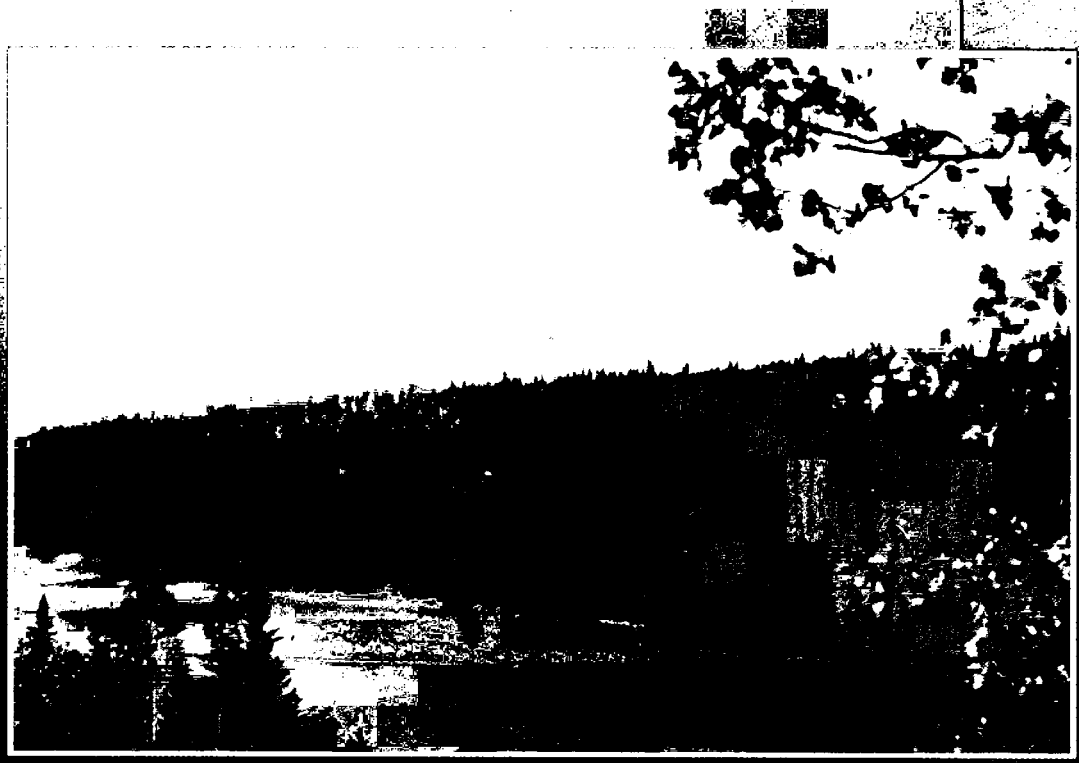
Environmental Overview of the Northern River Basins

3

Synthesis Report



Canada · Alberta · Northwest Territories

Northern River Basins Study

DATE DUE

MAR 15 1998	
BRODART	Cat. No 23-221

NORTHERN RIVER BASINS STUDY
SYNTHESIS REPORT NO. 8

ENVIRONMENTAL OVERVIEW OF THE NORTHERN RIVER BASINS

by

R. B. MacLock, B. Lyons and E. Ellehoj
Other Uses Component
Northern River Basins Study

edited by

Wm. D. Gummer and M.S.J. Ouellette
Ecological Research Division
Environment Canada

Published by the
Northern River Basins Study
Edmonton, Alberta
March, 1997

CANADIAN CATALOGUING IN PUBLICATION DATA

MacLock, R. Bruce

Environmental overview of the Northern River Basins

(Northern River Basins Study synthesis report,
ISSN 1205-1616; no. 8)
Includes bibliographical references.
ISBN 0-662-25576-3
Cat. no. R71-49/4-8E

1. Aqatic ecology -- Alberta, Northern.
2. Environmental monitoring -- Alberta, Northern.
3. Athabasca River Watershed (Alta.) -- Environmental aspects.
4. Peace River Watershed (B.C. and Alta.) -- Environmental aspects.
5. Slave River Watershed (Alta. And N.W.T.) -- Environmental aspects.
I. Lyons, B. (Bernadette)
II. Ellehoj, Erik Aksel, 1960-
III. Northern River Basins Study (Canada)
IV. Title.
V. Series.

QH541.5.W3M32 1997 577.6'4'0971231 C97-980106-0

If you would like:
- additional copies of this report, or
- other information regarding the Northern River Basins Study

please contact:

Alberta Environmental Protection
Information Centre
9920 - 108 Street
Edmonton, Alberta T5K 2M4

Telephone: (403) 422-2079 Fax: (403) 427-4407

Acknowledgments

This report is based on the contributions of many people. In particular considerable use has been made of several of the Study's synthesis reports. We are grateful to those individuals whose NRBS work we have cited extensively and from which we have "borrowed" thoughts and details. We acknowledge the review comments from the Study Board, Science Advisory Committee, and Mr. Ken Crutchfield, Associate Science Director.

Table of Contents

List of Tables

List of Figures

1. Introduction

The Northern River Basins Study was started with the signing of a federal-provincial-territorial agreement in Fort McMurray, Alberta on September 27, 1991. The Governments of Canada, Alberta and the Northwest Territories formed a partnership to examine how development in the headwaters of the Peace and Athabasca rivers affected downstream reaches of these two rivers and the Slave River.

Through a set of three objectives in the federal-provincial-territorial agreement, the study was directed to gather and assess information relating to water and ecosystem quality, fish and fish habitat, vegetation, wildlife, hydrology/hydraulics and human and in-stream uses of the aquatic resources of these three rivers. This information has been gathered and now forms an information base that in turn, has been used to assess the cumulative effects of industrial, municipal, agricultural and other development on these northern river basins.

Pouce de Coupé Source: NRBS

The study has also provided the basis for recommendations to governments, respecting future wise management of the three strategic transboundary river basins in northwestern Canada. Figure 1 shows the location of the study area. Although the northern river basins comprise watersheds that overlap into the provinces of British Columbia and Saskatchewan, the study's primary scientific focus is confined to the Peace and Athabasca rivers in northern Alberta and the Slave River in the Northwest Territories south of Great Slave Lake.

This document is based on several Northern River Basins Study technical contributions and the Study's synthesis reports. Together they provide an overview accounting through the use of maps and narrative of the people and environmental setting of the river basins. Included as well is a description of the legislative authorities of the senior levels of government (Canada, Provincial and Territorial) relevant to water resource management. This overview concludes with a short summary of the societal issues and concerns relating to economic development and basin management in these important transboundary rivers and will review some of the types of changes than have occurred in the basins since the start of the Study in September, 1991.

In giving the reader a broad environmental and socio-economic picture of the Athabasca, Peace and Slave river basins, this report provides a background against which to measure and understand the scope and contribution of the Northern River Basins Study's final and synthesis reports.

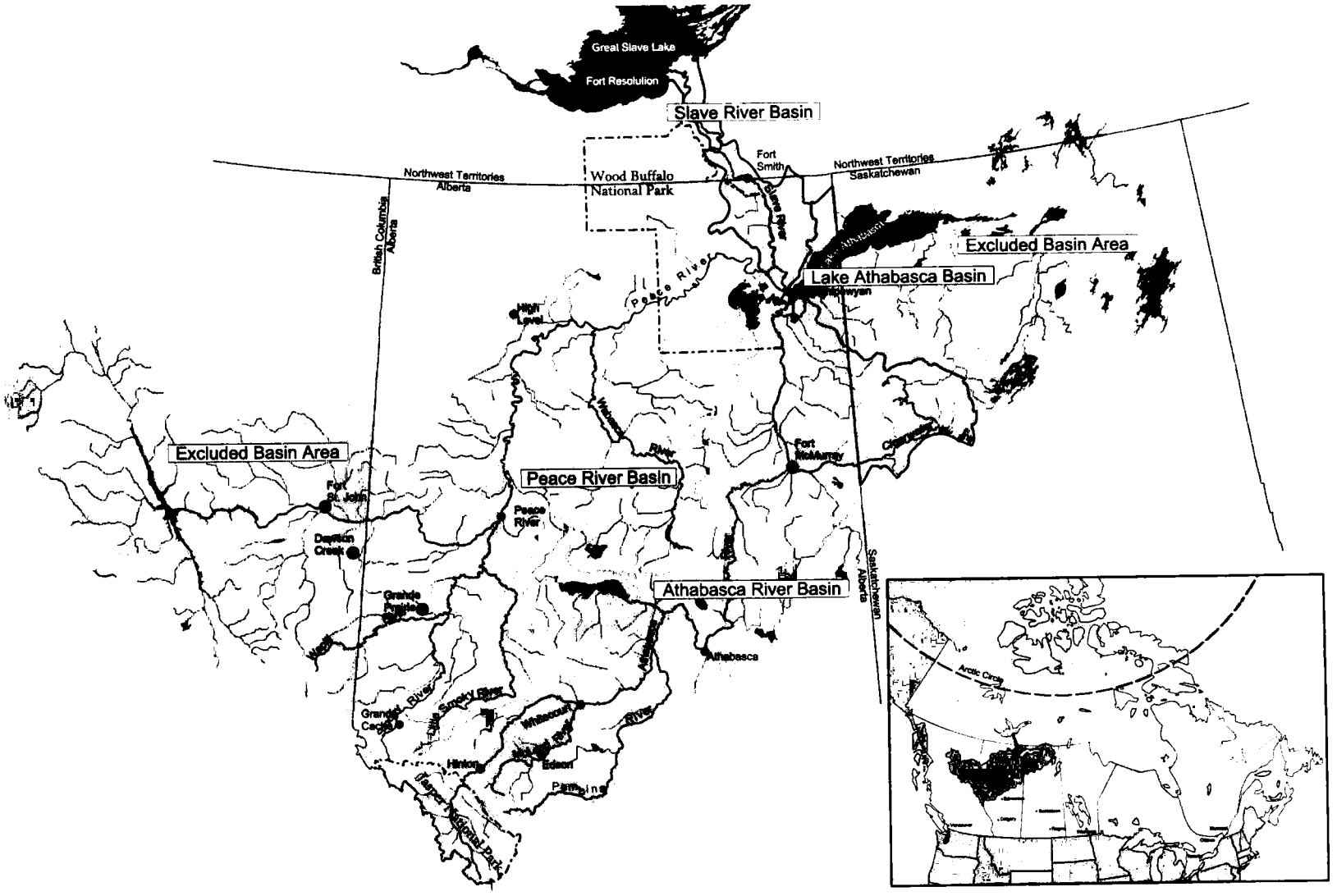


Figure 1. Map of the Northern River Basins.

2. Study Area

The study area lies between the 52° N and 61.5° N parallels of latitude and the 103° W and 128° W meridians of longitude. The area is lightly populated, with the 1991 populations of the area in both Alberta and Northwest Territories being reported as approximately 268,000 persons (see Section 3.0). It consists of four drainage basins: the Athabasca River Basin, the Peace River Basin, the Slave River Basin and the Lake Athabasca Basin; all four of which function as key parts of the upper catchment area of the Mackenzie Basin which drains into the Beaufort Sea.

The four basins are transboundary, with portions lying in British Columbia (B.C.), Alberta, Saskatchewan and the Northwest Territories (NWT) and two major national parks. Since British Columbia and Saskatchewan are not official participants in the study, much of the information in this report deals mainly with the Alberta and NWT portions of the basins. It is important to note that over 90% of the Lake Athabasca Basin is situated in Saskatchewan and with Saskatchewan not being a signatory to the Northern River Basins Study Agreement, this basin was not included in the Northern River Basin Study. The upper portion of the Peace drainage, representing approximately 42% of the basin, is located in British Columbia.

2.1 The Basins

The Peace, Athabasca and Slave river basins cover 580,000 km^2 in northern Alberta, British Columbia, Saskatchewan and the southern Northwest Territories.

Figure 1 illustrates the vastness of landscape the rivers drain, (the complex transboundary character) and finally, the integrating nature of their drainage pattern across this large area. The Athabasca River originates at the Columbia Ice Fields in Jasper National Park and flows northeast 1,231 km across Alberta until it terminates in Lake Athabasca. The Athabasca River Basin covers 157,000 km^2 which accounts for approximately 22% of the province of Alberta. Although the Athabasca River mainstream lies within the province of Alberta and Jasper National Park, one of its primary tributaries, the Clearwater River, originates in Saskatchewan, thus extending the basin boundaries into that province. Approximately 152,756 persons lived in the basin in 1991.

The Peace River finds its source at the confluence of the Parsnip and Finlay rivers in northern British Columbia. It flows into Williston Lake and over the Bennett Dam, entering Alberta west of the town of Peace River from where it travels north and then east until its confluence with the Slave River. The overall length of the Peace River is 1,650 km. The Peace drains much of northeastern BC and northern Alberta and, together with the tributary Smoky/Wapiti system, conveys the largest volume of water of any river in Alberta, with a mean annual flow almost four times that of the Athabasca River. The Peace River Basin is the largest and westernmost of the Northern River Basins Study basins, with a total area of 300,000 km^2, of which 173,000 km^2 are in Alberta. This basin represents about 29% of the land area of Alberta. The population of the Peace drainage in Alberta was 116,000 in 1991.

The strategically important Slave River originates in the world-renowned Peace-Athabasca Delta, at the confluence of the Peace River and the Rivière des Rochers. From there it flows north across the Alberta-NWT border some 434 km before emptying into Great Slave Lake. The Rivière des Rochers is the main outlet channel of Lake Athabasca. The lake is fed by the Athabasca and Fond du Lac Rivers which enter the lake from the southeast and east, respectively. Although the Slave River Basin covers an area of only 15,096 km^2, it draws its flow from a huge catchment area of about 600,000 km^2, which includes the Athabasca River, the Peace River, and the Lake Athabasca drainage basins along with the Fond du Lac and Birch River basins. The area of the Lake Athabasca drainage basin is approximately 114,000 km^2 of which 6,449 km^2 lies within the province of Alberta. The respective populations of the Alberta portions of the Slave River and Lake Athabasca drainage basin in Alberta are 800 and 785 and approximately 500 in NWT.

From a simple flow or discharge perspective, the magnitude of the importance of these rivers to Alberta and the Northwest Territories is best illustrated by Figure 2. In a simple examination of, for example, Alberta's geopolitical stake in the northern rivers, one needs only to note the small flows moving east though dry, populous and developed southern Alberta compared to the enormous discharges of the relatively unpopulated Peace, Athabasca and Slave basin systems.

Given southern Alberta's historical development pattern involving an early dependency on irrigated agriculture, it should come as no surprise to the

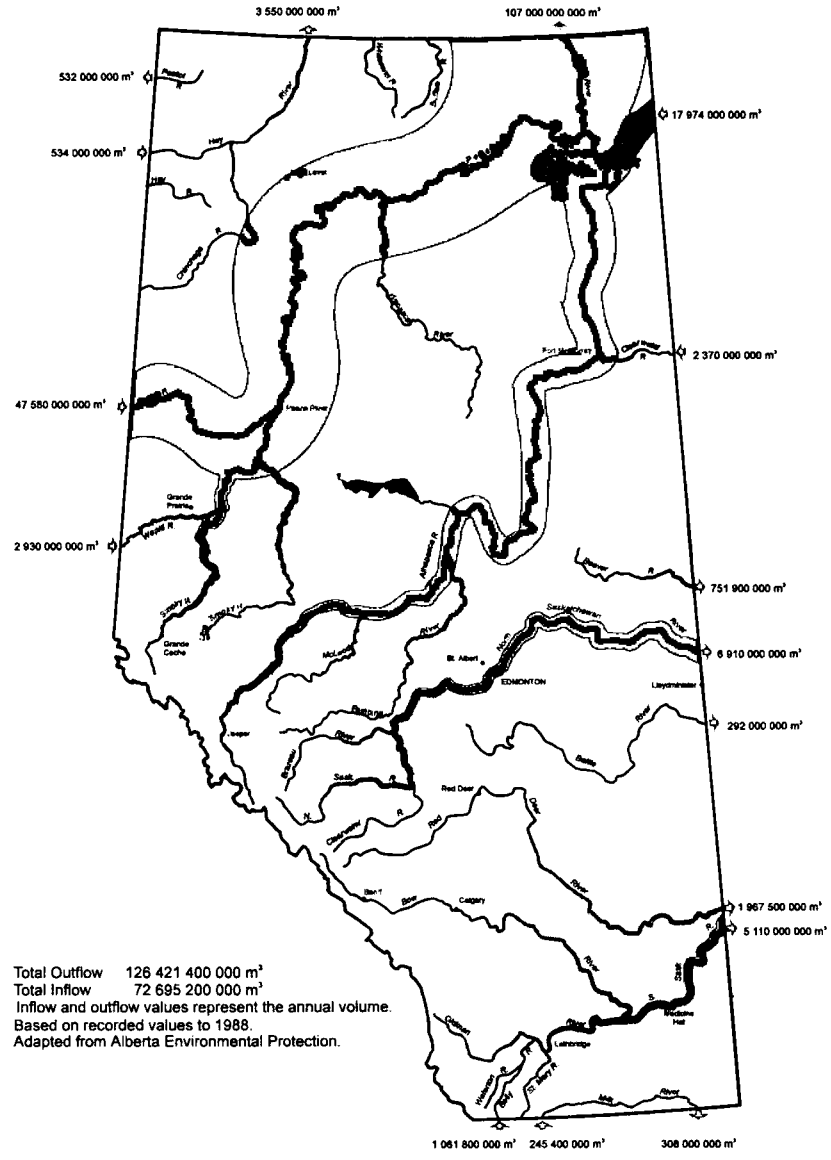


Figure 2. Water Volumes in Major Alberta Rivers.

casual reader that the large volumes of clean, northward flowing rivers hold a considerable attraction for southern, as well as northern residents.

2.1.1 Athabasca River

The Athabasca River headwaters are formed by the melting snow and glaciers of the Columbia Ice Field on the continental divide. Finely ground particles of rock (or "rock flour") formed by glacial action lend a silty grey colour to the water. The water at this point is hard and alkaline with a low organic content (Noton and Saffran 1995).

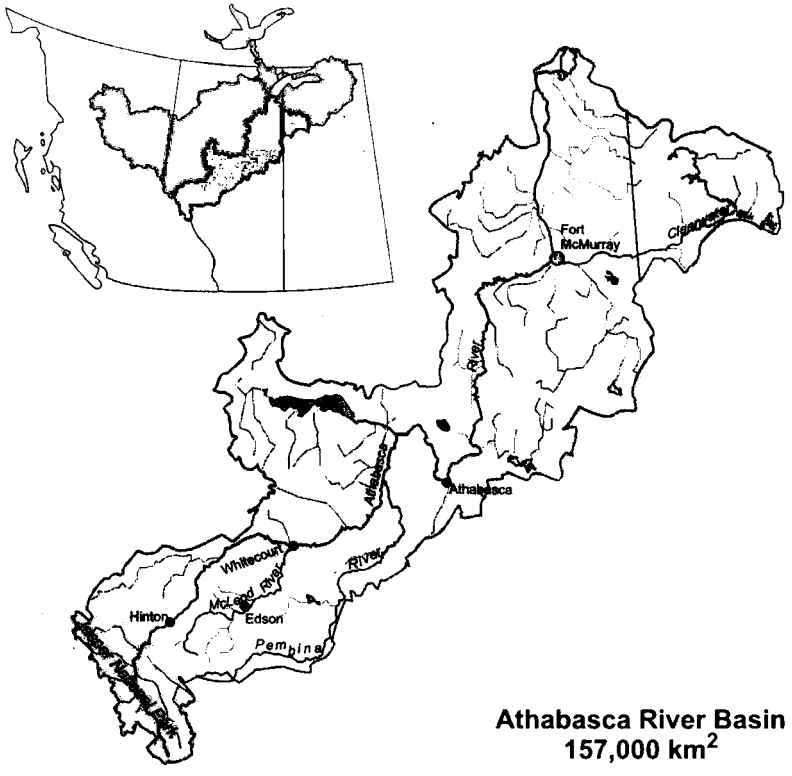
Athabasca Glacier Source: Environment Canada

The river travels north, cutting a path through the scenic mountains and forests of Jasper National Park. The landscape that surrounds the river valley is a mixture of open forests and grasslands. White spruce grows near to the waters edge. Further back, forests of Douglas-fir, limber and lodgepole pine, and aspen provide habitat for elk, mule deer and many species of birds.

As the river leaves the park, the rugged topography softens into rolling foothills. Coal underlies much of these foothills, covering a broad diagonal swath across the province that parallels the Rocky Mountains. Some of western Canada's largest active open-pit coal mines are found in this region.

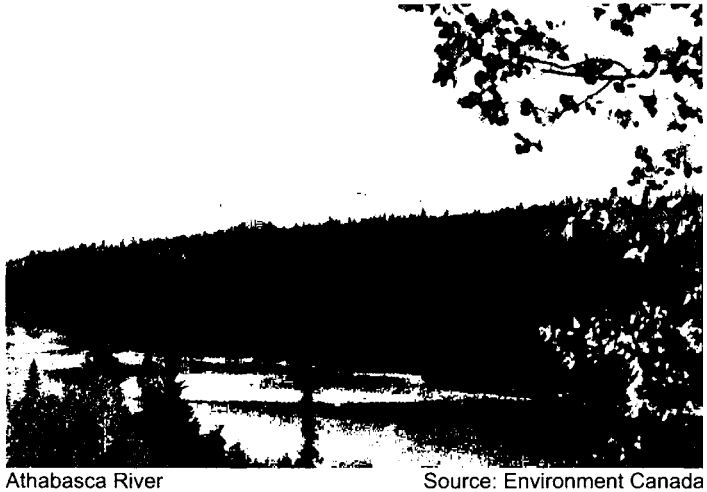
Further on, the Athabasca River passes the Weldwood pulp mill at Hinton, the oldest of the five mills in the Athabasca River basin. The mill relies completely on the region's softwoods: white and black spruce, lodgepole pine and alpine fir.

The river continues north and swings eastward towards the town of Whitecourt, where it encounters the Alberta Newsprint Company and Millar Western pulp mills. At Whitecourt, the river is joined by the McLeod River that drains areas with open pit coal mines and limestone quarries to the



south. The McLeod contributes 6.7% of the final volume of the Athabasca. Oil and natural gas deposits are found to the north of the river, near Fox Creek and Swan Hills. In fact, one of the largest producing gas fields in the country is located in the Fox Creek area.

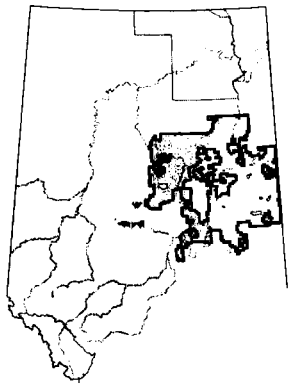
Leaving Whitecourt, the Athabasca River swings north again and is joined by the Pembina River (contributing 4.6 % of the final volume) that drains through prime agricultural lands to the south. By now the waters of the Athabasca are brown from the soil and other materials that it has picked up along its course. As the physical environment changes, so too do the numbers and kinds of organisms in the river. These changes continue along the length of the river, corresponding to specific habitat and nutrient requirements of different fish and aquatic organisms.


Athabasca River Source: Environment Canada

The Athabasca is joined by the Lesser Slave River (6.4%), which drains the agricultural and forested areas surrounding Lesser Slave Lake. Another pulp mill, Slave Lake Pulp, is located along the banks of the Lesser Slave River. Beyond Lesser Slave River, the Athabasca dips southward toward the town of Athabasca. Prior to 1904, the town of Athabasca was known as Athabasca Landing and was a site of great importance in northern development. Goods were moved from Edmonton to Athabasca Landing, where they could be barged to northern outposts. The Athabasca Landing Trail, created in the 1870s, was a portage that linked the North Saskatchewan River to the Mackenzie River system, allowing access to the fur trade. With the decline of the fur trade, agriculture, forestry and natural gas rose as the dominant regional industries. Barge traffic along the river declined after the railway was extended to Fort McMurray in the early 1900s.

Turning northeast once again, the Athabasca River passes by a newer feature to the land, the pulp mill owned by Alberta-Pacific (ALPAC) Forest Industries Inc. The river runs through the middle of the ALPAC Forest Management Agreement (FMA) area that defines the potential timber supply for the mill. Covering an area of roughly 61,000 km^2, ALPAC's FMA is much larger than that of other pulp mills in the province. The pulp mill was constructed to make use of both the hardwood (e.g., aspen and balsam poplar) and softwood (e.g., white spruce, black spruce and jack pine) resources within the FMA area.

Continuing north through the FMA, the Athabasca is joined by La Biche River (6.7%) that drains the agricultural regions surrounding Lac La Biche. Commercial fishing, oil, lumbering and natural gas also contribute to the local economy of the Lac La Biche area.



ALPAC FMA

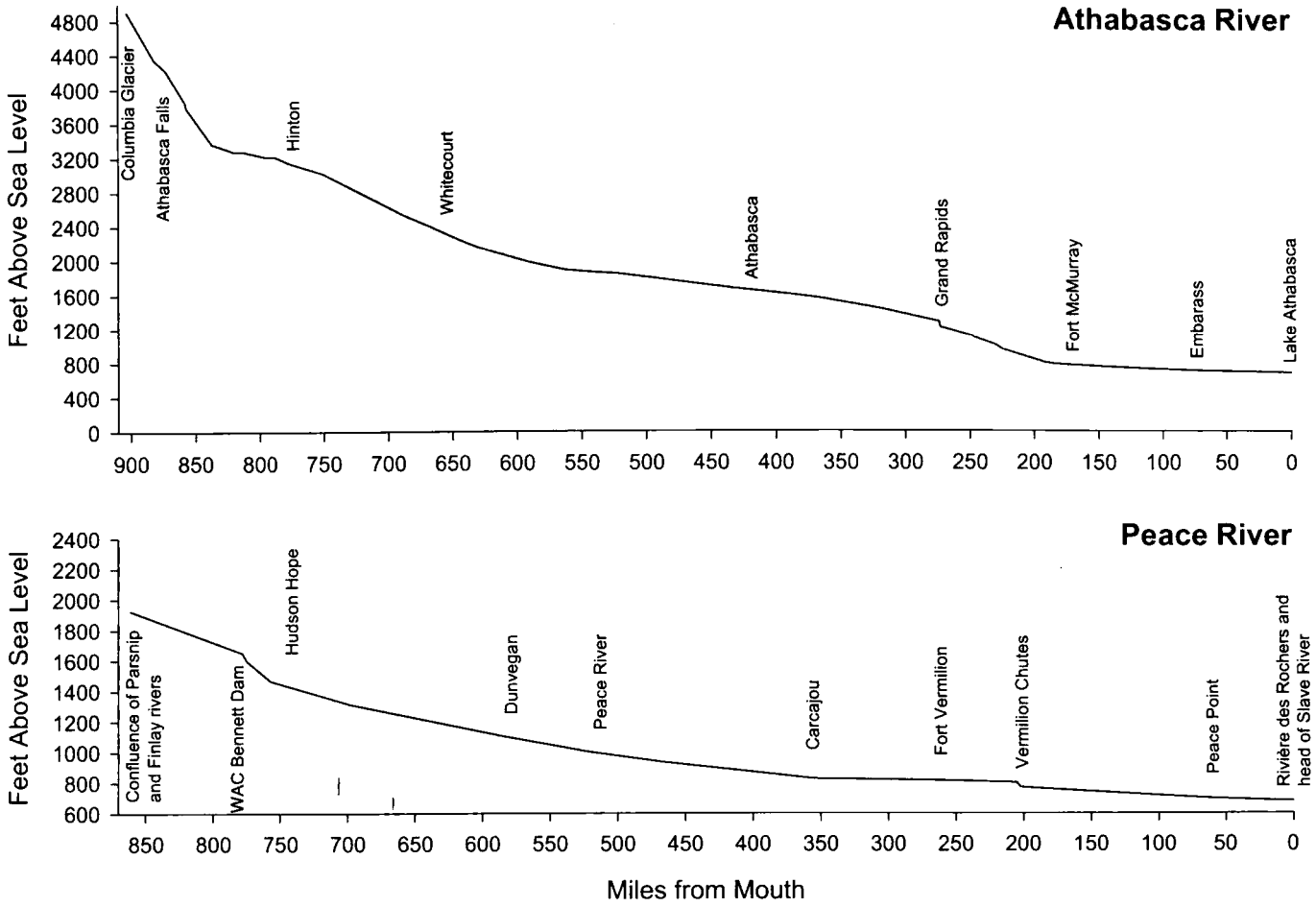
The Athabasca River continues northward through the boreal mixed wood forest and evolves into a series of major rapids. The influence of these rapids on the rest of the Athabasca River is quite significant. Not only do they pose an obstacle to river travel, they also serve as a major spawning area for fish, such as lake whitefish and walleye. The turbulence of the water replenishes levels of dissolved oxygen needed for fish and other aquatic organisms. This aeration takes on an added significance during the winter months, when ice cover blocks contact with the air over most of the river and dissolved oxygen levels dwindle.

Beyond the rapids, the Athabasca River encounters the city of Fort McMurray. Historically, Fort McMurray was another outpost of the fur trade and a major site for the transport of goods north along the Athabasca River. Here, the river cuts through shallow oil sands deposits and its waters are tinged with natural hydrocarbons. Bitumen (the raw hydrocarbon of the oil sands) is visible as an asphalt-like substance along the banks of the river. Indians once used bitumen to patch their canoes. Today, the Athabasca oil sands provide a non-conventional source of oil that is currently mined by two companies (Suncor and Syncrude) located just north of the city of Fort McMurray.

At Fort McMurray, the Athabasca River is joined by the Clearwater River that flows across the border from Saskatchewan. The Clearwater is the largest tributary of the Athabasca, contributing 18.5% of the final volume of the Athabasca. The Clearwater River's major tributary, the Christina River, drains an area with extensive oil and gas development. The Athabasca continues north past Fort McKay and Bitumont, where the abandoned facilities of Alberta's first pilot oil sands operation can be found. The river then becomes the eastern border of Wood Buffalo National Park, where the terrain becomes wetter and dominated by black spruce and boggy areas. The main portion of the Athabasca and its tributary (the Embarras River) continue on to Lake Athabasca.

Lake Athabasca marks the end of the Athabasca River's 1,231 km trek from the Rocky Mountains, having fallen 1,254 metres, at an average slope of 0.86 m/km (Figure 3). With an area of 7,936 km^2, it is the fourth largest lake entirely in Canada. The lake is shared by Alberta and Saskatchewan, and is a valuable local resource for fishing. It is surrounded by areas that are naturally rich in uranium.

Commercial Fishing, Lake Athabasca Source: NRBS



Data from: Hydraulic and Geomorphic Characteristics of Rivers in Alberta. R. Kellerhalls, C.R. Neill and D.I. Bray, 1972. Research Council of Alberta. River Engineering and Surface Hydrology Report 72-1.

Figure 3. Elevation Profiles of the Athabasca and Peace Rivers.

Over its course, the Athabasca has increased it's concentrations of organic carbon, iron manganese, sodium, chloride and silica, becoming darker in the process. Through dilution, concentrations of calcium, magnesium and sulphate have decreased (Noton and Saffran 1995).

The Athabasca River is not regulated by dams or weirs, and as such varies greatly with the season. Water management in the basin includes the reservoirs and regulated lakes shown in Figure 4. High flows are in May, June and July, with low flows from January to March. Mean annual flow of

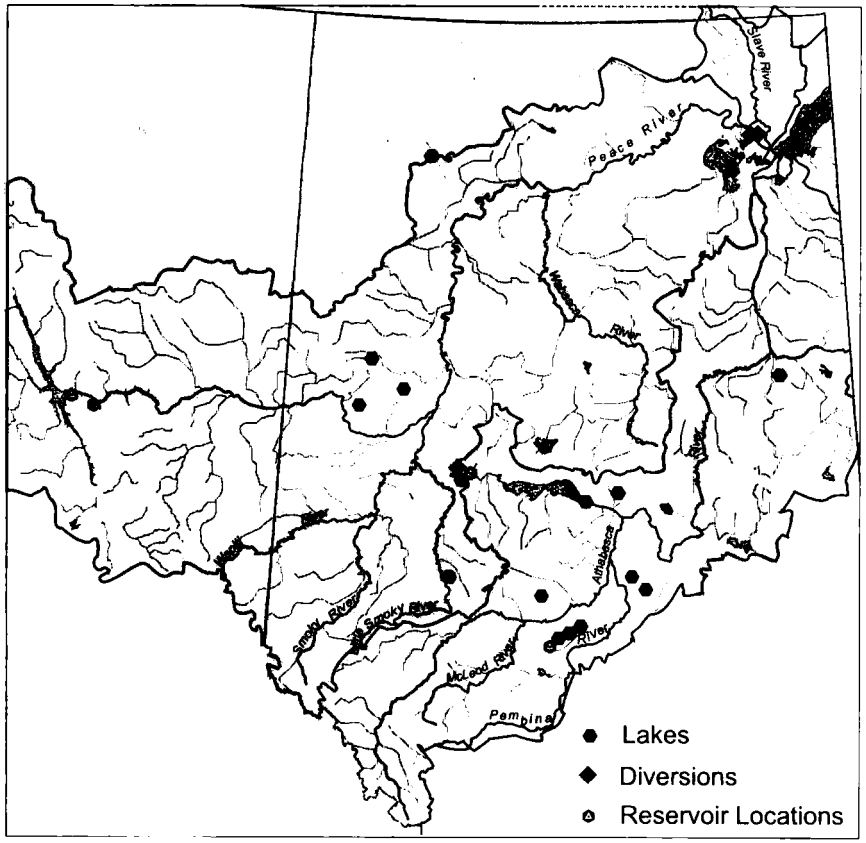


Figure 4. Flow Regulation in the Northern River Basins.

the river is 800 cubic metres per second (m^3/s), with a minimum and maximum flow of 400 and 2,800 m^3/s respectively (DPA Group Inc. et al. 1987). The low flows in winter, typically only 21% of the mean flow, are an important water quality concern. Such small volumes of water limit the capacity of the river to dilute both natural and man-made inputs.

Freeze-up generally occurs in mid-November on most sections of the river. Ice-cover remains until mid to late March as Jasper and mid to late April at the Town of Athabasca and Fort McMurray (Hamilton et al. 1985). There are open water leads at some locations due to the influence of industrial and municipal effluents.

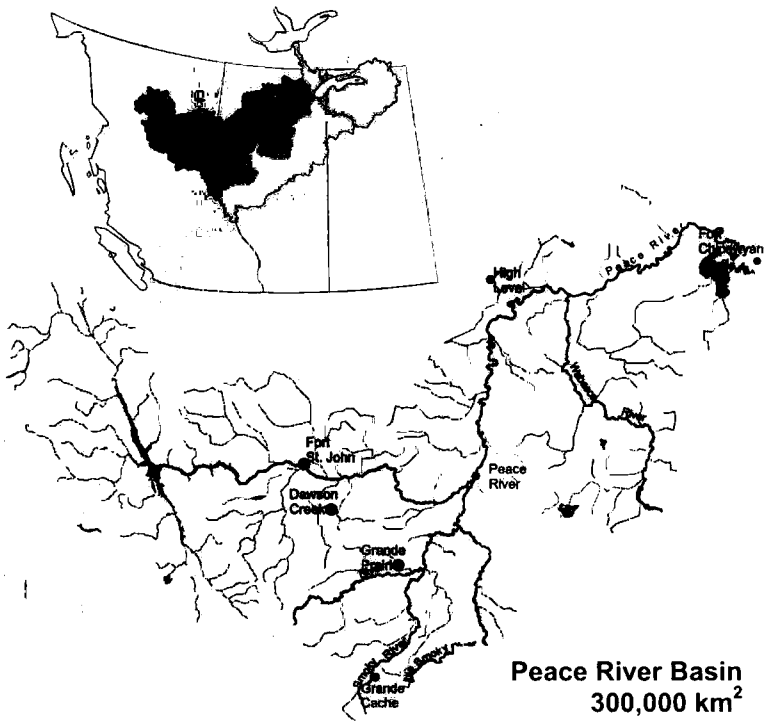
Sunset over Manawitche Source: Alberta Fish and Wildlife

2.1.2 Peace River

The Peace River has its origin in hundreds of cold mountain streams in the Rocky Mountains of British Columbia. Each spring, water from melting snow and ice trickles down from the mountains and eventually drains into Williston Lake, the largest man-made lake in British Columbia.

Less than 30 years ago, the northern and southern ends of the reservoir would have appeared as the Finlay and Parsnip rivers. The rivers have since been backflooded by the creation of the W.A.C. Bennett Dam near the town of Hudson's Hope, British Columbia. Williston Lake feeds the dam's hydroelectric generators, and the Peace River now flows from the reservoir's eastern arm.

The Bennett dam, built by B.C. Hydro, is among the largest earthfilled structures in the world (The Canadian Encyclopaedia 1988). The completion of the dam in 1968 and the subsequent flooding of several river valleys formed Williston reservoir, the largest fresh water body in B.C., with a surface area of approximately 1,660 km^2. The creation of Williston Reservoir destroyed winter wildlife habitat, cut off important fish migration corridors and forced the relocation of First Nation villages (Province of British Columbia 1993).



Peace River Basin
300,000 km^2

The Williston Reservoir filling period from 1968 to 1971 marked some of the lowest recorded water levels on the Peace River in Alberta. The mean annual flows on the Peace River have changed little due to regulation. Mean annual flows from recorded or computed natural flow data on the Peace River at Hudson Hope and Peace Point for the period from 1960 to 1992 are 1,110 m^3/s and 1,910 m^3/s respectively, compared with the regulated period from 1972 to 1990 were the mean annual flows were 1,150 m^3/s and 1,920 m^3/s. Yet since the dam came into full operation in 1972, river flow has been redistributed throughout the year with lower monthly mean flows during the summer and high monthly mean flows during the winter. Maximum and minimum mean monthly flows at Hudson Hope have changed from 3,900 m^3/s, occurring in June, and 246 m3/s, occurring in March, under natural conditions; to 1,440 m3/s, occurring in December, and 875 m^3/s, occurring in June, under regulated conditions. The effects of regulation are felt less strongly further downstream from the dam, where for example at Peace Point the maximum and minimum mean monthly flows were 6,560 m^3/s, occurring in June, and 455 m^3/s, occurring in March, under natural conditions; and were 3 660 m^3/s, occurring in June, and 1,460 m^3/s, occurring in March, during the 1972 to 1990 post-regulation period. Flow regulation, immediately downstream of the dam, has also substantially reduced maximum daily flood peaks and increased minimum daily flows (Shaw et al. 1990).

The ice regime of the Peace River has also been affected by regulation. An ice-free reach extends on average 178 km downstream from the dam, but the length varies with temperature and discharge. The increased flows during the winter months have delayed freeze-up and expedited ice off on all sections of the river downstream from the dam. For example, freeze-up at the Town of Peace River has been postponed from early November to late December and break up now occurs about two weeks earlier in mid rather than late April. The effects are not as

pronounced downstream. In Fort Vermilion, freeze-up has been delayed from early to mid November, but the time of break-up has changed little (Shaw et al. 1990).

These changes in water levels and temperature can alter many aspects of the ecosystem, such as the quantity of habitat, the movements of fish and animals, and the period for which the river remains frozen.

The Gordon M. Shrum Generating Station produces the electrical power harnessed by the Bennett Dam. It was the world's largest underground powerhouse when it was built and now produces 6.3% of B.C., energy needs (Province of British Columbia 1993). Water management projects in the northern river basins are shown in Figure 4.

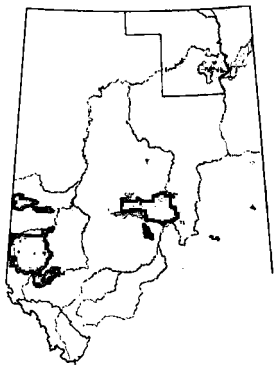
The reservoir is used by local pulp and paper mills as a corridor for transporting logs and as an outlet for their waste waters. There are three mills located in the general area of Williston Lake. The Fletcher Challenge and Finlay Forest Industries mills are located in the town of Mackenzie. The Louisiana-Pacific mill, which is located further east in the town of Chetwynd, does not rely on local surface water supplies and has little or no impact on water quality. The two mills in Mackenzie, however, are licensed to discharge waste effluent into the reservoir and, ultimately, these wastes flow into the Peace River.

The flow of water past the Bennett Dam marks the beginning of the Peace River. The river flows eastward, carving a deep chasm in the undulating landscape and passes through the Peace Canyon Dam. It is joined by the Halfway River to the north and passes near Fort St. John, the oldest white settlement on mainland British Columbia and a former outpost of the fur trade. Further east, the Peace is joined by the Pine River near the town of Taylor, where it encounters the Fibreco pulp mill.

The river then crosses the border into Alberta's northern agricultural region, an area that stretches south to the city of Grande Prairie and north along the river to the town of Fort Vermilion. Much of the soil in this area once lay at the bottom of ancient glacial-meltwater lakes. Today, the gently rolling plains surrounding the river are a patchwork of fields and forests. Canola, alfalfa, clover and oats are a few of the region's main crops. Aspen and balsam poplar dominate the forests, often interspersed with white spruce and jack pine.

W.A.C. Bennett Dam Source: NRBS

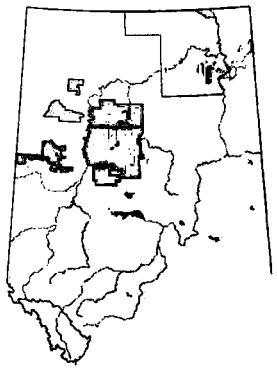
The river passes south of the town of Fairview, traversing a high, walled canyon-like reach that was studied during the mid-1980s as a possible site for the Dunvegan Dam and Reservoir. The Peace is later joined by the Smoky River from the south. Together with its tributaries, the Smoky River drains roughly 20 per cent of the Peace River basin and extends as far south as Jasper National Park. As with any tributary, the Smoky brings with it the history of its journey, written in the nutrient and chemical contents of its waters. The areas that the river drains are developed extensively for forestry, agriculture, coal, oil and gas. The river also receives effluent from the Weyerhaeuser Canada pulp mill through one of its major tributaries the Wapiti River. Just past its picturesque confluence with the Smoky River, the Peace flows past the town of Peace River. Here the river cuts deep into the surrounding grasslands to form a green valley surrounded by high, steep bluffs.



Weyerhaeuser FMA.

The Daishowa-Marubeni pulp mill is located roughly 25 km north of the town. A little further north, the Cadotte River joins with the Peace River. The Cadotte River is not a major tributary to the Peace, but it drains an area that is underlain by a relatively large oil sands deposit. Commercial-scale operations are currently underway to extract and refine this non-conventional source of oil. The extraction process involves injecting pressurized steam into the deposit to melt the tar and places demands on local surface water supplies. The mixture of tar and water is then pumped out of the ground and refined.

The agricultural corridor surrounding the Peace River continues as the river travels north past the Métis Settlement of Paddle Prairie. Further on the river veers east, passing near various native settlements representing Dene Tha', Cree and Beaver nations. Agricultural development along the Peace River slowly phases out east of Fort Vermilion, a town that is over 200 years old and a former outpost of the fur trade.



Daishowa-Marubeni FMA.

Outside the town of Fort Vermilion, the Peace is joined by one of its major tributaries, the Wabasca River. Each year, cobble and other materials are washed down the Wabasca, forming fan-shaped deposits of material at the river's mouth. Historically, spring floods on the Peace River have stripped away these deposits and washed them towards the Peace-Athabasca Delta. Many speculate that the Bennett Dam has reduced the Peace River's ability to "scour" away these deposits, resulting in a growing deposit of material.

East of the Wabasca, the Peace River passes through the Vermilion Chutes rapids. During certain times of the year, these rapids have drops of three to five meters posing a major obstacle for river travel and fish movements. The Caribou Mountains lie to the north, an area of peat, lichen, black spruce and permafrost.

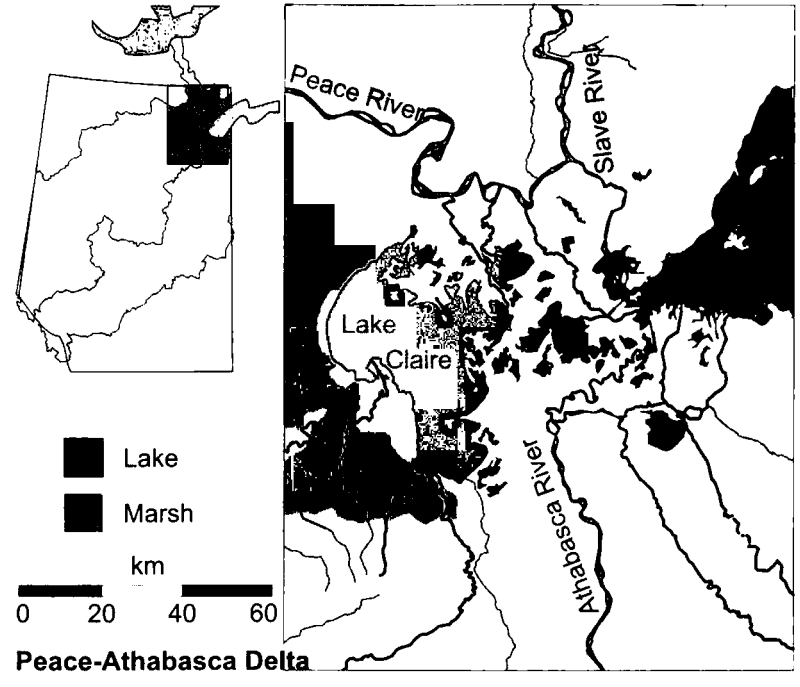
Further to the east, the Peace passes the Jean D'Or Prairie and Fox Lake Indian reserves before entering Wood Buffalo National Park. The park is noted for one of the world's largest free-roaming herds of bison and is recognized as a world heritage site. Finally, the Peace River finishes its 1,650 km trek as it joins with outflow from the Peace-Athabasca Delta to form the Slave River. The river has dropped 370 m at an average slope of 0.16m/km (Figure 3).

Bison, Wood Buffalo National Park Source: L.N. Carbyn

At its origin in B.C., the Peace River has a high dissolved oxygen content; relatively large amounts of algae attached to rocks (determined by measuring chlorophyll a); low concentrations of nutrients, metals, organic matter, bacteria and salts; and is relatively clear (Shaw et al. 1990). As the river flows northeast its suspended solid concentration increases dramatically due to the erodible nature of its channel material. The high suspended solids content is the major water quality concern of the Peace River because metals, such as mercury, are often associated with suspended clays. Due to the river's large size, input from tributaries and municipal and industrial effluents have only a small effect on water quality.

