset of the defined habitat.
4. A Species Richness class might be falsely interpreted as a subset of another class with more species, whereby classes with higher abundance are assumed to include the species found in the classes with lower abundance. This would be incorrect. Conservation of only the “richest” classes will not represent many of the specialist species breeding in more species-poor classes.
5. Conservation only of areas with the highest species richness will not be the most space efficient way to protect bird habitat. Conservation of areas with a full suite of habitats, and therefore a variety of species richness classes, would result in representation of more bird species overall.

In sum, the map needs to be assessed in conjunction with the other coarse-filter indicator, habitat representation, and with an eye to thinking at large scales (e.g. watersheds). For both indicators, the aim is to ensure representation of all classes in a conservation zone, and a suitable conservation outcome involves including full representation of all habitats across elevational and latitudinal gradients. These are questions of interpretation, but the map is still our best indicator to meet our goal of showing regional patterns of general biodiversity.

Table 8: Number of species of breeding birds for each ecosystem land class.

HABITAT TYPE	NUMBER OF SPECIES
High Elevation Rock/Exposed	4
High Elevation Dry Sparse Herb	14
High Elevation Bryoid	14
High Elevation Dryas/Dwarf Shrub	22
Sub-alpine Shrub	13
High Elevation Coniferous Forest	17
Low-Mid Elevation Exposed Rock/Rubble	3
Low-Mid Elevation Wet Herb	11
Low-Mid Elevation Wet Shrub	20
Low-Mid Elevation Wet Mixedwood/ Broadleaf Forest	20
Low-Mid Elevation Wet Coniferous Forest	40
Low-Mid Elevation Moist Herb	6
Low-Mid Elevation Moist Shrub	15
Low-Mid Elevation Moist Mixedwood/Broadleaf Forest	20
Low-Mid Elevation Moist Coniferous Forest	33
Low-Mid Elevation Dry Herb	5
Low-Mid Elevation Dry Shrub	14
Low-Mid Elevation Dry Mixedwood/ Broadleaft	17
Low-Mid Elevation Dry Coniferous Forest	26
Low-Mid Elevation Lichen	1
Gravel-Sand Bars	11
Riparian Herb Marsh	12
Riparian Shrub	22
Riparian Mixedwood/Broadleaf Forest	34
Riparian Spruce Forest	35
Wetland Herb	31
Wetland Shrub	39
Wetland Forest	50
Open Water	36
Flowing Water	8
Snow/Ice	0

Map 25: Breeding Birds – Species Richness

Map 25: Breeding Birds – Species Richness (reverse page)

Species of Conservation Concern (Rare Birds)

Rationale: Species of conservation concern (e.g. species at risk, identified by the federal Species at Risk Act process or the Yukon Wildlife Act process) require protection of critical habitats. Due to a lack of data, our analysis was limited to rare birds. Bird species at risk are generally habitat specialists, and therefore represent high value or unique habitat.

Experts: Pam Sinclair, Wildlife Biologist, Canadian Wildlife Service, Whitehorse
Cameron Eckert, Conservation Biologist, Yukon Environment, Whitehorse

Context: All breeding birds of conservation concern are listed on one or more species conservation lists (CESCC 2006, COSEWIC 2007, Milko *et al.* 2003, Rich *et al.* 2004, USFWS 2004). Twelve such species are thought to nest in the Peel Watershed:

American Golden-Plover – USSCP "High Priority" shorebird in North America, General Status "Sensitive" in Canada
Harlequin Duck* – General Status "Sensitive" in Canada
Olive-sided Flycatcher – COSEWIC "Threatened", Partners in Flight "Watch List" of declining landbird species
Rusty Blackbird – COSEWIC "Special Concern", General Status "Sensitive" in Canada, Partners in Flight "Watch List" of declining landbird species
Peregrine Falcon* – COSEWIC "Special Concern"
Short-eared Owl – COSEWIC "Special Concern", General Status "Sensitive" in Canada, Partners in Flight "Watch List" of declining landbird species
Smith's Longspur – General Status "Sensitive" in Canada, Partners in Flight "Watch List" of landbird species with restricted distributions
Solitary Sandpiper – USSCP "High Priority" shorebird in North America
Surfbird - USSCP "High Priority" shorebird in North America, General Status "Sensitive" in Canada
Swainson's Hawk – Partners in Flight "Watch List" of declining landbird species
Upland Sandpiper – USSCP "High Priority" shorebird in North America
Wandering Tattler – General Status "Sensitive" in Canada
***** These species were not considered in this analysis

We do not have detailed inventories for these species in the Peel watershed, though we do know that they all occur in the basin. Consequently we must infer their distribution from our considerable knowledge of their nesting habitat choices in similar taiga, alpine and boreal habitats in the larger region, along with the limited data from the Peel.

Methods: We compiled a list of bird species which have been recorded in the Peel watershed, using the Birds of the Yukon Database (CWS, Whitehorse) and defining the Peel watershed as including the following NTS mapsheets: 116A/5-16, 116B/14-16, 116G/1-9, 116H/1-12,14-16, 116I/1-2, 106B/5-6, 106C/6-16,106D/5,8-16, 106E, 106F, 106K, and 106L. From this list of 139 species, we excluded species which only migrate through the area, and species which do not occur regularly (i.e. vagrants). This left 113 species which regularly breed in the planning region. From these 113, we excluded all ducks, geese, swans, loons, and grebes (26 species), as well as Peregrine Falcon, because these species are covered by waterfowl and Peregrine Falcon mapping. This left 86 species.

The conservation status of each of the 86 species was determined using the various conservation authorities listed above. Ten of the 86 species are listed as high continental and/or national conservation concern (list above). We used these 10 species to map priority areas for breeding birds. The rationale for basing this map on only 10 species was that: (i) they are the species most in need of conservation; (ii) they are a different suite of species than those mapped for other values; (iii) they are habitat specialists.

We created a spreadsheet of bird species presence/absence for each habitat on the biophysical map, where presence means the bird is likely to regularly use the habitat in the nesting season. We determined presence/absence from our knowledge of habitat use by birds in some portions of the Peel watershed and more generally in Yukon, along with brief descriptions, photos, and a map of the habitat classes. (This process included slight modifications to the biophysical map to include vegetation succession from herb to shrub categories in burns of the 2000-2004 fire seasons.) For each habitat we added up the number of rare species rated as present. To map these totals across the planning region, we divided habitats into four classes depending on the number of species likely to be present. The resulting map is somewhat similar to a habitat suitability map with the following classes: Nil (none of the 10 species regularly uses these habitats), Low (1 of the 10 species regularly uses each of these habitats), Moderate (2 of the 10 species regularly use each of these habitats), High (3 to 5 of the 10 species regularly use each of these habitats).

Results**:** Table 8 includes the raw data on bird presence/absence by habitat, from which we produced the map of the distribution of birds of conservation concern (Map 26. Birds of Conservation Concern: Distribution). The number of breeding bird species of conservation concern ranged from zero to five across habitats. Habitats without such species were generally riparian forests and expanses of exposed rock at higher elevations. Habitats hosting three or more species were wetlands, wet meadows, and vegetated alpine areas. Consequently, mountainous areas had strong contrasts between areas predicted either to host none or many such species. More rugged mountains, such as the Wernecke and Selwyn ranges, contained fewer areas with high suitability. Lower, more vegetated mountains, including the Richardson, Trevor, Knorr, and Ogilvie Mountains, had higher density of high suitability habitats. Other areas of concentrated high suitability habitats include the Ogilvie pediments, Edigii Hill, and wetlands in the Peel Plateau.

There may be errors in this mapping because presence/absence scores were not ground-truthed, and no bird surveys were conducted with prior knowledge of the habitats in the biophysical map. These habitats do not correspond neatly with habitat selection by bird species, so it was not straightforward to assign habitat classes to bird species. For example, a bird species may use only part of a habitat, or it may use a habitat only under certain conditions (e.g. when it is adjacent to a second habitat). Alternatively, a habitat may be used by a species for nest placement but not foraging; or the species may use it at very low densities, but a different habitat at high densities. Despite these difficulties, we feel that the map gives an adequate strategic display of the regional distribution of these sensitive species.