2.1.3 Peace Athabasca Delta

The Peace-Athabasca Delta is an unique environmental feature. Athabasca is Cree for "where there are reeds", describing the delta's marshes and grasslands. The flat terrain is a patchwork of marshes, lakes, mud flats, sedge meadows, willow and shrub thickets and forests of white spruce and balsam poplar, interwoven by numerous winding channels. With its variety of landforms and lush vegetation, the delta has the capacity to support a diverse mixture of animal species. In 1985, the Canadian Wildlife Service (Canadian Wildlife Service 1985) counted 220 species of birds, mammals and fish that inhabit the delta during some part of their lifecycle. Well over half of these species are birds. Twice each year, millions of birds follow



Peace-Athabasca Delta

established routes (or "flyways") on their north or south migrations. All of the four major flyways in North America converge on the Peace-Athabasca Delta. Many birds use the delta as a pit stop to "fuel up" for the rest of their long trek, while others stay on to nest. Among these are tundra swans, snow, white-fronted and Canada geese, Ross' goose and a variety of ducks. In 1982 the delta was recognized by the Convention on the Conservation of Wetlands of International Importance.

The characteristics of the delta that contributed to the Ramsar designation have been significantly altered. The complex water flows in the Peace-Athabasca Delta are fundamental to its environmental characteristics. Since the landscape of the delta is relatively flat, many of its waterways can flow in two directions. The direction of the flow depends upon the relative water levels in different parts of the delta. When the water level in Lake Athabasca is higher than Claire and Mamawi lakes, water flows westward into the delta. When Lake Athabasca is low, water flows east out of the delta lakes and into Lake Athabasca.


Marsh, Peace-Athabasca Delta Source: NRBS

The reversing concept holds true for the channels that drain the delta: Chenal des Quatre Fourches, Revillon Coupé and Rivière des Rochers. Usually, these three channels flow north to meet with the Peace River and then continue north as the Slave River. However, when the flooding of the Peace River rises higher than the water level of Lake Athabasca, water flows south into Lake Athabasca and the delta.

The effects of flow regulation on the Peace River are felt strongly in the Peace-Athabasca Delta. The lower flows have reduced both the magnitude and frequency of natural flooding events on the delta, causing many of its perched lakes to dry out and begin going through succession.

The backflooding of the three channels by the Peace plays an important role in maintaining the delta wetlands. Many of the small lakes of the delta exist as "perched basins" that are only replenished through the periodic, spring ice jam flooding by the Peace River (Prowse and Conly 1996). However, since the construction of the Bennett Dam, these floods have been rare and less extensive. As a result, many of the marshy areas of the delta are transforming into terrestrial landforms dominated by willows and sedges.

The transformation is of concern to both ecologists and local residents. Residents of Fort Chipewyan, located on the shores of Lake Athabasca, rely on the delta for fishing, hunting and recreation. Fort Chipewyan is one of the oldest communities in Alberta. During the peak of the fur trade, Fort Chipewyan was an important outpost for the Hudson's Bay Company and the delta was renowned for the quantity and quality of its muskrat pelts. However, many of the marshes are now too shallow for muskrats to overwinter. Falling water levels have also decreased habitat for waterfowl and fish.

During the 1970s, a considerable amount of effort went into stabilizing the water levels of the delta through the construction of control weirs along the three channels (Choles et al 1996). Weirs were installed on the Rivière des Rochers and Revillon Coupé in hopes of restoring water levels to their pre-dam conditions The weirs were intended to reduce the outward flow of water while still allowing the Peace River floods to wash into the delta. The weirs proved effective in retaining water, but they could not mimic the natural fluctuations in water levels that are integral to the unique environmental characteristics of the delta. The Quatre Fourches dam was later removed because it kept waters artificially high year-round. Further remediation efforts are currently being considered under the Peace-Athabasca Delta Ecosystem Management Study.

Peace-Athabasca Delta Source: NRBS

2.1.4 Slave River and Delta

The Slave River drains north, still serving as the eastern border of Wood Buffalo National Park. As it travels towards the Northwest Territories, the river passes by the town of Fitzgerald. Fitzgerald is the last stop before a major series of rapids that culminate in the Rapids of the Drowned just north of the town of Fort Smith. The rapids impede travel and form a natural barrier to the upstream movement of fish, such as arctic lamprey and inconnu. The scenic beauty of the area attracts a growing number of tourists each year and the rapids have become a popular site for white water kayaking and rafting.

Slave River Basin
15,096 km2

The town of Fort Smith marks the crossover of the Slave River into the Northwest Territories. The volume of water flowing across this border is enormous, with an annual flow estimated at 107 billion m^3. Regulation in the Slave Basin includes two fixed rock-filled weirs; on the Revillion Coupé and Rivière des Rochers. The weirs were put in place in 1975 and 1976, to help control outflow from the Peace-Athabasca Delta. The Slave River itself is not regulated, however, regulation of the Peace River has affected the flow regime of the Slave (Prowse and Conly 1996). Due to the high volume of water, the rapids along this stretch of river possess enormous hydroelectric potential and a large-scale hydroelectric development was proposed for the area. Alberta Environment conducted the Slave River Hydro Feasibility Study during the early 1980s to investigate the economic benefit and environmental impacts of the proposed dam. The monetary and environmental costs were deemed too high for the power demand, and the project was put on hold indefinitely (Alberta Environment 1987). The proposed dam would have been a rock filled structure with a 12 unit powerhouse and reservoir, constructed near the Fort Smith rapids.

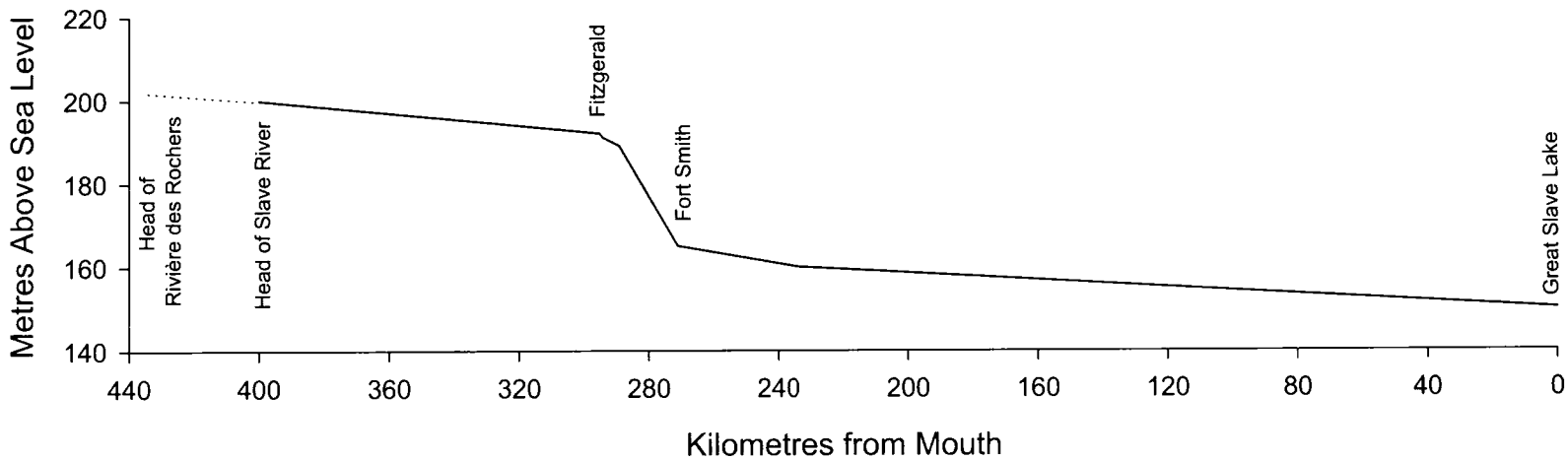
At the end of its 434 km course, having dropped 50 m over

its length, the river flows into Great Slave Lake through the Slave Delta (Figure 5). Covering an area of 640 km^2, the Slave Delta is considerably smaller than its more southerly counterpart, but is still valuable habitat for fish and waterfowl. In 1985, the Canadian Wildlife Service reported that 212 species of birds, mammals and fish frequented or live in the Slave Delta (Canadian Wildlife Service 1985).

Originating at the confluence of the Peace and Athabasca rivers and Lake Athabasca, water quality in the Slave River is a reflection of the water quality of these basins. At its source, the river is relatively turbid (mainly due to suspended silt) and alkaline, and the principle ions are calcium and bicarbonate (Alberta Environment 1987). As the river flows north, the water quality changes little due to input of tributaries. An exception is the Salt River, which drains an area of Karst formations, whose waters increase the concentrations of sodium and chlorine in the Slave River.

The Peace River has the largest influence on the flow regime of the Slave, contributing over 60% of the Slave's total flow. Since the completion of the Bennett Dam the hydrograph of the Slave River has smoothed. Peak floods on the Slave occur in June and July as a result of the spring melt on the Peace. The maximum and minimum mean monthly flows at Fitzgerald for the period from 1972 to 1993 are 5,230 m^3/s, occurring in June, and 2,130 m^3/s in March. The mean annual flow of the Slave River at Fitzgerald over the same period is 3,390 m^3/s.

Freeze-up usually occurs in mid-November. The timing of ice off varies with location; the river is usually free of ice at Fort Smith by mid-May and Fort Resolution by early June. Open water remains year round at the Slave Rapids and at Grand Detour. Ice jams are a major factor in all major



From: Hicks, F.E., and K. McKay. 1996. Hydraulic Flood Routing Model of the Peace and Slave Rivers, Hudson Hope to Peace Point. Northern River Basins Study Project Report No. 77.

Figure 5. River Elevation Profile, Slave River.

flooding events on the Slave River (Prowse and Conly 1996).

Fort Resolution on the southern shore of Great Slave Lake marks the northernmost limit of the northern river basins. From there, the waters become part of the Mackenzie River system that eventually drains into the Beaufort Sea.

2.2 References

Alberta Environment. 1987. Slave River Basin Overview. Prepared for Alberta/Northwest Territories Technical Committee on the Transboundary Water management Agreement. 94 pp.

The Canadian Encyclopedia, Second Edition. 1988. Hurtig Publishers, Edmonton.

Canadian Wildlife Service. 1985. Northern Deltas: Oases for Wildlife. [pamphlet].

Choles,J., W. Aitken and A. DeBoer. 1996. An overview of streamflows and lake levels for the Peace, Athabasca and Slave river basins. Northern River Basins Study Technical Report No. 146. Northern River Basins Study, Edmonton, Alberta. 49 pp. + app.

DPA Group Inc. in association with W-E-R Engineering Ltd. and Environmental Management Associates Ltd. 1987. Water in Northern Alberta: Technical Report December, 1987. Prepared for the Northern Alberta Development Council, Peace River, Alberta. 124 pp.

Hamilton, H.R., M.V. Thompson, L. Corkum., Nanuk Engineering & Development Ltd. 1985. Water Quality Overview of the Athabasca River Basin. Prepared for Alberta Environment. 117 pp.

Noton, L. and K. Saffran. 1995. Water Quality in the Athabasca River System 1990-1993. Surface Water Assessment Branch Technical Services and Monitoring Division Alberta Environmental Protection.

Prowse, T.D., and M. Conly. 1996. Impacts of flow regulation on the aquatic ecosystem of the Peace and Slave Rivers. Northern River Basins Study Synthesis Report No. 1. Nothern River Basins Study, Edmonton, Alberta. 168 pp.

Province of British Columbia. Ministry of the Environment, Lands and Parks and Environment Canada. 1993. State of the Environment Report for British Columbia. 127 pp.

Shaw, R.D., L.R. Noton, A.M. Anderson and G.W. Guenther. 1990. Water Quality of the Peace River in Alberta. Prepared for Alberta Environment.

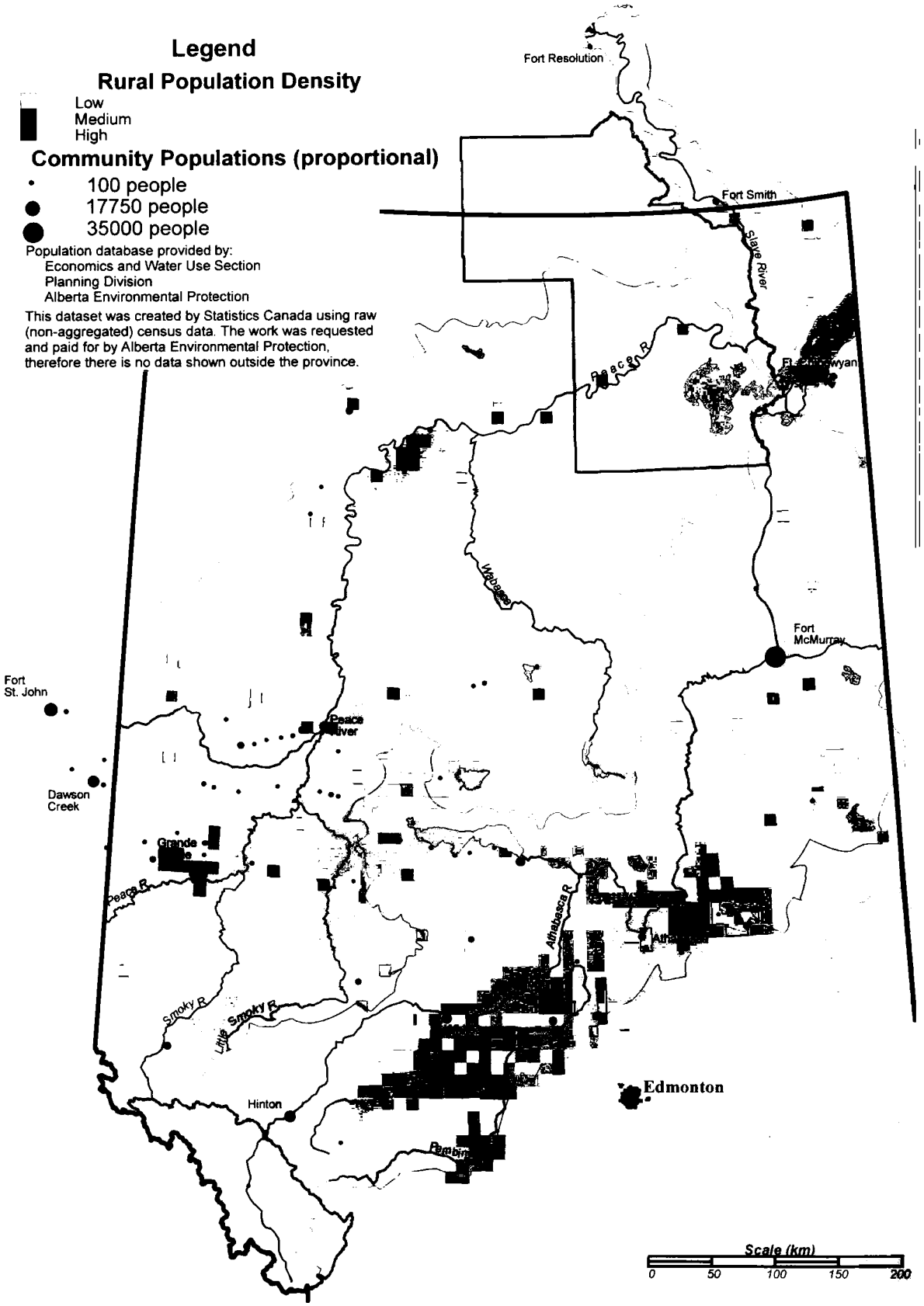


Figure 7. Population Distribution in the Northern River Basins.

3. The People

The philosophy that people are an integral part of the environment has unique significance for basin residents. Many still hold to traditional lifestyles that rely on a natural environment. The rivers provide a direct source of drinking water for many inhabitants, and habitat for fish and other game species. The rivers are also a means of transportation and the basis for culture. For indigenous peoples, the basins hold an added significance. The intimate connection between these peoples and the land spans generations and provides a source of strength and spirituality. Due to their lifelong experience with the rivers, native elders and other traditional residents embrace a wealth of knowledge regarding the natural cycles of the ecosystem and the changes in the land.

In contrast to their size and richness, the northern river basins are sparsely populated. According to 1991 census figures, approximately 266,000 people reside in the Alberta portion of the basins and 3,000 in the Northwest Territories. Of these, ten per cent are aboriginal peoples (Figure 6) representing Cree, Chipewyan, Dene Tha', Beaver and Métis. Fifty-six per cent of study area residents reside in urban areas (Figure 7). There are four cities within the basins - Fort McMurray and Grande Prairie in Alberta, and Dawson Creek and Fort St. John in British Columbia. Just over 23 per cent of the population resides in one of the two cities in the Study area. About 44 per cent live in rural areas (Figure 7).

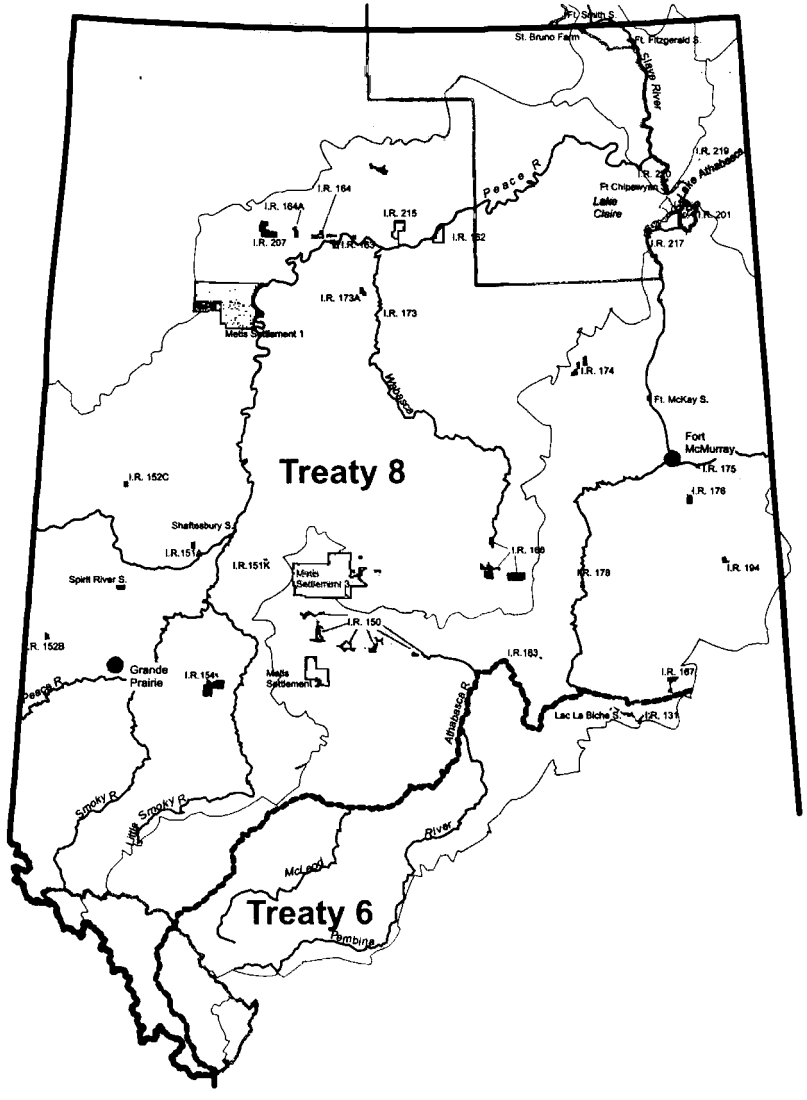


Figure 6. Indian Reservations and Métis Settlements in the Northern River Basins.

The majority of the Study area population (57 per cent) resides in the Athabasca drainage, while only 42 per cent live in the larger Peace River basin. Only one per cent live in the Peace-Athabasca Delta and Slave River basin. The rate of population growth is lower in the NRBS area than in the rest of Alberta, and residents tend to be younger and more mobile. Many more residents than provincial average work in the primary industries of agriculture, energy and forestry. There is less ethnic diversity within the Study area than province-wide and a much higher proportion of aboriginal peoples whose first language is Cree (MackLock and Thompson 1996).

Over the last several decades, the rate of development in the basins has accelerated with the growing marketability of the basins' rich resources and the introduction of technologies to harvest these resources. Paralleling this was a growing unease among basin residents that these changes may be damaging the natural ecosystem. To many, "development" had become a word that implies the deterioration of their cultural and natural lifestyles. Inseparable from these sentiments was the realization that prudent management strategies are required to enable the sustained use of the basins' resources for all stakeholders. The groundswell of public concerns regarding northern development would eventually give rise to the Northern River Basins Study. Issues surrounding the forest industry played an important role in the genesis of the Study.

The upswing in the forestry sector was paralleled by a similar rise in environmental awareness across the country. Forestry-related concerns focussed on the effects of land clearing and the potential impacts of pulp mill effluent on the aquatic ecosystem.

3.1 References

MacLock, B. and J.P. Thompson. 1996. Characteization of aquatic uses within the Peace, Athabasca and Slave rivers. Northern River Basins Study Synthesis Report No. 7. Northern River Basins Study, Edmonton, Alberta. 80 pp.

4. Physiographic Features

The major physiographic regions and the patterns of relief in all three basins are illustrated in Figure 8. Viewed from the southwest corner of the map, from the vantage point of the Continental Divide, the landscape in both the Peace and Athabasca basins slopes down in a northeasterly direction along a line from Jasper to Fort Chipewyan. Then, from the vicinity of Fort Chipewyan, the small Slave Basin slopes "down north" towards Great Slave Lake. In terms of physiographic regions, both the Peace and Athabasca Basins extend from the Rocky Mountain Cordillera and associated foothills in the west onto the Interior Plains east of the foothills. Elevations in the western half of the two basins range from 2,125 to 2,450 metres (10,000 and 11,000 feet) above mean sea level to some of the lowest interior elevations in western Canada at less than 300 metres. As a result of these strong topographic influences, the Peace and Athabasca rivers and tributaries drain 'expeditiously' to the northeast towards a confluence with the Lake Athabasca system. The Slave River itself, being combined flows of the above three tributary basins, acts as a key dividing line between the flat interior plains to the west of the Slave River in Wood Buffalo National Park and the almost uninhabited bare rocks, muskeg and lakes of the Canadian Shield to the east.

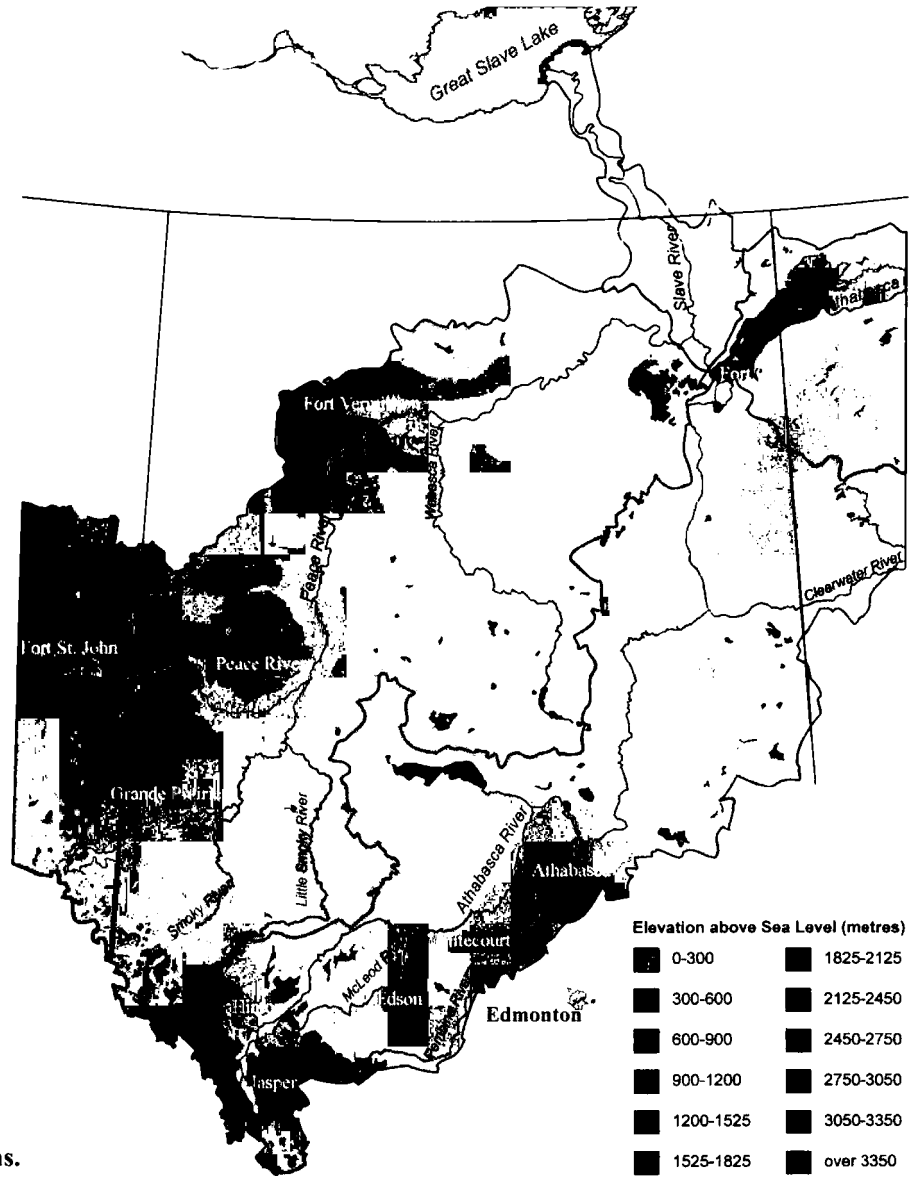


Figure 8. Relief of the Peace-Athabasca-Slave River Basins.

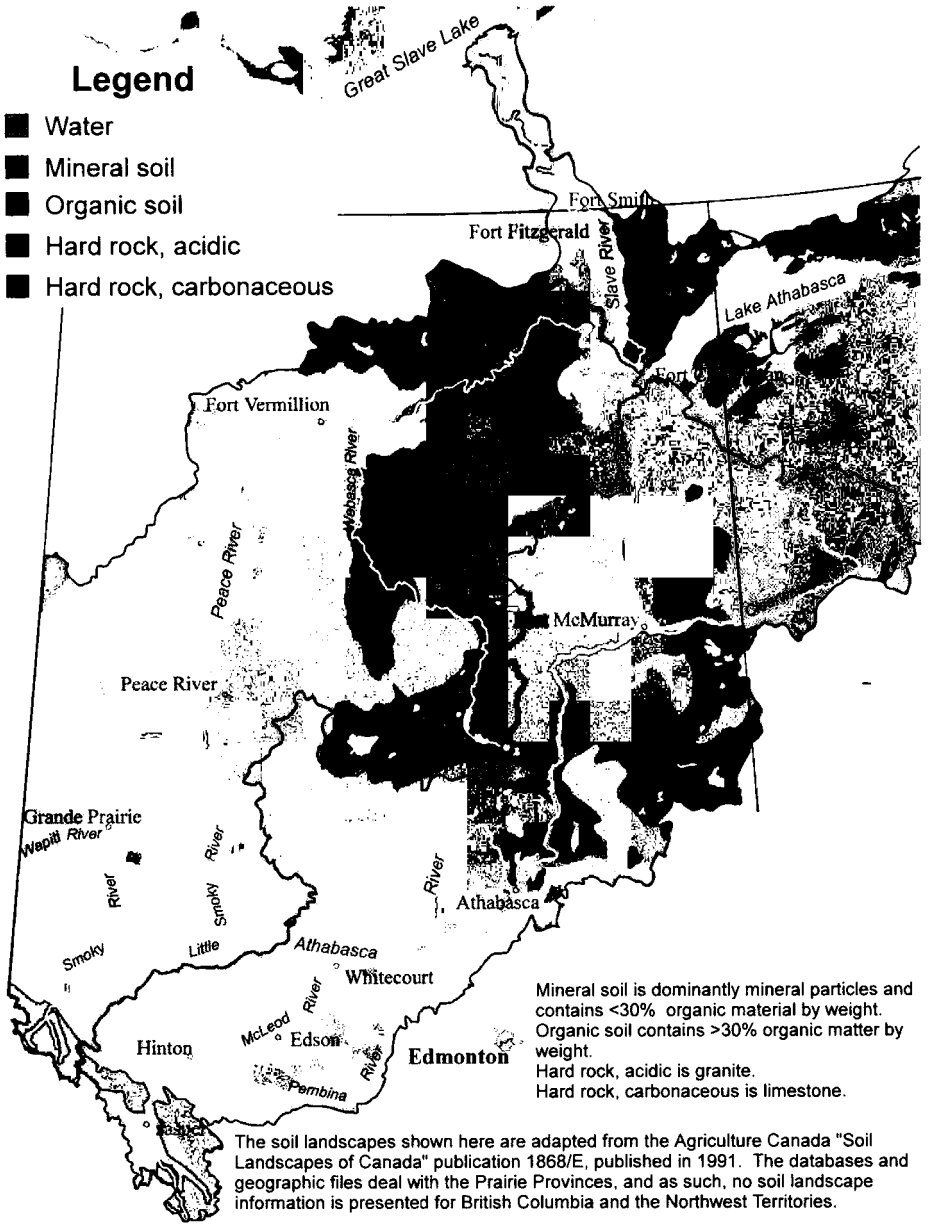


Figure 9. Dominant Surficial Materials in the Northern River Basins.

4.1 Geologic Regions

4.1.1 Athabasca River Basin

There are three major physiographic regions in the Athabasca River Basin. The westernmost is the Cordillera, which includes the mountains and foothills where the river finds its headwaters. Crystalline and steeply folding sedimentary rocks of lower Mesozoic and upper Palaeozoic periods form the bedrock in this region.

The largest portion of the basin lies on the Interior Plains. The Interior Plains are characterized by flat lying sedimentary deposits, and surficial material deposited by glaciers which covered the area during the Pleistocene period (Figure 9). In this region the sedimentary bedrock formations become increasingly older as you move north-east through the basin. In the south-west corner of the basin the bedrock is a mixture of upper Cretaceous and Tertiary sandstone and shale. Dark grey upper Cretaceous marine shale forms the majority of the bedrock in the region between the Athabasca and Fort McMurray. Downstream from Fort McMurray, lower Cretaceous sandstones dominate, except for along the Clearwater River where the bedrock is formed by upper and middle Devonian limestone shales. The only instance of marked topographic relief on the plains is the Swan Hills.

The Canadian Shield is located to the far north-east of the basin near the confluence of the Athabasca with the Slave River. This region is

underlain by the oldest bedrock formations in the basin which consist of Precambrian sedimentary, igneous and metamorphic rocks.

Hydrocarbon deposits in the basin are shown in Figure 10. They include upper Cretaceous and Tertiary coal deposits in the foothills; upper Cretaceous coal of marine origin in the Interior Plains between Whitecourt and the Town of Athabasca; the largest oil sand deposit in Canada, the Athabasca deposit, in the Fort McMurray area; and oil and gas fields scattered throughout the Interior Plains. (Hamilton et al. 1985)

4.1.2 Peace River Basin

There are two major physiographic regions in the Peace River Basin; the Cordillera and the Interior Plains. The majority of the Peace River basin in British Columbia lies within the Cordillera as do the headwaters for most of its B.C. and Alberta tributaries. Bedrock in the western Cordillera is primarily steeply folding sedimentary, volcanic and crystalline rocks of the Tertiary, upper Cretaceous and Jurassic periods.

The Interior Plains covers most of the Peace River Basin in Alberta and the remaining portion of the basin in B.C. The bedrock is primarily sedimentary and Devonian or Cretaceous in age. Unconsolidated material in the area is of glacial, aeolian and more recently deltaic origin. The glacial deposits are primarily made up of silt and clay ground moraine (Figure 9). The fine grained nature of the deposits makes them susceptible to erosion. The topography of the plains has been modified by the Pleistocene glaciation and in general dips gently to the north-east. Exceptions to this are the Clear Hills in the west, Buffalo Head Hills and

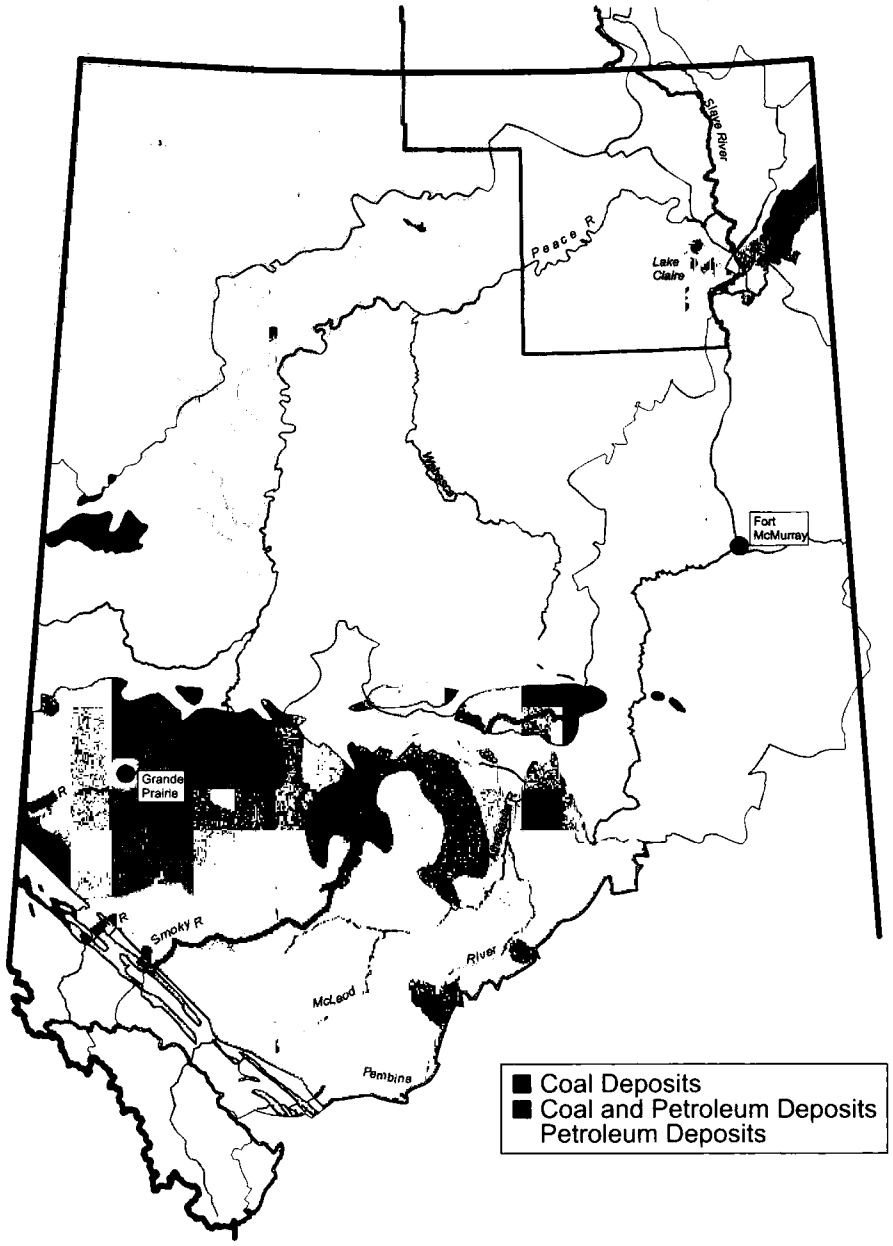


Figure 10. Hydrocarbon Deposits in the Northern River Basins.

Birch Mountains in the east and the Caribou Mountains in the northern-most portion of the basin.

Hydrocarbon deposits in this area include coal seams located in the upper Cretaceous Wapiti Formation south of Grande Prairie; oil and gas fields found throughout the region in lower Cretaceous and Devonian formations; and the Peace River oil sands, which are the largest petroleum deposit in the region (Figure 10). (Shaw et al. 1990 p. 15-16)

4.1.3 Slave River and Lake Athabasca Basins

There are two physiographic regions in the Slave River Basin. The river acts as the dividing line between the Interior Plains to the west and the Canadian Shield to the east. Most of the bedrock in the basin is overlain by unconsolidated sediment such as glacial drift deposits, post glacial alluvial and aeolian deposits and recent organic deposits.

Bedrock on the Interior Plains is composed primarily of Devonian and Cretaceous sedimentary rocks along with more recently formed metamorphic rocks. In the south-west portion of the plains, including the Salt River catchment area, resistant Devonian carbonate rocks overly easily weatherable gypsum deposits. Here water dissolves the gypsum resulting in karst topography. As the river flows north toward the NWT it travels through the "Slave River Lowlands, an area of deep lacrustrine deposits with little bedrock control on channel location" (Alberta Environment 1987). Generally the interior plains show little relief.

The Canadian Shield portion of the basin exhibits the rolling terrain typical of the shield. The bedrock is predominantly Precambrian granites, gneisses and metasedimentary rocks (Alberta Environment 1987).

The Lake Athabasca Basin is located entirely on the Canadian Shield. The bedrock is made up of Precambrian sedimentary and metasedimentary deposits and intrusive granites and granidiorites (Matthews 1985). The topography is smooth and undulating, strewn with countless lakes, as is characteristic of the Canadian Shield.

4.2 Soils and Vegetation

Vegetation is largely a consequence of the combination of soil type (Figure 9) and local climate (see Section 5). Historically, the entire Northern River Basins Study area was covered by a mixed boreal forest. The generally dominant species across the whole region were white spruce, trembling aspen and balsam poplar, frequently found in closed, pure stands, but more often in mixed settings. Recent classification efforts have identified thirteen distinct ecoregions in the Northern River Basins Study area. They have been mapped by Environment Canada (Ecological Stratification Working Group 1995) and are shown in Figure 11. The largest group of ecoregions are the mid-Boreal Uplands, Western Alberta Uplands and Boreal Transition where the largest, continuous spruce and aspen forests are found, mixed with small stands of black spruce in wet, boggy locations. One area greatly changed by human activity is the Peace Lowlands which has historically been cleared for agriculture. Other well

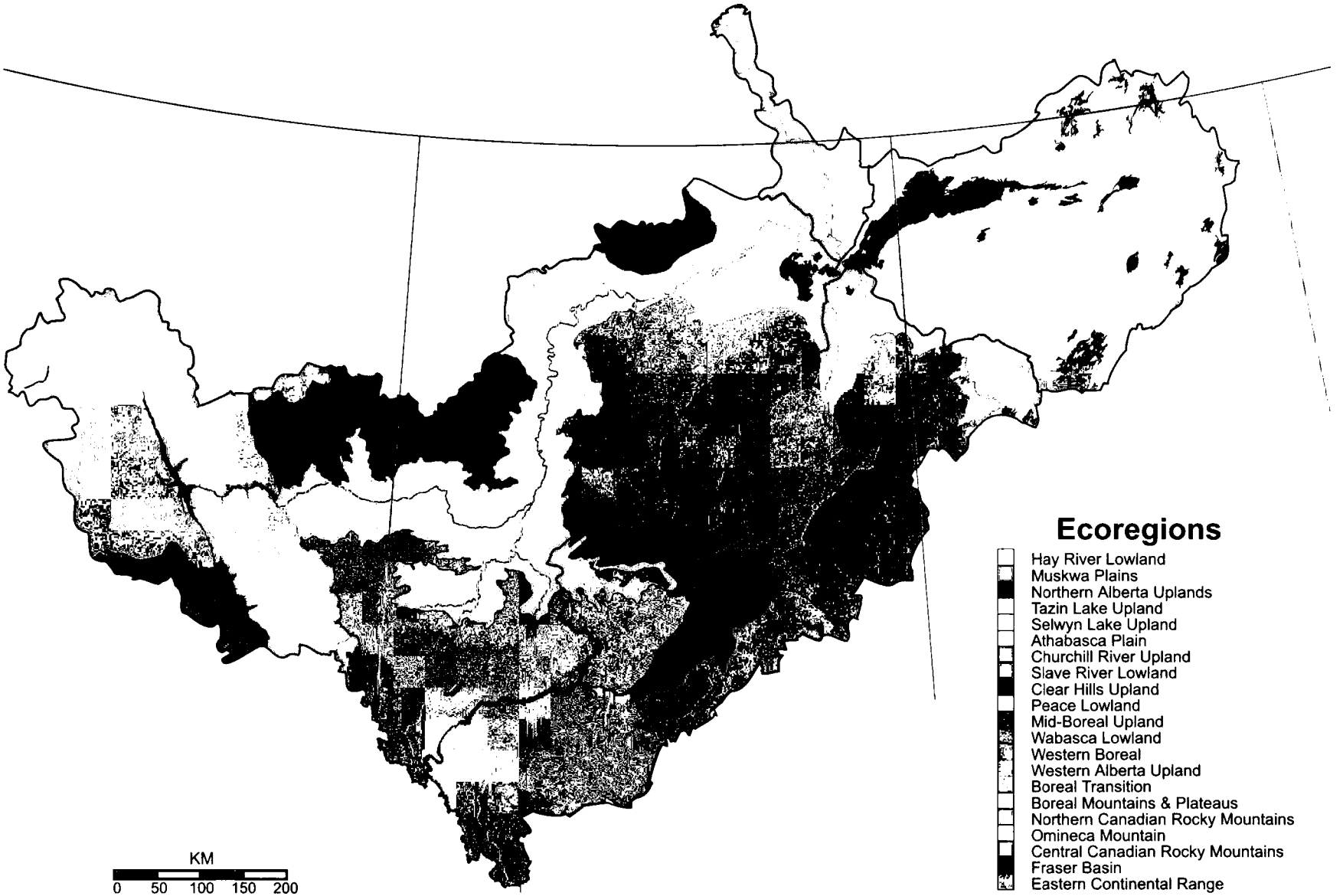


Figure 11. Ecoregions in the Northern River Basins.

forested regions are the Wabasca Lowlands, Slave River Lowlands, Hay River Lowlands and Athabasca Plains. These regions, along with the Boreal group of ecoregions, form part of the broad belt of mixed boreal forest extending from northwestern Ontario to the foothills of the Rocky Mountains.

4.3 Geographical Factors

Figures 1 illustrated the vastness of the landscape covered by these rivers but also that rivers do not recognize man-made boundaries. Because of their location in the northerly latitudes, these basins experience a true northern winter followed by a spring break-up that starts in the south first and progresses slowly "down" north. Many large historically well-remembered ice jams have occurred.

It is now clear that waste compounds from industrial and municipal wastewater discharges into the headwaters of the Athabasca or Peace Rivers can easily migrate from one regulatory jurisdiction to another in a matter of days (Mill et al. 1997). Further, some of these compounds can alter habitat and bioaccumulate in the aquatic foodchain, irrespective of distance. It is also now clear that fish migrations among some species cover very long distances with few man-made obstructions in their way. Further, urban and industrial developments are concentrated in the upstream, southern reaches of these major systems and are nearly absent in the northern, downstream reaches where most of the First Nation peoples live. Finally, some reaches of these systems are better protected from industrial effluent discharges, such as Jasper and Wood Buffalo National Parks.

4.4 References

Alberta Environment. 1987. Slave River Basin Overview. Prepared for Alberta/Northwest Territories Technical Committee on the Transboundary Water management Agreement. 94 pp.

Ecological Stratification Working Group. 1995. A National Ecological Framework for Canada. Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research and Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch, Ottawa/Hull.

Hamilton, H.R., M.V. Thompson, L. Corkum., Nanuk Engineering & Development Ltd. 1985. Water Quality Overview of the Athabasca River Basin. Prepared for Alberta Environment. 117 pp.

Matthews, G.J. and R. Morrow Jr. 1985. Canada and the World Atlas of Resources. Prentice-Hall Canada Inc.

Mill, T., P. Sparrow-Clark and R.S. Brown. 1997. Fish distribution, movement, growth and external pathology information for the Peace, Athabasca and Slave river basins. Northern River Basins Study Project Report No. 147. Northern River Basins Study. Edmonton, Alberta.

Shaw, R.D., L.R. Noton, A.M. Anderson and G.W. Guenther. 1990. Water Quality of the Peace River in Alberta. Prepared for Alberta Environment. 247 pp.

5. Climate and Weather

The Northern River Basins region in North America is located in an area of complex air mass circulation (Hudson 1996). Figure 12, taken from *The Climates of Canada* (Phillips 1990), show the directions and movement of the summer and winter air masses that affect the region. From these figures, one can conclude that the Northern River Basins Study area is located in an area of complex air mass circulation. Note that in the summer, the Northern River Basins Study area is along one of the primary Canadian storm tracks.

As one would expect when considering an area of over 500,000 km^2 such as the Northern River Basins Study area, temperature and precipitation vary widely between the mountain climate of Jasper National Park near the 52° N latitude to the sub-Arctic climate of Fort Resolution north of the 60th parallel. Temperature and precipitation also vary with elevation, though these variations cannot always be seen when considering a large area. In general, higher elevations receive greater amounts of precipitation and have slightly warmer winter temperatures and slightly cooler summer temperatures than low-lying areas (Hudson 1996).

The bulk of the study area can be classified as having warm, continental, temperate summers and cold to extreme cold continental temperate winters.

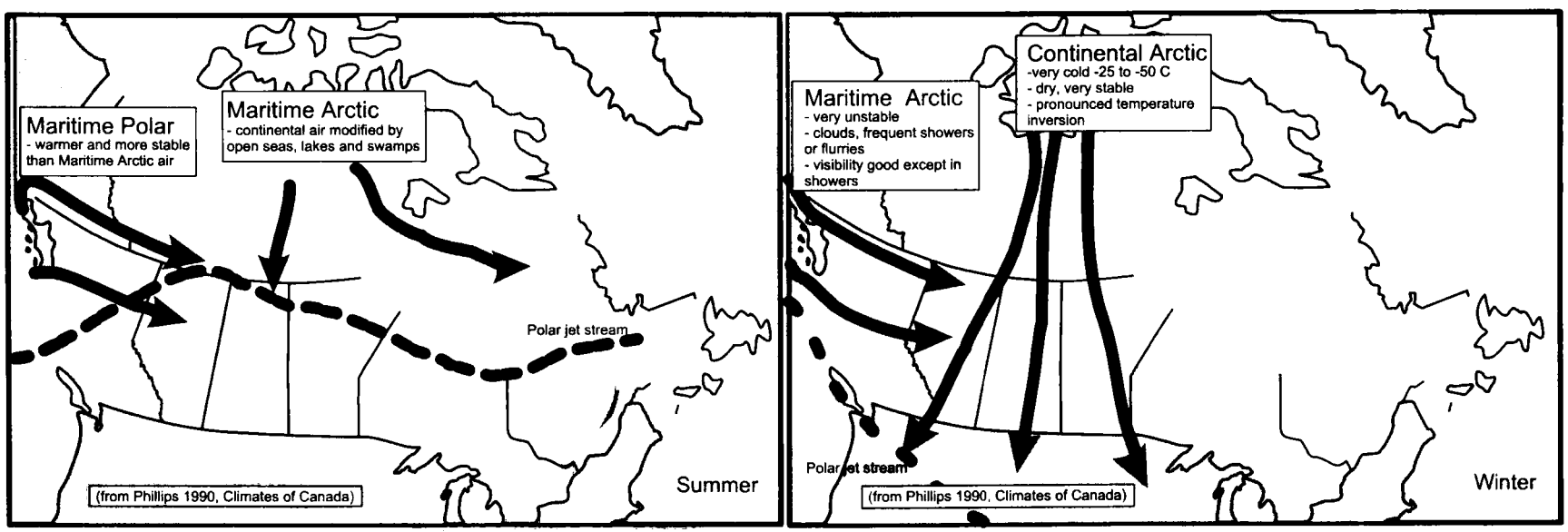
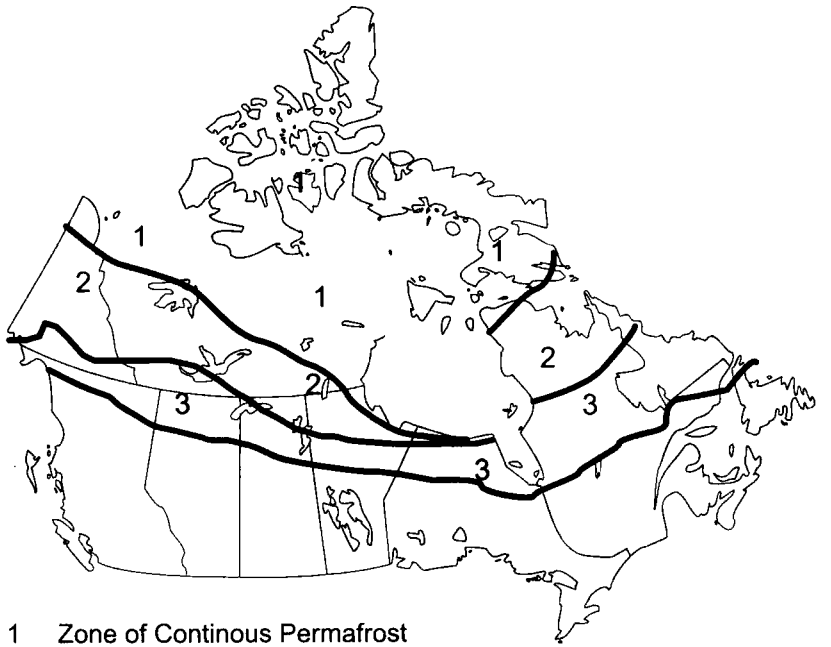


Figure 12. Typical Air Masses over Canada in the Summer and Winter.