Map 26: Birds of Conservation Concern – Distribution

Map 26: Birds of Conservation Concern – Distribution (reverse page)

Rare Plants (Species at Risk)

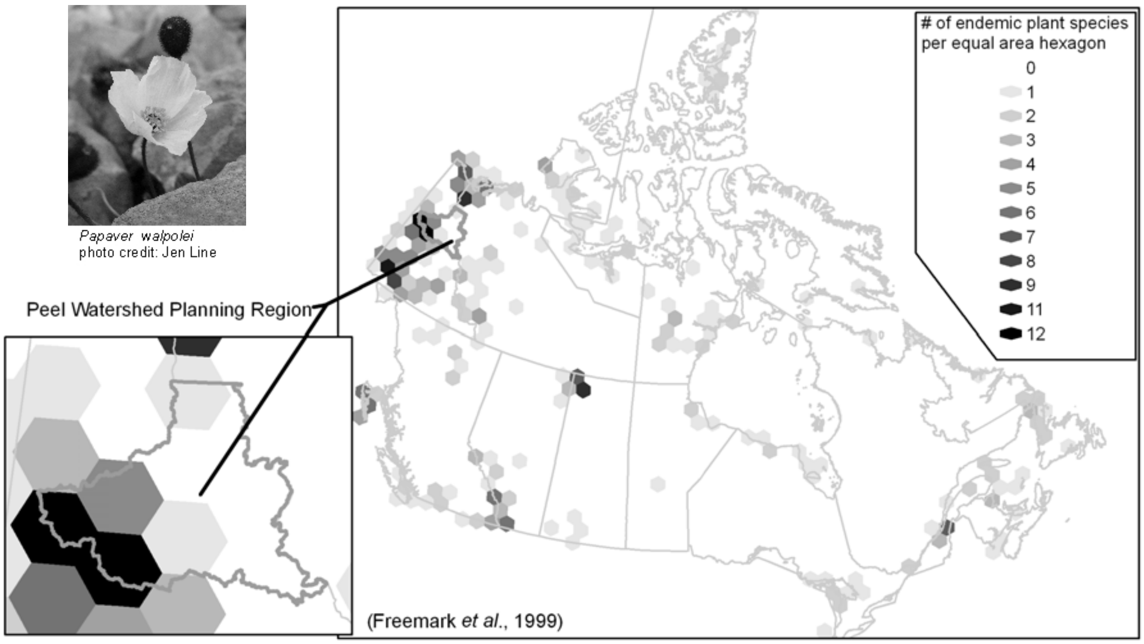
Rationale: Conservation planning should include an effort to protect rare and endangered species, and especially their critical habitats, as mandated by federal and territorial legislation. Large portions of the planning region were not glaciated in the Pleistocene, and today support endemic plant species found nowhere else in Canada.

Experts: Bruce Bennett, Botanist and Interpreter, Yukon Environment, Whitehorse, YT
Jen Line, Botanist, Yukon Environment, Whitehorse, YT

Current Status: Data on distribution of rare species are very patchy and poorly recorded, except for birds and plants. We deal with rare birds separately, rare or endemic plants here, but have to leave out other species. This means that we do not explicitly consider among mammals the wolverine nor the Ogilvie Mountain collared lemming, nor any invertebrates.

Our knowledge of the current distribution of rare and endemic plant species is incomplete for the planning region, but does include some focused sampling along the Dempster Highway, the southern Richardsons, and at scattered places in the Wernecke and Ogilvie Mountains. However, these records are not precise enough to allow accurate assignment to “habitat” type on the biophysical map, so our knowledge of their distribution is best characterized as likelihood of occurrence among watersheds on a sub-regional basis. Endemism and rarity are inter-related, with many endemic species also being rare because of their limited distributions. However, some endemic species are quite common in Yukon but rare nationally or globally. The Yukon is a region of very high levels of endemism nationally, and the southwest corner of the planning region (Northern Ogilvie Mountains) is a particular hotspot of endemism (Figure 2). Also, some species though rare in the Yukon, have widespread distributions and may be common elsewhere. Consequently we decided to rate the likelihood of occurrence of rare species and endemic species separately.

Figure 2: Frequency distribution of endemic plant species in national and regional contexts



Methods: Experts were able to rank the likelihood of occurrence of Rare species (based on life history and plant community composition) in each of the habitat classes from the biophysical map, independent of ecodistrict (Table 9). Experts were able to rank the likelihood of occurrence of Endemic species at an ecodistrict level, reflecting the geographic extent of un-glaciated Beringia and possible plant dispersal since then (Table 10). Two ecodistricts were subdivided to better reflect different patterns in plant endemism: the SW corner of the Bonnet Plume Basin ecodistrict, and the western quarter of the Canyon Range ecodistrict were ranked independently from the remainder of their respective ecodistricts. To combine rarity and endemism in one map, we multiplied the rarity and endemism rankings throughout the biophysical map. We then reclassified the products into four classes to produce a Unique Plant Likelihood Map. Specifics of this reclassification are found in Table 11.

Results: The plant rarity rankings by biophysical habitat type (Table 9) were multiplied by the plant endemism ranking by ecodistrict (Table 10), then reclassified (Table 11) to produce the Unique Plant Likelihood map (Map 27. Plants: Rare and Endemic Species). This mapping approach has obvious potential pitfalls given the small amounts of inventory done in the region, and the fact that most of that inventory has been along the Dempster Highway and in the southern Richardson Mountains.

Table 9: Likelihood of occurrence of rare plant species in each of the Peel biophysical habitat classes (0=Nil, 1=Low; 2=Moderate; 3=High).

HABITAT TYPE	RARITY RANKING
High Elevation Rock/Exposed	1
High Elevation Dry Sparse Herb	3
High Elevation Bryoid	2
High Elevation Dryas/Dwarf Shrub	3
Sub-alpine Shrub	2
High Elevation Coniferous Forest	1
Low-Mid Elevation Exposed Rock/Rubble	1
Low-Mid Elevation Wet Herb	1
Low-Mid Elevation Wet Shrub	1
Low-Mid Elevation Wet Mixedwood/Broadleaf Forest	1
Low-Mid Elevation Wet Coniferous Forest	1
Low-Mid Elevation Moist Herb	2
Low-Mid Elevation Moist Shrub	1
Low-Mid Elevation Moist Mixedwood/Broadleaf Forest	1
Low-Mid Elevation Moist Coniferous Forest	1
Low-Mid Elevation Dry Herb	3
Low-Mid Elevation Dry Shrub	2
Low-Mid Elevation Dry Mixedwood/Broadleaf	1
Low-Mid Elevation Dry Coniferous Forest	2
Low-Mid Elevation Lichen	1
Gravel-Sand Bars	1
Riparian Herb Marsh	3
Riparian Shrub	2
Riparian Mixedwood/Broadleaf Forest	1
Riparian Spruce Forest	1
Wetland Herb	3
Wetland Shrub	1
Wetland Forest	1
Open Water	1
Flowing Water	0
Snow/Ice	0

Table 10: Relative ranking of the degree of endemism likely to be found at an ecodistrict scale, and relative ranking of the intensity of inventory by ecodistrict.

ECODISTRICT	**RELATIVE DEGREE OF ENDEMISM** (1=Low; 2=Moderate; 3=High)	**RELATIVE RANKING OF INVENTORY EFFORT** (0=Nil; 1=Low; 2=Moderate; 3=High)
Plateau -East of Peel River	1	0
Jackfish Lake Wetlands	1	0
Wernecke Mountains	1	1
Eagle Basin Chance Creek	1	1
Peel Plateau North	1	1
Peel River Lowland	1	1
Peel Plateau South	2	1
Tatonduk Mountains	3	1
Turner Lake Wetlands	1	2
Richardson Foothills	2	2
Bonnet Plume Basin*	2	2
West Bonnet Plume**	3	2
Canyon Range	2	2
West Canyon**	3	2
South Ogilvie Taiga	3	3
Blackstone River Uplands	3	2
Nahoni Range	3	2
Hart River/ Blackstone River Mountains	3	3
Whitestone River - Cathedral Rocks	3	2
Richardson Foothills East	2	3
Richardson Mountains South Glaciated	3	3
Richardson Mountains South Unglaciated	3	3
Plateau -East of Peel River	1	0

* Original ecodistrict from which a portion was removed to better reflect different levels of plant endemism
** Smaller portion of subdivided ecodistricts (*) renamed for this analysis only

Table 11: Reclassification of endemism and rarity rankings

Products	Unique Plant Likelihood Classification
0, 1	0
2	1
6, 9*	3

Map 27: Plants: Rare and Endemic Species

Map 27: Plants: Rare and Endemic Species (reverse page)

Wilderness

Rationale: The PWPC's statement of intent states that a goal of the planning process is to ensure that wilderness characteristics in the planning region are maintained over time.