For some parts on the Northern River Basins Study area, mean monthly temperatures during the winter months are affected by warm dry winds known as Chinooks. These winds are caused by westerly air masses with above freezing temperatures that reach the surface as they move down the eastern slopes of the Rocky Mountains. Chinooks have the greatest warming effect in southern Alberta but effect the south-western parts of the study area near the Rocky Mountains. To give a general impression of seasonal temperatures across the study area, isoline maps of mean temperature for the months of January, April, July and October are provided as Figures 13 and 14.

Although the entire Northern River Basins Study area is located south of the treeline (the location of which is closely associated with the onset of continuous permafrost), the area spans various permafrost zones. The study area encompasses parts with no permafrost in the southeast, localized or sporadic permafrost in the southwest and central parts of the basin, and discontinuous permafrost in the Northwest Territories and the extreme northeast portion of the Lake Athabasca Basin. Permafrost zones in the study are illustrated in Figure 15.

Precipitation includes the deposition of rain, mist, sleet, hail and snow. In general, the Northern River Basins Study area is classified as semi-arid, since potential annual evaporation and transpiration exceeds precipitation. Isoline maps of mean precipitation for January, April, July and October are supplied, as Figures 16 and 17, in order to illustrate the spatial and temporal variation in precipitation over the Northern River Basins Study area. The heaviest rainfalls generally occur during the convective season from mid-May through to early September. The convective season can be described



1 Zone of Continous Permafrost
2 Zone of Discontinous Permafrost (Widespread Permafrost)
3 Zone of Discontinous Permafrost (Scattered Permafrost)
Source: The National Atlas of Canada

Figure 15. Canadian Permafrost Zones.

as the period when enough buoyancy is generated in the air mass by daytime heating from the ground surface that, cooling aloft, the clouds develop and produce showers or thundershowers.

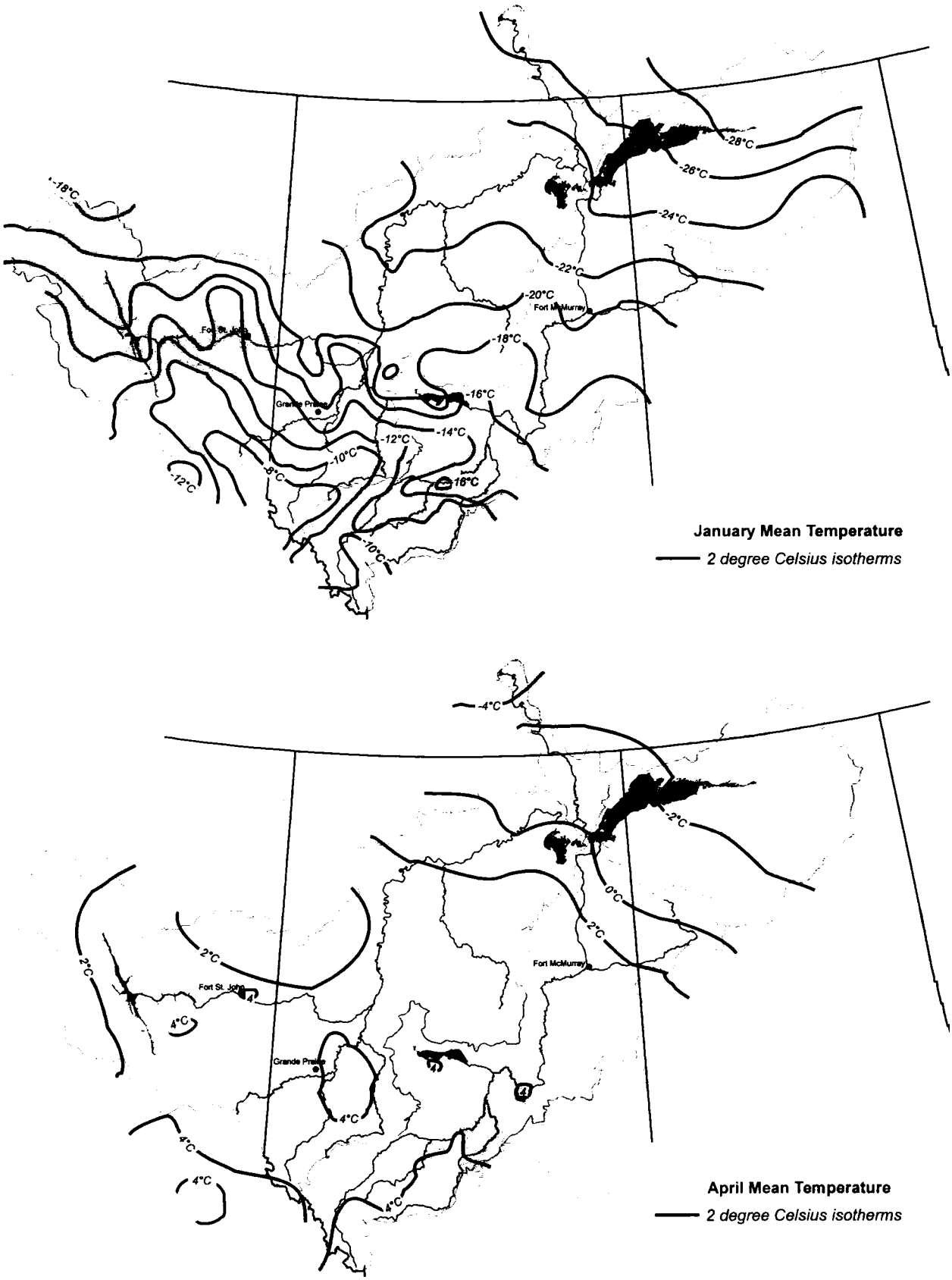


Figure 13. Mean Temperatures in the Northern River Basins - January and April.

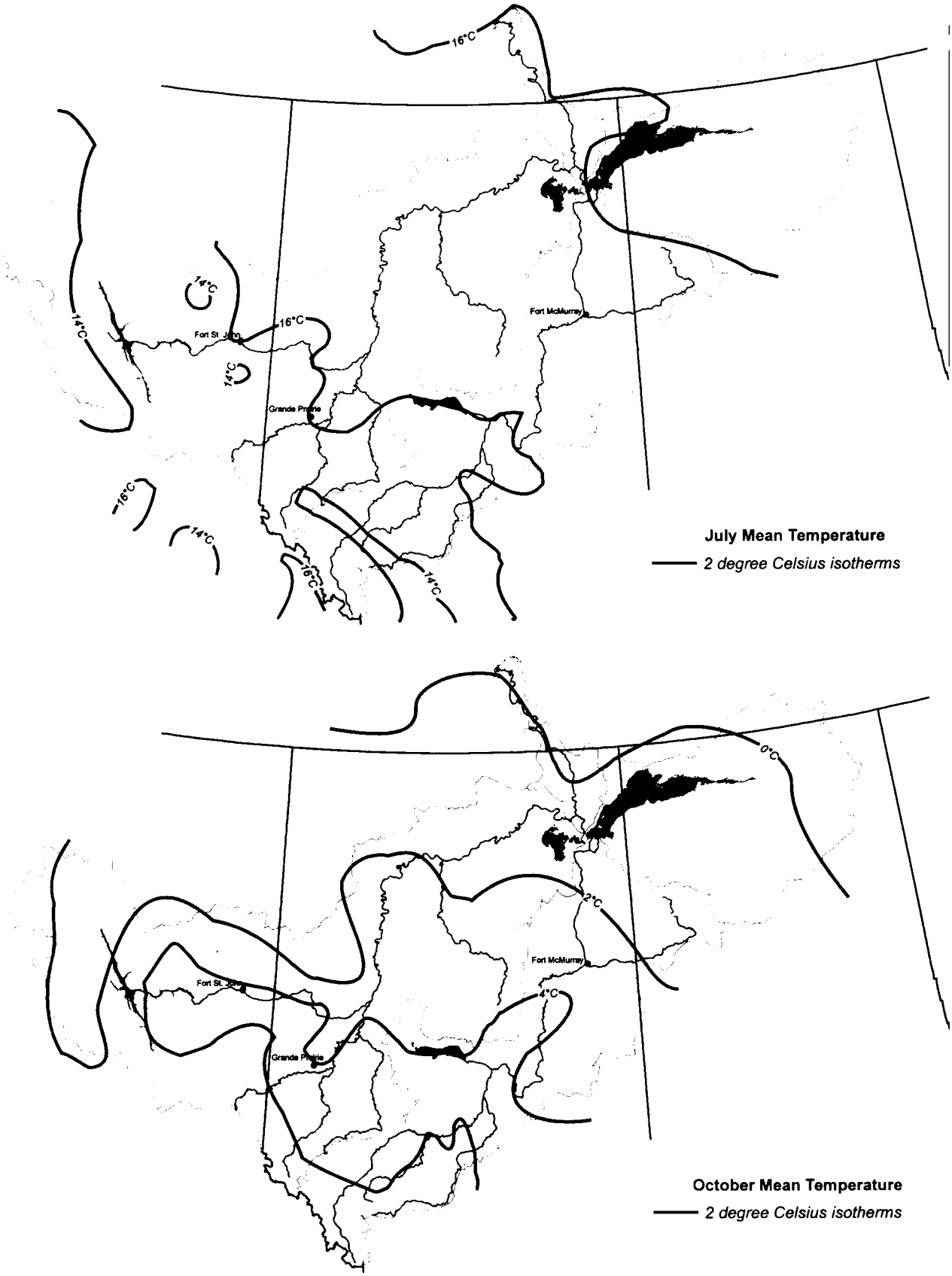
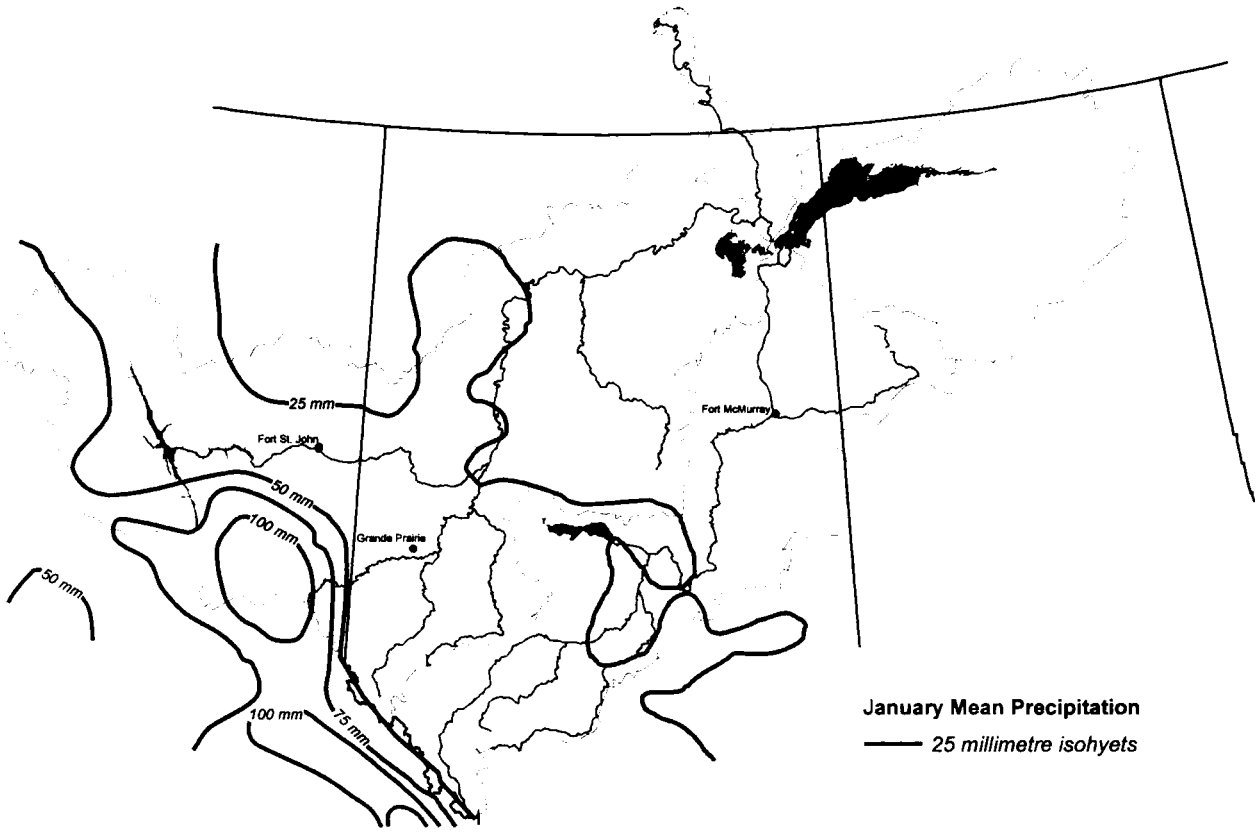


Figure 14. Mean Temperatures in the Northern River Basins - June and October



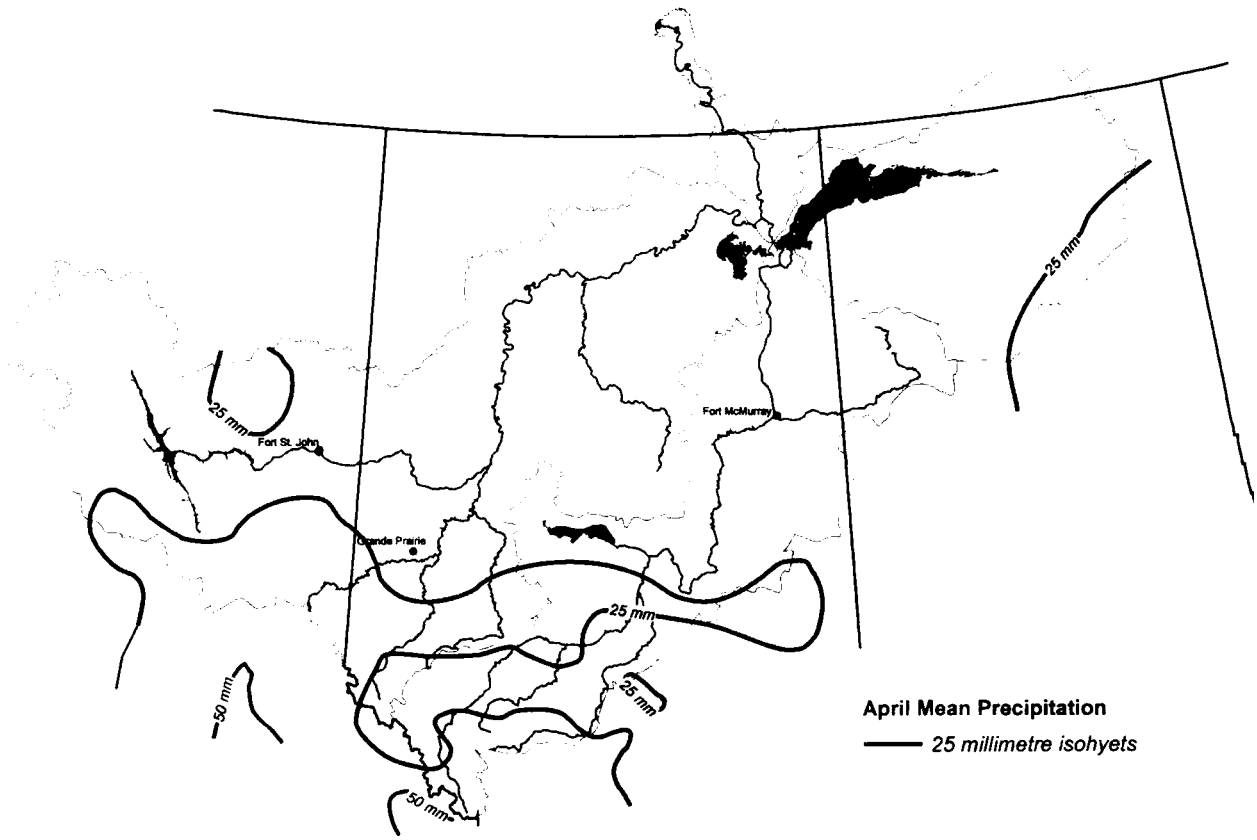
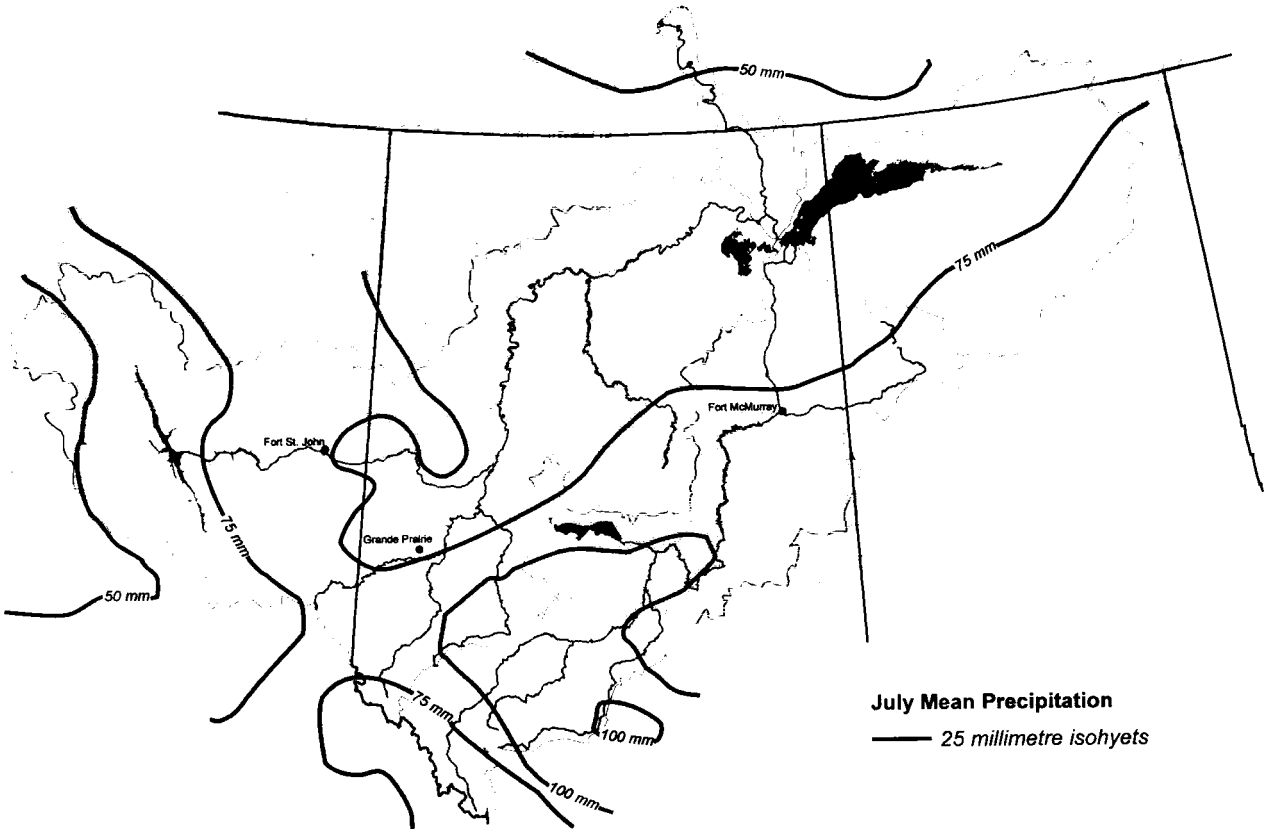


Figure 16. Mean Precipitation in the Northern River Basins - January and April.



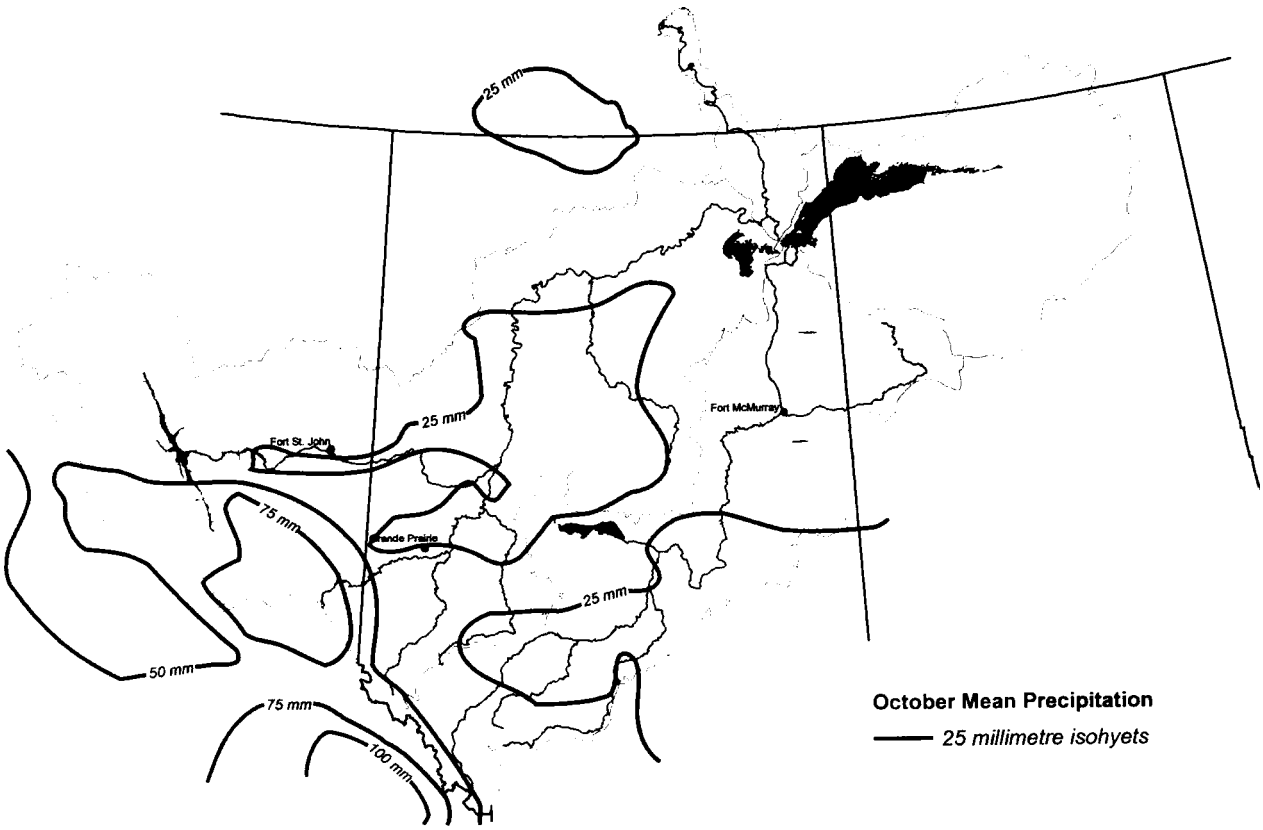


Figure 17. Mean Precipitation in the Northern River Basins - June and October

Snowfall is of particular hydrological importance, since peak flows on the Peace, Athabasca and Slave rivers are associated with snowmelt. On the Peace River during the period from 1959 to 1992, large amounts of snow accumulation (snowpack) occurred in 1967, 1972 and 1974 and were coincident with flooding events on the Peace-Athabasca Delta. Since 1974 (with the exception of 1985), most stations in the Peace River Basin have experienced below normal snowpack, which may have contributed to the concurrently fewer flooding events on the Peace-Athabasca Delta.

5.1 Climate and Agriculture

Three climatic variables that effect crop growth are length of frost-free period, number of daylight hours and number of growing-degree days:

- The length of the frost free period is one of the main limitations to agriculture in the study area. Figure 18 shows the annual mean number of frost free days for stations across the Northern River Basins.
- While the basin contains the most northerly farmlands in Canada, the area also contains the farmland with the greatest number of daylight hours during the growing season.
- The number of growing degree days during a frost free period is determined by the summation of the mean daily temperature less 5°C over the frost free period. Five degrees Celsius is used because cool season crops such as wheat, barley, and oats grow best at temperatures between 5°C and 25°C. These crops are considered stressed when temperatures reach 30°C.

5.2 References

Hudson, E. 1996. The climate of the Peace, Athabasca and Slave River basins. Northern River Basins Study Technical Report No. 124. Northern River Basins Study. Edmonton, Alberta.

Phillips, D. 1990. The Climates of Canada. CGPC, Ottawa. 176 pp.

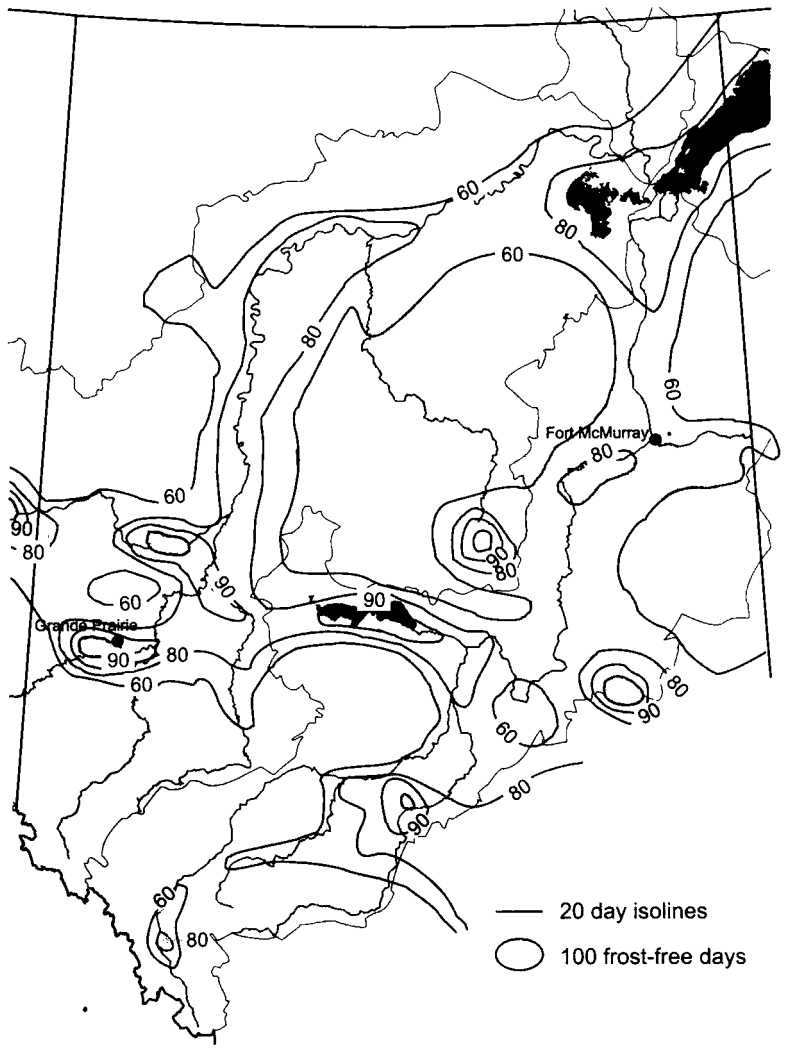


Figure 18. Mean Frost Free Days in the Alberta Portion of the Northern River Basins.

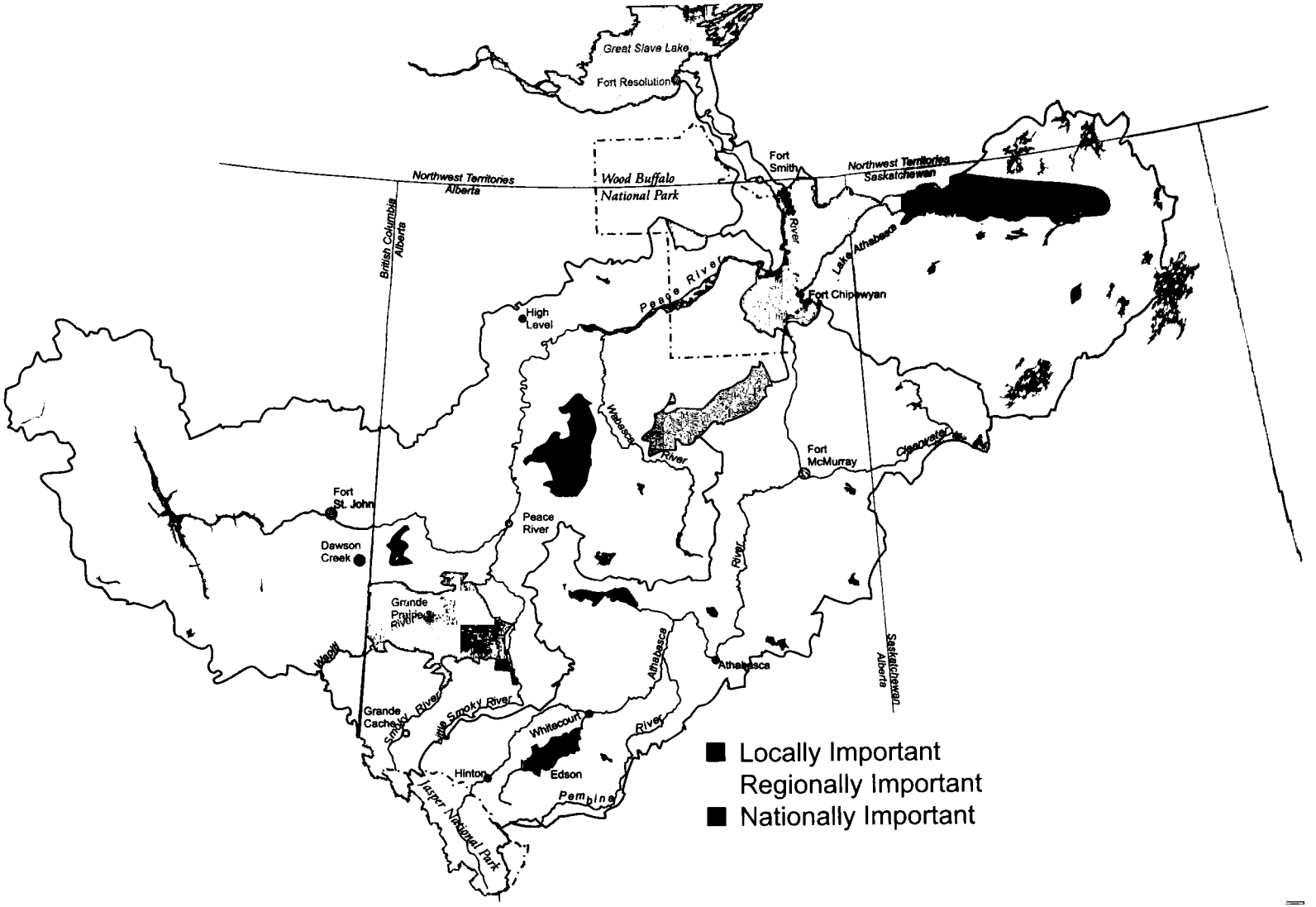


Figure 19. Habitat Use by Rare, Threatened and Endangered Species in the Northern River Basins.

6. Fish and Wildlife

The northern river basins are home to a wide range of fish and wildlife species. Many of these species are of significant economic importance to the region. In addition, many species are central to peoples living traditional lifestyles. Increases in human activity over the last century both in the basins and in other regions for migratory species, has placed considerable pressure on some of these species, Figure 19 shows the sensitive areas for wildlife, while Figure 20 shows the critical habitat areas for fish in the basins.

Although most fish caught in the northern river basins are suitable for eating, Alberta has issued human health consumption advisories for some species.

Dioxin/furan

- although levels are generally low, it is recommended that mountain whitefish from the Peace basin should not be eaten, and that consumption be limited to one per week for mountain whitefish caught in the Athabasca basin.
- only filet portions from burbot taken in the Smoky/Wapiti system, or in the Athabasca River between the headwaters and the Town of Athabasca should be eaten.
- only filet portions from bull trout caught in the Athabasca River between the headwaters and the town of Whitecourt should be eaten.
- filets from the following species have been tested and guidelines are not required: rainbow trout, lake whitefish, Arctic grayling, walleye, northern pike and goldeye.
- livers from burbot caught in the lower Slave River should not be eaten more than once a week.

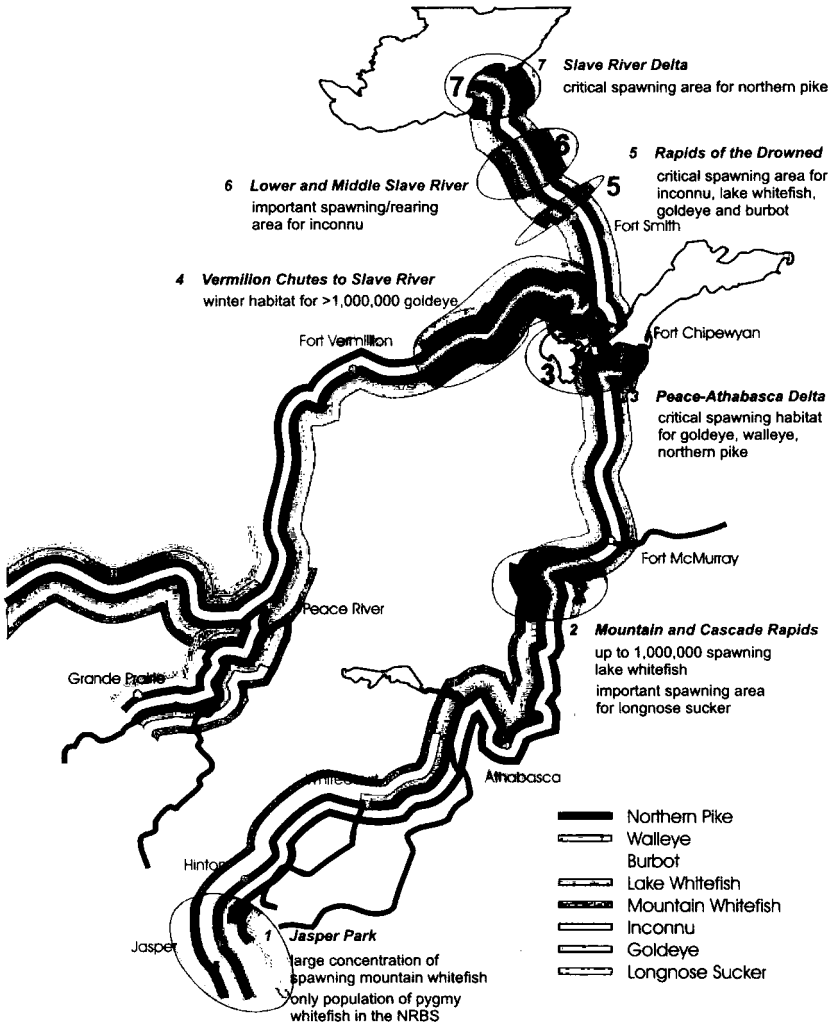


Figure 20. Distribution of Selected Fish Species and Critical Habitat in the Northern River Basins.

Mercury

- walleye caught in the following locations should not be eaten more than once a week and not at all by pregnant women or children under the age of 15:
- Christina (Windy) Lake;
- Edith Lake;
- Lac La None;
- upper McLeod River;
- Muskwa Lake (northern pike from this location are included in the advisory); and
- the mainstem of the Athabasca River

Toxaphene

6.1 Athabasca River Basin

6.1.1 Fish

The Athabasca River Basin supports 32 species of fish from seven different families, within the roughly 4,390 km of fish habitat provided by its mainstream and tributaries (Table 1). This habitat can be separated into three categories: cold water, cool water, and transition zone habitat.

Approximately 1,500 km, or 34% , is cold water habitat; supporting salmonoid fish. Salmonoid, cold water tolerating fish, are both the most abundant fish in the basin and the most important to commercial and sport fishing. Salmonoid fish inhabiting the Athabasca basin include: Arctic grayling, cisco, lake whitefish, mountain whitefish, bull trout (until recently, also referred to as Dolly Varden), lake trout, rainbow trout, and brook trout. As a result of overfishing and habitat destruction, bull trout numbers have been greatly reduced during the last 25 years. In an effort to increase the bull trout population, the Alberta government is promoting catch-and-release fishing for the species, providing information on bull trout identification to the public, restricting the use of bait, closing critical bull trout spawning areas to fishing, trying to prevent stream disturbances in bull trout habitat, reintroducing them into parts of their former range, maintaining bull trout food sources, permitting the harvesting of non-threatened species that compete with bull trout and initiating a Bull Trout Task Force (AEP 1994).


Recreational fishing Source: Alberta Fish & Wildlife

Roughly 2,250 km, or 51%, is cool water habitat which supports species that are tolerant of warmer water and lower dissolved oxygen levels. The principal cool water species in the basin are: northern pike, walleye, yellow perch, and goldeye. The remaining 640 km, or 15%, represents a transition zone where warm water and cold water species intermix.

Table 1. Fish Species of the Northern River Basins.

Type	Species	River Basin			
		Athabasca	*Peace*	*Upper Slave*	*Lower Slave*
Cold Water	Arctic grayling	•	•		
	Arctic lamprey				•
	Brook trout	•	•		
	Bull trout		•		
	Brown trout	•			
	Burbot	•	•	•	•
	Chum salmon				•
	Cisco	•			•
	Cutthroat trout	•	•		
	Inconnu				•
	Kokanee	•			
	Lake trout	•	•		
	Lake whitefish	•	•	•	•
	Mountain whitefish	•	•		•
	Rainbow trout	•	•		•
	Slimy sculpin	•	•	•	
	Tullibee		•		

Type	Species	River Basin			
		Athabasca	*Peace*	*Upper Slave*	*Lower Slave*
Cool Water	Brassy minnow		•		
	Brook stickleback	•	•		
	Emerald shiner			•	•
	Flathead chub	•	•	•	•
	Goldeye	•	•	•	•
	Iowa darter	•			
	Lake chub	•	•	•	•
	Largescale sucker		•		
	Longnose dace	•	•		•
	Longnose sucker	•	•	•	•
	Ninespine stickleback	•		•	
	Northern pike	•	•	•	•
	Northern redbelly dace	•	•		
	Northern squawfish		•		
	Pearl dace	•			
	Redside shiner		•		
	Sculpins				•
	Spoonhead sculpin	•			
	Spottail shiner		•	•	•
	Trout-perch	•	•	•	•
	Walleye	•	•	•	•
	White sucker	•	•		•
	Yellow perch	•	•		

Information derived from:

Alberta Environment. 1987. Slave River Basin Overview. Prepared for Alberta/Northwest Territories Technical Committee on the Transboundary Water Management Agreement.

Paetz, M. J. 1984. The Fish and Fisheries of the Peace River Basin: Their Status and Environmental Requirements. Prepared for Planning Division Alberta Environment in association with Fish and Wildlife Division, Alberta Energy and Natural Resources. Edmonton.

Wallace, R. and P. McCart. 1984. The Fish and Fisheries of the Athabasca River Basin: Their Status and Environmental Requirements. Prepared for Planning Division Alberta Environment. 269 pp.

6.1.2 Wildlife

Of the NRBS basins, the Athabasca River Basin is home to the greatest diversity of wildlife species, most likely because it extends farther south than the other basins. Jasper National Park is located at the headwaters of the Athabasca River. The park is located in the Rocky Mountains and foothills, and supports many species that are unique to this portion of the basin. Following is a brief discussion of the most significant species in the basin, for a more complete listing see Table 2 (mammals) and Table 3 (birds).

Table 2. Mammal Species of the Northern River Basins.

Family	Species	Species Located: Throughout the Basin	Species Located: Primarily in Mountain Regions	River Basin: Athabasca	River Basin: Peace	River Basin: Slave
Shrews	Arctic Shrew	•		•[c]	•[c]	
	Dusky Shrew	•		•	•	•
	Masked Shrew	•		•[c]	•[c]	•[c]
	Pygmy Shrew	•		•[c]	•[c]	•[c]
	Water Shrew	•		•	•	•
Bats	Big Brown Bat	•		•	•[c]	•
	Hoary Bat	•		•	•	•
	Little Brown Bat	•		•[c]	•[c]	•[c]
	Long-eared Bat		•	•[c]	•[c]	
	Long-legged Bat		•	•	•	
	Northern Long-eared Bat	•		•[c]	•[c]	•[c]
	Silver-haired Bat	•		•	•[c]	
Pikas, Hares and Rabbits	Pika		•	•	•	
	Snowshoe Hare	•		•	•	•
Rodents	Least Chipmunk	•		•	•	•
	Yellow-pinned Chipmunk		•[c]	•	•	
	Richardson's Ground Squirrel	•		•		
	Franklin's Ground Squirrel	•		•		
	Columbian Ground Squirrel		•	•	•	
	Golden-mantled Ground Squirrel		•	•	•	
	Red Squirrel	•		•	•	•
	Northern Flying Squirrel	•		•	•	•
	Hoary Marmot		•	•	•	
	Bushy-tailed Woodrat		•	•	•	
	Woodchuck	•		•[b,c]	•[b,c]	•
	Deer Mouse	•		•[a]	•[a]	•[a]
	House Mouse	•			•[h]	
	Meadow Jumping Mouse	•		•[b]	•[b]	•
	Western Jumping Mouse	•		•	•[d]	•
	Heather Vole	•		•	•	
	Meadow Vole	•		•[d]	•[a]	
	Long-tailed Vole		•	•	•	
	Southern Red-backed Vole	•		•[a]	•[a]	•[a]
	Taiga Vole	•		•[c]		
	Water Vole		•	•[c]	•[c]	
	Brown Lemming	•		•[c]		
Rodents	Northern Bog Lemming	•		•[c]	•[c]	•[c]
	Muskrat	•		•	•	•
	Porcupine	•		•	•[c]	•
	Beaver	•		•	•	•
Carnivores	Canada Lynx	•		•	•	•
	Cougar		•	•[c]	•[c]	
	Coyote	•		•	•	•
	Gray Wolf	•		•	•	•
	Red Fox	•		•	•	•
	Black Bear	•		•	•	•
	Grizzly Bear	•		•[c]	•[e]	
	Marten	•		•	•	•
	Fisher	•		•[c]	•[c]	•[c]
	Wolverine	•		•[c]	•[c]	•[c]
	Striped Skunk	•		•	•	•[i]
	Ermine	•		•	•	
	Least Weasel	•		•	•	
	Long-tailed Weasel	•		•[d]	•[d]	
	Mink	•		•	•	
	River Otter	•		•	•	•
Ungulates	Mule Deer	•		•	•	
	White-tailed Deer	•		•	•	•[c]
	Wapiti		•	•	•	
	Moose	•		•	•	•
	Caribou	•				•[e]
	Woodland Caribou	•		•[e]	•[e]	
	Bison	•			•[e]	•[e]
	Bighorn Sheep		•	•	•	
	Mountain Goat		•	•	•	

Key: [a] Very Common; [b] Located throughout most of the basin except in Jasper National Park/Willmore Wilderness Park; [c] Uncommon; [d] Located primarily in southern half of the basin; [e] Considered endangered or threatened in Alberta; [f] Are scarce in the northern part of the basin due to rabies extermination; [g] Located in the Willmore Wilderness Park area and along the B.C.-Alberta border; [h] Found primarily in agricultural region; [i] Not located in the Canadian Shield region.

Information derived from:

Smith H.C., R.I. Hasyings and J.A. Burns. 1993. Alberta Mammals: An Atlas and Guide. The Provincial Museum of Alberta, Edmonton, Alberta. 238 pp.

Table 3. Bird Species Breeding in the Northern River Basins.