Experts: None

Context: Much of the Peel watershed is currently wilderness. The wilderness qualities of the region are highly prized internationally (Green *et al.* 2008), nationally, and locally by back-country enthusiasts, naturalists, artists, hunters, subsistence harvesters, and those whose soul is tied to the land. Wilderness is a sustainable resource rooted in wild nature; if managed properly it can largely be maintained. In a crowded world, however, wilderness is increasingly rare, because it takes significant care to manage it properly, and it is, by definition, largely empty of people. The Peel watershed planning process offers a unique opportunity to plan for careful management of this wilderness.

Methods: We consider wilderness best described as natural areas where certain human impacts and activities do not occur, and other impacts are closely constrained. In particular, roads and motorized vehicle routes, along with aircraft landing zones and permanent buildings, are incompatible with wilderness. In addition, natural areas have to be large to be considered wilderness; a sense of limitless space is integral to a sense of wilderness. Consequently we mapped wilderness as all areas where the following classes of human activity are excluded: (i) Long-term human footprint: regularly used motorized corridor in all seasons with 5 km buffer (Dempster Hwy); (ii) Short-term human footprint: motorized vehicle corridor with intermittent, or only seasonal use, with 2 km buffer (Wind River trail, camps and cabins, airstrips); or if use is not every year, with 0.5 km buffer (seismic lines); (iii) Disturbance without footprint: sites with repeated annual or seasonal use but no infrastructure, with 2 km buffer (float plane landing lakes). We did not exclude mine exploration camps, which can destroy wilderness values at least for a period of time, because they are relatively impermanent and often changing. We also did not exclude the canoe and river rafting corridors down the main rivers, assuming that non-motorized travel impinges on wilderness values far less than motorized travel. We also did not address flight paths or frequency of flights over wilderness. However, impermanent camps, frequency of use on river and hiking routes, and frequency and paths of flights, are all types of human activity for which this planning process will have to provide management direction. Without limits to their location, intensity, and frequency, they will ultimately destroy wilderness.

Results: Map 28 (Wilderness) depicts the extent of wilderness, and buffered areas with human footprint or repeated human activity. Wilderness is widespread at present, and occurs in large contiguous blocks in all major drainages. The Hart River watershed stands out as having the least impacted wilderness values to date, a trend also realized by Green *et al.* (2008). The actual human footprint in the planning region is remarkably small. Map 28 over-represents this footprint, because roads, airstrips, camps, and seismic lines are buffered. This buffering is essential because the impact of the footprint is dispersed well beyond the footprint itself, by noise and visual cues.

Map 28: Wilderness

Map 28: Wilderness (reverse page)

Subsistence Harvesting

Rationale: First Nations communities have traditional areas for subsistence harvesting of wildlife, fish, and plants. These resources significantly contribute to the well-being of these communities, and promoting this well-being is a goal of the planning process (YLUPC 2004).

Experts: Community members from the Tr'ondëk Hwëch'in (Percy Henry, JJ Van Bibber, William Henry, Ronald Johnson, Peggy Kormendy, Julia Morberg, and employees Renee Mayes, Chris Evans, Jody Beaumont, Marta Selassie, Ryan Peterson, Madeline deRepentigny, Georgette McLeod), Teetł'it Gwich'in (Robert Alexie, Thomas Koe, Abe Koe, Micheal Pascal, Peter Kaye Sr., Peter (PJ) Kaye, William Teya, Charlie Snowshoe, Woody Elias, Mary M. Firth, Bertha Francis, Mary Teya, Edna Norysoo, Johnny Charlie, and Rosie Stewart), and Nacho Nyak Dun First Nation (several members), who use portions of the Peel watershed.

Context: Subsistence harvesting of plants, fish, and wildlife by First Nations members has long been a part of the ecological food web. Certain portions of the Peel watershed are particularly important areas for harvesting, and have been traditionally used over many years. These might be areas of higher productivity for the harvested species, areas where a number of resources can be harvested from one camp, or areas to which access is relatively easy. Even though First Nations use of these traditional areas may have dwindled in recent years, the land and sites in question are still central to family identity and cultural connectedness with the land. Conserving these spaces will be essential for maintaining community well-being and a diversity of livelihoods in the future.

Methods: The planning staff organized workshops in Dawson City (Tr'ondëk Hwëch'in; December 5th, 2005), Fort McPherson (Teetł'it Gwich'in; March 28-30th, 2006) and Mayo (Nacho Nyak Dun; January 23rd, 2007). Staff of the First Nations governments were asked to recommend knowledgeable harvesters to attend the workshops and map traditional areas of subsistence harvesting.

Information was gathered largely by drawing lines on hard copy maps. Staff from the respective First Nations governments collated and digitized the information and maps, and these were passed on to the Peel Commission planning staff.

Results: Map 29 (Traditional Knowledge: Subsistence harvesting and wildlife areas) displays the traditional use polygons and sites of importance to each of the three First Nations. Ancillary data about each polygon, line or point – such as use, importance or harvest type – are not all displayed on Map 29, for simplicity's sake.

Map 29: Subsistence Harvesting

Map 29: Subsistence Harvesting (reverse page)

Special Features

Rationale: Certain site-specific habitats, or landscape features, are highly valuable to wildlife survival. They are not captured by other indicators, so need to be mapped separately.

Experts: Various people who have traveled in the planning region and recorded features. Most notable are guide-outfitters, First Nations travelers, naturalists, and recreationalists.

Context: Maps of species occurrences and habitat suitability portray the general pattern of species distribution across the planning region, but necessarily overlook some kinds of habitats and features which are key to wildlife survival, or are themselves unique habitats. These include mineral licks, hot-springs, patches of open water in winter, major game trails, low-elevation mountain passes (likely game travel routes), canyons, and generalized seasonal migration routes for caribou. Apart from migration routes, these features are generally restricted to small areas, and need to be recognized for site-specific conservation or management attention.

Methods: Mark O'Donoghue interviewed knowledgeable guide-outfitters, First Nations members, and trappers who could map some of these features. The information he gathered was digitized and transferred to planning staff. Some features were already well documented, and had previously been compiled (CPAWS 2004). Additional features were mapped by First Nations members attending community workshops to map areas of traditional use. Using watershed boundaries and slope maps as guides, we mapped all significant mountain passes between watersheds in the Mackenzie, Ogilvie and Richardson Mountains, noting which ones corresponded to known travel routes. We also located glaciers using 1:250,000 NTDB topographic maps.

Results: Map 30 (Special Features) shows the locations of special features. More of these are found in the Mackenzie Mountains ecoregion than elsewhere, and the Peel Plateau and Fort McPherson Plain have few such features. This pattern probably reflects a combination of real patterns on the ground, and differing amounts of information being reported or gathered for different portions of the region. For example, the higher incidence of mineral licks in the Snake River compared to Wind River valleys may result from more detailed reporting by one guide-outfitter compared to another. However, mineral licks are probably more common in the frequent bedrock and till exposures in the mountains compared to the forested plateau. The mapping of canyons, low-elevation passes, hot springs, and migration routes is most likely complete. Mineral licks and major game trails are likely under-reported and incompletely mapped.

Map 30: Special Features

Map 30: Special Features (reverse page)

Landscape Processes

Fire Regime

Rationale: Wildland fire is the main natural disturbance that transforms boreal and taiga ecosystems at a landscape scale. Fires change habitat quality for most species for decades, so interpreting current suitability of habitats depends on knowing fire histories and the fire regime.

Experts: David Milne, Wildland Fire Management, Community Services, Whitehorse, YT