Family	Species	River Basin: Athabasca	Peace	Slave
Loons	Red-throated Loon			•
	Pacific Loon		•	•
	Common Loon	•	•	•
Grebes	Pied-billed Grebe	•	•	•
	Horned Grebe	•	•	•
	Red-necked Grebe	•	•	•
	Eared Grebe	•	•	
	Western Grebe	•	•	
Pelicans and Cormorants	American White Pelican	•	•	•
	Double-crested Cormorant	•	•	
Herons	American Bittern	•	•	•
	Great Blue Heron	•	•	
	Black-crowned Night-Heron	•		
Waterfowl	Trumpeter Swan		•	
	Canada Goose	•	•	•
	Green-winged Teal	•	•	•
	Mallard	•	•	•
	Northern Pintail	•	•	•
	Blue-winged Teal	•	•	•
	Northern Shoveler	•	•	•
	Gadwall	•	•	
	American Wigeon (Baldpate)	•	•	•
	Canvasback	•	•	•
	Redhead	•	•	•
	Ring-necked Duck	•	•	•
	Greater Scaup			•
	Lesser Scaup	•	•	•
	Harlequin Duck	•	•	
	Surf Scoter	•	•	•
	White-winged Scoter	•	•	•
	Common Goldeneye	•	•	•
	Barrow's Goldeneye	•	•	
	Bufflehead	•	•	•
	Hooded Merganser	•	•	
	Common Merganser	•	•	•
	Red-breasted Merganser	•	•	•
	Ruddy Duck	•	•	•
Birds of Prey	Osprey	•	•	•
	Bald Eagle	•	•	•
	Northern Harrier	•	•	•
	Sharp-shinned Hawk	•	•	•
	Cooper's Hawk	•		
	Northern Goshawk	•	•	•
	Broad-winged Hawk	•		
	Red-tailed Hawk	•	•	•
	Golden Eagle	•	•	•
	American Kestrel	•	•	•
	Merlin (Pigeon Hawk)	•	•	•
	Peregrine Falcon	•	•	•
Game Birds	Gray Partridge	•	•	
	Ring-necked Pheasant	•	•	
	Spruce Grouse	•	•	•
	Blue Grouse	•	•	
	Willow Ptarmigan	•	•	
	White-tailed Ptarmigan	•	•	
	Ruffed Grouse	•	•	•
	Sharp-tailed Grouse	•	•	•
Cranes and Rails	Yellow Rail	•	•	•
	Virginia Rail	•	•	•
	Sora	•	•	•
	American Coot	•	•	•
	Sandhill Crane	•	•	•
Shorebirds	Semipalmated Plover	•	•	•
	Killdeer	•	•	•
	Greater Yellowlegs	•	•	•
	Lesser Yellowlegs	•	•	•
	Solitary Sandpiper	•	•	•
	Spotted Sandpiper	•	•	•
	Upland Sandpiper	•	•	•
	Marbled Godwit	•		
	Least Sandpiper			•
	Short-billed Dowitcher	•	•	•
	Common Snipe	•	•	•
	Wilson's Phalarope	•	•	
	Red-necked Phalarope			•
Gulls and Terns	Franklin's Gull	•	•	•
	Bonaparte's Gull	•	•	•
	Mew Gull			•
	Ring-billed Gull	•	•	•
	California Gull	•	•	•

Family	Species	River Basin: Athabasca	Peace	Slave
	Herring Gull	•	•	•
	Caspian Tern		•	•
	Common Tern	•	•	•
	Arctic Tern			•
	Black Tern	•	•	•
Owls	Great Horned Owl	•	•	•
	Northern Hawk-Owl	•	•	•
	Northern Pygmy-Owl	•	•	
	Barred Owl	•	•	
	Great Gray Owl	•	•	•
	Long-eared Owl	•	•	•
	Short-eared Owl	•	•	•
	Boreal Owl	•	•	•
	Northern Saw-whet Owl	•	•	
Swifts	Black Swift	•	•	
and	Ruby-throated Hummingbird	•	•	
	Calliope Hummingbird	•	•	
	Rufous Hummingbird	•	•	
Woodpeckers	Lewis's Woodpecker	•	•	
	Yellow-bellied Sapsucker	•	•	•
	Red-naped Sapsucker	•		
	Downy Woodpecker	•	•	•
	Hairy Woodpecker	•	•	•
	Three-toed Woodpecker	•	•	•
	Black-backed Woodpecker	•	•	•
	Northern Flicker	•	•	•
	Pileated Woodpecker	•	•	•
Flycatchers	Olive-sided Flycatcher	•	•	•
	Western Wood-Pewee	•	•	•
	Yellow-bellied Flycatcher	•	•	•
	Alder Flycatcher	•	•	•
	Least Flycatcher	•	•	•
	Hammond's Flycatcher	•	•	
	Dusky Flycatcher	•	•	
	Western Flycatcher	•	•	
	Eastern Phoebe	•	•	•
	Say's Phoebe	•	•	
	Eastern Kingbird	•	•	•
Swallows	Purple Martin	•	•	
	Tree Swallow	•	•	•
	Violet-green Swallow	•	•	
	Northern Rough-winged Swallow	•		

Family	Species	River Basin: Athabasca	Peace	Slave
	Bank Swallow	•	•	•
	Cliff Swallow	•	•	•
	Barn Swallow	•	•	•
Jays and Crows	Gray Jay	•	•	•
	Steller's Jay	•	•	
	Blue Jay	•	•	
	Clark's Nutcracker	•	•	
	Black-billed Magpie	•	•	
	American Crow	•	•	•
	Common Raven	•	•	•
Chickadees	Black-capped Chickadee	•	•	•
	Mountain Chickadee	•	•	
	Boreal Chickadee	•	•	•
Nuthatches	Red-breasted Nuthatch	•	•	•
and Creepers	White-breasted Nuthatch	•		
	Brown Creeper	•	•	
Wrens	Rock Wren	•		
	House Wren	•	•	•
	Winter Wren	•	•	•
	Sedge Wren	•		
	Marsh Wren	•	•	•
Kinglets	Golden-crowned Kinglet	•	•	•
and Thrushes	Ruby-crowned Kinglet	•	•	•
	Mountain Bluebird	•	•	
	Townsend's Solitaire	•	•	
	Veery	•	•	
	Gray-cheeked Thrush			•
	Swainson's Thrush	•	•	•
	Hermit Thrush	•	•	•
	American Robin	•	•	•
	Varied Thrush	•	•	
Pipits	Water Pipit	•	•	
	Sprague's Pipit	•	•	
Waxwings	Bohemian Waxwing	•	•	•
	Cedar Waxwing	•	•	•
Shrikes	Northern Shrike	•	•	•
	Loggerhead Shrike	•		
Vireos	Solitary Vireo	•	•	•
	Warbling Vireo	•	•	
	Philadelphia Vireo	•	•	•
	Red-eyed-Vireo	•	•	•

Family	Species	River Basin: Athabasca	Peace	Slave
Warblers	Tennessee Warbler	•	•	•
	Orange-crowned Warbler	•	•	•
	Yellow Warbler	•	•	•
	Chestnut-sided Warbler	•		
	Magnolia Warbler	•	•	•
	Cape May Warbler	•	•	•
	Yellow-rumped Warbler	•	•	•
	Townsend's Warbler	•	•	
	Black-throated Green Warbler	•	•	•
	Blackburnian Warbler	•		
	Palm Warbler	•	•	•
	Bay-breasted Warbler	•	•	•
	Blackpoll Warbler	•	•	•
	Black-and-white Warbler	•	•	•
	American Redstart	•	•	•
	Ovenbird	•	•	•
	Northern Waterthrush	•	•	•
	Connecticut Warbler	•	•	
	Mourning Warbler	•	•	
	MacGillivray's Warbler	•	•	
	Common Yellowthroat	•	•	•
	Wilson's Warbler	•	•	•
	Canada Warbler	•	•	•
Sparrows	American Tree Sparrow			•
	Chipping Sparrow	•	•	•
	Clay-coloured Sparrow	•	•	•
	Brewer's Sparrow	•	•	
	Vesper Sparrow	•	•	•
	Savannah Sparrow	•	•	•
	Le Conte's Sparrow	•	•	•
	Sharp-tailed Sparrow	•	•	•
	Fox Sparrow	•	•	•
	Song Sparrow	•	•	•
	Lincoln's Sparrow	•	•	•
	Swamp Sparrow	•	•	•
	White-throated Sparrow	•	•	•
	Golden-crowned Sparrow	•	•	
	White-crowned Sparrow	•	•	•
	Dark-eyed-Junco	•	•	•
Blackbirds	Red-winged Blackbird	•	•	•
	Western Meadowlark	•	•	
	Yellow-headed Blackbird	•	•	

Family	Species	River Basin: Athabasca	Peace	Slave
	Rusty Blackbird	•	•	•
	Brewer's Blackbird	•	•	
	Common Grackle	•	•	•
	Brown-headed Cowbird	•	•	•
	Northern Oriole	•	•	
Finches	Rosy Finch	•	•	
	Pine Grosbeak	•	•	•
	Purple Finch	•	•	•
	Red Crossbill	•	•	•
	White-winged Crossbill	•	•	•
	Common Redpoll			•
	Pine Siskin	•	•	•
	American Goldfinch	•	•	
	Evening Grosbeak	•	•	•
Other	Mourning Dove	•	•	
	Black-billed Cuckoo	•		
	Common Nighthawk	•	•	•
	Belted Kingfisher	•	•	•
	Horned Lark	•		•
	American Dipper	•	•	
	Gray Catbird	•		
	European Starling	•	•	•
	Western Tanager	•	•	•
	Rose-breasted Grosbeak	•	•	•
	Lazuli Bunting	•		
	House Sparrow	•	•	•

Information derived from: W.E. Godfrey - Birds of Canada. National Museums of Canada, 1986.

Over 60 species of mammals; including ungulates, carnivores, rodents, shrews and bats; are found in the basin. Mule deer, white-tailed deer, moose and caribou are ungulates found throughout the basin while wapiti or elk, mountain goat and bighorn sheep are only found in areas within or adjacent to Jasper National Park. The larger carnivores of the area are the gray wolf; the black bear; the grizzly bear, which is located primarily in the southern portion of the basin; and the cougar, which is rare and only found

in Jasper National Park. The smaller carnivores include species which have been prized for their fur such as the red fox, mink and lynx. Among the rodents of the basin are beavers, muskrats, porcupines, and many species of mice, squirrels, chipmunks and voles.

The birds that breed in the Athabasca River Basin include many species of waterfowl, game species (used for food), hawks and owls, shorebirds and approximately 100 species of song birds. Many species of waterfowl can be found in the area. Some examples are 17 species of ducks, several species of grebes, the Common Loon, American White Pelican, Great Blue Heron and Canada Goose. The Gray Partridge, Ring-necked Pheasant, White-tailed Ptarmigan and four species of grouse make up the game birds of the area. The predatory birds include owls and hawks such as the Bald and Golden Eagles, many species of hawks and the endangered Peregrine Falcon. The population decline in Peregrine Falcons was directly related to the agricultural use of pesticides. Birds of prey are situated at the top of the food chain and organochlorine pesticides biomagnify in their bodies (Baril et al. 1990). Although peregrine falcons still acquire residues from their prey in Alberta, it is believed that most residues are acquired in their wintering grounds in Latin America where DDT continues to be used in agriculture and mosquito (malaria) control (Fyfe et al. 1990). An international effort has been initiated to protect and increase the numbers of Peregrine Falcons (AEP 1992a).

6.2 Peace River Basin

6.2.1 Fish

Within almost 5,833 km of fish habitat, the Peace River Basin supports 29 species of fish from ten different families (Table 1). One third of this habitat, or 1,925 km, is cold water habitat, while the remaining two thirds, or 3,850 km, is habitat more suitable for cool water species. The most abundant salmonoid (i.e. cold water) species in the basin are: Arctic grayling, mountain whitefish and various species of trout. The bull trout population in the Peace River Basin is threatened and is undergoing the same remedial measures discussed in Section 6.1.1. The important cool water species include: pike, goldeye, walleye, and perch. Brook trout, cutthroat trout, and rainbow trout have been introduced to the Peace River (Paetz 1984).

The Vermilion Chutes act as a partial barrier to fish movement, separating the upstream and downstream populations of some species (Boag 1993). Deep water habitats upstream of Fort Vermilion are used as over-wintering areas by most of the dominant fish species in the Upper Peace River. Mountain whitefish are abundant in reaches above the town of Peace River. Large tributaries including Cadotte, Notikewin, Wabasca, Mikkwa and Jackfish contain spawning runs of walleye, longnose sucker and northern pike (Boag 1993, EnviResource Consulting Ltd. 1994). Goldeye and other coarse fish in the Lower Peace River utilize areas downstream of Peace Point for over-wintering and rearing.

6.2.2 Wildlife

The Peace River Basin is home to a multitude of mammal and bird species. The following discussion focuses on the key species residing in the Alberta portion of the basin. For a more complete listing see Table 2 (mammals) and Table 3 (birds).

Many of the mammals in the basin are important game species, which can be separated into three broad groups; the ungulates, carnivores, and rodents. The ungulates or hoofed mammals are: moose, wapiti or elk, white-tailed deer, mule deer, woodland caribou and sometimes in winter Barren Ground caribou which browse for food in the northern parts of the basin. The grizzly bear, black bear, lynx, fox, coyote, fisher, weasel, and marten; along with the less common cougar, mink, otter and wolverine are some of the carnivores found in the area. The rodents found in the Peace River area include: squirrels, chipmunks, woodchuck, mice, muskrat, snowshoe hare and beaver. In the upper Peace River Basin skunks and porcupine are reportedly absent because of massive extermination following a rabies epidemic in the 1960s (Pers. Comm. Norman Simpson; Outfitter - Peace River). The habitat preferences of mammal species in the Peace and Slave River basins are described in Table 4.

Muskrat Source: Alberta Fish & Wildlife

A portion of the North American flyway is located in the Peace River region. As a result many species of ducks, geese and swans, as well as loons, grebes and other waterfowl spend a portion of the year in the area. Two rare waterfowl species occupy the basin, the Trumpeter Swan and the White Pelican. The Trumpeter Swan is the largest of the North American waterfowl. In the early 1900s the Trumpeter Swan was near extinction due to over hunting and destruction of habitat. Its main Alberta nesting area is the small lakes in the Grande Prairie/Peace River Region. In 1990, this population was estimated to be 321(AEP 1992b). White Pelicans occupy Peerless Lake and other remote northern lakes. In addition to waterfowl, the Peace River region is also home to upland game species and predatory birds, including the Snowy Owl which winters in the region when food is scarce in the Arctic. For a more complete listing of bird species that breed in the basin see Table 3.

The Peace-Athabasca Delta is located at the meeting point of the Peace River, the Athabasca River, Lake Athabasca and the Slave River. It must be noted that this freshwater delta represents some of the richest wildlife habitat in the NRBS area. Many species of fish spawn in the delta. The area supports the common northern ungulate species such

Table 4. Wildlife Habitat Regions and their Significance in the Peace and Slave River Basins (Prowse and Conly 1996).

Habitat region	Brief description of biophysical region	Significance to wildlife populations
1. Peace-Athabasca and Slave deltas	Alluvial deposits, numerous islands, silt bars, meadows, open and closed marshes. Abundant aquatic vegetation, some aspen, balsam poplar and spruces.	Muskrat, beaver, moose, waterfowl breeding, migration and staging areas, raptors. P.A. Delta has significant bison habitat.
2. Lowland forests	Typically high water tables and numerous channels. White and black spruce, aspen and willow. Meadows with some marsh habitat.	Moose and other ungulates, aquatic and upland furbearers.
3. Savannah lowlands	Relatively low relief, large areas of grass-sedge meadows, scattered willow and aspen forest. Drainage channels provide wet regions in spring.	Slave River savannah main range of bison herds. Wolf, ptarmigan winter habitat, sharp-tailed grouse and sandhill cranes.
4. Open forest lowlands	As (3) but with more extensive regions of forest which also includes spruce.	Slave River bison herd winter range during severe winters.
5. Upland forests (Peace basin)	Upland and foothill regions with extensive forest cover of aspen, balsam poplar, spruce and pine. Dry and wet channels with some riparian and marsh habitats.	Muskrat, beaver, ungulates, wolf, wolverine and bear. Also numerous songbirds and raptors.
6. Upland forest-wetland complex (Slave basin)	Transition zone between the Canadian Shield and lowland areas of the Slave River. Variable relief, sparse upland cover of aspen and pine. Areas of wetlands include lakes, streams, marshes and meadows.	Beaver, muskrat, waterfowl breeding, fall migration and staging areas, raptors.
7. Murdock Meadows and lowlands (Slave basin)	Vegetation includes willow, balsam poplar and white spruce. Murdock Creek, side channels and sinkhole lakes provide riparian and meadow habitat.	Winter range of bison population, waterfowl and muskrat. Possibly also moose.
8. Upland forest on karst (Slave basin)	Extensive forests of pine, aspen, spruce and willow. Areas of sinkholes, sand dunes, beach ridges, underground caverns and evaporite flats provide unique diversity of habitat features.	Bison summer range, bat hibernacula (possibly snake) and forest species; marten, fisher, wolf, *etc.*
9. Salt plains (Slave Basin)	Saline/sedge meadows and grasslands interspersed with aspen and willow.	Summer/winter range of bison, wolf, garter snake hibernacula, spring waterfowl, pelican foraging area, sharp-tailed grouse.
10. Peace and Slave river mainstems and floodplains	River habitats include islands, silt bars, floodplains and side channels; vegetation highly variable from sedge meadow in channels to riparian vegetation consisting of *Equisetum*, willow and balsam poplar, white spruce and floodplain forest. Perched channels and backwaters along certain reaches.	Probably ungulates, beaver in side channels, some bison use in Slave River basin, some limited waterfowl migration, staging areas.

as deer, moose, and bison as well as many smaller mammals such as muskrats and beavers. The delta is one of the most important waterfowl staging areas for migrant waterfowl areas in North America, as three of the four major North American flyways cross the delta.

6.3 Slave River Basin

6.3.1 Fish

The Slave River basin provides habitat for many common northern species. Important spawning areas in the basin include the Slave River Delta and Fort Smith rapids. The latter is also significant because it acts as a barrier to the upstream movement of fish from the lower river; obstructing the movement of parasites, such as the Arctic lamprey, into the upper reaches. In the upper reaches of the Slave (*i.e.* upstream of the Fort Smith rapids) the primary fish species include the cold water species lake whitefish and burbot; along with the cool water species goldeye, northern pike, walleye and flathead chub and longnose suckers. Many of these species migrate between the lakes of the PAD and the Upper Slave River (Prowse and Conly 1996). The lower reaches of the river (*i.e.* below the Fort Smith rapids) contains a larger number of species. The chief salmonoid species are: rainbow trout, chum salmon, lake whitefish, mountain whitefish, cisco and inconnu. The major cool water species include: goldeye, northern pike, walleye, burbot and flathead chub (Alberta Environment 1987). A more thorough list of the fish species in the basin is provided in Table 1.

6.3.2 Wildlife

The Slave River Basin supports a diverse population of wildlife, which includes many rare and endangered species. Many of these species inhabit Wood Buffalo National Park (WBNP) and although only a small portion of the park lies within the Slave River basin, many of the rare species inhabiting the park namely the wood bison, Whooping Crane and White Pelican either occupy the basin for part of the year or use it as a migratory pathway. Another important area of wild life habitat is the Slave River Delta which supports 212 different species of fish, mammals and birds and is particularly important for muskrat, migrant waterfowl and shorebirds.

Bison, Wood Buffalo National Park

Source: L.N. Carbyn

The basin is home to more than 44 species of mammals. All common northern ungulate species inhabit the basin. The largest free ranging herd of wood buffalo (bison) in the world occupy WBNP, and a smaller herd live on the Slave River Lowlands. Moose, mule and white tailed deer are found as far north as Grande Detour and on some islands in the river. Barren Ground caribou occupy the Canadian Shield area in the north-east corner of the basin, but have been seen crossing the river as far south as Grande Detour. Other important mammals of the basin are fur bearing species which include carnivores such as the coyote, red fox, lynx, ermine, mink, wolf; and rodents chiefly muskrat, beaver and red squirrel. See Table 2 for a listing of the mammal species in the Alberta segment of the basin, and Table 4 for a description of their habitat preferences.

The Slave River Basin is located along the route of three major flyways for migratory waterfowl; and the Slave delta is an important staging area for many species of birds. Seventeen species of ducks, geese and upland game species such as grouse breed in the basin. The area is also home to the Bald Eagle and the endangered Peregrine Falcon, discussed in Section 6.1.2. The American White Pelican nests in the Mountain Rapids area on the Slave River, which is the only population of White Pelicans in Canada that can be found nesting on a river. Although the Whooping Crane does not nest in the basin, the birds occasionally visit the section of river downstream of Fort Smith. Until recently, the only nesting area in the world lay just outside the NRBS area, west of the Slave Basin, in the Sass River area of the Little Buffalo River Basin (Alberta Environment 1987). A listing of bird species which breed in the basin is located in Table 3.

6.4 References

Alberta Environment. 1987. Slave River Basin Overview. Prepared for Alberta/Northwest Territories Technical Committee on the Transboundary Water management Agreement. 94 pp.

Alberta Environmental Protection (AEP) (Fish and Wildlife). 1987. Alberta's Threatened Wildlife: Whooping Crane. [pamphlet].

Alberta Environmental Protection (AEP) (Fish and Wildlife). 1992a. Alberta's Threatened Wildlife: Peregrine Falcon. [pamphlet].

Alberta Environmental Protection (AEP) (Fish and Wildlife). 1992b. Alberta's Threatened Wildlife: Trumpeter Swan. [pamphlet].

Alberta Environmental Protection (AEP) (Fish and Wildlife). 1994. Alberta's Threatened Wildlife: Bull Trout. [pamphlet].

Baril, A., J.E. Elliot, J.D. Somers and G. Erickson. 1990. Residue levels of environmental contaminants in prey species of the Pergrine Falcon, *Falco peregrinus*, in Canada. Canadian Field-Naturalist, 104(2): 273-284.

Boag, T.D. 1993. A greneral fish and riverine habitat inventory, Peace and Slave rivers, April to June 1992. Northern River Basins Study Project Report No. 9. Northern River Basins Study, Edmonton, AB. 89 pp.

EnviResource Consulting Ltd. 1994. Distribution, movement, residence and relative abundances of fish in the Peace, Athabasca and Slave river drainages - volume 1: Monograph. Draft report prepared for the Northern River Basins Study. 149 pp

Fyfe, R.W., U. Banasch, V. Benavides, N.H. DeBenavides, A. Luscombe amd J. Sanchez. 1990. Organoclhlorine residues iof potential prey of Pergrine Falcons, *Falco peregrinus*, in Latin America. Canadian Field-Naturalist, 104(2): 285-292.

Prowse, T.D. and M. Conly. 1996. Impacts of flow regulation on the aquatic ecosystem of the Peace and Slave rivers. Northern River Basins Study Synthesis Report No. 1. Northern River Basins Study, Edmonton, AB. 168 pp.

Paetz, M.J. 1984. The Fish and Fisheries of the Peace River Basin: Their Status and Environmental Requirements. Prepared for Planning Division Alberta Environment in association with Fish and Wildlife Division, Alberta Energy and Natural Resources. Edmonton. 240 pp.

7. Land Use

7.1 Urban Development

Grande Prairie, in the Peace River Basin, and Fort McMurray, in the Athabasca River Basin, are the only cities in the study area in Alberta (Figure 7). Dawson Creek and Fort St. John are two cities in the British Columbia portion of the Peace Basin whose municipal effluents directly or indirectly enter the Peace River system. The largest urban community in the NWT part of the basin is Fort Smith. Due to their small size, municipalities are not the primary water users in the study area. The main municipal water uses include household water use, lawn and park maintenance and fire-fighting.

In general, municipal effluents in the NRBS area do not pose as big a threat to water quality as do industrial effluents. Larger municipalities tend to operate a continuous discharge directly into the receiving water body, while smaller municipalities often store wastewater in lagoon systems which are discharged into an adjacent water body once or twice a year in spring and/or autumn (see Tables 5 and 6). Municipal effluents receive three different levels of treatment:

- Primary Treatment involves the removal of large solids and floating matter by screening; and the removal of sediment and organic matter in settling ponds (Government of Canada 1991).
- Secondary Treatment involves the removal of biodegradable organic matter through the use of bacteria and micro-organisms (Government of Canada 1991). This process removes 70% to 90% of the biological oxygen demand (BOD), 50% of the nitrates, 30% of the phosphorus, reduces the adsorbable organic halides (AOX) and total suspended solids (TSS) levels (Province of British Columbia 1993).
- Tertiary Treatment involves further removal of nitrates and phosphates along with chlorinated compounds, salts, acids, metals and toxic organic compounds (Province of British Columbia, 1993). Common water quality effects associated with municipal wastewater are an increase in BOD, nutrients, TSS, faecal coliforms and toxic contaminants (Province of British Columbia 1993).

Other municipal environmental concerns not related to effluents are urban storm-water runoff and solid waste. Storm-water tends to flow or run over roads and parking lots picking up residues of oil and gasoline and is therefore a potential source of diffuse surface water contamination.

7.1.1 Athabasca River Basin

Settlement in the Athabasca River Basin occurs mainly along the upper reaches of the mainstem and upper tributaries, the obvious exception being Fort McMurray. Fourteen municipalities with populations over 500 are located in the Alberta portion of the basin, information concerning their water use and wastewater discharges and treatment can be found in Table 5. In the area from Fort Assiniboine to Fort McMurray water quality concerns have been raised in connection with the use of insecticides for blackfly control.

Table 5. Athabasca River Basin - Water Intake and Discharge Information for Municipalities with Populations Greater than 500.

Municipality	Population	Withdrawal: Type of Water Source	Withdrawal: Surface Water Source	Withdrawal: Average Consumption (m^3/day)	Withdrawal: Design Capacity (m^3/day)	Discharge: Discharge Location	Discharge: Wastewater Average Flow (m^3/day)	Discharge: Design Capacity (m^3/day)	Discharge: Discharge Dates	Discharge: Treatment
Athabasca	1,975	Surface	Athabasca River	1,221	2,045	Athabasca River	873	2045	Continuous	Tertiary
Barrhead	4,014	Surface	Paddle River	1,883	2,700	Paddle River	1,852	2,500	NA	Tertiary
Boyle	704	Surface	Skeleton Lake	331	907	Flat Lake	400	1,995	Sept. 1	Secondary
Edson	7,323	Ground	----	2,958	7,823	McLeod River	2,844	4,623	Continuous	Secondary
Evansburg	750	Ground	----	332	1,140	Lobstick River	237	1,023	Nov. 6	Secondary
Fort McMurray	33,698	Surface	Athabasca River	14,250	17,000	Athabasca River	11,695	12,721	Continuous	Secondary
Hinton	9,893	Surface	Athabasca River	6,736	13636	Athabasca River	4,047	8,180	Continuous	Done by Weldwood
Lac la Biche	2,553	Surface	Lac La Biche	1,601	3,273	Field Lake	1,630	2,045	Continuous	Secondary
Mayerthorpe	1,414	Ground	----	660	1,027	Paddle River	453	910	Sept. 7	Secondary
McLennan	1,026	Surface	Winagami Lake via canal	371	1,225	Kimiwan Lake	297	795	Oct .12	Secondary
Slave Lake	5,607	Surface	Lesser Slave Lake	2,461	6,214	Lesser Slave River via Sawridge Creek	1969	1955	Continuous	Secondary
Swan Hills	2,407	Surface	Freeman Lake	852	3,637	Athabasca River via Morse Creek	1,233	1,531	Oct. 25	Secondary
Whitecourt	6,692	Surface	Macleod River	3,813	6,548	Athabasca River	2,550	4,400	Continuous	Secondary
Westlock	4,463	Surface	Pembina River	2,298	3,820	Pembina River via Wabash Creek	2,619	3,670		Secondary

Information derived from: Alberta Environmental Protection, Standards and Approvals Division, Municipal Branch. 1993.
Alberta Water and Wastewater Facilities Survey 1993.

7.1.2 Peace River Basin

The Peace River Basin is the most populated basin in the study area. Settlements in the Peace River Basin are concentrated around the Peace Lowland agricultural region. Twenty municipalities with populations over 500 are located in the Alberta portion of the basin, information concerning their water use and wastewater discharges and treatment can be found in Table 6. All municipalities in the B.C. portion of the basin have secondary sewage treatment (Province of British Columbia 1993).

7.1.3 Slave River Basin

Three municipalities with populations over 500 are located in the basin; Fort Chipewyan, Fort Resolution and Fort Smith; information concerning their water use and wastewater discharges and treatment can be found in Table 6. Fitzgerald and Salt River are the only other permanently occupied settlements in the basin. Temporary settlements include the abandoned community of Bell Rock, Cunningham Landing, a fire-fighting base at Hay Camp, the Pine Lake summer cottage developments and scattered trapper's cabins.

Table 6. Peace and Slave River Basins - Water Intake and Discharge Information for Municipalities with Populations Greater than 500.

Municipality	Population	Withdrawal: Type of Water Source	Withdrawal: Surface Water Source	Withdrawal: Average Consumption (m^3/day)	Withdrawal: Design Capacity (m^3/day)	Discharge: Discharge Location	Discharge: Wastewater Average Flow (m^3/day)	Discharge: Design Capacity (m^3/day)	Discharge: Discharge Dates	Discharge: Treatment
Peace River Basin										
Beaverlodge	1,808	Surface	Beaverlodge River	844	3,542	Beaverlodge River	1,054	1,145	Apr. 1 & Aug 2	Secondary
Berwyn	606	Ground		326	819	Peace River	311	318	Sept. 9	Secondary
Falher	1,183	Surface	Winagami Lake			Peavine Creek	379	1,018	Oct 18	Secondary
Fairview	3,281	Surface	Peace River	1,420	5,564	Boucher Creek	1135	1932		Secondary
Fort Vermilion	823	Surface	Peace River	,520	1,637	Peace River	416	414	Apr. 30 & Oct.	Secondary
Fox Creek	2,068	Ground		936	1,738	Iosegun Lake via Fox Creek	955	955	Apr. 26 & Nov 1	Secondary
Grande Cache	3,842	Surface	Victor Lake	1,857	3,270	Smoky River	1,946	3,636	Continuous	Secondary
Grande Prairie	28,350	Surface	Wapiti River	10,507	3,270??	Wapiti River	8,406	18,182	Monthly	Secondary
Grimshaw	2,812	Ground		996	4,090	Peace River	797,	NA		Secondary
High Level	2,921	Surface	Footner Lake	1,189	3,409	Bushe River	951	1,818	May 16-26	Secondary
Hines Creek	513	Surface	Jack Creek	169	1,500	Jack Creek	150	382	early summer & mid-fall	Secondary
La Crete	689	Ground		526	418?	Drainage Ditch	421	1,006	Oct. 13	Secondary
Manning	1,144	Surface	Notikiwin River	455	1,963	Notikewin River	364	1,136	Continuous	Secondary
Peace River	6,696	Surface	Peace River	4,059	11,500	Peace River	2,570	3,291	Continuous	Primary
Rycroft	634	Surface	Spirit River	250	1418	Spirit River	200	350	Oct. 17	Secondary
Sexsmith	1,256	Ground		632	791	Kleskum Creek	506	1,050	Mar. 29 & Oct. 25	Secondary
Spirit River	1,044	Surface	Surface Runoff	362	2290	Rat Creek	290	732	Oct. 12	Secondary
Valleyview	2,039	Surface	Sturgeon Creek	965	3927	Little Smoky River via Sturgeon Creek	772	1,305	Apr., Aug. & Nov.	Secondary
Wabasca	501	Surface	North Wabasca Lake	144	717	North Wabasca Lake	165	360	Continuous	Secondary
Wembley	1,382	Ground		409	1211	Wapiti River	251	400	Aug. 16	Secondary
Slave River Basin										
Fort Chipewyan	1,200	Surface	Lake Athabasca	905	1100	Rivière des Rochers	905	1,320	Continuous	Secondary
Fort Smith NWT	2,480[a]	Surface[b]	Slave River b	1,500[b]	3,192[b]	Slave River[b]	943[b]	NA	Continuous[b]	
Fort Resolution NWT	515[a]	Surface[b]	Great Slave Lake[c]	72.1,[b]	242[b]	sand bottomed seepage pit that discharges to the subsurface[b]	72.1[b]	NA		

Information derived from: Alberta Environmental Protection, Standards and Approvals Division, Municipal Branch. 1993; and, Alberta Water and Wastewater Facilities Survey 1993.

a From 1991 Statistics Canada census.

b Information obtained from: Community Development Division, Municipal and Community Affairs, Government of the Northwest Territories.

c Lopatka, S., D. Ross and R. Stoesz. 1990/91. Northwest Territories Data Book: A Complete Information Guide to the Northwest Territories and its Communities. Outcrop: The Northern Publishers. 238 pp.

7.2 Agricultural Development

Agriculture is one of the predominant economic activities in the Northern River Basins Study area. Cultivated land in the study area is primarily located in two regions, the Peace Lowland and the Pembina Sub-basin in the Athabasca River Basin (Figure 21). Between 35% and 40% of all undeveloped land in Canada with a potential for agriculture is located in the study area (Bentley 1994). Despite this, agricultural expansion is reaching its limits, as all economically viable land is already in use. These un-developed lands are of marginal quality and would require drainage prior to cultivation, but could be developed if economic conditions were to change.

Although their are no point source effluents directly associated with agricultural development there are diffuse sources of contamination that are of concern. Pesticides, fertilizers, manure and soil have the potential to be washed into fresh water systems by agricultural runoff. The extent of use of fungicides, herbicides, fertilizers and manure are shown in Figure 22.

Fertilizers, manure and pesticides which include, herbicides, insecticides, fungicides, and vertebrate toxicants can enter surface water in runoff after heavy rainfall or snow melt and can be leached into shallow ground water deposits. Pesticides may also be transported into the atmosphere through evaporation and transpiration and later deposited into the aquatic ecosystem as precipitation. Fertilizers are a potential manmade source of nutrients and can contribute to soil acidification. Runoff from fields where manure application rates are high can cause an increase in nutrient levels, faecal coliforms and bacteria which can be harmful to both aquatic and human health, as well as cause odour problems.

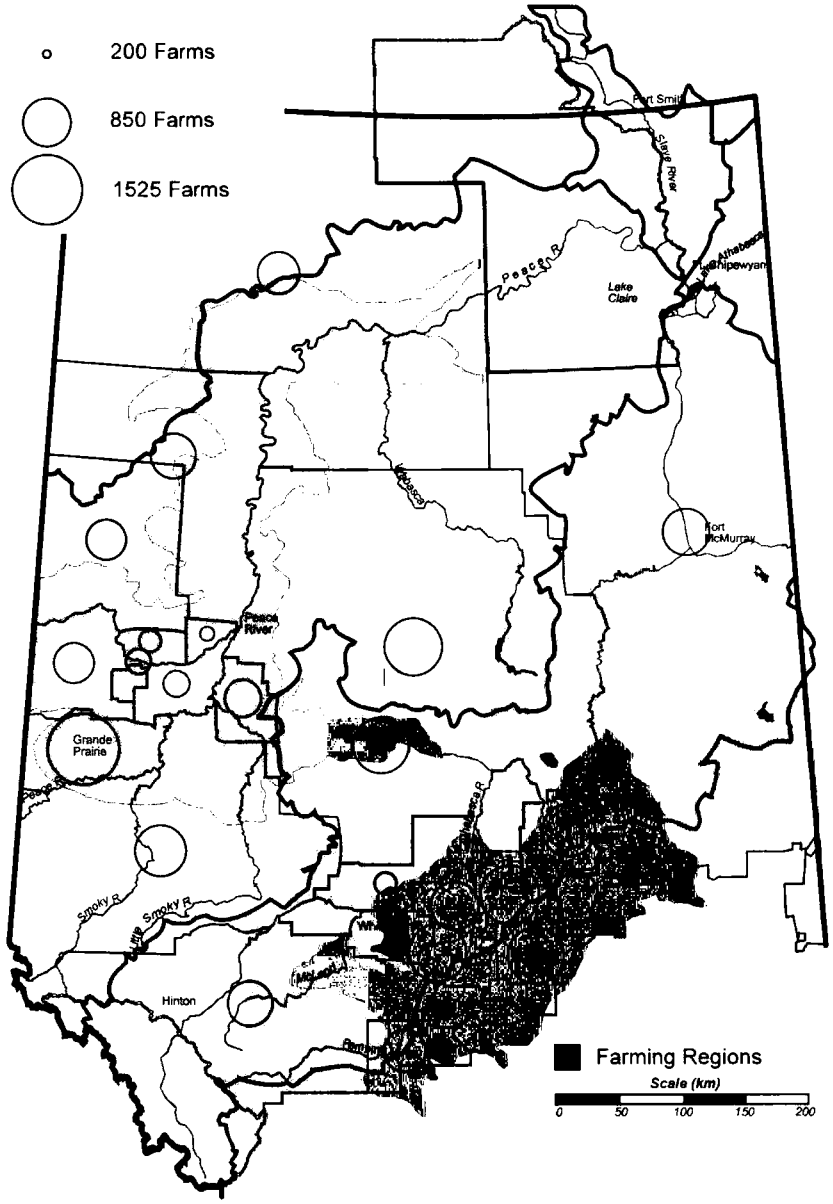


Figure 21. Agricultural Areas and Number of Farms by County.

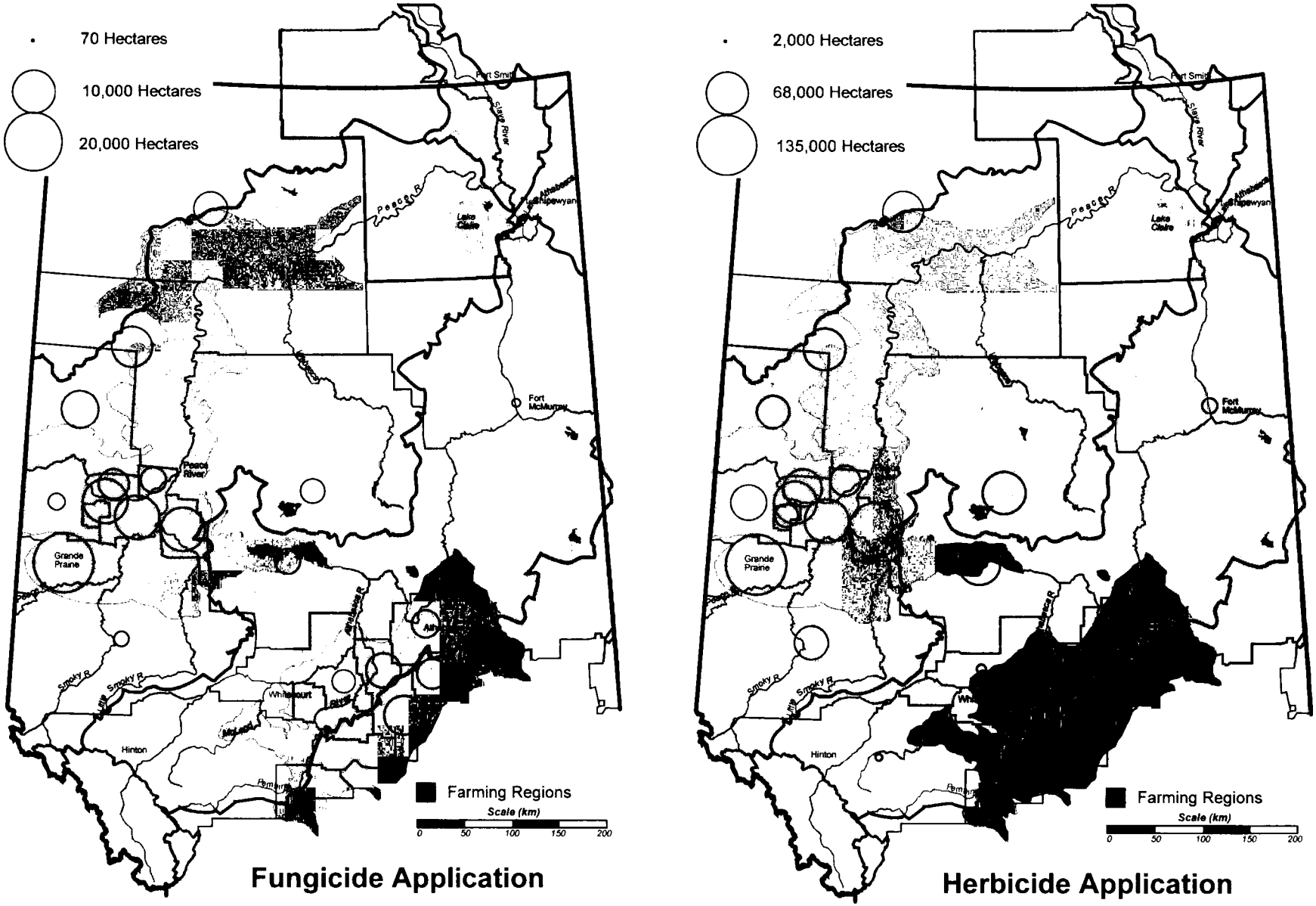


Figure 22. Application of Fungicide, Herbicide, Commercial Fertilizer and Manure in the Northern River Basins - Part A.

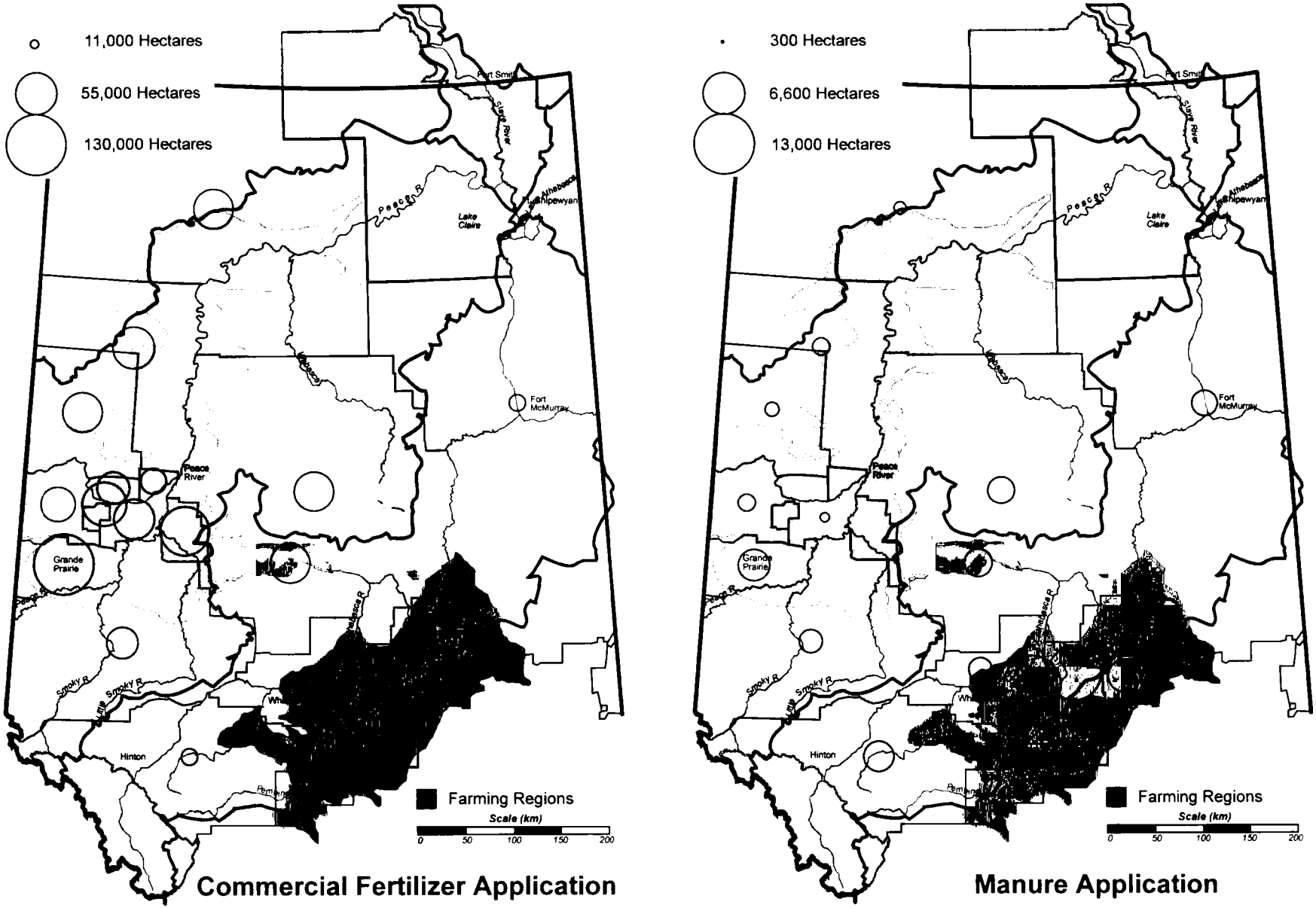


Figure 22. Application of Fungicide, Herbicide, Commercial Fertilizer and Manure in the Northern River Basins - Part B.

As a result of erosion, large volumes of soil can enter water bodies causing an increase in suspended solids. Erosion results in soil with low water holding capacity, poor nutrient content, low organic matter content, poor cultivation potential and persistent weed problems (Province of British Columbia 1993). Fine textured soils, impermeable substrate and sloping topography are all natural influences which favour erosion. The principal anthropogenic factors contributing most to soil erosion in the NRBS area are land clearing, land drainage and summer fallowing.

Land clearing removes ground cover thereby increasing the volume and velocity of runoff and increases peak runoff flows because snow cover melts more rapidly when directly exposed to the sun. Both of these factors facilitate erosion.

Agricultural activity, Peace River Basin Source: NRBS

Draining agricultural lands increases the agricultural landbase, and improves production by reducing the risk of crop loss and enabling earlier spring seeding. Yet it also has many undesirable consequences such as increasing soil erosion, flooding lower or downstream agricultural lands and the destruction of wetlands. The destruction of wetlands is of particular concern since they are a rich habitat for wildlife and vegetation, and play a key role in reducing erosion by controlling the rate of runoff and by trapping sediments.

Summer fallowing is the practice of soil tilling and leaving sections of land uncultivated for a season in order to control weeds and increase soil moisture and nutrient content. An alternative to summer fallow is to leave stubble in the fields, minimizing erosion and trapping moisture, while controlling weeds through chem-following (following through the use of chemicals rather than mechanical tilling of the soil). This is now considered to pose less of a threat to the environment than summer fallowing (Alberta Environmental Protection 1995).

7.2.1 Athabasca River Basin

Agricultural development in the basin is concentrated in the middle reaches south-east of the river, surrounding the towns of Mayerthorpe, Barrhead, Westlock, Athabasca and Lac La Biche (Figure 21). Important crops in the area include canola, wheat, oats, peas, and forage crops. Livestock production includes beef cattle, hogs, elk and bison.

7.2.2 Peace River Basin

Approximately 45,000 km^2, or 12%, of land in the Alberta portion of the Peace River Basin has been devoted to agriculture. The soil in almost 30% of this area is considered acidic, requiring modified farming practices (Alberta Environmental Protection 1995). These lands are located from Valleyview to as far north as High Level and Fort Vermilion; and are the most northerly commercially important farmlands in Canada (Figure 21). In B.C., the Peace River region contains half the cultivated crop area in that province (Province of British Columbia 1993). The area produces cereal grains such as wheat, barely, and oats; oilseeds primarily canola and flax; forage crops including seed, hay and alfalfa; and pulses which include peas, lentils and beans. Many market gardens in the area provide fresh fruit and vegetables to local residents. The livestock industry is developing with cattle, bison, elk and sheep being commercially raised in the basin. An alfalfa pelleting plant is located near Fairview. The area also has a Timothy Hay compaction plant which exports a large portion of its product to Japan. Also of note is honey production, as the Peace River Basin produces almost 30% of Canada's honey.

Fine soils, long slopes and the need to drain much of the agricultural land makes the Peace River agricultural area particularly susceptible to erosion. Alberta Agriculture estimated the cost of replacing nutrients lost due to soil erosion to be almost $10 million per year (Northern Alberta Development Council 1991).