Context: Numerous natural disturbances change the quality or suitability of animal habitats year to year. Some of these, such as landslides, permafrost slumping, and trees thrown by wind, are generally too small to regularly map, and too localized to have large effects on habitat suitability at a watershed scale. Wildland fires in boreal and taiga regions can burn large areas (500 to >10,000 ha; Eberhardt and Woodard 1987), and consequently change the pattern of habitat quality dramatically across watersheds. Wildland fires do not burn wetland or tundra habitats as frequently as drier forested habitats. Forested ecoregions without extensive wetlands are most likely to be affected (Eagle Plains; low elevation portions of Ogilvie, Richardson, and Mackenzie Mountains; drier areas of Peel Plateau), followed by forested areas with wetlands (much of Peel Plateau, and Fort McPherson Plain), then tundra zones in all mountainous ecoregions. Where and when fires take place, more surface fire and less crown fire occur relative to the denser forests in more southern latitudes. Our maps of focal species habitat quality are suitability maps, showing current conditions. These will change because areas recently burned will mature, and new fires will burn. We cannot precisely predict the pattern and timing for these events. The best conservation strategy is to include a range of forest types (i.e. ages since burn) within the same conservation zone, so that species can move to better quality habitat as conditions change. This includes letting wildland fires burn as long as they are not so frequent as to remove all the older age classes of forest. This strategy is partially consistent with existing Yukon Government policy in the planning region: the planning region falls within the *Wilderness Fire Management Zone* where fire monitoring and not suppression typically occurs.

Methods: We used existing fire history data from 1957 to 2006 (Wildland Fire Management, Community Services, Yukon Government, 2007), and the ecoregion boundaries, to show the pattern of documented large burns in the watershed. Yukon Government - Wildland Fire Management provided Table 12 which relates fire cycle to ecoregions (based on 1957 – 2004 data).

Results: Map 31 (Fire History by Decade: 1957-2006) shows the pattern of burns on the landscape. Fire patches show a great range in size (from 0.07 – 1959 ha), and can reach very large sizes. However, the actual extent of historic fires may be underestimated because subsequent fires may have burnt through the same areas as the earlier fire(s) (i.e. "over-burning"), and because not every historical fire has been captured in the fire history mapping, particularly in the 1950's and 60's. Fire patches in flatter ecoregions tend to be larger than those in more mountainous ecoregions largely because of the abundance of natural fire barriers in the mountains. Table 12 shows how fire cycle, or the length of time it takes to burn an area equivalent to the size of the study area, varies among the six ecoregions in the planning region. The effects of the severe fire year of 2004 can be seen by comparing the two rightmost columns. Such extreme fire events are expected to occur more frequently with climate change.

Table 12: Fire cycle of the ecoregions of the Peel Watershed Planning Region

ECOREGION	Fire Cycle 1950 to 2003 (years)	Fire Cycle 1950 to 2004 (years)
British-Richardson Mountains	397	400
Eagle Plains	310	121
*Fort McPherson Plain	72	74
Mackenzie Mountains	485	404
North Ogilvie Mountains	1339	709
Peel River Plateau	289	206

* Insufficient data as only a small portion of the ecoregion occurs in Yukon. In this case, the fire cycle more likely resembles the Peel River Plateau.

Map 31: Fire History (1957 – 2006)

Map 31: Fire History (1957 – 2006) (reverse page)

Climate Change

Rationale: Climate change threatens to force new distributions on most species and ecosystems as ecological conditions change. A conservation strategy needs to minimize the risks these changes pose to natural ecosystems.

Experts: None. We use existing literature, modeling, and thought to propose some general approaches.

Context: In Section II we outline the issue of climate change. Warming temperatures, and increasing precipitation are changing the living conditions for most species, but we cannot predict exactly how fast and where these changes will occur.

Methods: We reviewed recent literature on climate change impacts on biodiversity and ecosystems with particular attention to potential ways in which conservation planning can help ecosystems adapt to the ongoing changes. The following references are particularly useful: Halpin 1997, Noss 2001, IPCC 2002, Ogden and Innes 2007.

Results: These are the principal adaptation approaches (general points followed by specifics) that have been suggested by experts, as adapted by us to make sense in the Peel watershed context:

1. Conserve watersheds or sub-regions which are likely to be most resilient to projected climate change. This includes the following considerations.
   - Areas where relatively warm temperature and high precipitation currently limit the distribution of a significant number of species should be avoided in conservation zones, because these limiting conditions are likely to worsen
   - North-facing slopes may experience less intense warming effects, and so should comprise a significant component of a conservation zone.
   - Where we know or suspect that different populations of the same species have different genetic backgrounds or different histories of adaptation, conserve representative examples of all populations, especially those at the upslope or northward edges of current distribution.
   - Pay particular attention to keystone species and processes (e.g., wildland fire), including efforts to keep the condition, strength, and frequency of these processes within natural ranges where possible (e.g. fire suppression introduced when fires have become more common than historically; natural regeneration rather than planting following fire).