7.2.3 Slave River Basin

In Alberta, agriculture in the Slave Basin is limited to the west of the mainstream by land use policies governing Wood Buffalo National Park and to the east by the thin topsoil and shallow and exposed bedrock characteristic of the Canadian Shield (Alberta Environment 1987). Yet in the Northwest Territories, the basin is one of the few areas with some potential for agriculture. Growth of large commercial farming operations in the basin is limited by a harsh climate, high transportation costs and a scattered population. Currently agricultural activity is limited to market gardening in Fort Smith and Fort Resolution, hay cropping near the Salt River and a cattle farm on Ryan's Island, near Fitzgerald.

7.3 Forestry

Forestry is one of the primary economic sectors in the Northern River Basins Study area. Alberta contains 382,000 km^2 of forested land most of which lies in the NRBS area. Over 85% of this land is owned provincially, the rest is either federal or private forest. The principal commercial softwoods harvested in the basins include jackpine, lodgepole pine and white spruce; while the major commercial hardwood species is trembling aspen (Praxis Inc. 1985). The principal wood products produced by the forestry industry in the area are lumber, plywood, oriented strandboard, fibreboard, roofing shakes, fence posts and wood pulp.

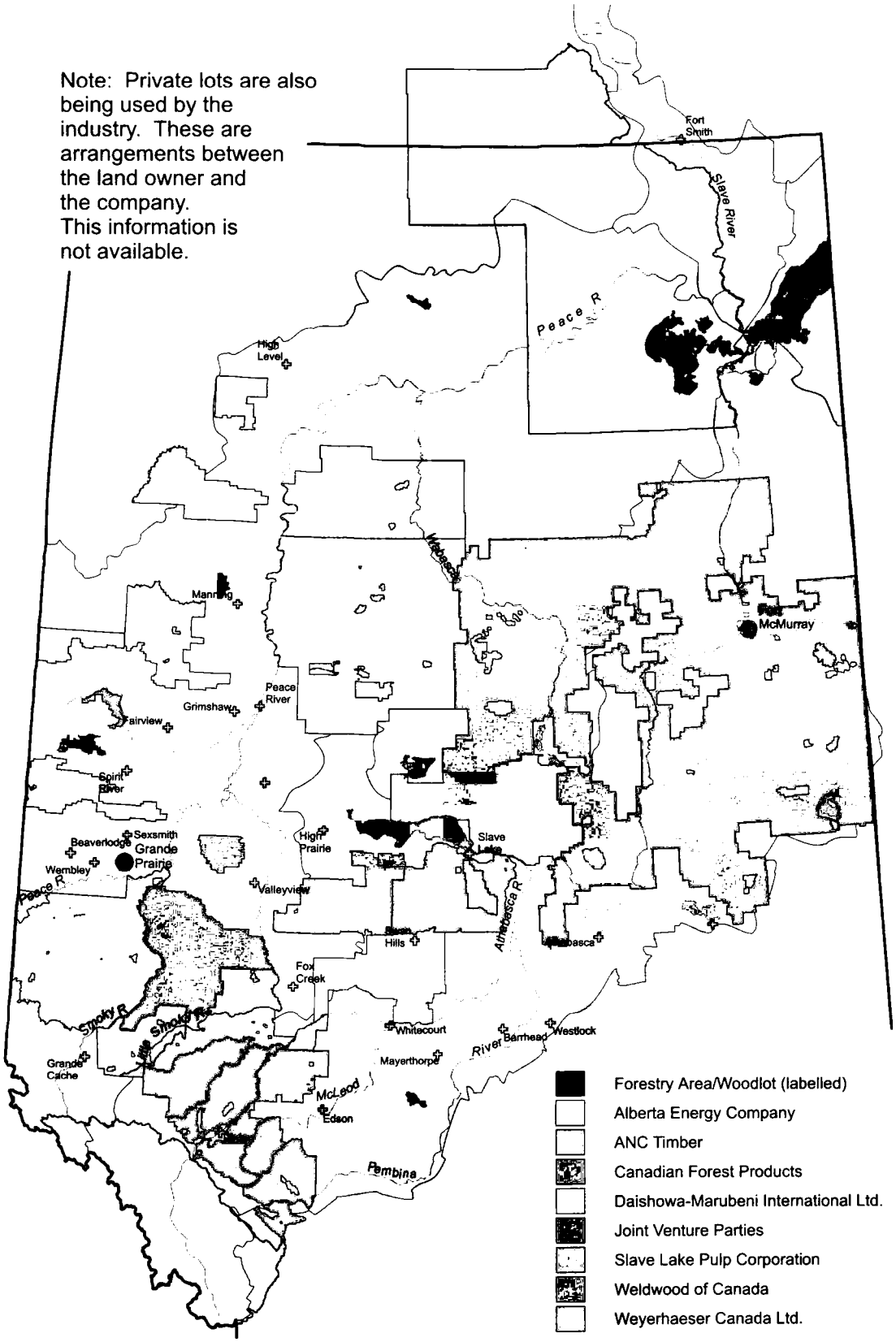


Figure 23. Forest Management Areas in the Northern River Basins.

There are eight companies that have been allocated forestland for management in the NRBS area (Figure 23).

The environmental consequences of timber harvesting operations include destruction of wildlife habitat, increased soil erosion and nutrient leaching; all resulting from deforestation. Subsidiary logging activities, such as road building, cause further habitat disturbance and soil compaction.

The wood processing industry has recently gone through a major expansion in Alberta, with five of its seven pulp mills being built since 1988. As a result, environmental effects of wood processing have become a major issue in the NRBS area. The two main types of wood processing operations located in the basin are lumber mills and pulp mills.

Lumber mills are of limited concern to water quality because they do not discharge effluent directly into fresh water bodies. For information on the location of lumber mill operations in the study area see Figure 24.

The pulp mills in the study area can be separated into three categories based on their pulping process.

Bleached Kraft Mills (BK) - These mills use both chemicals and heat to break down wood chips into soft pulp. The pulp is then chemically bleached to achieve a white pulp with very high brightness. This pulp is sold to paper mills which manufacture tissues and quality papers used for books, photocopy and office paper. Traditionally molecular chlorine was used in the bleaching process; but recently mills have begun partial substitution of molecular chlorine with chlorine dioxide or hydrogen peroxide, which reduce the formation of chlorinated

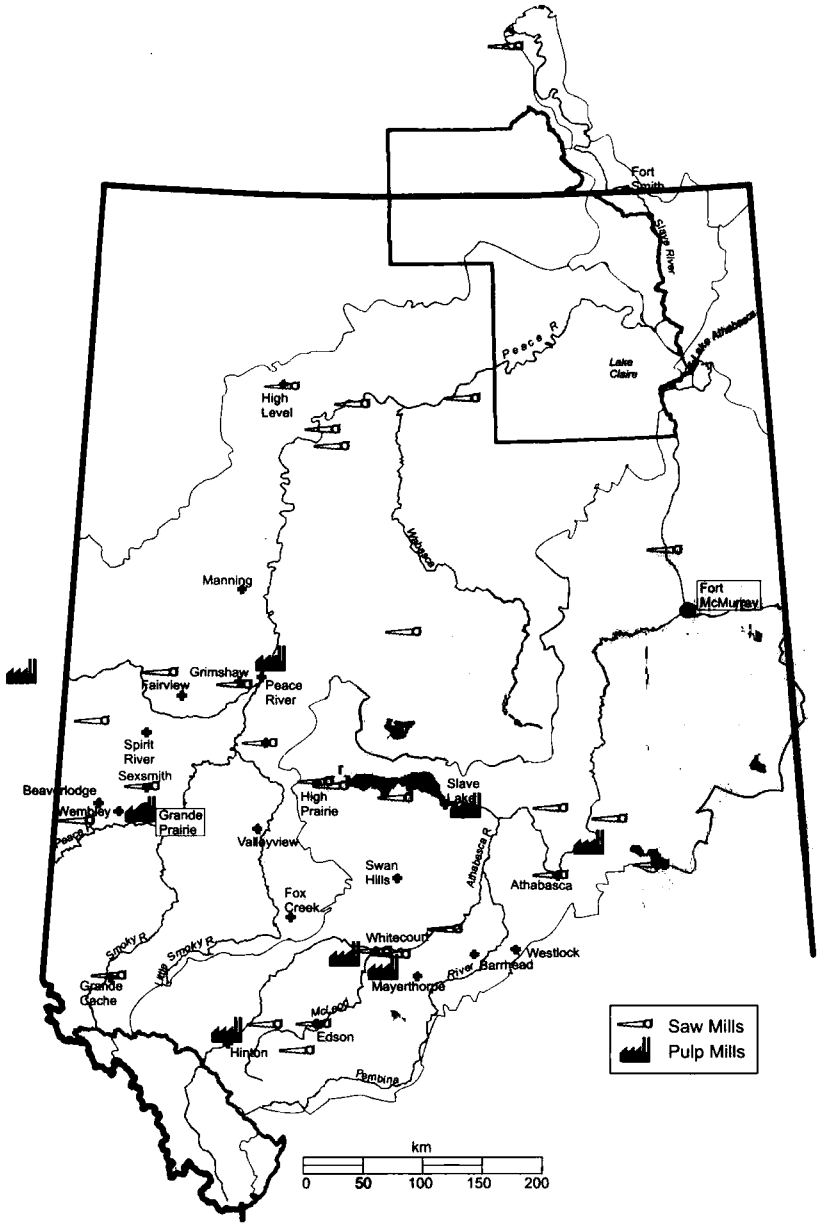


Figure 24. Sawmills and Pulp Mills in the Northern River Basins.

organic compounds in the effluent. All bleached kraft pulp mills in the study area have modified their equipment to allow for complete chlorine substitution. However, complete chlorine substitution has not been implemented in all mills as it dramatically increases the cost of producing pulp of equivalent brightness to that produced by traditional chlorine bleaching.

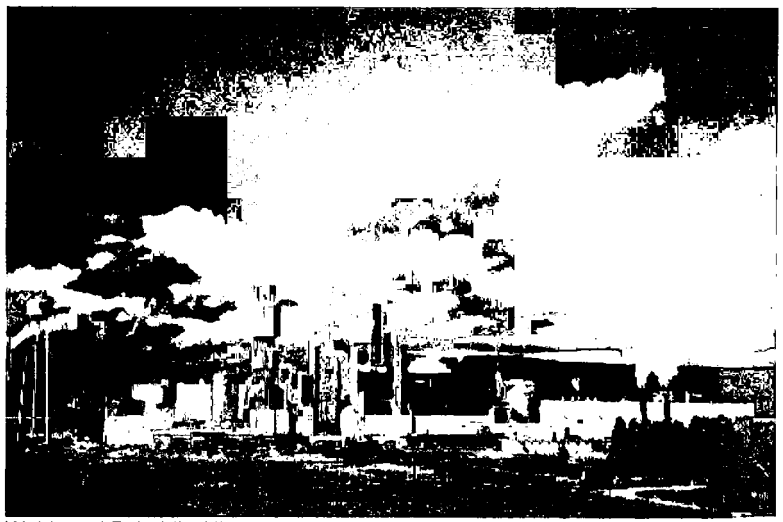
Bleached Chemi-thermomechanical Pulp Mills (BCTMP) - These mills use a combination of chemicals (often sodium sulphate), heat and mechanical grinding to break wood chips down into pulp. Although these mills use smaller quantities of chemicals per tonne of pulp, the pulp they produce is not as bright as the pulp produced by bleached kraft mills.

Thermo-mechanical Pulp Mills (TMP) - These mills use heat and mechanical action to grind wood chips into the pulp. The pulp produced is darker than that of the other types of mills and is generally used to manufacture newsprint.

The major water quality concerns associated with the effluent of all types of pulp mills include increases in biological oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), nutrients, odour and colour. The increases in COD and BOD are a result of the oxidation of chemicals, and the decay of organic solids contained in the effluent respectively. All Alberta pulp mills are required to perform secondary treatment prior to discharge in order to remove the majority of COD and BOD causing constituents.

Elevated adsorbable organic halides (AOX) values are related to bleached kraft mill effluents. AOX is used to measure concentrations of chlorinated organic compounds in the effluent. Chlorinated organic compounds, including dioxins and furans, are formed during the bleaching process and tend to accumulate in plants, fish and sediments.

Alberta Environmental protection requires that each Alberta pulp mill meet standards for the amount of BOD, TSS, AOX and colour contained in their effluent. These standards are different for each operation and are constantly being amended as technology improves. Although the effect of pulp mill effluents on surface water quality is rightfully a concern, it is important to note that the effluent quality of pulp mills in the Northern River Basins Study area "ranges from very good to equalling the best in the world" (McCubbin and Folke 1993).



Weldwood Pulp Mill, Hinton Source: C.L. Podemski

7.3.1 Athabasca River Basin

Logging is the primary land use activity in the lower half of the Athabasca River Basin (Hamilton et al. 1985). Logging activity has caused some concern over soil erosion problems in the Swan Hills region while the perceived effects of pulp mill effluents on winter water quality have caused considerable concern.

Five pulp mills are found in the basin: Weldwood of Canada Limited (Hinton) opened in 1957, Millar Western Pulp Ltd. (Whitecourt), opened in 1988; Alberta Newsprint Co. (Whitecourt), opened in 1990; Slave Lake Pulp Corp. (Slave Lake), opened in 1991; and Alberta Pacific Forest Industries (AlPac) (Athabasca), opened in 1993. For information on their water use and discharges consult Table 7. Weldwood of Canada Ltd. doubled its production capacity in 1990. As part of the expansion, Weldwood made process and effluent treatment improvements, reducing its effluent load per tonne produced for most contaminants by half. The resulting expanded mill effluent loads for most contaminants are similar to pre-expansion levels (Noton and Saffran 1995). Weldwood also began full chlorine dioxide substitution in its bleach plant in 1993. Alberta Pacific Forest Industries, the newest and largest pulp mill in Alberta, has replaced chlorine with hydrogen peroxide in its bleaching process.

The Foothills Model Forest, a 12,000 km^2 section of boreal forest, is located in the Athabasca Basin. The primary goal of this model forest, which is managed by over seventy partners, is to develop a computer model to predict wildlife responses to changes in habitat caused by timber harvesting.

Timber processing Source: NRBS

7.3.2 Peace River Basin

There are five pulp mills in the Peace River Basin: Weyerhaeuser Canada Ltd. (Grande Prairie), which commenced operations in 1973, and Daishowa-Marubeni International Ltd. (Peace River), opened in 1990, in Alberta; and Fiberco Pulp Inc. (Taylor), Finlay Forest Industries (Mackenzie) and Fletcher Challenge Canada Ltd. (Mackenzie) in B.C.. For information on their water use and discharges consult Table 7. Due to high flows on the Peace River throughout the year, the effect of pulp mill effluents on water quality is less of a concern along the Peace River mainstem than in the Athabasca River Basin. The Weyerhaeuser Mill near Grande Prairie has historically caused considerable regional concern over the impacts it has had on the small Wapiti River.

7.3.3 Slave River Basin

The forestry industry in the Slave River Basin consists mainly of two saw mills: one in Fort Smith and the other in Fort Resolution. A main consumer of wood in the basin is the Town of Fort Smith which has converted its water plant boiler from oil-fired to wood-fired. Timber harvesting is primarily done by local residents for domestic heating and fuelling.

Table 7. Pulp Mill Water Use and Effluents in the Northern River Basins

		Withdrawal			Discharge			
Company Name	Type	Type of Water Source	Surface Water Source	Average Consumption (m^3/day)	Discharge Location	Average Flow (m^3/day)	% of Water and Treatment Received	Effluent Monitored for [c]
Athabasca River Basin								
Alberta Pacific Forest Industries, Athabasca	BK	Surface	Athabasca River	28,135 [b]		51,840[a]	Primary & Secondary	Ammonia, Sulphides, Major Ions, TOC, DOC [e]
Alberta Newsprint Company, Whitecourt	TMP	Surface	Athabasca River	21,027	Athabasca River	16,224	82% Primary 100% Secondary	Organic Priority Pollutants, Ammonia, Major Ions, TOC, DOC, EDTA, Faecal Coliforms [d]
Millar Western Pulp Limited, Whitecourt	BCTMP	Surface	McLeod River	15,132 [b]	Athabasca River	12,096[a]	Primary & Secondary ??	Silicate, Chelators [d]
Slave Lake Pulp Corporation, Slave Lake	BCTMP	Surface	Lesser Slave River	5,537[b]	Pembina River	3,456[a]	Primary ?? Secondary ??	Silicate, EDTA, Faecal Coliforms [d]
Weldwood of Canada Limited, Hinton	BK	Surface	Athabasca River	107,780	Athabasca River	107,780	52% Primary 100% Secondary	[e]
Peace River Basin								
Daishowa- Marubeni International Limited, Peace River	BK	Surface	Peace River	76,986	Peace River	65,910	93% Primary & Secondary	Oil and Grease [e]
Fiberco Pulp Incorporated, Taylor, BC	BCTMP[f]	NA	NA	NA	Peace River [f]	NA	NA	NA
Finlay Forest Industries, Mackenzie, BC	TMP[f]	NA	NA	NA	Peace River [f]	NA	NA	NA
Fletcher Challenge Canada Limited, Mackenzie, BC	BK[f]	NA	NA	NA	Peace River [f]	NA	NA	NA
Weyerhaeuser Canada Limited, Grande Prairie	BK	Surface	Wapiti River	81,083	Wapiti River	67,001	60% Primary 93% Secondary	Manganese, Chromium, 2,4 Dichlorophenol, TDS, Sulphide [e]

All information from 1991 Statistics Canada Water Use Survey unless otherwise noted.
All information is assumed to be for 100% of the withdrawal or discharge water unless otherwise noted
AOX - Adsorbable Organic Halogen
BOD - Biochemical Oxygen Demand
COD - Chemical Oxygen Demand
DOC- Dissolved Organic Carbon
EDTA - A Chelator
NA - Not Available
TOC - Total Organic Carbon
TON - Threshold Odour Number
TDS - Total Dissolved Solids
TSS - Total Suspended Solids

[a] Noton, L. and K. Saffran. 1995 . Water Quality in the Athabasca River System 1990-1993. Surface Water Assessment Branch Technical Services and Monitoring Division Alberta Environmental Protection. 239 pp.
[b] Values are for 1993 and assume the mill was in operation for 365 days. Information obtained from Alberta Environmental Protection, Water Resources Administration Division..
All pulp mill monitoring information was derived from the companies' "Licence to Operate or Use" under the Clean Water Act.
[c] Only those parameters that are not monitored by all Alberta pulp mills of that type are mentioned.
[d] All Alberta Chemi-thermomechanical Pulp Mills monitor for: BOD, TSS, COD, Colour, Acute Lethality, Chronic Lethality, Resins and Fatty Acids, pH, Heavy Metals, Temperature, Specific Conductance and Nutrients.
[e] All Alberta Bleached Kraft Pulp Mill monitor for: AOX, BOD, TSS, Colour, Temperature, pH, Chlorite/Chlorate, Resins and Fatty Acids, Acute Toxicity, Chronic Toxicity, COD, Specific Conductance, TON, Heavy metals, Chlorinated Phenolics, Total Phenols, Nutrients, Organic Priority Pollutants, Chloroform, *Kassiella* and Coliforms, Dioxins and Furans
f McCubbin, N. and J. Folke of N. McCubbin Consultants Inc. 1993. A Review of Literature on Pulp and Paper Mill Effluent Characteristics in the Peace and Athabasca River Basins. Northern River Basin Study Report # 15, Northern River Basin Study; Edmonton, Alberta. 85 pp.

7.4 Petroleum

The petroleum industry in the Northern River Basins Study area includes conventional oil and gas fields, heavy oil and gas fields, oil sand bitumen deposits and numerous oil and gas processing plants (Figure 25). Some of the largest producing oil and gas fields in Canada are located in the Basins. Over 60,000 km^2 of north-eastern Alberta is underlain by oil sand deposits, most of which lie within the study area (Figure 26).

Land disturbances are associated with pipelines, seismic lines, temporary roads, oil and gas wells and tar sand mining operations. Along with disturbing the land, seismic lines provide access for hunters and trappers into what would otherwise be natural forest and inconvenient to reach.

The petroleum industry is a principal water user in the NRBS area. The industry uses large volumes of surface and ground water for secondary oil recovery and natural gas processing. Although water shortage is not a big concern in the area, the petroleum industry also produces large amounts of brine solution in conjunction with oil and gas operations. This solution is often injected back into the formation raising concern about possible contamination of ground water aquifers. Another potential source for both ground and surface water contamination is oil spills from pipelines. Although the petroleum industry is a potential source of oil and grease, heavy metals, bitumen, trace organics, sulphur and phenol; in the NRBS area the industry does not have an appreciable affect on surface water quality.

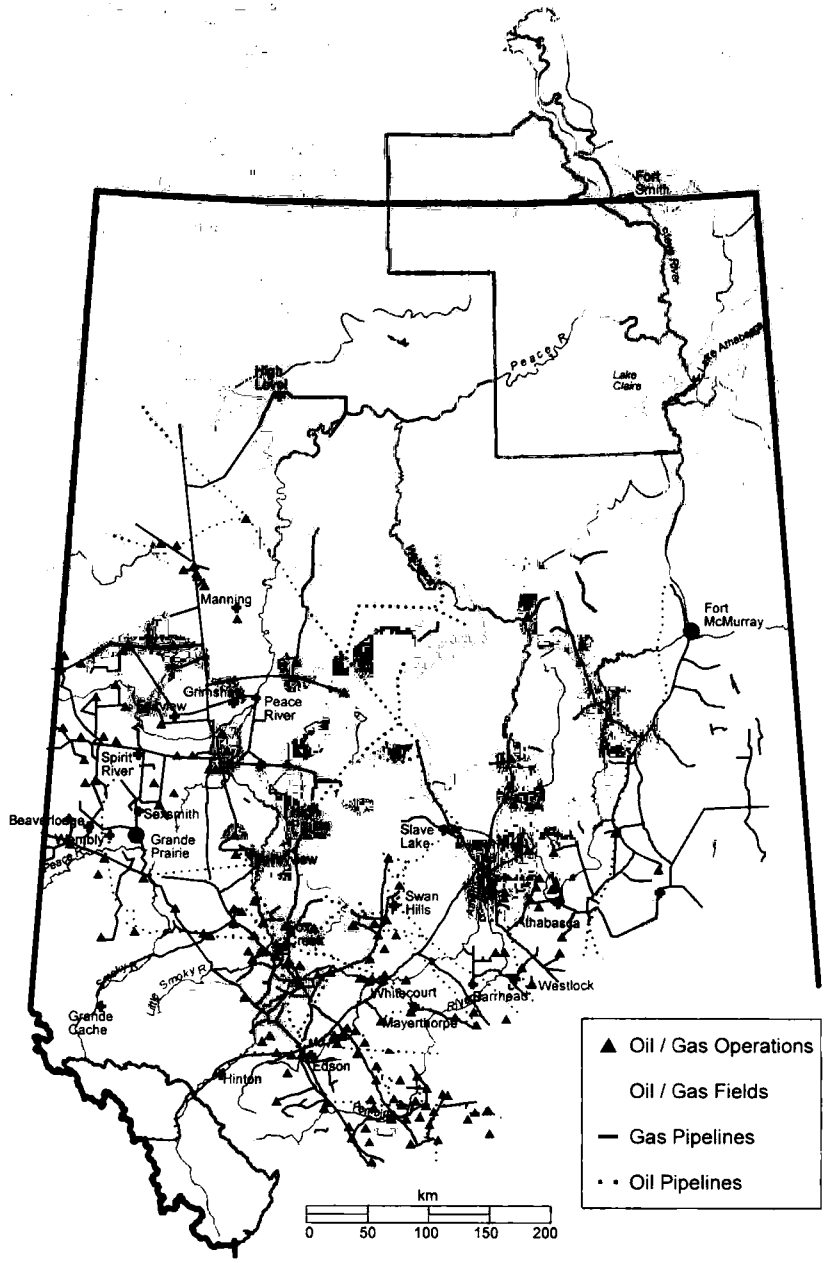


Figure 25. Oil and Gas Fields and Main Pipe Lines in Alberta.

7.4.1 Athabasca River Basin

The Athabasca Oil Sand deposit is largest in Alberta, containing approximately 212 billion m^3 of bitumen (The Canadian Encyclopaedia 1988). Although this bitumen is located at depths of up to 750 meters, it reaches near the surface in the Fort McMurray area. The Suncor Incorporated Oil Sands Group and Syncrude Canada Limited are the largest among the companies that mine this deposit. Suncor discharges its oil sands upgrading process wastewater and mine drainage systems into the Athabasca after treatment. While Suncor's extraction plant tailings and mine depressurization wastewater are stored in tailings ponds, concern has been raised about the potential for accidental spills related to Suncor's tailings pond which is located right on the edge of the Athabasca River. Currently, Syncrude only discharges treated sewage from its 'Lower Camp' into the River. Information regarding water use and effluent discharges associated with oil sands operations in the Athabasca River Basin can be found in Table 8.

7.4.2 Peace River Basin

The largest producing conventional oil and gas field in Canada is located at Fox Creek in the Peace River Basin. The Elmsworth field, south-west of Grande Prairie, is also a large producer. The Peace River and Wabasca oil sands deposits are two of the four largest in the province. The Peace River oil sand deposit contains roughly 21 billion m^3 of bitumen ranging in depth from 300 m to 600 m (The Canadian Encyclopaedia 1988). The deposit is currently being exploited by Shell Canada Limited using *in situ* steam

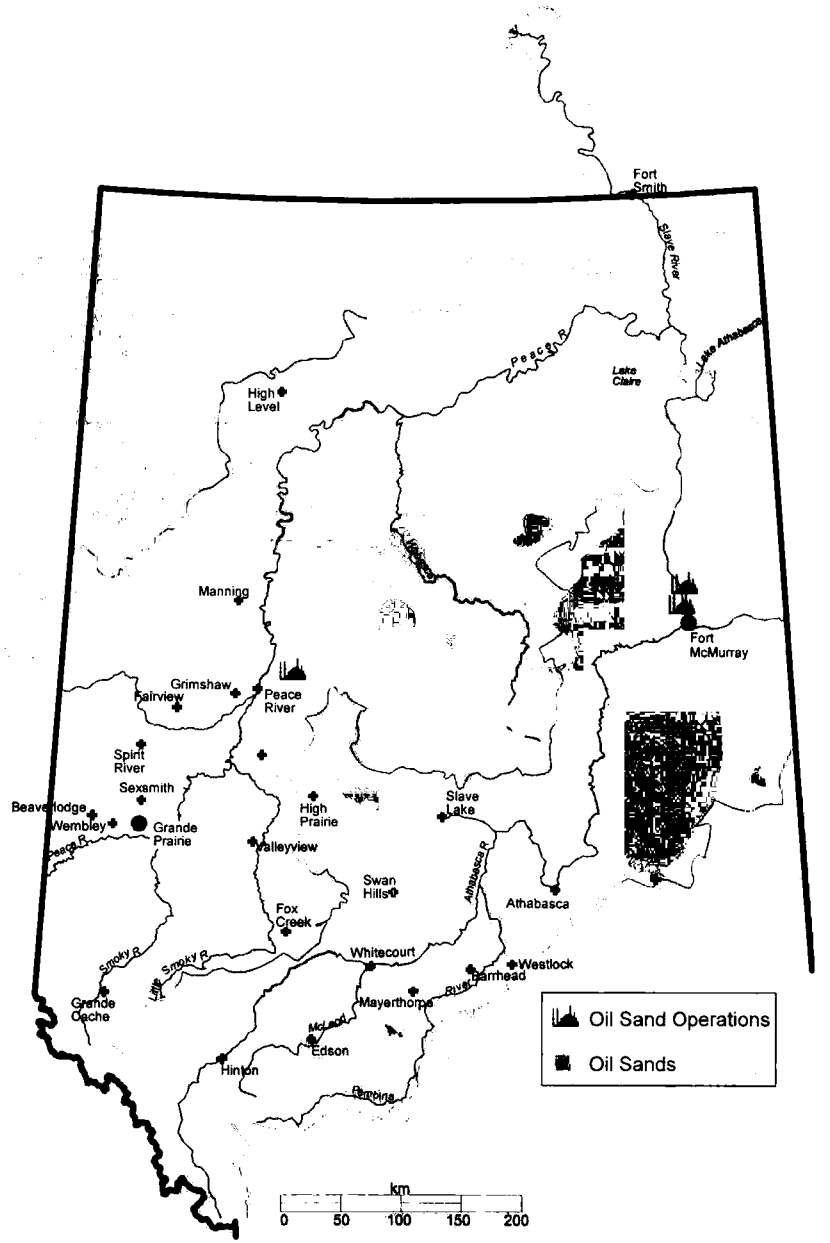


Figure 26. Oil Sands Deposits and Operations in Alberta

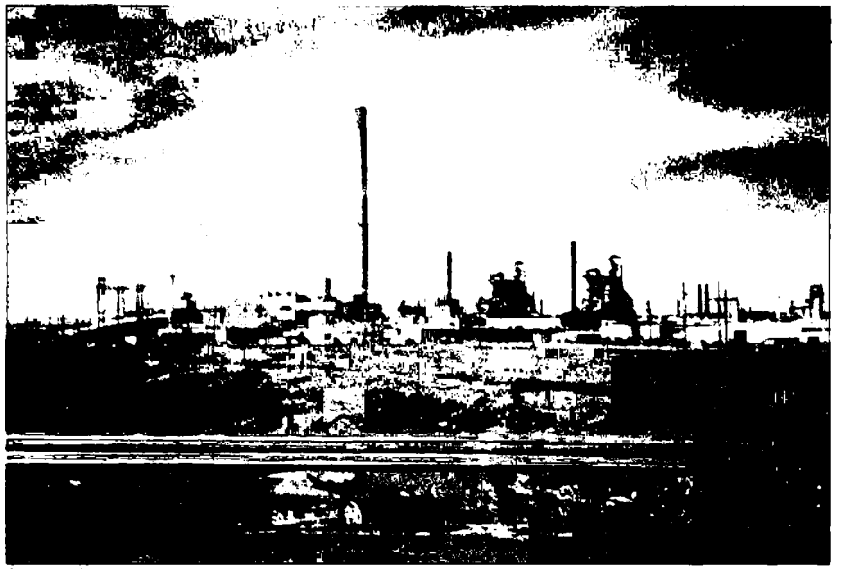
Table 8. Oil Sands Water Use and Effluents Northern River Basins.

		Withdrawal			Discharge			
Company Name	**Type**	**Type of Water Source**	**Surface Water Source**	**Average Consumption (m^3/day)**	**Discharge Location**	**Average Flow (m^3/day)**	**% of Water and Treatment Received**	**Effluent Monitored for**
Athabasca River Basin								
Alberta Oil Sands Technology, 90 km NW of Fort McMurray	Experimental Steam Injection Oil Recovery Operation	Ground		81.4	93% Trucked off-site for processing 7% (Sewage) Discharged into fresh water body.	81.4	Secondary (Sewage Only)	BOD, TSS, pH, Grease, Colour
Chevron of Canada Resources Ltd., Mitsue	Experimental Steam Injection Oil Recovery Operation	Surface	Lesser Slave River	15,452	Unnamed Fresh Water Body	2,009	None	None
Imperial Oil Resources (Esso Resources Canada Ltd.), Swan Hills	Experimental Fresh Water Injection Oil Recovery	None		None	Injected Into Producing Formation	4,181	Primary & Secondary	None
Suncor Inc. Oil Sands Group, Fort McMurray	Oil Sands	Surface	Athabasca River	91,711 [b]	Athabasca River	28,512 [a]	Secondary [a]	COD, Phenols, Sulphide, Ammonia-Nitrogen, Oil and Grease, TSS, Acute Lethality, pH, Heavy Metals
Syncrude Canada Ltd., Mildred Lake	Oil Sands	Surface	Beaver Creek	81,286 [b]	Beaver Creek (Sewage)	691[a]	Secondary [a]	[c]
					Tailings Pond	NA	NA	COD, Alkalinity, Hardness, Ammonia, Bitumen Content [c]
Peace River Basin								
Shell Canada Limited, Peace River	Oil Sands	Surface	Peace River	NA	Peace River (sewage & discharge from raw water intake facilities) [d]			oil and grease, chloride and pH [d]

All information from 1991 Statistics Canada Water Use Survey unless otherwise noted.
All information is assumed to be for 100% of the withdrawal or discharge water unless otherwise noted
All monitoring information was derived from the companies' "Licence to Operate or Use" under the Clean Water Act.

BOD - Biochemical Oxygen Demand
DIC - Dissolved Inorganic Carbon
DOC - Dissolved Organic Carbon
NA - Not Available
TDS - Total Dissolved Solids
TSS - Total Suspended Solids

[a] Noton, Leigh and Karen Saffran. 1995. Water Quality in the Athabasca River System 1990-1993. Surface Water Assessment Branch Technical Services and Monitoring Division Alberta Environmental Protection. 239 pp.
[b] Values are for 1993 and assume the plant was in operation for 365 days. Information obtained from Alberta Environmental Protection, Water Resources Administration Division.
[c] The Syncrude tailings pond and effluent are monitored for: Oil and Grease, pH, TSS, Phenols, Conductivity, TDS, DOC, DIC, Total Carbon, Chloride, Carbonate and Bicarbonate, Sulphate, Total Sulphide, Calcium, Magnesium, Sodium, Potassium, Nitrate, Nitrite, Heavy Metals.
[d] Information was derived from the companies "Licence to Operate or Use" under the Clean Water Act.



Syncrude Source: NRBS

injection technology. For information on water use and effluent **discharges** of oil sands operations in the Peace River Basin please see Table 8.

7.4.1 Slave River Basin

The potential for oil and gas production in the eastern portion of the basin is precluded by the Canadian Shield. As of yet, there is no petroleum industry development in the portion of the basin lying in the Interior Plains.

7.5 Mining

The main mining activity in the Northern River Basins Study area is coal mining. Metallurgical grade coals are found on the eastern slopes of the Rocky Mountains and sub-bituminous coal beds suitable for thermal power generation are found in the southern Interior Plains (Figure 27). Other mining activities in the area include sand and gravel, sulphur, vanadium, peatmoss and uranium mining. There is mining potential for salt, limestone, granite, gypsum and silica (Figure 28).

Currently, coal mining activities in the NRBS area are mainly surface mining operations. Five of the six operational mines in the area are surface mines. As a result, the main environmental concern associated with coal mining is land disturbance. Provincial law requires, that, upon closure, mining companies restore each site to a suitable wildlife habitat. Mining activities are a potential source of iron, coal dust and salts, but as yet have not had a major impact on surface water quality in the study area. However, some headwater streams like the McLeod River have seen some fish habitat damage from mine runoff.

Sulphur is produced as a by-product of natural gas production and oil sand extraction. Therefore sulphur mines are located in areas adjacent or near to natural gas or oil sand processing plants (Figure 28).

Cardinal River Coal Mine Source: NRBS

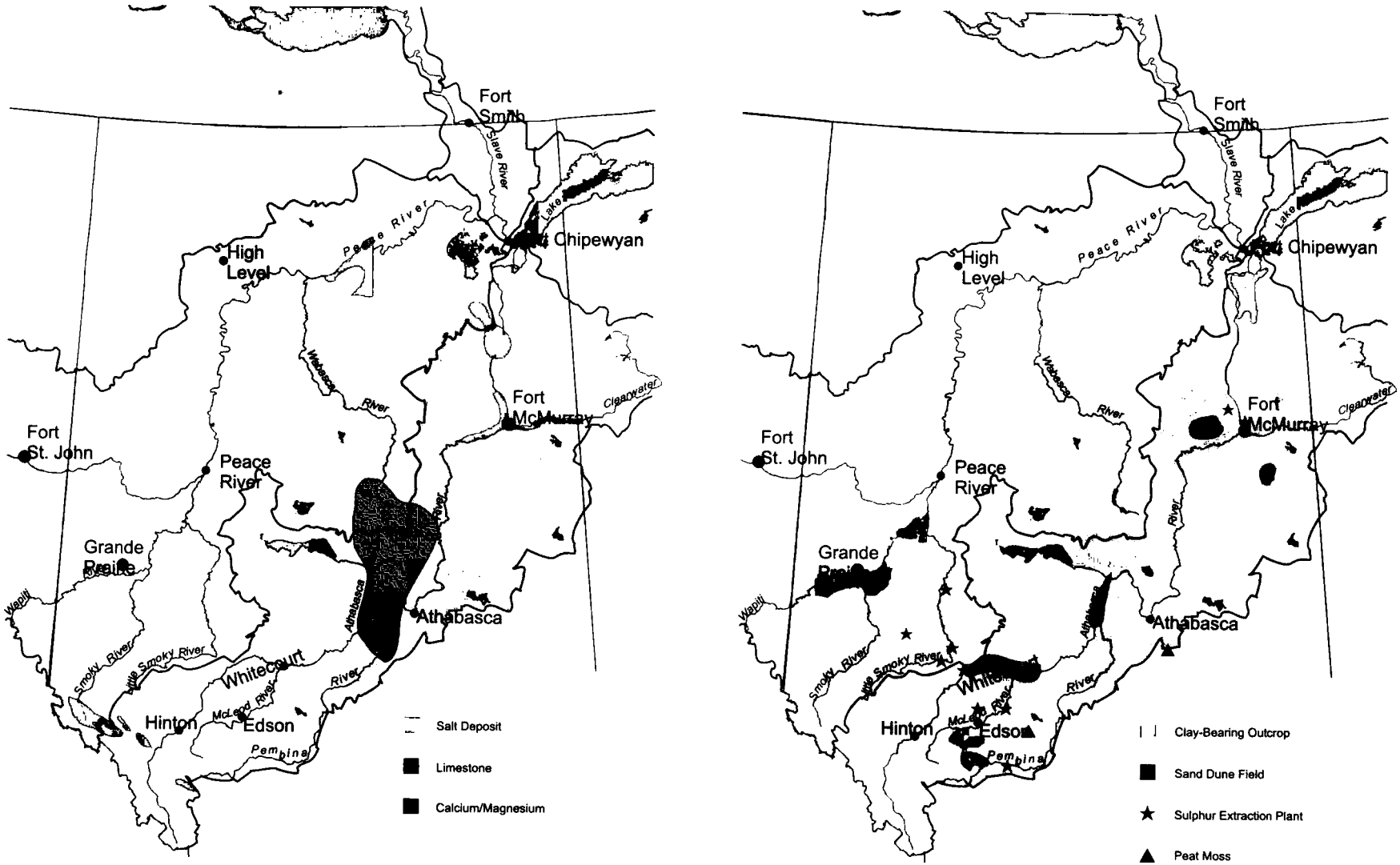


Figure 28. Minerals for Construction and Chemical Industries, 1989.

7.5.1 Athabasca River Basin

Mining activities in the Athabasca River Basin include coal, vanadium, sand and gravel and sulphur mining. There are four active mining operations in the Athabasca basin all of which are located in the foothills region. Previously, there were two additional mines in the foothills and two in the Interior Plains Region. For information regarding the water use and effluent discharges of coal mining operations in the basin, see Table 9. The Athabasca oil sand deposit is rich in several heavy metals including vanadium, titanium and zirconium, which concentrate during oil sands processing and may be recoverable (Praxis Inc. 1985). Carbovan Incorporated is currently extracting vanadium from the Suncor tailings pond.

7.5.2 Peace River Basin

Coal and sulphur mining are carried out in the Alberta portion of the Peace River Basin. Smoky River Coal Limited operates one surface and one underground mine in the Grande Cache area. Information regarding their water use and effluent discharges can be found in Table 9. Potential exists for limestone, gypsum and silica mining developments in the basin.

7.5.3 Slave River Basin

Currently, mining activity in the Slave River Basin is limited to small scale sand and gravel operations. In the Canadian Shield area in the eastern portion of the basin, there are gypsum deposits and large red granite deposits suitable for the production of dimensional stone. Until 1987, Cominco Limited ran the Pine Point lead-zinc mine located 80 km east of

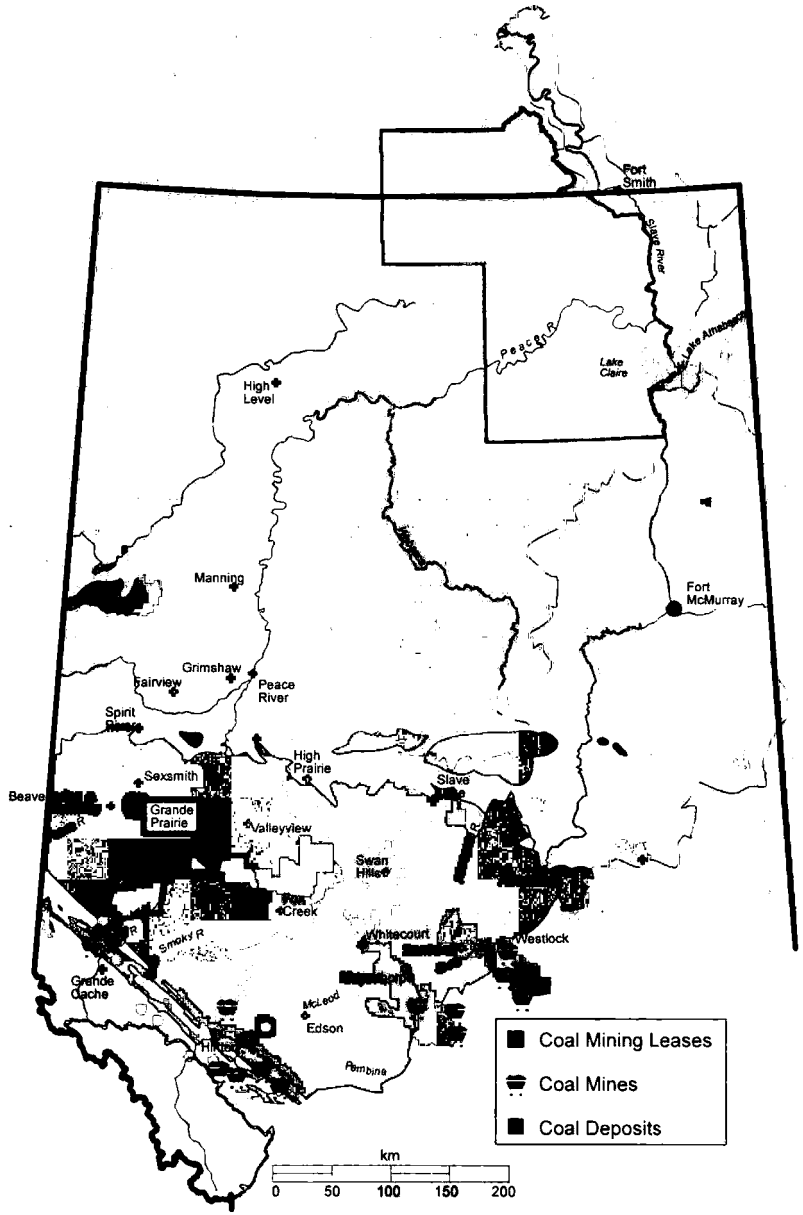


Figure 27. Coal Leases and Reserves in the Northern River Basins.

Hay River. Although it lies just outside the NRBS boundary it is of interest due to its size. It was the largest industrial operation in the Northwest Territories with proximity to the Slave River Delta. Future development of the mining industry will likely be limited by transportation costs.

There are currently two operational uranium mines in the Lake Athabasca Basin (Figure 29). Until the 1970s there were three additional mines in the Uranium City (Saskatchewan) area. Concern was raised that radionuclides, unstable atoms that emit radiation, may be released into the aquatic ecosystem as a result of uranium mining. Sampling has been carried out in the Peace-Athabasca Delta and Lake Athabasca areas and radionuclide concentrations were found to be well within the Guidelines for Canadian Drinking Water Quality (Armstrong et al. 1995).

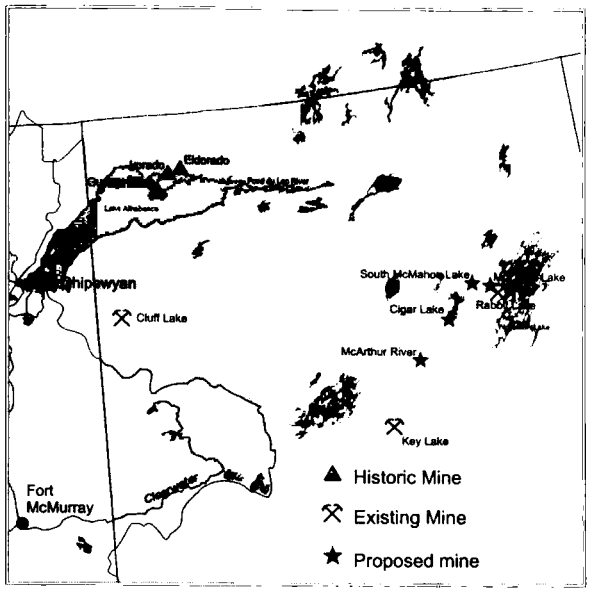


Figure 29. Uranium Mine Locations

Table 9. Coal Mining Water Use and Effluents in the Northern River Basins

		Withdrawal			Discharge			
Company Name	Type	Type of Water Source	Surface Water Source	Average Consumption (m^3/day)	Discharge Location	Average Flow (m^3/day)	% of Water and Treatment Received	Effluent Monitored for
Athabasca River Basin								
Carbovan Inc., Fort McMurray	Vanadium Extraction	2.2% Ground 0.2% Public Water Utility System 97.6% Processed Water From Suncor's Tailings Pond		2,294	Suncor's Tailing Pond	2,294		TSS, pH, Other
Cardinal River Coals, Luscar	Coal Processing	59% Surface 41% Ground	Luscar Lake	3,456	99% McLeod River 1% Ground	10,600 [a]	99.6% Primary 3% Secondary	BOD, TSS, Phenols, Toxics, pH, Temp., Colour, Other [b]
Obed Mountain Coal Limited, Obed	Coal Processing	NA	NA	NA	NA	NA	NA	[b]
Luscar Sterco Limited, Coal Valley	Coal Processing	NA	NA	NA	NA	NA	NA	[b]
Gregg River Resources Ltd., Luscar	Coal Processing	63% Ground 27% Runoff		1,352	Unnamed Fresh Water Body	7,050 [a]	95% Primary	BOD, TSS, pH, Other [b]
Peace River Basin								
Smoky River Coal, Grande Cache	Coal Processing	76% Surface 24% Ground	Smoky River	591	Smoky River	137	85% Secondary	BOD, TSS [b]

All information from 1991 Statistics Canada Water Use Survey unless otherwise noted. All information is assumed to be for 100% of the withdrawal or discharge water unless otherwise noted
BOD - Biochemical Oxygen Demand ; NA - Not Available; TSS - Total Suspended Solids
[a] Discharge is higher than withdrawal due to dewatering of the formation; [b] All Alberta coal processing operations are required to monitor for: TSS, pH. Nitrate, Nitrite, Turbidity, Oil & Grease, Iron, Nutrients, Metals and Benthic Invertebrates.

7.6 Transportation

Transportation costs are the main limiting factor to industrial development in the Northern River Basins Study area. Historically, transportation both drove and hindered settlement of the area. Barge traffic, once crucial to the area, is now very limited.

Currently even the most northerly communities in the area are accessible year round by air. Yet many communities, such as Fort Chipewyan, are only accessible by land from the south via winter roads and are not accessible by water from the beginning of freeze-up until break-up is completed. Figure 30 is a current map of the road, railway and airport network in the NRBS area. Transportation networks provide an essential service, but produce some negative environmental effects. Highways increase access to wilderness areas and alter storm runoff, increasing erosion, harming roadside vegetation and creating a diffuse source of wastewater containing salts and hydrocarbons. Railways cause noise pollution and cut off wildlife corridors. Airports require large quantities of land. Barge transportation system are sources of sewage and potential small scale oil spills. Overall though, the combined effects of transportation do not have a major effect on water quality in the NRBS area.

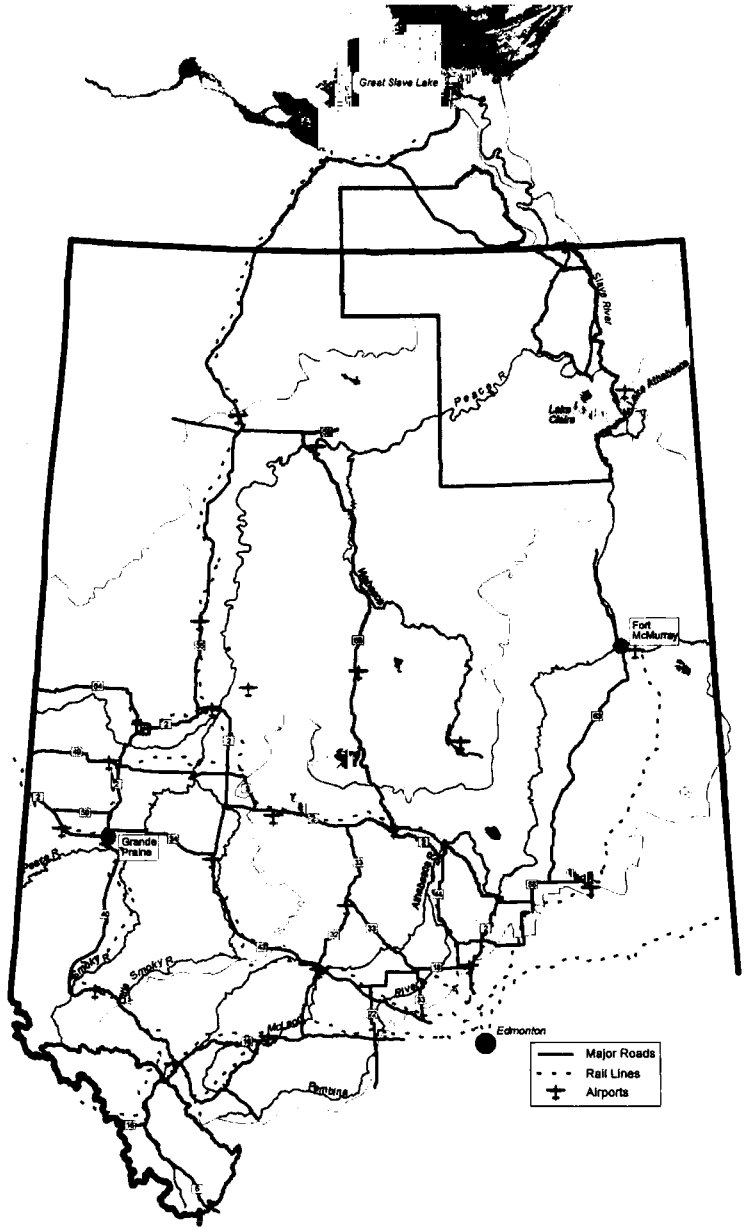


Figure 30. Transportation Infrastructure in the Northern River Basins.

7.7 Hunting, Trapping and Fishing

Hunting is undertaken in the Northern River Basins Study area for recreation and as a primary source of food. Moose, caribou, deer, black bear and waterfowl are the chief species hunted for recreation. While the principal species hunted for food are caribou, moose and small game birds such as grouse and ptarmigan are also utilized.

Many area residents trap to supplement their income. For some in the most northerly portions of the NRBS area, trapping is a main source of income. Beaver, muskrat and squirrel are taken in the greatest number, but due to the high value of their furs, lynx and mink produce the greatest revenue for trappers.

Preparing Marten set

Source: NRBS

Trapping statistics for Alberta suggest that there were about 3,470 trappers in the NRBS area in 1994/95, the majority of which (62 percent) have registered trap lines. The remainder include trappers on private lands, licensed Métis and Indian trappers, as well as people licensed to trap within Wood Buffalo National Park. Survey data also indicate that there are about 10 active trappers in the Fort Smith area of the Northwest Territories.

Beaver is the key species trapped in the NRBS area, with an estimated 25,600 animals harvested in 1993/94. This represents about 47 percent of all the animals trapped in the region and accounts for nearly 74% of all the beaver trapped in Alberta.

More than 10,000 muskrats and coyotes are also trapped in the region, with each of these species accounting for about 20 percent of the total fur harvest in the NRBS area. The NRBS area accounts for more than 80 percent of the provincial harvests of weasel, fisher and otter.

The total value of fur harvested from the NRBS area in 1993/94 was $1.3 million. Trapping represents a major source of revenue for the NRBS area, especially for residents of the lower Peace and Athabasca basins.

The fish populations in the NRBS area are used for recreational, domestic and commercial purposes. Recreational fishing in the study area is mainly of local or provincial significance. Exceptions to this are sport fishing in Jasper National Park, and fishing camps in the eastern portion of the Slave Basin which are of national and international significance. Domestic fishing licences are issued to First Nation and Métis residents for use on lakes within their reserve or settlement and to residents north of Township 62 (approximately 54.3° latitude) when they are in need of fish for sustenance (Paetz 1984). The

fish caught with domestic licenses are used for human consumption and dog food.

It is estimated that there are currently 400 commercial fishermen in the NRBS area. This represents a reduction of 200 commercial fisherman since 1990/91. Commercial fishermen caught an average of 1.37 million kilograms of fish per year in lakes in the NRBS area over the past five years, representing about two-thirds of the total Alberta commercial fish harvest.

As shown in Figure 31, lake whitefish account for 70 percent of the commercial harvest, while northern pike account for 17 percent. Much of the remainder of the catch consists of walleye and tullibee. Other commercial species include burbot, perch, suckers and trout.

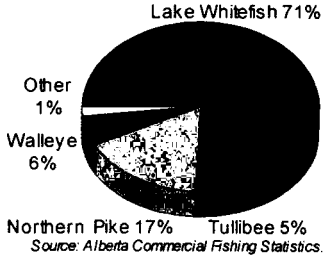


Figure 31. Composition of Commercial Fish Harvest.

More than 25 lakes in the NRBS area are used for commercial fishing. The most important lakes include Lesser Slave Lake, Lac la Biche, Snipe Lake, Lake Athabasca, Utikuma Lake and Winagami Lake. These six lakes account for 81 percent of the total harvest in the NRBS area. Commercial fishing also occurs on Sturgeon Lake, Peerless Lake, North Wabasca Lake and Lake Nipisi. The relative importance of key commercial fishing lakes is shown in Figure 32. No commercial fishing occurs in the mainstems of the Peace, Athabasca or Slave rivers.

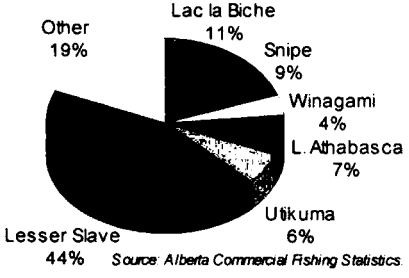


Figure 32. Key Commercial Fishing Lakes.

7.8 Tourism, Recreation and Parks

Tourism is a growing industry in the Northern River Basins Study area. Hard economic times have caused many Albertans to seek tourist destinations inside the province (Figure 33), and the study area offers many interesting vacation destinations. Although the majority of the tourists are from Alberta, a growing number of Americans and Europeans and other visitors come to the area for its remote wilderness experiences such as eco-tourism tours of the Peace-Athabasca Delta, Whooping Cranes and bison watching in Wood Buffalo National Park, and rafting trips on the Slave River. Ever since the railway pushed through the Rocky Mountains in the early part of the century, Jasper National Park has been attracting visitor from around the globe.

The study area provides many high quality recreational resources including, camping and wildlife areas (Figure 34), heritage sites, golf courses and ski trails and lakes suitable for fishing (Figure 35), swimming and boating (Figure 36). Recreational activities are not without some adverse environmental impacts. Golf courses and groomed parks use fertilizers, pesticides and herbicides which can be a source of diffuse water contaminants. Cottages, hotels, trails and roads *etc.* cause land disturbance, while concentrating people who produce noise, solid waste and sewage. The environmental effects of recreation and tourism on the study area as a

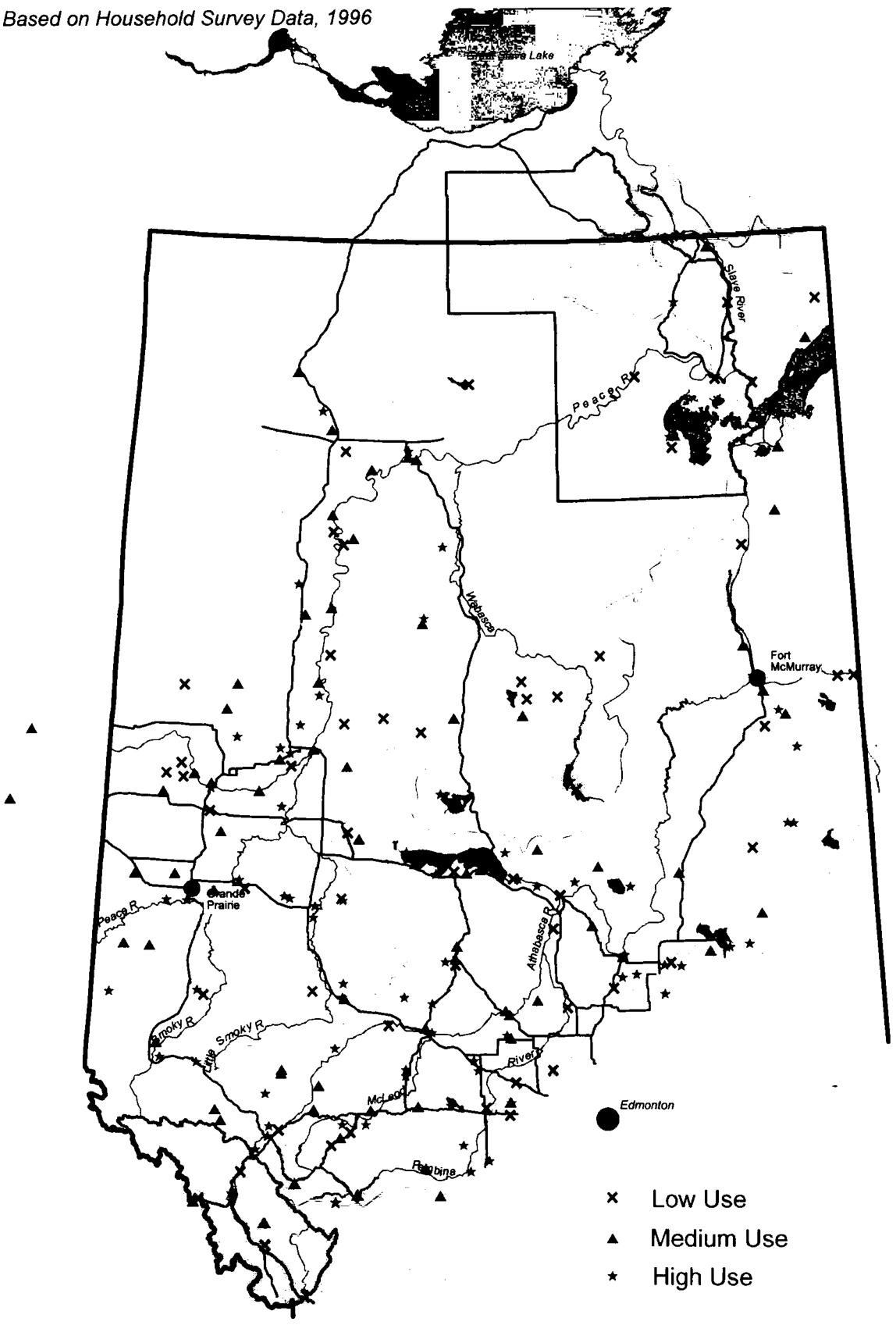


Figure 33. Key Recreational Sites used by Basin Residents

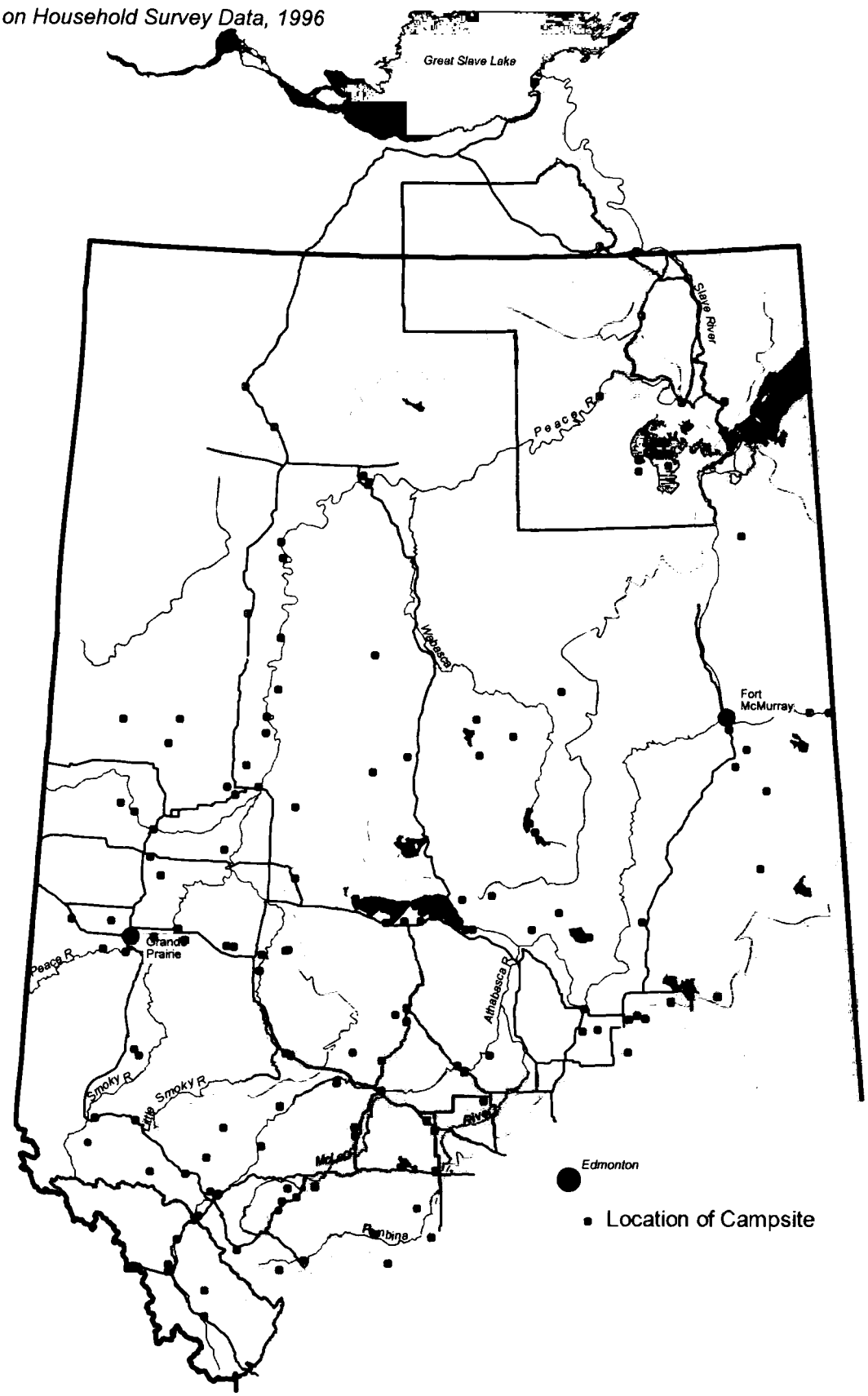


Figure 34. Key Camping Sites used by Basin Residents

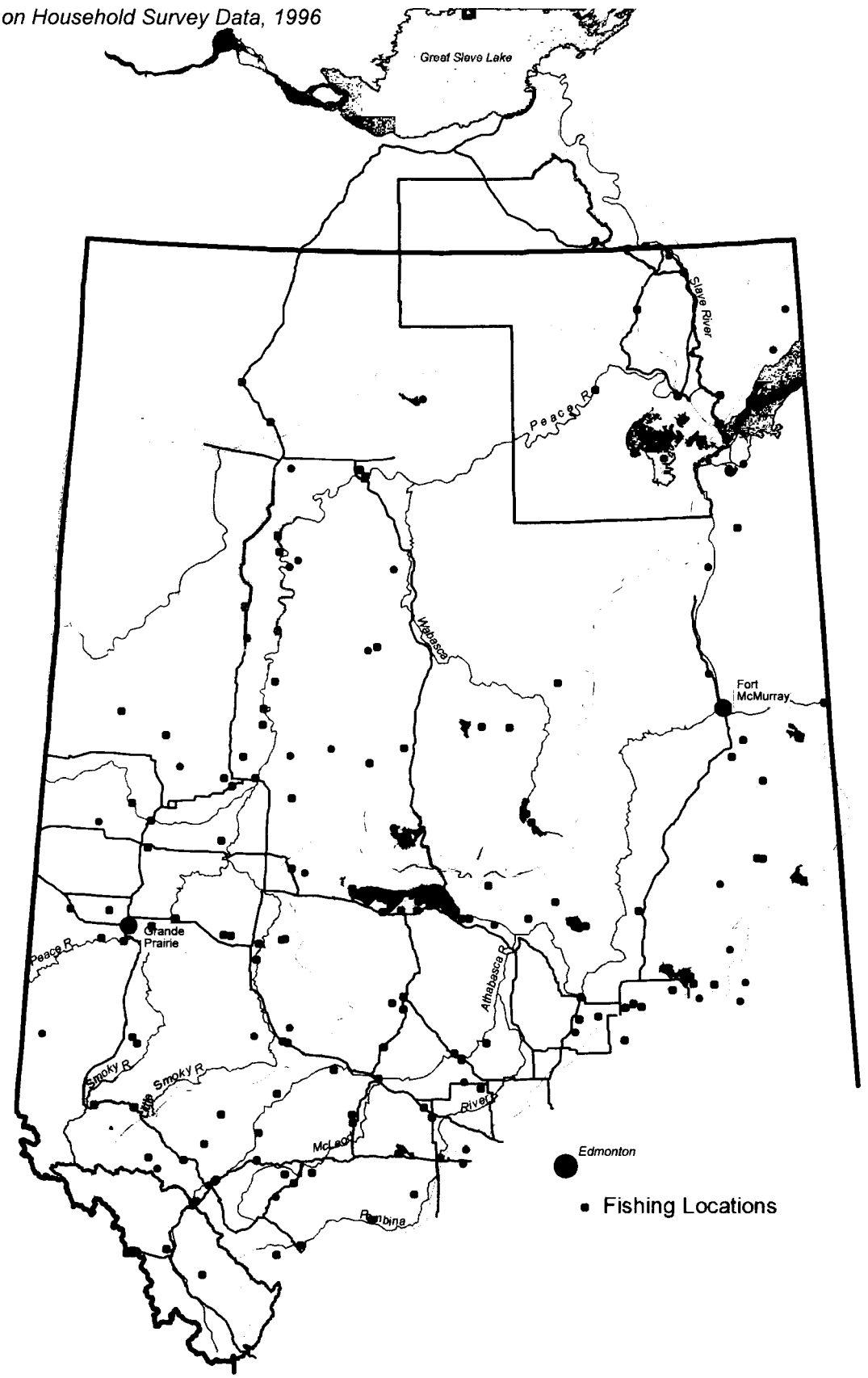


Figure 35. Key Fishing Sites used by Basin Residents

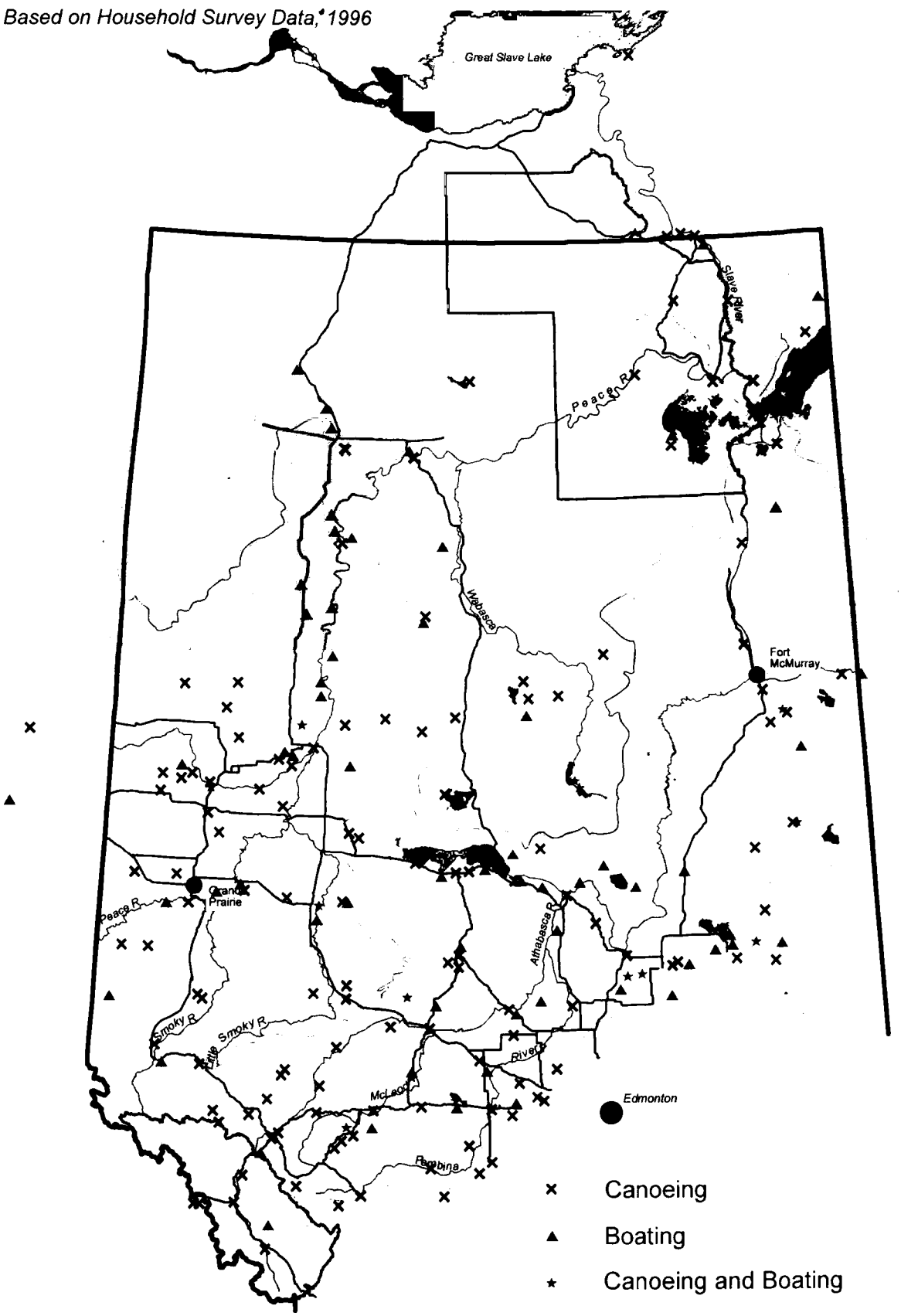


Figure 36. Key Boating and Canoeing Sites used by Basin Residents

whole are negligible except in areas with intensive recreational development such as Jasper National Park.

Several types of protected wilderness areas are located in the NRBS area. In Alberta, these include two national parks, one wilderness park, several provincial parks (Figure 37), national wildlife areas, ecological reserves and natural areas (Alberta Environmental Protection 1995). All these lands are protected to varying degrees by legislation to help protect their vegetation and wildlife.

7.8.1 Athabasca River Basin

The Athabasca River Basin contains the largest number of recreational lakes of the basins included in the study. Recreational activity is concentrated in the Lesser Slave Lake area and Jasper National Park.

Jasper National Park was established in 1907 under the National Parks Act. The park encompasses 10,800 km^2 of the Rocky Mountains in the most southern portion of the basin (The Canadian Encyclopaedia 1988). Jasper attracts more than 2 million visitors each year; who come from all over the world to see the scenery and wildlife, as well as visit such attractions as the town of Jasper, the Columbia Ice Fields and Miette Hot Springs.

7.8.2 Peace River Basin

Willmore Wilderness Park was established in 1959 under its own legislation. This 5,570 km^2 park is located in west central Alberta, bordered by Jasper National Park to the south and the Alberta-B.C. border to the west (Lopatka et al. 1990/91). The park is unique in that it provides hiking, horseback riding, cross country skiing and hunting and fishing, yet does not allow motor vehicle access or provide camping facilities (Alberta Environmental Protection 1995).

Wood Buffalo National Park, established in 1922, is the largest park in the Canadian National Park system (The Canadian Encyclopaedia 1988). It was founded to protect the last herd of wood bison, which has grown from 500 to over 5000 bison since the park opened. The park is a World Heritage Site and contains two wetlands of international significance, the Whooping Crane Summer Range and the Peace-Athabasca Delta.

7.8.3 Slave River Basin

The Slave River Basin is an important tourism location in the Northwest Territories, 15,000 (25%) of the 60,000 people that visited the NWT in 1988 visited the Fort Smith area (Lopatka et al. 1990/91). Protected areas of ecological significance in the area include the Salt River Plains, the Grande Detour Plains, Brile Point and the Fort Smith Rapids (Alberta Environment 1987).

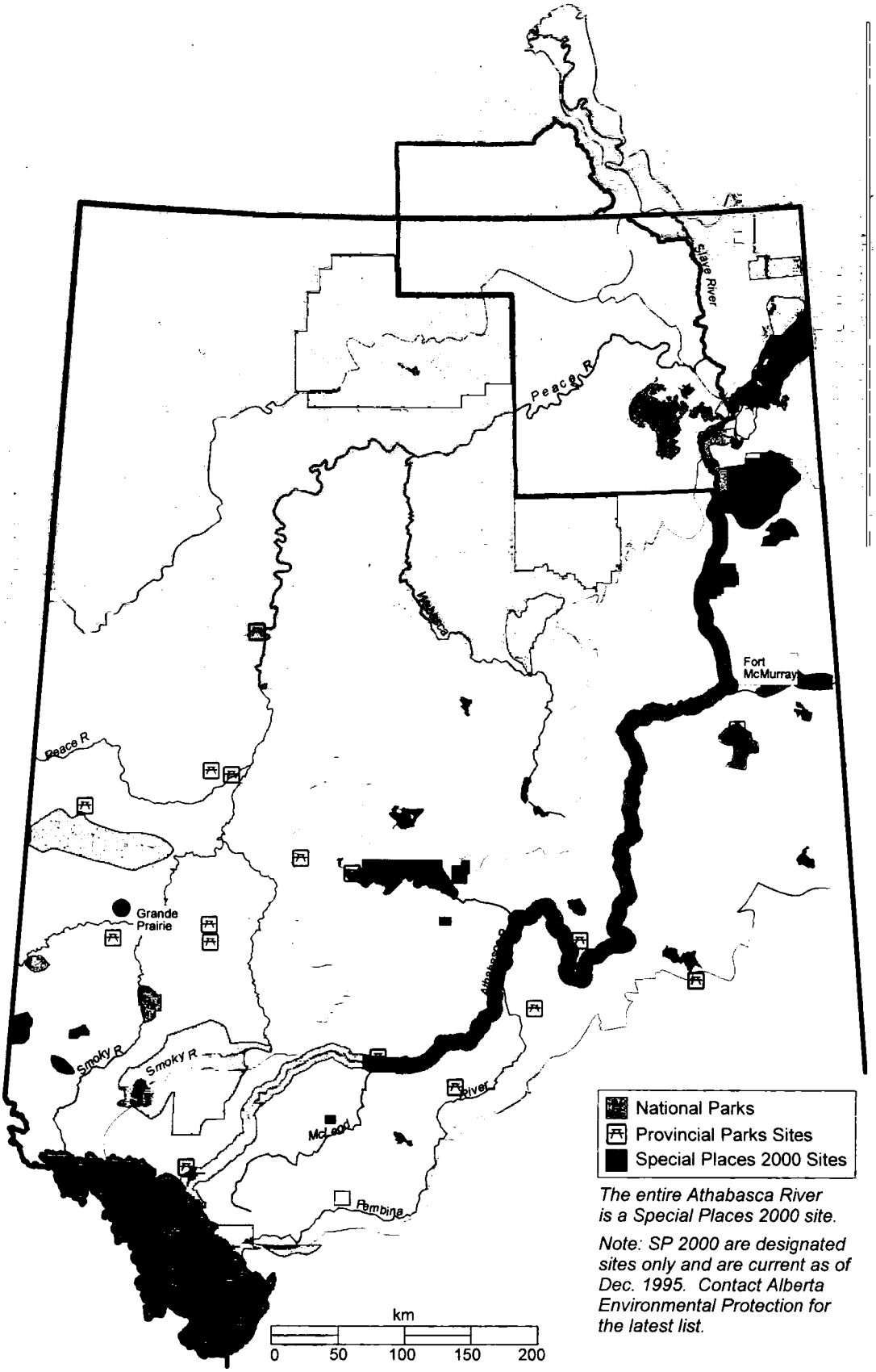


Figure 37. Parks and Protected Places in the Northern River Basins.

7.9 References

Alberta Environment. 1987. Slave River Basin Overview. Prepared for Alberta/Northwest Territories Technical Committee on the Transboundary Water management Agreement. 94 pp.

Alberta Environmental Protection. 1995. Alberta State of the Environment Comprehensive Report. 119 pp.

Armstrong, T.F., D.S. Prince, S.J. Stanley and D.W. Smith. 1995. Assessment of drinking water quality in the Northern River Basins Study area. Northern River Basins Study Synthesis Report No. 9. Northern River Basins Study, Edmonton, Alberta.

Government of Canada (Ministry of the Environment). 1991. The State of Canada's Environment. Banfield and Seguin Ltd. Ottawa.

Hamilton, H.R., M.V. Thompson, L. Corkum., Nanuk Engineering & Development Ltd. 1985. Water Quality Overview of the Athabasca River Basin. Prepared for Alberta Environment. 117 pp.

Lopatka, S., D. Ross and R. Stoesz. 1990/91. Northwest Territories Data Book: A Complete Information Guide to the Northwest Territories and its Communities. Outcrop: The Northern Publishers. 238 pp.

McCubbin, N. and F. Jens of N. McCubbin Consultants Inc. 1993. A Review of Literature on Pulp and Pare Mill Effluent Characteristics in the Peace and Athabasca River Basins. Northern River Basins Study Report #15, Northern River Basins Study; Edmonton, Alberta. 85 pp.

Northern Alberta Development Council (NADC). 1990. Trends in Northern Alberta: A Statistical Overview 1970 - 1990.

Noton, L. and K. Saffran, 1995. Water Quality in the Athabasca River System 1990-1993. Surface Water Assessment Branch Technical Services and Monitoring Division Alberta Environmental Protection. 239 pp.

Paetz, M.J. 1984. The Fish and Fisheries of the Peace River Basin: Their Status and Environmental Requirements. Prepared for Planning Division Alberta Environment in association with Fish and Wildlife Division, Alberta Energy and Natural Resources. Edmonton. 240 pp.

Praxis Inc. 1985. Northern Alberta Today. Prepared for Northern Alberta Development Council. Craftsman Printing & Graphics Ltd. 83 pp.

Province of British Columbia. Ministry of the Environment, Lands and Parks and Environment Canada. 1993. State of the Environment Report for British Columbia. 127 pp.

The Canadian Encyclopedia, Second Edition. 1988. Hurtig Publishers, Edmonton.

8. Water Statistics

Water is a precious commodity to those who live in the basins. This section provides an overview of the basins hydrography and water use.

8.1 Water Quality

8.1.1 Athabasca River System

The Athabasca River originates in the Rocky Mountains, and its water quality reflects the sedimentary bedrock and seasonal flow patterns. The headwaters are high in calcium bicarbonate and suspended solids and low in organic carbon. Tributaries draining areas of boreal forest alter the major ion composition and increase both the organic carbon and colour of the river as it flows northeast (Noton and Saffran, 1995).

8.1.2 Peace River System

The Peace River has three relatively distinct regions (Prowse and Conly 1996). The upstream reach, from Dunvegan to the Smoky River confluence, has few tributaries, clear water and high dissolved oxygen content (Shaw et al. 1990). Organic matter content, metals, salts and nutrients are all low. In the reach between the Smoky River and Fort Vermilion, the concentration of most parameters gradually increases, most likely as a result of the contribution of tributaries (Shaw et al. 1990). Due to a shift in bedrock and bank materials from gravel to sand and silt, and to a lesser extent to the contribution of tributaries, the lowest reach of the river exhibits a change in water quality. Suspended solids and metals associated with clays are high in this reach (Prowse and Conly 1996).

8.1.3 Slave River System

The Slave River is relatively turbid and alkaline (Alberta Environment 1987). Principle ions in the upper reaches are calcium and bicarbonate. However, conductivities decline as a result of significant upstream runoff routed through the Peace-Athabasca Delta/Lake Athabasca drainage and the dominance of Canadian Shield drainage feeding into the river. Sodium and chlorine ion concentrations increase in the mainstem towards Fitzgerald, probably due to inflows from the surrounding Karst area (Alberta Environment 1987, as in Prowse and Conly 1996).

8.2 Water Quantity

The rivers of the study area drain over 606,000 km^2, with a total runoff of over 100 billion cubic metres (Choles et al. 1996). The following descriptions are extracted from NRBS Technical Report No. 146. entitled *An overview of streamflows and lake levels for the Peace, Athabasca and Slave river basins,* and NRBS Synthesis Report No. 1, *Impact of flow regulation on the aquatic ecosystems of the Peace and Slave rivers.*

8.2.1 Athabasca River System

The Athabasca River accounts for 20 percent of the total flow of the Slave River at Fitzgerald, of which slightly less than half is contributed by its major tributaries, The McLeod, Pembina, Lesser Slave and Clearwater rivers (Table 10).

The flow regime of the Athabasca River varies greatly with the season, as is typical of a mountain-fed stream with little anthropogenic regulation. The high flows occur in May, June and July coincident with summer runoff; low flows generally occur from January to March. The mean annual flow of the river near its termination in Lake Athabasca is 800 cubic meters per second (m^3/s), with a minimum and maximum mean monthly flow of 400 m^3/s and 2,800 m^3/s respectively (DPA Group Inc. et al. 1987). The low flows in the winter, typically only 21% of the rivers mean annual flow, are an important water quality concern. Such small volumes of water limit the river's capacity to dilute both natural and anthropogenic inputs.

Table 10. Drainage Areas and Flows in the Athabasca River and Selected Tributaries. After MacDonald and Radermacher 1992, Choles et al 1996.

Site	Drainage area (km^2)	Mean annual flow (m^3/s)
Mainstem		
Hinton	9,780	33
Athabasca	74,600	117
Fort McMurray	133,000	142
Tributaries		
McLeod River near Whitecourt	9,100	10.2
Pembina River at Jarvie	13,100	6.8
Lesser Slave River at Hwy #2A	14,400	43.7
Clearwater River at Draper	30,800	58.6

Table 11. Drainage Areas and Flows in the Peace River and Selected Tributaries. From Prowse and Conly 1996

Site	Drainage area (km^2)	Mean annual flow (m^3/s)
Mainstem		
Dunvegan	130,000	1,630
Peace River	186,000	1,930
Peace Point	293,000	2,170
Tributaries		
Smoky River at Watino	50,300	358
Notikewin River at Manning	4,680	14.1
Boyer River near Fort Vermilion	6,660	5.18
Wabasca River at Wadin Lake Road	35,800	97.5

8.2.2 Peace River System

The Peace River is the major contributor to flow of the Slave River, providing about 60 percent of the water in the Slave at Fitzgerald. Its major tributaries, the Pine, Smoky and Wabasca rivers, contribute 30 percent of the total volume of the Peace (at Peace Point) (Table 11).

Mean annual runoff of the Peace River at Peace Point is approximately 66 billion m^3, of which approximately two thirds originate outside the Province of Alberta (van der Giessen 1982).

Large scale regulation of the Peace River began in 1968 with the completion of the W.A.C. Bennett Dam. The Williston Reservoir filling period from 1968 to 1971 marked some of the lowest recorded water levels on the Peace River in Alberta. The mean annual flows on the Peace River have changed little due to regulation. Mean annual flows from recorded or computed natural flow data on the Peace River at Hudson Hope and Peace Point for the period from 1960 to 1992 are 1,110 m^3/s and 1,910 m^3/s respectively, compared with the regulated period from 1972 to 1990 were the mean annual flows were 1,150 m^3/s and 1,920 m^3/s. Yet since the dam came into full operation in 1972, river flow has been redistributed throughout the year with lower monthly mean flows during the summer and high monthly mean flows during the winter. Maximum and minimum mean monthly flows at Hudson Hope have changed from 3,900 m^3/s, occurring in June, and 246 m^3/s, occurring in March, under natural conditions; to 1,440 m^3/s, occurring in December, and 875 m^3/s, occurring in June, under regulated conditions. The effects of regulation are felt less strongly further downstream from the dam, where for example at Peace Point the maximum and minimum mean monthly flows were 6,560 m^3/s, occurring in June, and 455 m^3/s, occurring in March,

under natural conditions; and were 3,660 m^3/s, occurring in June, and 1,460 m^3/s, occurring in March during the 1972 to 1990 post-regulation period. Flow regulation, immediately downstream of the dam, has also substantially reduced maximum daily flood peaks and increased minimum daily flows (Shaw et al. 1990). Hydrograph of the Peace River at Peace River comparing peak flow before and after regulation is shown in Figure 38.

8.2.3 Slave River System

The Slave River receives about 80 percent of its flow from the Athabasca and Peace rivers. The remaining 20 percent flows largely from Lake Athabasca, with a small portion from the direct tributaries to the Slave. Table 12 shows the major drainage areas for the basin.

The Peace River is the largest influence on the flow regime of the Slave River, as it contributes over 60% of Slave River's flow. Since the completion of the Bennett Dam the hydrograph of the Slave River has smoothed. Peak floods on the Slave River occur in June and July as a result of the spring melt period on the Peace. The maximum and minimum mean monthly flows at Fitzgerald for the period from 1972 to 1993 are 5,230 m^3/s, occurring in June, and 2,130 m^3/s occurring in March. The mean annual flow of the Slave River at Fitzgerald over the same period is 3,390 m^3/s. Annual maximum daily flows for the Slave River at Fitzgerald are illustrated in Figure 38.

Table 12. Major Drainage Basins of the Slave River Catchment. From Prowse and Conly 1996.

Watershed	Drainage Area (1000 km^2)	Drainage Area % of Total
Peace River	295.6	48.7
Athabasca River	198.5	32.7
Fond du Lac River	78.7	13.0
Birch River	24.4	4.0
Slave River	9.6	1.6
Total (Slave River at Fitzgerald)	606.8	100.0

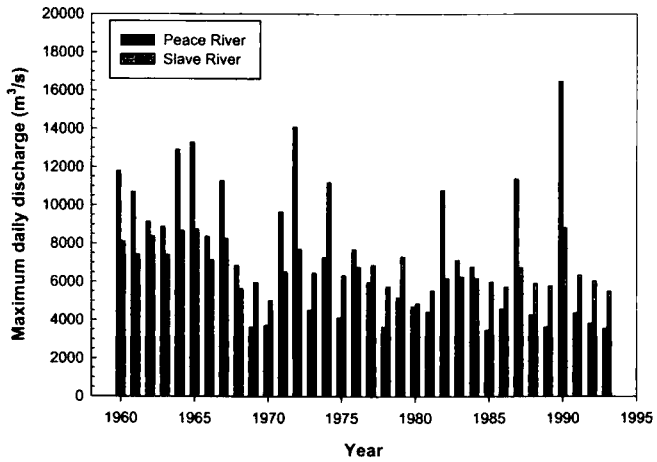


Figure 38. Maximum Daily Discharges for Peace River at Peace River and Slave River at Fitzgerald, 1960-1993. From Prowse and Conly 1996.

8.3 Consumptive uses of water

How water is used for consumptive and non-consumptive purposes has been described in detail in "*Characterization of Aquatic Uses Within the Peace, Athabasca, and Slave River Basins*, NRBS Synthesis Report 7 (MacLock and Thompson 1996). What follows has been extracted from this report.

Consumptive uses of water including drinking and other domestic uses, as well as water use for municipal, agricultural and industrial purposes. For these uses, water is withdrawn from a water body and may then be returned to the water body in diminished quantity or quality.

8.3.1 Licenced Water Use

Major allocations of water for industrial purposes commenced in the 1950s. Since then, there has been a steady increase in licenced water use for industrial and municipal purposes, with the largest growth occurring during the 1970s.

In Alberta, two percent of water licences issued to users in the NRBS area allow them to use water from the mainstems of the Peace, Athabasca or Slave rivers. These 82 licences allow withdrawals of up to 291,200 acre-feet of water per year. This represents nearly half (47 percent) of the total volume of licenced water use in the basins. Of the licences issued for the mainstem Athabasca River, 90 percent are for industrial purposes with nine percent for municipal purposes. Small amounts have been allocated for agriculture, irrigation, and storage.

In the Peace basin, 18 percent of licenced water use is from the Peace River. Eighty-three percent is for industrial use with 15 percent for municipal use and two percent for irrigation.

All of the water licences issued for the Alberta portion of the Slave River are for municipal purposes. These amounts account for 12 percent of all water licences issued for the Slave River Basin.

8.3.2 Drinking Water Use

The majority of people living in the NRBS area obtain their drinking water from municipal water sources. Household survey data (Reicher and Thompson 1995) suggest that 55 percent of the households use municipal sources while 31 percent, especially farm households, take their water from wells or springs. About five percent of households use water from various surface water sources and four percent take their water from dugouts. Another four percent of households use bottled water (Table 13).

Table 13 Source of Drinking Water Supplies in the Northern River Basins. MacLock and Thompson 1996.

Region	Municipal Water	Bottled Water	Well/ Spring	Lake Water	River Water	Dug-Outs
Upper Athabasca	72.0%	2.0%	18.0%	0.0%	8.0%	0.0%
Middle Athabasca	18.6%	0.0%	79.7%	0.0%	1.7%	0.0%
Lower Athabasca	98.1%	1.9%	0.0%	0.0%	0.0%	0.0%
Upper Peace	42.6%	1.9%	25.9%	0.0%	1.9%	27.8%
Middle Peace	48.9%	2.8%	23.4%	0.0%	2.1%	12.8%
Lower Peace	66.7%	3.9%	9.8%	2.0%	5.9%	11.8%
Slave River/Delta	92.3%	1.9%	0.0%	3.8%	0.0%	1.9%
Smoky/Wapiti	51.1%	6.7%	31.1%	4.4%	3.3%	3.3%
Lesser Slave	79.2%	1.9%	3.8%	3.8%	3.8%	7.5%
Pembina/MacLeod	39.4%	5.3%	53.2%	0.0%	2.1%	0.0%
Wabasca	76.9%	7.7%	73.8%	5.8%	5.8%	0.0%
La Biche/Other	36.2%	4.3%	46.8%	12.8%	0.0%	0.0%
Total	55.3%	4.4%	31.0%	2.0%	2.8%	4.4%

The Traditional Knowledge Component of the Northern River Basins Study found that only five percent of the 221 traditional resource users from nine native communities use municipal water supplies (Bill et al. 1996).

Within the Alberta portion of the NRBS area, some 321 municipal water licences for 28,800 acre-feet of water have been issued. Nearly half of these licences have been issued since 1980. There are 214 licenced drinking water treatment facilities in the basin (Armstrong et al. 1995, Appendix D). The location of these facilities is shown in Figure 39. Surveys of municipal and local governments suggest that water for households accounts for 78 percent of municipal water use. The balance is used for commercial purposes (12 percent), industries (four percent) or government buildings, including hospitals and schools (four percent). These results are representative of towns and small communities and do not reflect water use patterns for the two cities (Fort McMurray and Grande Prairie) and some rural parts of the region.

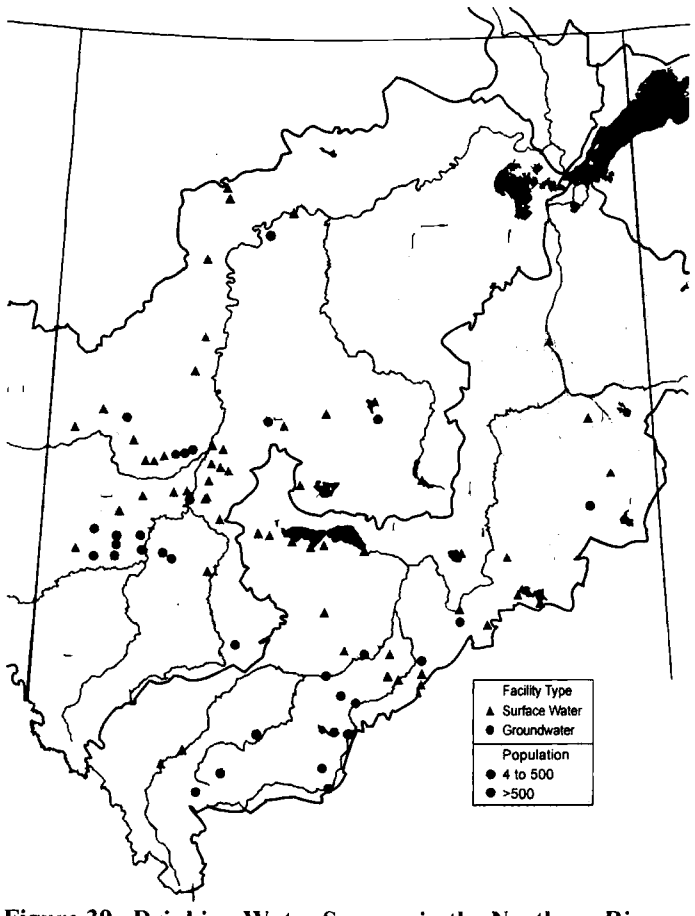


Figure 39. Drinking Water Sources in the Northern River Basins.

Groundwater wells

About 31 percent of households in the NRBS area use groundwater from wells. Figure 40 shows the regional distribution of these users.