2. Enhance the ability of organisms, particularly plants, to move by natural dispersal so as to find suitable growing conditions. This includes:
   - Design conservation around large watersheds which allow downslope-upslope (elevational) dispersal, and often south-north (poleward) dispersal, without human barriers.
   - When watersheds are not aligned south-north, conserve any appropriate dispersal corridors (e.g. mountain passes, watershed divides) which can be poleward dispersal routes.

- Include, where possible, representative areas of all bedrock and soil parent materials (i.e. enduring features), and soil moisture regimes, along the likely dispersal pathways of plants, both elevational and poleward.
- Maintain natural vegetation along environmental gradients, such as latitude, altitude and soil moisture.
- Minimize the number of linear corridors, especially roads, because these features act as barriers to some species.
- Consider human-assisted dispersal of some species which are under stress but have limited natural ability to move.

3. Minimize the effects of other factors limiting the health or distribution of ecosystems or species. This includes:
   - More stringent controls on human harvesting of wild species when other natural factors affecting their health are becoming stronger (e.g., loss of caribou winter range to fire or unusually deep snow).
   - Considering all development actions as having additional potential risk because they may well act synergistically with climate change to produce cumulative effects beyond what might be anticipated from development alone.
   - Minimizing road development so as to keep the spread of invasive species, and the detrimental effects of disturbance, under control.
   - Placing thresholds on the intensity of human activity in conservation zones to keep disturbance within levels manageable by the species.
   - Putting buffer zones around core protected areas, where buffers allow human activities at lower intensities than multiple use zones.

4. Monitor the condition of focal or keystone species, ecosystems or processes that are central to ecosystem integrity and/or likely to be strongly affected by the climate trends. Although not a question of land use, this is a general planning principle, especially in the implementation phase.

The synergistic impacts of development working in the context of climate change are particularly worrisome. For example, permafrost degradation and increased evapo-transpiration on the Peel Plateau puts the future of many of this ecoregion's perched lakes in jeopardy, meaning that current water supply from these lakes and associated water table cannot necessarily be relied on to supply industrial demand and keep wetland ecosystems intact. Also, permafrost degradation will results in increased soil slumping into various water bodies with potential impacts on the quality of downstream spawning habitat. Therefore the future availability of spawning habitat cannot be assumed constant when considering potential loss of such habitat to other human activity.

Only some of these recommendations can be assessed on maps, and there is no one map that can summarize the best suite of adaptation options. Instead, climate change adaptation is best applied in the Scenarios phase of the conservation planning process, where various land use options are compared and contrasted for their abilities to satisfy various values. For example, a number of different conservation zones might be under consideration by the Commission, and each one should be assessed for its ability to satisfy the climate change recommendations.

SECTION V: NEXT STEPS

Two general goals of the Peel Watershed Planning Commission, as stated in it's General Terms of Reference (YLUPC 2004), are to develop a land use plan that: "recommends measures to minimize actual or potential land use conflicts throughout the planning region" (reference UFA 11.4.5.4)[2]; and "takes into account that the management of land, water and resources, including fish, wildlife, and their habitats, is to be integrated" (reference UFA 11.4.5.8). An important tool for reaching these difficult goals is land use zoning. This approach requires detailed information about resources of interest in order to locally manage potentially incompatible land uses and thus minimize and mitigate land use conflicts. This report provides such detailed information on various indicators of conservation value.

This report and the Resource Assessment Report (PWPC 2008a) provide the Commission and the interested parties with the background needed for making informed, intelligent land use decisions. Further, the information on natural, human and economic resources compiled in the Resource Assessment Report (PWPC 2008a) and information in this document will be integrated into maps of existing and potential land use conflicts. This process, described in detail in the Scenarios Methods Report (PWPC 2008b), will lead to the development of a small number of potential land use zoning configurations, or scenarios options. These scenarios will be presented to interested parties, stakeholders, and the general public. Input garnered from these consultations will help determine and shape an acceptable, rational, and intelligent land use plan.

2 These goals do not represent direct quotations of the UFA, but are derivations of the referenced clauses, as stated in the Commission's General Terms of Reference. See referenced clauses in the UFA for actual wording.

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