Groundwater use is especially important in areas with a high agricultural population. The highest use of groundwater is reported in the Middle Athabasca, Pembina/McLeod and Wabasca regions.

About 30 percent of households that rely on groundwater use some form of treatment. The most common treatments for groundwater consist of distillation (29 percent), filtering (26 percent), mineral removal (23 percent) or chlorination (10 percent).

Dugouts

Just over four percent of households in the NRBS are get their drinking water from dug-outs. Dug-outs are used in six of the 12 regions and are the usual source of drinking water for between 10 and 30 percent of households in the Peace River basin.

Forty percent of the households that rely on dug-outs treat this water before using it. Common forms of treatment include filtration (33 percent), distillation (eight percent) or some type of chemical treatment (chlorine, copper sulphate) to control vegetation and bacterial growth (59 percent).

River Water

Nearly three percent of households in the NRBS area draw their drinking water directly from rivers. This practice occurs throughout the basins (Figure 41). River water is treated by 42 percent of households. This treatment involves either filtration (55 percent) or boiling (45 percent). Only four percent of households using river water have water quantity problems. The problems are related mostly to summer droughts.

Lake Water

Only two percent of basin households draw their water from lakes. This practice is most common in Lac la Biche portion of the basin (Figure 42). Over half (57 percent) use some form of water treatment, most commonly distillation (37 percent), filtering (31 percent) chlorination (19 percent) or boiling (17 percent).

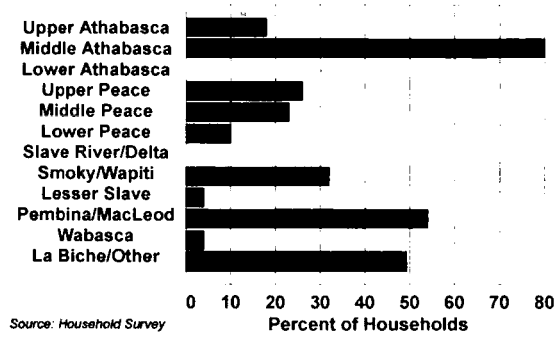


Figure 40. Regional Distribution of Households Using Groundwater.

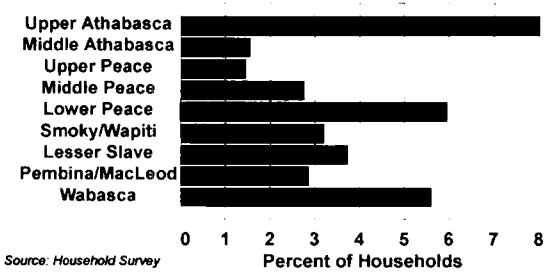


Figure 41. Regional Distribution of Households Using River Water.

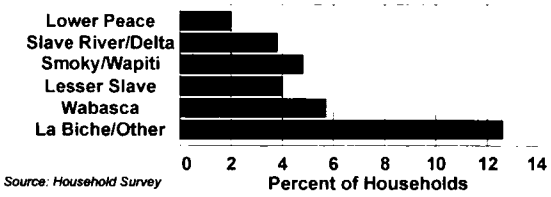


Figure 42. Regional Distribution of Households Using Lake Water.

8.3.3 Agricultural Water Use

Agricultural water use varies according to the type of operation. Small amounts of water are used on grain and oil seed farms. Livestock and mixed farms require water for livestock. Specialty farms may use water for irrigation. Farm operations using more than five acre-feet of water per year from surface water sources or dug-outs are required to get a water licence. Five acre-feet is sufficient for about 200 head of cattle. Licences can be issued for lesser amounts. Licences are also required where water is used for irrigation.

At the present time, 887 agricultural water licences have been issued for a total of 3,397 acre-feet of water from both surface and groundwater sources in the NRBS area. The average licence is for about 3.8 acre-feet of water. Agricultural water licences are held by about three percent of farms in the basin.

There has been rapid growth in the number of agricultural water licences issued in recent years (Figure 43). This does not represent a change in water use but reflects a move by farmers towards establishing and protecting their water rights.

There are currently 194 irrigation water licences, allocating 7,144 acre-feet of water for irrigation purposes, with an average of 36.8 acre-feet per licence. Irrigation accounts for about two percent of water drawn from the mainstem of the Peace River. There has also been considerable growth in the amounts of water being used for irrigation (Figure 43). Typically, irrigation water is used to grow hay for livestock operations or to grow specialty crops.

8.3.4 Industrial Water Use

Some 95 companies hold 896 water licences issued for industrial purposes in Alberta. The water allocated under these licences amounts to 430,618 acre-feet.

The majority of this water (92 percent) is taken from surface-water sources, while eight percent comes from groundwater sources. About 71 percent of licenced industrial water use comes from the Athabasca River basin, while 28 percent is from the Peace River basin (Figure 44). Only one percent of licenced industrial water use comes from the Slave River basin.

There was a major increase of water allocated to industrial uses during the 1950s. Since then, volumes have increased by a factor of ten. Much of the growth in industrial water demand occurred during the 1980s, when licenced industrial water use almost doubled.

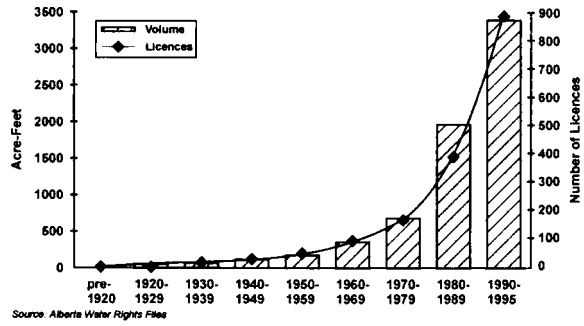


Figure 43. Agricultural Water Licences.

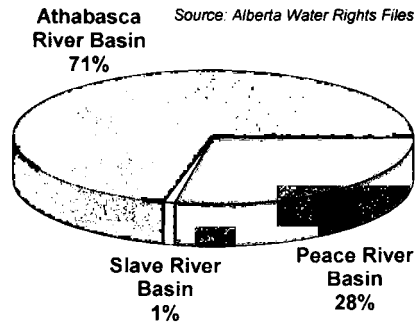


Figure 44. Allocations of Surface Water for Industrial Use by Source

The vast majority of industrial water allocations (62 percent of licenced volume) are issued for the purposes of processing. This includes pulp mills and gas plants. The second most important use (16 percent) is for cooling purposes, including the oil sands plants and a thermal power facility. Another 14 percent is allocated for the purposes of oilfield injection purposes. Water used for other purposes including gravel washing, steam processing for oil and gas operations and various other activities, accounts for the remaining seven percent of industrial water allocations.

Some 223,560 acre-feet of water has been allocated from the mainstem of the Athabasca River for industrial purposes. These 17 licences represent 73 percent of all industrial allocations in the Athabasca basin.

Water allocations from the mainstem of the Peace River amount to only 33,850 acre-feet, which represents 28 percent of allocations for the Peace basin. There are no industrial water licences for the mainstem of the Slave River.

8.4 Non-consumptive uses of water

Many uses of water within the basins are classified as non-consumptive in that they do not result in any actual consumption of water. Previous sections of this report discuss the nature of these uses. Non-consumptive uses include recreation (see 7.8), tourism (see 7.8), commercial fishing (see 7.7), trapping (see 7.7), and river transportation (see 7.6) all of which have dependencies upon the water resources of the basins.

8.5 Ecological (Instream Uses)

Ecological uses of water in a riverine ecosystem involve both an aquatic, or in-channel, component and a riparian component. The aquatic ecosystem, which includes fish and other aquatic life, is dependent upon not only minimum stream flows and various temporal stream flow characteristics, but also upon natural levels of water quality. The riparian ecosystem, which includes vegetation communities and wildlife on river floodplains, is also dependent upon certain streamflow characteristics, such as floods and ice regimes.

Human uses of water may directly affect the quantity and quality of water available for ecological uses. Dams and reservoirs, diversions for consumptive uses and effluent discharges can have dramatic effects on the physical, chemical and biological characteristics in downstream reaches of the river. Human manipulations of both the Peace and Athabasca rivers have impacted the natural equilibria of ecological uses in both rivers, with subsequent impacts downstream in the Peace-Athabasca Delta and Slave River.

A detailed summary of the key findings of the work on ecological uses of water is provided in NRBS Synthesis Report No. 1 (Prowse and Conly 1996).

8.6 References

Alberta Environment. 1987. Slave River Basin Overview. Prepared for Alberta/Northwest Territories Technical Committee on the Transboundary Water management Agreement. 94 pp.

Armstrong, T.F., D.S. Prince, S.J. Stanley and D.W. Smith. 1995. Assessment of drinking water quality in the northern river basins study area. Northern River Basins Study Synthesis Report No. 9. Northern River Basins Study, Edmonton, Alberta.

Choles,J., W. Aitken and A. DeBoer. 1996. An overview of streamflows and lake levels for the Peace, Athabasca and Slave river basins. Northern River Basins Study Technical Report No. 146. Northern River Basins Study, Edmonton, Alberta. 49 pp. + app.

DPA Group Inc. in association with W-E-R Engineering Ltd. And Environmental Management Associates Ltd. 1987. Water in Northern Alberta: Technical Report December, 1987. Prepared for the Northern Alberta Development Council, Peace River, Alberta. 124 pp.

Bill, L., J. Crozier and D.C. Surrendi. 1996. A report of wisdom synthesized from the traditional knowledge component studies. Northern River Basins Study Synthesis Report No. 12. Northern River Basins Study, Edmonton, Alberta. 366 pp. + appendices.

MacDonald, G. and A. Radermacher. 1992. Athabasca River water quality modelling 1990 update. Prepared for Alberta Environement, Standards and Approvals Branch, Edmonton, Alberta.

MacLock, B. and J.P. Thompson. 1996. Characteization of aquatic uses within the Peace, Athabasca and Slave rivers. Northern River Basins Study Synthesis Report No. 7., Edmonton, Alberta. 80 pp.

Noton, L. and K. Saffran, 1995. Water Quality in the Athabasca River System 1990-1993. Surface Water Assessment Branch Technical Services and Monitoring Division Alberta Environmental Protection. 239 pp.

Prowse, T.D., and M. Conly. 1996. Impacts of flow regulation on the aquatic ecosystem of the Peace and Slave Rivers. Northern River Basins Study Synthesis Report No. 1. Northern River Basins Study, Edmonton, Alberta. 168 pp.

Reicher, P and J.P Thompson. 1995. Use of aquatic resources in the Northern River Basins: Results of the household and stakeholder surveys.. Northern River Basins Study Project Report No. 69. Northern River Basins Study, Edmonton, Alberta.

Shaw, R.D., L.R. Noton, A.M. Anderson and G.W. Guenther. 1990. Water Quality of the Peace River in Alberta. Prepared for Alberta Environment. 247 pp.

van der Giessen,N. 1982. Peace River basin overview. Prepared for Alberta Environment, Planning Division. 56 pp.

9. Jurisdictional Framework

Comprehensive river basin management, however ideal as a concept, and however well provided for in some Canadian statutes, has yet to be fully implemented in Canada. A considerable wealth of river basin study experience exists in both the USA and Canada, but in Canada the main serious experience in trying to manage both the land and water issues in a given river basin has been limited to the work of the Conservation Authorities of Ontario.

In Alberta and the Northwest Territories, the Northern River Basins Study represents a relatively large investment in building a modern ecosystem-based database of principally an aquatic nature to begin the process of trying to manage a major Canadian, transboundary river basin in an integrated, cooperative way. With the absence of resources and input from the provinces of British Columbia and Saskatchewan in the study, more information is now known about central reaches than the headwater reaches of the Peace River for example. In addition, very little terrestrial and land use information was assembled by Northern River Basins Study.

A number of other factors and constraints must be understood before full-scale, collaborative and comprehensive basin management of these strategic basins is pursued by the various jurisdictions in the region. Those factors can be categorized as follows:

1. legal, institutional, jurisdictional factors (Section 9.1)
2. geographical factors (Section 4.3)
3. historical and socio-economic factors (Section 10.1)

9.1 Legal, Institutional and Jurisdictional Implications

With the Northern River Basins Study area straddling three provinces, two national parks and one federal territory, considerable attention must be paid to the impact of the key federal, provincial and territorial statutes that govern the management, protection and use of the Basin's waters and related aquatic resources. Additionally, however, no river basin management initiative can be reasonably contemplated without also understanding the public and private land laws of the various jurisdictions.

Two brief jurisdictional summaries, one for water and one for land, follow. Some key points that must be raised from these summaries are as follows:

1. Water resources in Canada are recognized as being subject to two jurisdictions; federal and provincial. Generally, the provinces are the 'owners' of inland waters south of the 60th parallel while the federal government is said to have a "jurisdictional interest" in those waters, particularly when water flows over a provincial boundary.
2. The federal government is the owner of water in the Yukon and Northwest Territories.
3. The Canada Water Act is regarded suspiciously by the Provinces as a potential federal intrusion into ownership and management. It is unclear what role the federal government will choose in transboundary basin management but legal scholars generally agree that under the Constitution Act (1982), the federal government is paramount in any dispute and may have a potentially large role.
4. If Canada and Alberta, as water owners, wished to manage the Northern River Basins Study area (excluding BC and Saskatchewan initially) as a single river basin system (including land), the two parties may have to develop the co-operative management

approaches from scratch. Existing transboundary water management agreements like the Master Apportionment Agreement (M.A.A.) signed amongst the federal and prairie province governments in 1969 are possibly an insufficiently broad template to build on. The M.A.A. is focused almost exclusively on water quantity sharing and this issue is only one of a minor set of issues at stake in the Northern River Basins arena.

5. The potentially broad, water quality-focused draft Mackenzie River Basins Agreement is currently stalled after some twenty years in the making due to such jurisdictional concerns as First Nation's water rights and land claims and the federal role in water management.

6. Provincial governments south of 60° and the federal government north, own much of the land in the basins. Public land use and forest management policies are based on elderly statutes that don't speak to ecosystem-based management, but instead are designed to allocate land (and forests) to various applicants and uses.

7. Municipal government and private land owners control land uses in the remaining share of the lands in the northern basins, and have yet to be encouraged to assist senior governments in the task of ecosystem management and protection in both the NWT and Alberta. Some institutional innovations in the NWT are under development that will start the process of local and regional involvement in environmental management.

8. In general the statutory instruments for land and water management north and south of 60° are not designed to lay the basis for a successful comprehensive land/water river basin management authority for the Northern River Basins Study area. The proposed Water Act for Alberta does, in fact make provision for river basin plans and such ecosystem support tools as "instream flows and assessments" allocations. It, however, makes little reference to the issue of water quality and no reference to biodiversity and ecosystem health as management objectives. The draft Alberta Water Act leaves those tasks to the regulatory prerogative of Alberta's Environmental Protection and Enhancement Act.

9. A complete statutory overhaul and updating of such old statutes as the Public Lands Act and the Forestry Act are required. These overhauls should include provision for closer co-ordination with municipal land use and planning statutes first and secondly, with the aquatic planning and water quality regulatory statutes noted above.

10. Finally, a transboundary river basin authority for the study area may require a statutory co-ordination and harmonization initiative amongst the federal, territorial and provincial jurisdictions of the region.

9.2 Water Management

This section is extracted from the Northern River Basins Study Report "Water Management in the Northern River Basins" by R. Bruce MacLock.

9.2.1 Constitutional Situation

Both Alastair R. Lucas (1987) (Professor and Director of Research, Faculty of Law, University of Calgary) and J. Owen Saunders (1988) of the Canadian Institute of Resources Law have written extensively in the area of Canadian resources. In articles written in the late 1980's, both writers review the division of environmental and resources management powers between the federal and provincial governments as established by the British North America Act of 1867. These two papers are relatively new, short and present some of the clearest summaries to date.

Both writers review sections 91 and 92 of the British North America Act 1867. They also review the changes and clarifications made to exclusive provincial powers over conservation and management of non-renewable natural resources through the amendments to the BNA Act made by the 1982 Constitution Act. Although water is not specifically mentioned in these sections, Saunders notes that a province's authority over waters within its boundaries has major constitutional foundations: proprietary or

ownership rights and legislative powers. He further notes that it is because the provinces own the water rights within their boundaries, and can exercise the predominant role in water management.

Saunders notes that the federal jurisdictional authority is considerable but it "is greatest in the territories where the federal government possesses full plenary powers with respect to lands and resources". (Since Saunders wrote his November, 1988 paper, the Government of the Northwest Territories has been given powers over forest resources.) He nonetheless accurately outlines the considerable legislative authority the federal government has over navigation and fisheries under Section 91 of the Constitution Act. He also reviews the accepted view that the federal government has sole jurisdiction over international transboundary fresh waters and a strong jurisdictional interest in inter-provincial and territorial transboundary waters under the Peace, Order and Good Government provisions of the Constitution Act.

9.2.2 Water Legislation in the NRBS Area

As noted by Ruggeberg and Thompson, in 1984, "when dealing with water (in Canada), statutory law has tended to develop along three major lines: laws dealing with water quantity (or allocation), laws dealing with water quality (waste discharge or pollution), and laws that cover indirect uses of water such as fishing and navigation". Within these three major lines of statutory law, three general topic areas dominate:

1. the extent to which common law riparian rights still exist;
2. the allocation of waters among competing users;
3. regulating water use to maintain high levels of water quality.

The Northern River Basins Study area has two key jurisdictions: Alberta and the Government of Canada acting on behalf of the Northwest Territories and for the purposes of this paper, resource and environmental legislation will be reviewed in that order.

Alberta's Statute Law

Water Quantity-Alberta's Water Resources Act

The Alberta Water Resources Act (1931) was passed by the provincial legislature as a replacement for the federal Northwest Irrigation Act of 1894.

In summary, the key purposes of the Water Resources Act were to 1) limit or extinguish common law riparian rights (and then invest the bulk of these rights with the province); 2) take control of the process of allocating water amongst competing users; and 3) allocate the province's water resources and generally manage them carefully.

Despite the insertion of additional clauses from time to time after 1931 (such as the flood control sections of 1960), the Water Resource Act is still fundamentally a water resources allocation instrument with a first come first served policy to the permanent water allocations made under its administrative regime. It has often been viewed as having roots in the frontier economic development philosophies of the late 19th century with little regard to the environmental consequences of its irrigation allocations or water control projects.

New Direction - The Proposed Alberta Water Act

A much more modern and comprehensive water resource act is now being actively proposed by the province. The need for a more environmentally sensitive water act has been known since the mid-seventies when Alberta Environment wrote its "Water Resource Management Principles for Alberta" brochure. The proposed new water act will encompass these principles and extend them. The concepts of allocation based on water resource and river basin plans and protection of instream flow needs, water demand management, public involvement, sustainable management and conservation, transferable water rights etc. have all been recommended to the Alberta Minister of Environmental Protection and his cabinet colleagues for inclusion in the new statute. These more modern concepts will of course be added to the existing "first in time, first in right" water allocation provisions of the existing Water Resources Act. Existing water rights will be protected, but, new water rights may have short renewable terms.

Perhaps the simplest way to summarize the direction of the new water resources act for Alberta is to note the 'vision' for it proposed by the province's Discussion Draft.

Vision

All Albertans are stewards of the province's water resources. We have the privilege of using water to ensure the environmental, economic and social health of the province. We have the responsibility to live within the capacity of the natural environment to sustain water resources in the present and the future.

The key concepts of the new Act are summarized in the "Report of the Water Management Review Committee "July 1995".

One key area of water management not specifically dealt with either by the existing Alberta Water Resources Act, or the proposed new water act is water quality. This regulatory area is dealt with instead by the new Alberta Environmental Protection and Enhancement Act (1993). Some consideration was given at the outset of the development of the new water act to blending it into AEPEA. This strategy was eventually set aside, having regard for the complexities of preserving existing water rights inside an environmental protection instrument.

Water Quality - Alberta Environmental Protection and Enhancement Act (AEPEA)

Following extensive public consultation, AEPEA became law on June 26, 1992, coming into force on September 1, 1993. This single new act attempts to take an integrated approach to the protection of air, land and water. The act is reasonably modern in four key ways:

1. Some public involvement is provided for in the environmental assessment and licence approvals process.
2. It provides for a shared responsibility approach to environmental protection where industry, for example, is required to help with the task of monitoring. Other examples of this shared approach are provisions in section 13 involving co-operation and liaison with other jurisdictions.
3. The Act lays the basis for supporting sustainable development through the Environmental Impact Assessment (EIA) and approvals processes. The EIA requirements are in turn linked to the major projects review processes of the Alberta Energy Resources Conservation Board and the Natural Resources Conservation Board.
4. The Act embodies a "polluters pay" philosophy where polluters can be made to pay for environmental damages and subsequent remedial costs.

AEPEA is divided into 12 parts summarized as follows:

Part 1 Consultation, Communication and General Administration (includes Inter-jurisdictional Agreements)

Part 2 Environmental Impact Assessment and Approval

Part 3 Environmental Appeal Board

Part 4 Release of Substances

Part 5 Band Conservation and Reclamation

Part 6 Groundwater and Related Drilling

Part 7 Potable Water

Part 8 Hazardous Substances and Pesticides

Part 9 Waste Minimization and Recycling

Part 10 Enforcement and Prosecution

Part 11 Miscellaneous Provisions

Part 12 Transition Provisions

Parts 1, 2, 4, 7 and 10 are the key parts that the Northern River Basins Study science work and recommendations will relate most to, with particular emphasis on parts 1,2 and 4.

Part 1 makes provision for public Advisory Committees which report to the provincial Environmental Minister on the administration of the Act and government policies and programs related to the environment. In addition, it provides in clause 20, for co-operating and reaching formal agreements with other levels of government such as other provinces, the Northwest Territories or Government of Canada.

Part 2 the EIA process is of key importance to the Northern River Basins Study because:

1. it provides a means of reviewing proposed projects to assess their potential impact on the environment;
2. it has cleared up some former confusion and now includes a legislated step by step EIA process that is clear and consistent for proponents and the public;
3. specifies that certain projects such as pulp mills, oil refineries and large dams **must** comply with the EIA process;
4. provides for inter-jurisdictional administrative agreements for joint federal-provincial or territorial EIAs or the elimination of potential duplicate procedures such as can be found in the new Canadian Environmental Assessment Act.

Part 4 the Release of Substances area, empowers the Alberta Government to prohibit or control the release of harmful substances into the environment through approvals, regulations and prohibitions. This key part of AEPEA is of most interest to the final recommendations process of Northern River Basins Study because those same recommendations will most likely be aimed at evaluating the guidelines, standards and regulations written by Alberta Environmental Protection to limit future municipal and industrial pollutants in the northern basins area.

Summary of WRA and AEPEA

At this point in time, these two Alberta statutes regulate water use and water pollution separately using different administrative groups located in different services of AEP. Only through administrative initiative do the two services (Natural Resources Service and Environmental Regulatory Service) work together to co-ordinate or plan their necessary regulatory efforts.

Federal Statutes

Water resources north of the 60th parallel of latitude are administered by the Government of Canada through the Minister of Indian Affairs and Northern Development. In the Northwest Territories since June 23, 1992, the Northwest Territories Water Act is the key water resources planning and management statute.

In short the Federal government is the owner of the water resources in the NWT, as is a province south of the 60th parallel. As yet, no devolution of water resources management responsibility to the Government of the Northwest Territories has occurred. A relatively complete, but not recent, review of northern water law and water rights can be found in Percy "The Framework of Water Rights Legislation in Canada" (Percy 1988).

The Northwest Territories Water Act (1992)

This new statute, assented to June 23, 1992, replaces the older Northern Inland Waters Act (NIWA, 1970). Both statutes are much younger than the Alberta Water Resources Act. Like NIWA, the NWT Water Act provides for a number of more modern elements than the current Alberta Water Resources Act as follows:

1. It has much wider scope than the Alberta statute because it deals with water quality and pollution control regulation in Sections 9 and 33.
2. It decentralizes control over the water rights allocation process from a bureaucratic level (typically a single person called a Water Controller) to a ministerially appointed Water Board of 9 members.
3. As David Percy notes, NIWA (and now the NWT Water Act) are the most recent attempt at a new approach to water law from three vantage points.
   (a) In theory it uses a fundamentally different water rights approach, namely priority of use instead of Alberta's priority in time (Percy is somewhat critical of the level of discretion given to administrative levels under NIWA in managing the water rights allocation area). In practice, DIAND officials note that water rights allocation has been managed under the "first in time, first in right" approach.
   (b) It sets a maximum term limit of 25 years for any water rights it allocates in contrast to the "in perpetuity" approach of the Alberta Water Resources Act.
   (c) It defines and provides some protection for instream users who are defined as persons using water (other than for consumptive purposes) to earn income or for subsistence purposes.

Percy's criticism of NIWA regarding a failure to protect instream uses also applies to the newer NWT Water Act. As he noted, the NIWA "like its counterparts in southern Canada, is primarily designed to licence the consumptive use of water rather than to ensure a continued flow for the protection of natural ecosystems, wildlife habitat, fisheries, traditional uses of water, or navigation" (Percy 1988). Like NIWA, the new Northwest Territories Water Act provides minimal safeguards for instream uses. His

criticism of the Regulations of NIWA also applies to the newer NWT Water Act, that "the classification of water in the Regulations includes uses for conservation and recreational purposes, but it implies that even for these uses water will be managed through engineering works rather than left in its natural state" (Percy 1988).

Some protection of water for environment purposes is provided for in the NWT Water Act. Firstly, clause 34 provides the Minister the power to reserve public lands required for the protection of any adjacent waters. Secondly, the Territorial Water Board can be directed by the Governor in Council to withhold permits for waste deposit into adjacent waters or water use to allow for "comprehensive evaluation and planning to be carried out on those waters". The Water Board can be similarly instructed if the use and flow of designated waters or the maintenance of water quality is required for some undertaking deemed to be in the public interest.

Determining public interest is a key concept in the NWT Water Act. The Territorial Water Board is required, during the course of carrying out its duties "to provide for the conservation, development and utilization of waters." to hold public hearings. The act describes both mandatory hearings on large or type A licences, and optional hearings on type B licences. DIAND officials did not disagree with Percy's concern re: NIWA (or the NWT Water Act) that "although the intentions behind the requirements for public hearings were admirable, in practice they have seemed to be cumbersome and expensive" (Percy 1988).

The wider scope of the NWT Water Act involving the permitting and licensing of industrial and municipal wastes (effluents) to water courses was noted above. In effect the prohibition of and/or limitation on dumping wastes as covered in Sections 9 and 33 of the NWT Water Act, closely parallel the intent of Part 4 of the Alberta Environmental Protection and Enhancement Act. However, the NWT Water Act is constrained by the presence of the Canada Water Act, the Fisheries Act and more recently the Canadian Environmental Protection Act (CEPA) amongst others. A key to this constraint is clause 5 of the NWT Water Act which obliges the Act itself, its regulations and all the licences to not contravene any other federal act.

In practice this means that regulations under the Fisheries Act or CEPA covering deleterious substances can over-ride those of the NWT Water Act in the task of controlling water pollution. The Federal government appears to have some duplicative regulatory provisions in the NWT situation. This may need to be recognized and assessed in greater detail by the Northern River Basins Study Board before it finalizes its recommendations relating to ecosystem health protection, monitoring and research.

Other Federal Statutes

Other federal statutes that affect the management, protection and conservation of water resources in the NWT include the Canada Water Act, the Fisheries Act, the Canadian Environmental Protection Act, the Government Organization Act, Part III, the Navigable Waters Protection Act, the Canada Shipping Act and the new Canadian Environmental Assessment Act. With the partial exception of the latter, a thorough review

of all was undertaken in August, 1991 by the technical staff of the Canada-Saskatchewan South Saskatchewan River Basin Study Office. A summary of these statutes is presented below.

The Canada Water Act

The Canada Water Act provides the framework for the federal government to participate and assist in the management of the water resources of Canada, including the research, planning and implementation of programs relating to the conservation, development and utilization of water resources. The preamble addresses the necessity for co-operation between the Government of Canada and provincial governments in relation to water resources.

Part One of the legislation states that the Minister of the Environment may enter into agreements with one or more of the provincial governments to formulate policies and programs with respect to the water resources of Canada. Federal involvement in basin planning, flood damage reduction, and water quality monitoring is authorized.

The Minister may act unilaterally with respect to any federal waters, or any interjurisdictional waters where there is a significant national interest in the water resource management.

Part Two deals with water quality management. A water quality management area is designated pursuant to a federal/provincial agreement in waters wherein non-federal water quality management has become a matter of urgent national concern.

If an agreement with the provinces cannot be reached or if an agreement is terminated by virtue of a disagreement over water quality standards set, the Governor General in Council may designate a water quality management area unilaterally. In any event, he may do so unilaterally in the case of federal waters, in such areas as the NWT.

Water quality management agencies are to plan, initiate, and carry out programs for the restoration, preservation, and enhancement of the water quality in management areas.

Part Three of the legislation deals with nutrients. Specifically, it is a prohibition against the manufacture, use, sale or import into Canada of any cleaning agent or water conditioner that contains a prescribed nutrient in a concentration greater than the specified maximum.

Part Four is general in nature. An inspector may enter premises, vessels, vehicles, or areas where there is reason to believe that any waste or any process which may result or has resulted in waste being added to a water quality management area.

Navigable Waters Protection Act

The purpose of this legislation is to keep navigable waters free from obstruction which would hinder marine navigation. The term "navigable waters" is not defined in detail in the Act; the definition is inclusive. The Minister or his delegate determine by an on site basis if a waterway is navigable. The Act outlines that no one may build a work in, upon, over, through, or across any navigable water unless such work is approved by the Minister prior to the commencement of construction.

Work is defined as including bridges, booms, dams, causeways, docks, tunnels, pipes, power cables, or any fill or material dumped on the bed of a river, or anything that can interfere with navigation.

Government Organization Act (Part Three: Dept. of the Environment)

The Department of Environment was established pursuant to this all-encompassing piece of federal legislation. The duties and powers of the Minister of the Environment extend to and include all matters over which the Parliament of Canada has jurisdiction, not by law assigned to any other department, board or agency of the Government of Canada, relating to:

- preservation and enhancement of the quality of the natural environment, including water quality
- renewable resources, including forests, migratory birds, and other non-domestic flora and fauna
- water
- co-ordination of federal policies and programs regarding the preservation and enhancement of the quality of the natural environment
- and whatever other matters which are by law assigned to the Minister

Pursuant to these powers, the Minister may initiate and undertake programs to establish objectives regarding environmental quality or to control pollution.

Further, the Minister may ensure that new federal projects, programs and activities are assessed early in the planning process for potential adverse effects on the quality of the natural environment, and that those with probable significant adverse effects are further reviewed and the results thereof taken into account. This section was in essence the justification for the federal Environmental Assessment and Review Process (EARP) - now replaced by the Canadian Environmental Assessment Act.

The Canadian Environmental Assessment Act

The Canadian Environmental Assessment Act (CEAA) became law June 23, 1992. In brief, the purposes of CEAA are:

(a) to ensure that environmental effects of projects receive careful consideration before initiation;

(b) to encourage responsible authorities "to take actions that promote sustainable development";

(c) to ensure that projects that are to be carried out in Canada or are on federal lands do not cause significant adverse environmental effects outside the jurisdictions in which the projects are carried out; and

(d) to ensure that there be an opportunity for public participation in the environmental assessment process.

Along with the relatively routine matter of setting up a smart EIA process to screen projects, determine responsible authorities, set up screening criteria, involve the appropriate publics and establish mediation and panel review processes, the Act in clause 46 makes reference to powers of the federal environmental minister in transboundary situations. This section is of considerable interest to the Northern River Basins Study because it empowers the federal minister to set up a EIA mediation or review panel if he/she finds that the proposed project may cause significant adverse environmental effects in another province. A hydro electric project like the now defunct Slave River Hydro project would likely have been subject to such a federal review because of its potential effects in the NWT.

It is unlikely that such federal unilateral action will now occur because both the governments of Canada (using clause 46 (1)) and Alberta have signed an administrative agreement that provides for the setting up of joint federal-provincial review panels and the use of Alberta is technical criteria through an equivalency arrangement.

Section 48 of CEAA lays out an EIA process that would apply on federal lands like the NWT The balance of the act sets up access to information procedures, provides for regulations for tailoring the temporal and spatial dimensions of an EIA and sets up the Canadian Environmental Assessment Agency.

Canadian Environmental Protection Act

The Canadian Environmental Protection Act became law on June 30, 1988. It was drafted to update and replace several federal statutes including the Environmental Contaminants Act and section 6(2) of the Department of the Environment Act. Of particular impact on this study, Part III of the Canada Water Act dealing with nutrients was repealed but incorporated into this legislation with only minor changes.

The preamble to the Bill cited the national concern with regard to toxic substances in the environment and the perceived role of the federal government as a leader in establishing environmental water quality objectives, guidelines, and codes of practice.

Section 7 of the Act allows the Minister to monitor research and publish materials related to environmental quality. In addition, and after optional consultation with the provinces, the public or other departments, the minister may formulate objectives, guidelines, and codes of practice aimed at environmental quality.

Fisheries Act

Although the Fisheries Act relates to management of a resource, the primary thrusts in terms of water management deal with pollution of waters frequented by fish, the protection of fish habitat and protection of the fish as a resource. Highlights of the Act are:

- The Minister may authorize any river or other water to be set apart for the natural or artificial propagation of fish.
- No undertaking or work may be carried out which results in harmful alteration, disruption, or destruction of fish habitat unless authorized by the Minister or by the regulations.
- No-one shall throw overboard ballast, coal ashes, stones, or other prejudicial or deleterious substance into any river or other water where fishing is carried on. More importantly, it is contrary to the legislation to leave deleterious substances in waters frequented by fish or in locations where they will reach water frequented by fish.
- Anyone carrying on a work or undertaking which is likely to result in the deposit of deleterious substances into water frequented by fish shall, if requested and required, provide the Minister with plans, specifications, samples, studies, etc., so that the Minister may decide if an offence is likely to occur.
  Should an abnormal deleterious deposit occur and damage to fish habitat, fish or use by humans of fish result or may reasonably result, the owner of the substance or the person causing the deposit must report the event and take all reasonable measures as soon as possible to prevent, mitigate, or remedy any adverse impacts.

Pulp and Paper Effluent Regulations

These regulations address totally suspended solids which are oxygen demanding decomposable organic matters produced as waste and toxic waste, which may be directly or indirectly deposited to waters frequented by fish. The regulations establish the limits of such deposits on an individual plant basis which is pro-rated according to the amount of productivity per day.

Alberta Fisheries Regulations

These are federal regulations passed pursuant to the Fisheries Act. These regulations are enforced by provincial officers holding appointment as federal fisheries officers.

The regulations apply to all waters except those within the national parks, or those pertaining to commercial or private aquaculture licenced waters.

Under these regulations, no-one may alter the configuration of a bed, bank or boundary, nor remove or displace gravel or sand to waters or from waters frequented by fish.

Canada Shipping Act

The Government may make regulations prohibiting, and authorizing in limited quantities, the discharge from ships of specified pollutants into waters (e.g. Garbage Pollution Prevention Regulations, Pollutant Substances Regulations). "Ship" includes every vessel used in navigation without regard to method or lack of propulsion.

Pollutant is defined in this legislation as any substance that if added to waters would degrade, alter, or form part of a process of degradation or alteration of the quality of the waters to an extent that it would be detrimental to the use of humans, or any animal, fish or plant that is useful to humans.

The Indian Act

Bands appear to have the capacity to deal with non-navigable water resources within the bounds of Indian Reserves. These non-navigable water resources include sloughs, ponds, ditches, wells, reservoirs and locally owned and operated water supply and waste treatment and disposal systems. Where Reserves have navigable waterways, Bands appear to own the streambanks, but not the water or the streambed.

Any discussion of Indian rights to water, and the role of The Indian Act is fraught with legal uncertainties. The position of the Province of Alberta regarding native water rights is that the Province holds the authority in Alberta over water rights pursuant to the delegation of resources ownership powers made in the 1930 Natural Resources Transfer Act. North of 60°, that power is rested in the federal crown under the Water Act as described above.

9.2.3 The Interjurisdictional Problem

To simplify the water ownership issue in the Federal/Territorial/Provincial interjurisdictional setting, it is necessary to refer again to the Constitution Act and, in the case of Saskatchewan and Alberta, the Natural Resources Transfer Act (1930), which finally transferred water ownership to the provincial level. In short, Alberta is the owner of the water rights within her boundaries and Canada is the owner in the NWT.

Transboundary Basin Management

If Canada and Alberta, as water owners wished, for example, to manage the northern river basins (Peace, Athabasca and Slave Basins) as a single basin or ecosystem, or management issue, the approach and the methods used may have to be developed from scratch. These two partners will have to be innovative and reach farther for joint legal tools than those, for example promoted by Rueggeberg and Thompson (1988) in the Federal Inquiry on Water Policy. This document, plus a number of monographs written for the Canadian Institute of Resources Law by Saunders and Percy strongly advocate a more level, less federally dominated, playing field amongst the water resource owners in the area of transboundary water management.

These two writers suggest that there may also be a need for more legal research work as a basis for developing or refining existing Canadian interjurisdictional water law. In particular, they advocate a review of the Part I provisions of the Canada Water Act, which was originally designed to authorize interjurisdictional basin management but to date has "hardly been used".

It would appear that in the absence of other legislative tools, the federal government, in any potential interjurisdictional water management partnership with a province would use Part I of the CWA and clause 7 of the NWT Water Act. As Saunders and others note, the key to federal authority in dealing with basin situations south of 60° is essentially dependent on the willingness of the provinces to participate. However, with Canada being the owner and chief distributor north of 60° plus being the senior government, the situation is different, certainly for Alberta.

Probably the section of the Canada Water Act least liked by the provinces is Part II, which was designed to set up, if necessary, unilaterally, "water quality management areas". Saunders (1988) is typical of the many commentators that dislike the Part II provision of the CWA where he focuses on the questionable constitutionality of clauses 9, 10 and 11. These clauses authorize the minister, with cabinet approval, to enter into federal-provincial agreements providing for the implementation of water quality management programs for other federal waters or for other waters, "the water quality management of which has become a matter of urgent national concern."

The controversial Clause 11 authorizes unilateral federal action where "all reasonable efforts" to negotiate an agreement with a province has failed. In general, all the provinces have been unenthusiastic about this clause, as it was regarded as a federal intrusion into their authority over natural resources.

These Part II provisions have not been used in Canada to date and likely will not be in the foreseeable future. In fact, the Federal Inquiry on Water Policy proposed the repeal of the Part II provisions in favour of a dispute resolution mechanism.

Dispute Resolution

The Inquiry on Federal Water Policy (Pearce et al 1985) noted the uncertain legal status of waters following along and across boundaries and between provinces and territories. It noted that this issue must be clarified because of both the large number of interjurisdictional waters and the growing pressure on them for use and from pollution. In advising on the direction of the reform, the authors drew two quite important conclusions that form the basis of their recommendations:

1. The (federal) court would likely reject the view that a province has the right to use water in an interjurisdictional stream without regard to adverse impacts in neighbouring jurisdictions.
2. The (federal) court would probably recognize a federal government role in interjurisdictional waters.

With these conclusions the authors recommend that:

- Part 2 of the *Canada Water Act* should be repealed and replaced with provisions to authorize the federal government to assist in resolving disputes between provinces and territories about the use of interjurisdictional waters. These new provisions should authorize federal intervention where:
  - (i) The provincial or territorial governments have made reasonable efforts to reach agreement and have failed, and
  - (ii) The federal government receives a complaint from one or more affected jurisdictions.
- The legislation should provide that, where these conditions are met, the federal resolution of the problem should be based on the recommendations of a board established for this purpose and on which the affected jurisdictions are represented.

As Saunders notes, this solution does not have the federal government unilaterally imposing solutions, but it does leave the federal government in command of the *process*, perhaps correctly so.

This debate on federal primacy was quite thoroughly reviewed by Steven Kennett where he examines the federal and provincial jurisdictional capacities and inabilities to both plan for integrated basin management of interjurisdictional waters and reduce the possibility of water disputes. In the end, Kennett (1991) develops an argument for developing a clarification of POGG (peace, order and good government/provisions of the Constitution Act) that would reinforce a strong federal role in interjurisdictional waters.

9.3 Land Management

9.3.1 Introduction

As in the case of water management, land management responsibilities in the Northern River Basins Study area falls into two jurisdictional regions; the Province of Alberta and the Northwest Territories. However, unlike water management, the management of public lands and control of municipal land uses and development lies in the hands of at <u>least</u> three levels of government in both Alberta and the NWT For example, in the case of Alberta, public lands are owned and administered by the province, municipal governments have responsibility for land use controls in rural and urban municipalities and the federal government owns and manages large

tracts of national park lands and some Indian reserve lands. This section will review the Alberta land management and land use and control legislative situation first and the NWT situation second. A third and final part of the paper will attempt to define the major factors that must be considered in the land and water legislative situation in both Alberta and NWT for the Northern River Basins Study Board to develop recommendations on river basin management.

9.3.2 Alberta

Forestry is one of the major land use activities in the NRBS area. Similar to water, ownership of forests not on federal land, is granted by the constitution to the provinces. In Alberta timber harvesting permits are allocated under the Forestry Act based on the annual allowable cut (ACC). The ACC is a yearly allocation of timber that can be harvested in one year, as determined by Alberta government on a sustainable yield basis. The ACC is set for coniferous and deciduous timber independently, and is distributed according to three different types of agreements:

- Forest Management Units (FMAs) account for the largest portion of the ACC. FMAs are negotiated and legislated agreements under the Forestry Act between the provincial government and a company to grow and harvest timber on a sustainable yield basis (AEP 1995).
- Timber Quotas entitle the holding company to a proportion of the ACC and are given for a 20 year period. The two types of Timber quotas are Coniferous Timber Quotas and Deciduous Timber Allocations (AEP,1995).
- Miscellaneous Timber Use (MTUs) is the portion of the ACC reserved for local community use and small timber operations. There are three types of MTUs: Coniferous Timber Permits, Deciduous Timber Permits, and Local Timber Permits, which are allocated for a period of one to five years (AEP 1995).
- Part III of the Forestry Act permits the setting aside and management of Forest Recreation Areas.

Within the NRBS, a considerable amount of crown land has been set aside for public use and/or in a preservation effort under the Public Lands Act. These public lands are protected under various provincial and federal legislation.

- **National Parks** are areas that have been set aside as representative examples of Canada's natural regions. Their flora, fauna, natural features and resources are protected under the *National Parks Act* (AEP 1995).
- **National Wildlife Areas** have been deemed as important or unique wildlife habitat. They are legislated under the *Canada Wildlife Act* (AEP 1995).
- **Willmore Wilderness Park** is unique in that it is protected under its own legislation in order to provide recreational wilderness and conserve sensitive resources (AEP 1995).
- **Provincial Parks** have been set up to conserve provincially significant recreational resources and natural landscapes. Provincial Parks are legislated under the *Alberta Provincial Parks Act* (AEP 1995) in conjunction with Alberta Public Lands Act.
- **Wilderness Areas** are large areas of undeveloped land set aside by the province of Alberta to preserve their character. They are protected under the *Alberta Wilderness Areas, Ecological Reserves and Natural Areas Act* (AEP 1995) in conjunction with the Alberta Public Lands Act.
- **Ecological Reserves** have been selected as representative natural areas, due to unique natural landscapes or for research, education or heritage purposes. These reserves are legislated by the *Wilderness Areas, Ecological Reserves and Natural Areas Act* (AEP 1995).
- **Natural Areas** are also legislated under *the Wilderness Areas, Ecological Reserves and Natural Areas Act*. These areas are intended for low levels of public use in order to conserve their natural characteristics (AEP 1995).

The land base in the Alberta part of the Northern River Basins Study area can be divided into three distinct classes of lands from a legal viewpoint:

(i) Provincial Public or Crown Lands
(ii) Private Lands
(iii) Federal Lands such as National Parks

Provincial public lands are Crown-owned lands administered under the responsibility of the Minister of Environmental Protection through the Alberta Public Lands Act. Private lands are held by private title holders but commonly are taxed and governed by rural or urban municipal government councils. Federal lands, on the other hand, are federal Crown lands administered by Parks Canada in the case of Jasper and Wood Buffalo National Parks or by various First Nation band councils in the case of Indian Act reserve lands.

The Public Lands

The Alberta Public Lands Act

The Public Lands Act was first passed in 1931 shortly after the passage of the federal National Resources Transfer Act (1930) had delegated full responsibility for resources ownership and management to Alberta (and Saskatchewan). It's basic purpose and philosophy has remained largely unchanged since 1931. This simple statute established three key points immediately:

(a) it declares which provincial lands are public;
(b) it establishes that the Crown in right of Alberta has title over the bed and shores of all permanent naturally occurring water bodes (rivers, streams and lakes); and
(c) it establishes that all public land dispositions (i.e. grants of land or leases) made by predecessor legislation such as the Dominion Lands Act are subject to the provisions of this Public Lands Act.

The Act is then set out in six parts, four of which are noteworthy for NRBS:

Part I	Administration of Public Land
Part II	Dispositions Not Leading to Title (general leases)
Part III	Homestead Sales
Part IV	Grazing Leases

Parts II, III and IV set up the basis for granting title for or leasing privileges over public lands to private citizens and others and, as such, are routine matters. The key part for Northern River Basins Study is Part I where in Section 8, the Lt. Governor in Council is given the powers to set aside public lands for provincial parks, historic sites, natural areas, ecological reserves, forest reserves and forest recreation areas and wildlife sanctuaries. Lands to be set aside for federal government needs (i.e. National Parks and Indian Reserves) are also covered in Section 8. The Lt. Governor in Council is also empowered to make the necessary regulations, governing how the provinces' public lands will be disposed, and in Section 9, define the terms and conditions for mineral exploration and mining on public lands.

One of the first powers given to the Minister (in this case currently the Alberta Environmental Protection Minister) is Section 10 which in a modest, simple sentence notes that "the Minister may, by order, classify public land and declare the <u>use</u> for which he considers different classes to be adaptable".

This one small, but key section of the Act is the sole basis for the current provincial "Integrated Resources Planning" zoning and land use control process and, as such, is a tenuous basis for such a far reaching terrestrial resource management program. Officials of AEP working in the public lands planning area have noted that future revision work to the Act should make a priority of revisions to this section where modern resource management, protection and extraction principles need to be spelled out.

The balance of Part I provisions relate to the administrative procedures for the orderly, fair and equitable disposition of lands with emphasis on such concepts as tying the sale of public land to certain beneficial uses, prohibitions of sales to non-Canadians, cancellation and re-instatement of dispositions and public notification processes.

In summary, the Alberta Public Lands Act is an elderly statute that, like the existing Water Resources Act, set up a process for granting or leasing public lands of the Crown to whomever of the Canadian public applied in good faith for it. With the exception of the tersely worded Section 10, the Act is silent on how this, as yet, huge set of public assets are to be managed in the name of the public interest, ecosystem protection or sustainable development. Some of the beginnings of those concepts are spelled out in two sister acts, the Alberta Forestry Act and the Alberta Wildlife Act.

Alberta Forestry Act

The Alberta Forestry Act, like the Public Lands Act, was first drafted in the early 1930s with amendments added since. Unlike the Public Lands Act, the Forestry Act has a few more modern concepts embedded in it. As well as establishing the routine powers of the Lt. Governor in Council for making regulations on its terms and conditions on timber permits, licences quotas and forest management agreements, aspects of reforestation and afforestation, the Act empowers the Lt. Governor to make regulations governing the management and use of forest lands. This is a fundamentally important power, for the Northern River Basins Study Board to understand because so much of the northern basins area is now forest lands by virtue of being held under forest management agreements, timber quotas licences and permits. A reinforcement of this power is in Section 6 where the forestry minister (if he/she does not also hold the public lands portfolio) has the Public Lands Act administrative responsibility for all public lands subject to timber dispositions, forest land use zones (FLUZ), forest recreation areas and trails.

Sections 14 and 16 under Part 2, Crown Timber, allows the Minister to divide forest lands into forest management units then to enter into forest management agreements with persons who will establish, grow and harvest timber in a perpetual sustained yield manner. Section 16(ii) confers timber ownership to the FMA holder and then 16(iv) assigns to an FMA agreement holder the whole responsibility for forest management in that forest management agreement area and does not allow the FMA holder to give some of that area or responsibility to anyone else.

Part 3 of the Act encompasses two key sections dealing with forest land uses. The first of these two, Section 46, empowers the Lt. Governor in Council to make regulations regarding:

(a) any forest lands to be set up as forest land use zones (FLUZ);
(b) the controlling, regulating, permitting or prohibiting the uses of land in forest land use zones;

(c) the declaring of any forest lands to be forest recreation areas or trails;
(d) the controlling of uses and activities in such areas.

The second key section is Section 47 where, through a Ministerial Order, the Minister may prohibit entry to all or part of forest recreation areas or trails.

Section 46 has considerable potential for being greatly expanded in scope beyond recreational to ecosystem protection purposes as a basis for zoning and land use control under the FLUZ process, however, AEP is not actively contemplating such an expansion.

The Alberta Wildlife Act

The Wildlife Act's provisions for the setting up of wildlife resources are of most interest to the Northern River Basins Study Board. Section 8(2) empowers the Lt. Governor in Council to make regulations providing for the designation, control and management of any area of Crown land to be set aside as a wildlife sanctuary, bird sanctuary, wildlife protection area or habitat management area. To date, such areas have been set aside on a seasonal basis to prevent big game hunting from vehicles along road corridors and to restrict migratory waterfowl hunting along rivers. The whole length of the Peace River corridor in Alberta is a seasonal sanctuary until November 15 annually. This particular "seasonal" sanctuary includes a land base 100 yards wide from the edge of the water of the river. Short reaches of the Little Smoky and Smoky Rivers have a similar seasonal corridor hunting restriction. Finally, a group of islands upstream of Fort Smith in the Alberta section of the Slave River have been designated as colonial nester sanctuaries (pelicans) from April 15 to September 15 annually.

The Provincial Parks Act

Three closely related provincial statutes are the basis for the management and Operation of Alberta's parks, ecological reserves and wilderness areas: The Provincial Parks Act (1930's), the Willmore Wilderness Park Act (1958) and the Wilderness Areas, Ecological Reserves and Natural Areas Act (1980).

Under Section 3 of the Provincial Parks Act, the purpose of parks is stated as being:

(a) for the conservation and management of flora and fauna;
(b) for the preservation of specified areas and objects therein that are of geological, cultural, ecological or other scientific interest; and
(c) to facilitate their use and enjoyment for outdoor recreation.

Crown lands that are required for a provincial park are set aside by the Lt. Governor in Council using Section 7(c) of the Public Lands Act and Section 7(1) of the Provincial Parks Act. The Lt. Governor in Council can, in Sections 6(1) and 6(2) of the Parks Act, purchase or expropriate private lands for park and recreation purposes.

Section 11 empowers the Minister responsible for Provincial Parks to make regulations governing the land uses and activities in parks (including water reservoirs and the use of water stored in them) and generally, the rational administration of provincial parks.

The Willmore Wilderness Park Act was written with considerable foresight in the late 1950's to specifically set aside a very large block of Crown land on the north west corner of Jasper National Park comprising the headwaters of the Smoky and Berland Rivers. Section 3 of the Willmore Wilderness Park Act states that "The Park is dedicated to the use of the people of Alberta for their benefit, education and enjoyment, subject to this Act and the regulations, and shall, by the management, conservation and protection of its natural resources and by the preservation of its natural beauty, be maintained for the enjoyment of future generations".

The third Act in the trilogy of legislative tools available to the Provincial Parks Minister (AEP Minister currently) is the Wilderness Areas, Ecological Reserves and Natural Areas Act. The preamble to this Act is representative of relatively modern environmental thinking as follows:

> WHEREAS the continuing expansion of industrial development and settlement in Alberta will leave progressively fewer areas in their natural state; and
>
> WHEREAS it is in the public interest that certain areas of Alberta be protected and managed for the purposes of preserving their natural beauty and safeguarding them from impairment and industrial development; and
>
> WHEREAS to carry out these purposes for the benefit and enjoyment of present and future generations it is desirable to establish certain kinds of areas and reserves and to provide varying degrees of protection to those areas and reserves.

Section 2 of this statute sets up an Advisory Committee on Wilderness Areas and Ecological Reserves comprising 12 members (one-half of whom are non-government people) whose task it is to consult the public and then advise the Minister regarding the setting up of reserves and areas under this statute. Three large and a number of small such areas have been set up to date under Sections 3 and 4 of the Act. (Areas to be set aside under the Province's new Special Places Program will likely be designated under that legislation).

The bulk of the balance of the Act after Section 4 is the general administration of such areas including provisions for the regulation of land use activities and access.

As in the case of provincial parks, public lands designated for the purposes of this Act where set aside under Section 7(c) of the Public Lands Act.

In summary, these three statutes lay the basis for some potentially very important reserves of public land being set aside in future for ecosystem reasons. With particular emphasis in the third statute, this provincial government possesses the necessary tools for some time to come. Some active discussions are now underway with the Environmental Law Centre of Edmonton regarding rationalizing the three statutes into one in the next two to five years.

The Private Lands and Municipal Governance

Until spring 1995, two key statutes have governed the area of municipal land use and municipal government; the Planning Act and the Municipal Government Act. In May, 1995, Royal assent was given to an act that collapsed these two acts together. This new act is called the Municipal Government Amendment Act (1995).

One of Alberta's more unique innovations of the post-war years of economic development, the Regional Planning Commissions under the old Planning Act, ceased to exist with the passage of the new Municipal

Government Amendment Act. The Regional Planning Commissions had from their inception been potentially an excellent vehicle for environmental protection planning in the so-called white zone (or private land zone). With their demise, land-use planning having a river basin scope will be made more complex logistically simply because these are now so many municipalities to deal with. Formerly, the Regional Planning Commission retained the power of subdivision approval (and thus wise or not so wise land use approvals). Currently, the new Act has passed these powers back to the municipalities.

The former Planning Act provisions for statutory municipal plans have, of course, been carried forward into the new Act. The new Act provides for inter-municipal plans (and thus an inter-municipal planning process) that can in many ways replace some of the regional planning process embedded in the old Regional Planning Commissions. However, the province's perspective, presence and resources are no longer part of the picture. Environmental reserves can be set aside under Section 664(1) of the new Act but the scale of such a reserve is with the individual subdivision level.

The potential for the regional or municipal planning function to act as a vehicle for assisting in the long term, broad scale problem of ecosystem based river basin planning and management work has perhaps declined somewhat with the passage of the new municipal Government Amendment Act. The new Act is notably silent in the purpose of municipal land use planning when compared to the former Planning Act purpose which was "to provide the means whereby plans and related measures may be prepared and adopted to:

(a) achieve the orderly, economical and beneficial development and use of land and patterns of human settlement; and

(b) maintain and improve the quality of the physical environment within which patterns of human settlement are situated in Alberta without infringing on the rights of individuals except in the public interest."

In an effort to recover some provincial level of influence on the municipal/regional land use planning process, Alberta Municipal Affairs is now receiving public and local government comment on a "Land Use Policies Discussion Paper" (July 1995). This document notes that provincial and municipal roles in planning must be co-ordinated in nine key ways, two of which are of particular interest to the Northern River Basins Study Board's recommendation process. "In carrying out their land use and community planning responsibilities, municipalities are to:

2. co-ordinate their planning process with those of provincial departments having a responsibility for or related to land use planning (i.e. such as AEP);

6. contribute to the protection and enhancement of Alberta's natural environment through the implementation of appropriate planning initiatives".

The Land Use Policies paper is currently receiving some critical review and in a modified form will likely go to the Municipal Affairs Minister for approval early 1996. It will compel local governments to build the approved land use policies to land use planning.

In summary, the Alberta Municipal Government Amendment Act is very new and with its land use planning provisions being largely untried, it may be a number of years before its ability to buttress a river basin planning and management process is known.

The National Parks Act

The Northern River Basins Study area encompasses two of Canada's largest national parks; Jasper National Park in the headwaters of the Athabasca River and Wood Buffalo National Park centred at the confluence of the Peace and Athabasca Rivers, but also extending north into the Northwest Territories on the west side of the Slave River. These two national parks are of interest to the Northern River Basins Study Board's recommendation process because:

(i) under the National Parks Act, they are "dedicated to the people of Canada for their benefit, education and enjoyment" and "shall be maintained and made use of so as to leave them unimpaired for the enjoyment of future generations";

(ii) they are large tracts of federal land situated at key strategic locations in the basins;

(iii) the Peace/Athabasca Delta part of Wood Buffalo Park is currently the subject of an in-depth companion study to Northern River Basins Study out of which should emerge a delta ecosystem management plan that will involve some rehabilitation work to the perched basins;

(iv) Wood Buffalo National Park is Canada's only "inter-provincial" park where a huge tract of public land straddling two jurisdictions is the subject of one land management authority.

Probably the key land use provisions of the National Parks Act are found in Sections 5 and 6, Park Administration and Park Lands respectively. Section 5.1.1 compels the Minister to establish a management plan covering resource protection, zoning and visitor use, etc., while Section 5.1.2 notes that "maintenance of ecological integrity through the protection of natural resources shall be the first priority when considering park zoning and visitor use in a management plan". Section 5.1.4 empowers the Minister to provide appropriate public participation opportunities in the development of parks, policies and management plans. Subsection 5.8 establishes that the Governor in Council may, by regulation, declare wilderness areas in any National Park while 5.9 quite clearly bars a National Parks Minister from authorizing any activity likely to impair that area's "wilderness character".

Under the Park Lands provision of Section 6, a number of predictable tight limits on the disposition of public lands in national parks are described that essentially discourage settlement and leasing of lands in general.

The balance of the National Parks Act contains the necessary administrative references to the types of regulations needed by the Minister and Governor in Council to operate the diverse range of national parks in Canada including Section 8 which refers specifically to the boundaries and local government needs of Jasper and Banff townsites.

The planning and management process involving the four Rocky Mountain National Parks (Banff, Yoho, Kootenay and Jasper) has, in the last two decades, seen a considerable amount of pressure (from both within and outside of the Parks administration system) for provincial land use and mining controls on lands immediately adjacent to those national parks; in short, buffer zones managed for ecological purposes in certain sensitive wildlife habitat areas such as along the west boundary of Yoho and east boundary of Jasper National Parks. Discussions are ongoing and inconclusive to date.

9.3.3 The Northwest Territories

As in the case of Alberta, the land base of the Northwest Territories is comprised of public lands, some national parks and some municipal lands.

However, the similarity ends at that point because, unlike Alberta, some 99% of the NWT is made up of public lands under the control of the Federal Territories Lands Act. About 1% of the NWT is commissioners lands under the administration of the Territorial Government's "Commissioner's Land Act". A small number of Indian lands exist under the Indian Act (such as the Hay River Indian Lands). A number of First Nation land claims and co-management initiatives are influencing this mixture of ownership and administration. An example is the Mackenzie Valley Resource Management Act, arising out of the Gwichin land claim. Additionally, the future establishment of the new Nunavat Territory in the eastern Arctic will further alter this mix.

For purposes of assisting the NRBS recommendations process, the emphasis here will be on the Territorial Lands Act and the Commissioner's Lands Act.

The Territorial Lands Act

The "Territorial Lands Act" is a federal statute enacted by the Parliament of Canada to provide for the orderly development and regulation of land in the NWT and Yukon. It also sets up the regulation of timber harvesting.

Before laying out the routine administrative matters relating to the reserving, selling, leasing, mining and logging of territorial lands, this relatively modern statute sets out a concept of establishing "Land Management Zones" in Section 4. Although requiring a cabinet decision, the Governor in Council may, "where he deems it necessary for the protection of the ecological balance or physical characteristics of any area in the Yukon Territory or Northwest Territories, set apart and appropriate any territorial lands in that area as a land management zone". The sequel Section 5 empowers the Governor in Council to make regulations covering the protection, control and use of the surface of land in the land management zone. These vocabulary choices are not found at all in the Alberta Public Lands Act, which is somewhat silent with respect to its land management philosophies and principles by comparison.

An additional hint of more modern thinking is Section 11 which statutorily limits:

(i) to a maximum of 160 acres, the sale of territorial lands to any one person;
(ii) to a maximum of 640 acres, the lease of territorial lands to any one person;
(iii) to a maximum of 6400 acres, the lease of grazing land or muskrat farming lands to any one person.

Section 14 reserves for Crown ownership the bed (and shores below the ordinary high water mark) of any body of water. Although brief, Sections 17 and 18 set up a timber harvesting system under Governor in Council regulations that spell out permit conditions, stumpage fees, access, etc. The administrative responsibilities for these two sections were devolved to the Territorial Government in 1986.

Two sets of regulations are worth noting here:

(i) the Territorial Lands Regulations; and
(ii) the Territorial Land Use Regulations.

The Territorial Lands Regulation regulates the Section 11 limits noted above on maximum amounts of land for sale or lease amongst other things. The more important of the two for the Northern River Basins Study

purposes is the Territorial Land Use Regulations which are designed to regulate the "Land Management Zone" Sections 4 and 5 of the Act. Given Royal assent in 1971, the Regulation starts with a philosophical preamble that states:

> WHEREAS it is necessary for the protection of the ecological balance of the Yukon Territories and the Northwest Territories to set apart and appropriate each of the said Territories as separate land management zones

then moves directly to Section 3 of the Regulation that sets apart the whole of the two territories as separate land management zones.

A key reason for such a deliberate set of environmentally protective word choices is the long history of mining and minerals exploration activities in the Yukon and NWT In discussions with the Department of Indian Affairs and Northern Development (DIAND) personnel in Yellowknife, it was explained that the North's more delicate ecology required more controls than necessary south of 60° over exploration access (winter and summer) and general transportation. Administratively, the Territorial Land Uses Regulation lays out relatively standard conditions for river crossings, campsites, trails, *etc.* to be followed by DIAND in issuing land use permits. With the 1992 passage of the Canadian Environment Assessment Act (CEAA), administrative life has become considerably more complex. Every land disposition is now subject to CEAA provisions. Environment Canada now has a much larger role in the administrative framework using a three-level environment assessment screening process up to and including full public environmental assessment panels to hear disposition proposals prior to any DIAND decisions.

The Commissioner's Land Act, 1990

This tersely worded statute was enacted by the Legislative Assembly of the Government of the Northwest Territories (GNWT) in 1990. It applies only to a small portfolio of mostly municipal lands in the NWT called Commissioner's lands that were either purchased by the Territorial Government (GNWT) or were transferred from the federal government to the administrative framework of the GNWT under the Department of Municipal and Community Affairs. As noted earlier, these lands are principally municipal lands for urban and community development purposes or transportation corridors.

This Act is silent with respect to a management philosophy or principles and goes immediately in Section 3 to setting up a routine disposition process involving sales and leases and so on. Section 4 empowers the Commissioner (i.e. the most senior official in the GNWT), to either withdraw Commissioner's Lands from disposition or reserve them for public and other purposes.

Apart from a routine set of sections on trespass, fines and appeals, the remaining part of the Act empowers the Commissioner, on the recommendation of the Minister, to make regulations for the orderly sale or lease, or any other method of disposition, of Commissioner's Lands including the prescribing of tariffs, fees limitation and conditions.

In summary, this Act regulates the use and disposition of a small group of lands adjacent to urban communities like Yellowknife that are principally set aside for urban and community expansion and development. From a Northern River Basins Study recommendations perspective, they are of interest, but not of huge importance.

The Mackenzie Valley Resource Management Act - Proposed

This proposed Act will replace the NWT Lands Act. The preamble to the current federal Bill states that this new Act is "to provide for an integrated system of land and water management in the Mackenzie valley and to establish certain Boards for the purpose".

The key points of this proposed Act are:

1. It will apply to all of the NWT west of Nunavat and north of the 60° parallel.
2. It will set up an overseeing body called the Mackenzie Valley Land and Water Board.
3. It will establish the first two of five regional Land and Water Boards who will have land and water management responsibilities in the First Nation "Comprehensive Land Claims Settlement" areas. The first two of the five regional boards, the Gwichin and Sahtu Land and Water Boards appear to be assigned the tasks of administering water rights, waste deposition control, public lands disposition and land use controls. It leaves the specifics of an "integrated land/water management system" to the six Boards.
4. Control over the actual land use planning process is given under Part II of the proposed Act to the Gwichin and Sahtu Land Use Planning Boards.

   Guiding principals for land use planning are:

   (i) to protect and promote the economic, social and cultural well-being of residents in the comprehensive land claims settlement areas;

   (ii) special attention is to be devoted to the protection of rights of the First Nation in the settlement area; its social, cultural and economic well-being; as well as the protection of lands used by the First Nation for hunting, trapping, *etc.*

5. It defines in Section 72 an Aboriginal Water Right in land claims settlement areas that relates to the rights of a First Nation to the use of waters without a licence for the continuation of aboriginal traditional life style (i.e. hunting, fishing, trapping and spiritual and cultural purposes). Section 73 speaks to giving a First Nation an exclusive right to use water and deposit waste in water on First Nation lands while Section 74 entitles a First Nation to have waters on or adjacent to it substantially unaltered (re: quality, quantity, flow rate).
6. It establishes a Mackenzie Environmental Impact Review Board which will possess powers sufficient to replace the need for the Canadian Environmental Assessment Act (1992) as it now applies to the Northwest Territories.
7. Finally, it establishes a Cumulative Impact Monitoring and Audit process that, through "a responsible authority", shall collect and analyze scientific data, traditional knowledge and other relevant information for the purposes of monitoring the cumulative impact on the environment of sequential uses of land, water and the deposit of waste in the Mackenzie Valley.

DIAND personnel in Yellowknife have advised that the proposed statute is still not accepted by the South Slave (Treaty 8) or Decho (Ft. Liaird) First Nations. First reading of the proposed Act is expected in the federal parliament not earlier than mid 1996.

9.4 Summary Considerations

Some key considerations must be remembered by the Northern River Basins Study Board when considering the legislative background to making land or water related basin management recommendations. These include:

1. The Northern River Basins Study area encompasses the legislative jurisdictions of three elected parliaments or legislative assemblies, each with their own jurisdictional distinctiveness, mandate and agenda.

2. Current lands (and water and environmental protection) statutes north and south of the 60°N parallel differ in age and philosophies sufficiently that some "harmonization" of them will be required if a serious ecosystem based river basin scale management approach is to be successfully pursued in the Northern River Basins Study area.

3. Apart from the concepts of integration in the proposed Alberta Water Act and Mackenzie Valley Resource Management Act, current water and land laws in Alberta and the Northwest Territories are not well integrated. Attempts to undertake administrative level integration are currently underway in Alberta.

4. Lands (and forest) statutes in Alberta need the kind of modernizing that the Water Resources Act went through. Integration of all the resource management statutes could occur during such a modernization.

5. First Nation influence on the NWT environmental management and protection regulatory framework appears to be much greater than in Alberta.

6. A further level of legislative integration in both Alberta and NWT involving the harmonization of municipal land use controls with environmental management objectives of a river basin management "authority" would be a very difficult task individually in each separate jurisdiction, let alone a basin wide harmonization of this type across the 60° parallel. As noted above, the new Alberta Municipal Government Amendment Act alone is new and relatively untried with respect to encouraging local governments to help with the large tasks of environmental protection and sustainable development.

9.5 References

Alberta Environmental Protection (AEP). 1995. Alberta State of the Environment Comprehensive Report. 119 pp.

Percy, D. R. 1988. The Framework of Water Rights Legislation in Canada. Published by the Canadian Institute of Resources Law. University of Calgary.

Rueggeberg, H. and A. R. Thompson. 1984. Water Law in Canada. Inquiry on Federal Water Policy, Westwater Research Institute, University of British Columbia.

Rueggeberg, H. and A.R. Thompson. 1988. Water Law in Canada, Inquiry on Federal Water Policy, University of British Columbia, Vancouver.

Saunders, J. O. 1988. Interjurisdictional Issues in Water Management. C.I.R.L. University of Calgary.

10. A Basin in Transition

10.1 Historical and Socio-Economic Influences

Historically, the Peace, Athabasca, Slave river and Lake Athabasca systems functioned as migration, trade and transportation routes. From the start of the fur trade in western Canada in the late 1770s to the construction of roads into the north in the 1970s (Figure 30), these waterways were the principal transportation and lifeline focus of northern residents and migrants. A considerable societal-level 'memory' exists still in the north regarding the importance of these waterways to early northern society. The waterways, with particular emphasis on the Peace-Athabasca Delta, were and still are extremely important as winter snowmobile routeways, aquatic summer highways, and trapping and fishing areas for the First Nations of the region. The traditional uses of land and water are well documented in Northern River Basins Synthesis Report #12, 1996 entitled "*A Report of Wisdom Synthesized From the Traditional Knowledge Component Studies*". Additional historical information in the form of a history timeline follows this section.

Socio-economic factors potentially affecting the management of a transboundary set of basins have been studied in some depth by the Northern River Basins Study and are reported in the Northern River Basins Synthesis Report #7, 1996, entitled "*Characterization of Aquatic Uses within the Peace, Athabasca and Slave River Basins*". This report reveals a considerable level of active usage of the river basin system including its tributaries for industrial, agricultural, recreational and other social and environmental purposes. It further reveals a broadly-held northern societal consensus that these aquatic systems need particular levels of protection and care into the future such as may be afforded by a river basins management authority.

Historical Timelines

The following is a brief description of the settlement of the Northern River Basins Study area. More detailed historical information is provided in the form of historical chronologies of the Athabasca, Peace and Slave River Basins. See Table 14, 15 and 16 respectively.

Prior to the arrival of the first European, the Northern River Basins Study area was inhabited by Athapaskan-speaking people of the Chipewyan, Beaver, Slave and Sarcee nations. The first European influences on the area did not come with the arrival of the Europeans; but rather with that of the Algonkian-speaking Cree from north-west Ontario, who travelled west in search of rich trapping grounds in order to increase their trade with the Europeans. The Cree who had acquired fire arms through the fur trade pushed the Athapaskan-speaking peoples into the northern portions of the Northern River Basins Study area (Praxis 1985).

In 1715, William Stewart, of the Hudson Bay Company, arrived in the area in an effort to promote peace between the Athapaskan and Algonkian speaking peoples, whose conflict was hindering the fur trade. History credits him with being the first European to enter what is now the Mackenzie Drainage System. The first fur trading post in the area was set

up by Peter Pond near the present town of Fort Chipewyan. The rest of the 18th Century saw the expansion of the fur trade and the exploration of the north-west. The explorer of greatest significance was Alexander Mackenzie who, in 1793, charted the first overland route to the Pacific Ocean.

Settlement of the area was slow due to inaccessibility of the major farmlands which were separated from the south by dense forest and muskeg. The first waves of settlement into the area came in the late 1800s. In 1890 the railway reached Edmonton bringing the area closer to the rest of the world. In 1898 the Klondike Goldrush brought many into the area who believed that the Mackenzie was the quickest route to the Yukon. Many would-be prospectors never made it to the Yukon and instead settled in Northern Alberta.

1909 to 1916 marked the expansion of the railway into the study area and the beginning of large scale settlement . During this period many towns experienced boom periods while they were located at the "ends of steel", but soon the railway and the prosperity moved on. Other catalysts for settlement in the 20th century included the Great Depression which attracted farmers from the south to the less arid northern parkland, the building of the Alaska Highway, the *Veterans' Land Act* of 1942, the Yellowknife Goldrush of 1945, oil and gas exploration and development beginning in the 1950s, and the oil sands development in the 1960s.

Table 14. Historical Chronology of the Athabasca River Basin.

1715	William Stewart travels overland from Churchill to the Mackenzie Basin. He is the first to describe the oilsands. [f]
1778	Peter Pond establishes the first fur trade post on the Athabasca River. [f]
1788	Fort Forks established at the confluence of the Clearwater and Athabasca Rivers. [f]
1790	Philip Turnor and Peter Findler conduct the first survey of Lake Athabasca and the Athabasca and Slave rivers. [f]
17??	Fort Edmonton established by the Hudson's Bay Company. [c]
1795	Fort Augustus established by the North West Company. [c]
1799	David Thompson of the North West Company ventures up the Athabasca River. [b]
1800	Peter Fidler travels up the Athabasca for the Hudson's Bay Company. [b]
1802	Pierre au Calumet established on the Athabasca River as a provision post for trade with the Crees. [f]
1804	The North West Company absorbs the XY Company. [f]
1806	The Hudson Bay Company abandons the Athabasca fur trade to the North West Company. [f]
1810	David Thompson makes the first recorded visit to the Rocky Mountain portion of the Athabasca Valley. [h]
1813	The North West Company opens a depot on Brûle Lake, which later becomes known as Jasper House. [h]
1821	The Hudson Bay Company takes over the North West Company. [c]
1830	Jasper House relocated to a location on the Athabasca River near Jasper Lake, 36 km east of the present townsite. [h]
1852	Mission established by Catholic Oblate Priests at Lac La Biche. [f]
1869	The Hudson's Bay Company's monopoly of the fur trade ends. [f]
	First scows used from Lac La Biche to Fort Chipewyan. [f]
1870	Fort McMurray established. [f]
1872	Athabasca Depot established as a provisioning camp near the present Town of Jasper by Walter Moberly the engineer in charge of surveying for the transcontinental railway. [h]
1874	First recorded patrol of the North West Mounted Police in Alberta. [c]
1877	The Athabasca Landing (now the town of Athabasca) established as a seasonal post for the Hudson Bay Company. [c]
1884	Athabasca Landing permanently established as a transportation centre. [f]
	Jasper House abandoned due to the decline of the fur trade.
1889?	The Hudson Bay trade road from Edmonton to Athabasca declared public.[c]
1894	Anglican Mission opened at Athabasca Landing. [c]
	A game preservation act is passed, banning the hunting of Wood Buffalo until 1900 and imposing a closed season for hunting big game, fur bearing animals and birds. [f]
1897	The Hudson Bay Company established a trading post at the site that is now Whitecourt. [f]
1898	Klondike Goldrush.
1899	Treaty No. 8 signed by Beaver, Slavey, Cree and Chipewyan Natives. [f]
1900	First hospital built at Athabasca Landing. [c]
1904	Telegraph reaches Athabasca Landing. [f]
1905	The provinces of Alberta and Saskatchewan are formed.
1907	First oil well drilled in Fort McMurray. [f]
	The Federal Government forms Jasper Forest Park (now Jasper National Park). [h]
1908	The first coal claims are staked in the eastern part of Jasper National Park. [h]
1910	The railway reaches Edson. [d]
	A coal mine is established at Pocahontas near the present east entry to Jasper National Park. [h]

1911 Edson incorporated as a town. [d]
The Edson-Grande Prairie Trail is established by the provincial government to encourage settlement of the north. [d]
The Grand Trunk Pacific Railway reaches Fitzhugh (Jasper) Station. [h]
1912 The railroad arrives in the Town of Athabasca. [b]
1913 Federal department of mines begins a survey of the oilsands. (Survey completed in 1915.) [f]
The Research Council of Alberta is formed. [f]
The Canadian Northern Railway's tracks reach the Yellowhead Pass. A divisional point was built at Lucerne BC.
1914 The Edmonton, Dunvegan and British Columbia railway is completed. It passes through Sawridge (now known as the Town of Slave Lake). [a]
1915 Telegraph reaches Fort McMurray. [f]
1916 Railway tracks are desperately needed in France for troop trains, so consolidation of the lines of track, The Grande Trunk Pacific and Canadian Northern, through Jasper National Park begins. [h]
1917 The Alberta Provincial Police replaces the Royal North West Mounted Police as the policing agency in the province. [c]
The Edson-Grande Prairie trail becomes obsolete with the completion of the railway from Edmonton to Grande Prairie. [d]
1919 Fort McMurray Board of Trade is established. [f]
1921 The Alberta Great Waterways Railway is constructed to Waterways. [f]
1923 The settlement of Sawridge adopts the name Slave Lake. [a]
Several Canadian railways including the Grande Trunk Pacific and Canadian Northern railways amalgamate to form the Canadian National Railway. [h]
1928 Road opens from Edmonton to Jasper using much of the old railbed. [h]
1929 to 1930
The Research Council of Alberta builds and operats an experimental oil sands separation plant at Waterways. [f]
The railway divisional point moves from Lucerne BC to Jasper bringing with it an influx of new residents. [h]

1930 to 1940
Abasands and Bitumount oil sands plants begin operation. [f]
The National Parks Act is passed, eliminating further resource extraction in the parks. Jasper officially becomes a national park. (Final area 10,000 km^2)[h]
1931 As a relief project during the depression work begins on the Banff-Jasper Highway. [h]
1932 The Royal Canadian Mounted Police replace the Alberta Provincial Police. [c]
1935 Slave Lake is flooded and the town relocated to its present location along the river. [a]
1940 The Banff-Jasper Highway (now the Ice Fields Highway) officially opens. [h]
1943 Airport opens in Fort McMurray. [f]
1944 The Bitumount Oil Sands Plant closes. [f]
1945 The Abasands Oil Sands Plant destroyed by fire. [f]
1947 Fort McMurray and Waterways joined to become one village. [f]
1948 to 1950
The Research Council of Alberta opens an experimental plant at Bitumount. [f]
1949 Fort McMurray became a town. [f]
1955 The first wet gas discovery made near Edson. [d]
-Pulp Mill is constructed in Hinton. [e]
-Highway 43 officially opens. [g]
1959 Whitecourt officially becomes a village. [g]
1961 Whitecourt incorporates as a town. [g]
1963 Discovery of the Utikima oil and gas field near Slave Lake. [a]
The Great Slave Lake Railway to Hay River is completed diminishing Fort McMurray's importance as a transportation centre. [f]
1964 The discovery of the Mitsue oil and gas field near Slave Lake. [a]
The Great Canadian Oil Sands begins plant construction. [f]
1965 The discovery of the Nipisi oil and gas field near Slave Lake. [a]
Highway 63 to Fort McMurray completed. [f]
1966 A quota system for timber harvesting is introduced in Alberta. This promoted timber harvesting in northern areas. [a]
1970 The Yellowhead Interprovincial Highway officially opens. [h]
1984 Athabasca University opens in the Town of Athabasca . It is a world leader in distance education. [b]

[a] Noralta Consulting; Slave Lake Community Profile; May 1993.
[b] Athabasca University and the Town of Athabasca ;Discover Athabasca Country; Canada
[c] Town of Athabasca :Land of Whispering Hills; Received from the Athabasca and District Chamber of Commerce.
[d] Anchor Advertiser; Recreation/Tourist Guide: Edson and District, Summer 1995
[e] Community Profile: Hinton, Alberta; received from the Hinton and District Chamber of Commerce.
[f] Parker, J. M. , and K. W. Tingley; History of the Athabasca oil sands region, 1890 to 1960's. Volume I: Socio-economic developments. Prep. Fort the Alberta Oil Sands Environmental Research Program by Boreal Institute for Northern Studies, The University of Alberta, AOSERP Report 80. ;1980.
[g] History-Milestones of Whitecourt, Alberta Canada, received from the Whitecourt and District Chamber of Commerce.
[h] C. Smith; People; Places & Events a history of Jasper National Park; Jasper-Yellowhead Historical Society 1983; Second edition by Parks and People 1991.

Table 15. Historical Chronology of the Peace River Basin.

1670 The Hudson's Bay Company granted a charter by King Charles II. [a]
1778 Boyer's Post established by the North West Company near the mouth of Boyer River, about five miles downstream of Fort Vermilion. [a]
1789 C. Vaudrieul conducts the first recorded survey of Alberta. The Peace is surveyed as far downstream as Boyer Post. [A]
1792 Fort Fork is founded six miles above the confluence of the Smoky and Peace Rivers near the present town of Peace River.
Alexander Mackenzie begins his voyage down the Peace River to the Pacific Ocean. [a]
1798 LaFleur's Post built by the North West Company at the mouth of the Keg River near Fort Vermilion. [A]
1799 Wentzel's Post constructed by the North West Company on the north side of the river opposite the mouth of the Little Red River. (In operation until 1803)[a]
1800 Dunvegan established.
1802 Mansfield House built by the Hudson's Bay Company on the north side of the Peace near the present site of Fort Vermilion. (Abandoned in 1803)[a]
Fort Liaird built by the North West Company near Mansfield House. (In operation until 1804)
1809 Horses brought to Dunvegan.
1818 Colville House established east of the Vermilion chutes on the north side of the Peace River. (Active until 1821) [a]
1821 The Hudson's Bay Company and North West Company joined under the Hudson's Bay Company name.
1830 At Fort Vermilion a Hudson Bay Company outpost was moved near its current site. [a]
1840 By this time domestic cattle are plentiful in Dunvegan.
1866 Catholic Mission founded in Dunvegan. Father Christopher Tessier is the first resident priest. [b]
1868 The first Anglican mission, St. Henri's Mission, in Fort Vermilion opens its registers. [a]
1873 The Royal North West Mounted Police (RNWMP) is established. [b]
1880s Catholic and Anglican missions are established in the Peace River area.
1889 Treaty #8 was signed in Fort Vermilion on the 8th of July. [a]
1893 A sample of wheat from Shaftesbury takes first prize in the world wheat championship Exhibition Chicago. (Canadian Encyclopaedia)
1903 The SS St. Charles is launched by the Roman Catholic Mission on May 18th. It is the first steamer on the Peace to provide round trip service between Fort Vermilion and Peace River Crossing. [a]
1905 The Province of Alberta is formed on September 1st. [a]
1908 The RNWMP sets up its first headquarters in the Grande Prairie region. [b]
1909 The Argonaut Company of Edmonton selects the tiny Bear Creek settlement as a future townsite in anticipation of the coming of the railway. This town site was to become Grande Prairie. [b]
1910 Presbyterian Mission opens in Grande Prairie. [b]
Grande Prairie hosts its first Agricultural Fair. [b]
1911 The Edson Trail is cut from Edson (the end of steel at the time) to Grande Prairie. [b]
1912 The first school is built in the Grande Prairie area. [b]
1913 Presbyterian hospital opens in Grande Prairie. [b]
1914 Grande Prairie incorporated as a village. [b]
1915 Electricity first became available in Grande Prairie. [b]
1916 The Edmonton, Dunvegan and British Columbia Railway, built by private capital, reaches the Town of Peace River.
An extension of the railway is built to Spirit River, McLennan and Grande Prairie.
1918 The Spanish Flu hits the Peace River Country claiming 88 lives. [b]
1919 Grande Prairie is incorporated as a town. [b]
The winter is the worst in regional history. [b]
The Cow Bill is passed by the provincial government to encourage farmers to increase their cattle herds, causing cattle prices to drop. As a result of the cold winter and drop in cattle prices many area farmers go into debt. [b]
1920 The Alberta government takes over the Edmonton, Dunvegan and British Columbia Railway system, leasing it to the Canadian Pacific Railway.
1921 Hospital District No. 14 formed.
1922 Railway reaches Berwyn.
Beginning of the development of the highway network in the basin.
Grande Prairie is now the biggest town in Alberta north of Edmonton. [b]
1924 Railway reaches Whitelaw and Wembly.
1925 A freight-rate adjustment enables the region to sell crops at a price that can compete with older settlements closer to Edmonton.
1927 The first Catholic school is established in Grande Prairie. [b]
1928 Railway reaches Fairview.
1929 Railway reaches Hyth.
First airmail service to Fort Vermilion. [a]
The modern and well equipped Municipal Hospital is built in Grande Prairie. [b]
1930 Railway reaches Dawson Creek, Pouce Coupé and Hines Creek.
A telegraph is installed at Fort Vermilion. [a]
1931 Canadian Airways makes its first scheduled air flight to Fort Vermilion. [a]
1952 The final commercial river boat run is made to Fort Vermilion. [a]
1958 A.G.T. begins Radio telegraph service at Fort Vermilion. [a]
Grande Prairie becomes the first city in the Peace River region. [b]
1960 A.G.T. opens a radio toll office (payphone) in Fort Vermilion. [a]
The first Fort Vermilion Rural Electrification Association brings power to two area farms. [a]
1962 A.G.T. begins dial service to Fort Vermilion. [a]
1968 Completion of the W. A. C. Bennett Dam on the Peace River near Hudson Hope B. C.
1974 The Fort Vermilion bridge opens, ending ferry service that began in 1916. [a]
1987 The Watson Seed Farm of Fort Vermilion is awarded first prize at the Toronto Royal Agricultural Winter Fair for certified Algonquian Alfalfa seed. [a]

[a] Bratt, B., S. Ward and M. Toews. 1988. Fort Vermilion Alberta 1788-1988. Prepared for Employment and Immigration Canada Summer Employment Experience Development, Family and Community Support Services, Fort Vermilion and District Bicentennial Association [pamphlet]

[b] MacGregor, J. G. . 1983. Grande Prairie. 184 pp.

Table 16. Historical Chronology of the Slave River Basin.

1715 In an effort to promote peace between two warring Indian tribes William Stewart of the Hudson's Bay Company becomes the first European to enter the Mackenzie Drainage System. [c]

1770 Samuel Hern becomes the first explorer to enter the Athabasca District. He gives the first description of the basin. [c]

1778 Peter Pond establishes Pond's House, the first Fort in the Arctic drainage system. (Includes all three NRBS basins). [c]

1786 The North West Company opens a post near the present site of Fort Resolution. [a]

1788 The North West Company places Alexander Mackenzie in charge of their interests in the Athabasca Region. He relocates Pond's House to what is now known as Old Fort Point and called it Fort Chipewyan. [c]

1789 In search of new trade routes, Alexander Mackenzie starts an exploration voyage up the river that is named the Mackenzie River after him. [c]

1790 The first representatives of the Hudson's Bay Company enter the area not to trade, but to check the accuracy of Pond's maps. [c]

1792 Alexander Mackenzie leaves Fort Chipewyan and travels up the Peace River. [c]

1793 Alexander Mackenzie becomes the first explorer to travel to the Pacific Ocean overland. [c]

1799 The XY Company establishes itself in the Athabasca region. [c]

1802 The Hudson's Bay Company builds its first Fort in the Lake Athabasca area called Nottingham House on English Island. [c]

1803 Fort Chipewyan moves to its present location. [c]

1804 The XY Company is taken over by the North West Company. [c]

1806 The Hudson's Bay Company abandons Nottingham House, their only Fort in the district. [c]

1815 The Hudson's Bay Company returns opening Fort Wedderburn on Potato Island. [c]

1821 The Hudson Bay Company takes over the North West Company and abandons Fort Wedderburn in favour of Fort Chipewyan. [c]

1826 The Hudson's Bay Company withdraws liquor from trade at Fort Chipewyan. [c]

1847 Father Tache the first Roman Catholic missionary visits Fort Chipewyan. [c]

1851 The Nativity Mission opens at Fort Chipewyan. [c]

1866 The first Church of England clergyman visits Fort Chipewyan. [c]

1874 Fort Smith established as a Hudson's Bay Company Post. [b]

The first Church of England mission established in Fort Chipewyan by Reverend Arthur Shaw and his wife. [c]

Members of the Sisters of Charity arrive in Fort Chipewyan from Montreal and begin establishing a school, an orphanage and a hospital. [c]

1875 Botanist John Macoun, of the Geological Survey of Canada, surveys the Lake Athabasca Region. This marks the first scientific description of the area. [c]

1876 The Roman Catholic Mission is the first opened at Salt River. It then moves to Fort Smith. [c]

Grain from the Nativity Mission in Fort Chipewyan receives awards at the Philadelphia International Exhibition. [c]

1880 St. Paul's Anglican Church is opened in Fort Chipewyan, it is still in use today. [c]

1881 "The Grahame" the first steamer to be used in the Athabasca District is built in Fort McMurray by Captain J.M. Smith. [c]

188? Smiths Landing established by the Hudson's Bay Company at the south end of the rapids, It also becomes the location of the RCMP post, this settlement is now known as Fitzgerald. [b]

1898 The Yukon Gold Rush brings many goldseekers over the portages near Fort Smith. They believe the Mackenzie is the easiest route to the Yukon, but many freeze to death or die of starvation trying to cross the mountains between the Mackenzie and the Yukon. [b]

1899 Treaty #8 was signed with the Beaver, Slavey, Cree and Chipewyan natives in Fort Resolution. [c]

1902 The Mackenzie District comes under the North-West Administration which had its headquarters in Regina. [b]

1905 The provinces of Alberta and Saskatchewan are formed in the territory between the American border and the 60th parallel. All land north of latitude 60° came to form what was called the non-organized Territories of the North-West and comes under the jurisdiction of the Federal Government. [b]

1911 The first representative of the Federal Government, Indian Affairs representative A.J. Bell, arrives in Fort Smith. [b]

1915 Smith's Landing is renamed Fort Fitzgerald after an RCMP officer who died on the Peel River. [b]

1921 The discovery of oil at Fort Norman brings a rush of prospectors and developers through Fort Smith and lures the first airplane into the Canadian Arctic. [b]

During the summer of '21(before the aircraft) the first two automobiles arrive in Ft. Smith. [b]

The first government administration building and First Court of Justice open in Fort Smith. [b]

1922 Wood Buffalo National Park is established by Order-In-Council. [b]

1925 The first Royal Canadian Corps of Signals station opens in Fort Smith. [b]

The first Governor Generals visit to the Mackenzie district. [b]

1926 Commercial fishing begins on Lake Athabasca . [c]

1928 The St. Bruno Farms, near Fort Smith, with its 140 head of cattle closes. [b]

The first seaplane arrives in Fort Chipewyan. [c]

1929 The airport is built at Ft. Smith and airmail delivery commences. [b]

Western Canadian Airways begins regularly scheduled flights to Fort Chipewyan. [c]

1933 The first Anglican Church establishes its Diocese of the Arctic. [b]

1934 Anglican mission house built in Ft. Smith. [b]

The discovery of gold at Yellowknife causes another rush of prospectors and materials through Ft. Smith. [b]

Gold discovered in Saskatchewan in an area now known as Goldfields. [c]

1935 Establishment of the town of Yellowknife. [b]

1905 note: two commercial airlines are now operating: Canadian Airways, the successor of Western Canadian Airways; and the Mackenzie Air Service. [b]

The Northern Transportation Company is established to serve the Eldorado Mine on Great Bear Lake. [c]

1937 Gold discovered in the Beaverlodge area of Saskatchewan. [c]

1938 to 1939
The Oblates assisted by the Grey Nuns build a large TB hospital in Fort Resolution. [a]

1939 The first public school opens in Ft. Smith; previously, schooling was taken on by the Catholic and Anglican Missions. [b]

1940 The Chipewyan Band choose the site for their reservation. [c]

1942 The biggest boom for the town of Ft. Smith occurs as a result of the arrival of 2000 American soldiers for the "Canol" project. They build a portage road and a road to Hay River. The troops also build a modern airport in Ft. Smith as they did in: Ft. Resolution, Hay River, Ft. Providence, Ft. Simpson, Ft. Wrigley and Norman Wells. All can be used year round. [b]

1943 The American troops leave Fort Smith. [b]

1945 Second gold rush near Yellowknife. [b]
The population of Ft. Smith grows after W.W.II because of a general increase in interest in the north. Pop. In 1946 is 250; in 1956 is 1164; in the winter of 1979 is 1500; and in the summer of 1959 is 2000. [b]

1951 Logging operations begin in Wood Buffalo National Park. [c]

1953 Mining begins in Uranium City Saskatchewan. [c]

1954 The Department of Indian Affairs opens a secular school in Fort Chipewyan. [c]

1956 The first bank opens in Ft. Smith (the Canadian Imperial Bank of Commerce). [b]
Northern TB patient care is transferred from Fort Resolution to Edmonton. As a result Fort Resolution's importance as a regional centre declines. [a]

1958 The Hudson's Bay Company ends transportation along the Mackenzie River after 135 years of service. [c]

1960 The Canadian National Railway into Hay River is completed. [b]

1961 The gravel highway from Ft. Fitzgerald to Bell Rock is extended to the NWT as Highway #5. [b]
The Northlands School Division is created in Alberta

1962 The Department of Lands and Forests airstrip built at Fort Chipewyan.
Telephones installed in the homes in Fort Chipewyan.

1963 A new airport built in Fort Chipewyan. [c]

1964 A co-op sawmill opens in Fort Resolution. [a]

1965 River transportation at Ft. Smith ends. [b]
Electrical power supply from by a dam on the Talson River begins (previously had to rely on diesel powered generators). [b]

1966 Fort Smith incorporated as a town. [b]

1967 Yellowknife named capital of the NWT. Until this point Ft. Smith served as the Administrative centre of the NWT. [b]
The W.A.C. Dam, at Hudson Hope B. C. is completed on the Peace River.

1968 The highway from Bell Rock to Hay River is completed. [b]
A landslide occurs along the northern perimeter of Fort Smith, killing one person and causing approximately one million dollars damage. [b]

1969 A new airport is built and regular jet airplane service begins in Fort Smith. [b]

1970 The Mary Kaeser Library opens, it is the first permanent library in Fort Smith.
The waterworks plant in Fort Chipewyan is completed.

1973 Ft. Smith gets a satellite link (through the Anik satellite)[b]

1975 Weirs built on the Rivière des Rochers and Revillion Coupé in an effort to restore pre-Bennett Dam water levels on the Peace -Athabasca Delta.

[a] Lopatka, S., D. Ross and R. Stoesz. 1990/91. North West Territories Data Book: A Complete Information Guide to the North West Territories and its Communities. Outcrop: The Northern Publishers. 238 pp.
[b] Siemens, D. G. 1979. On the Banks of the Slave :A history of the Community of Fort Smith North West Territories. Prepared for tourism Committee, Education Programs and Evaluation Division Department of Education, Fort Smith, North West Territories.
[c] Peace-Athabasca Delta Project. 1971. A collection of Information on the History of the Fort Chipewyan Area.

10.2 Key Societal Issues

In the two decades leading up to the start of the Northern River Basins Study, a suite of six broad sustainable development issues gradually emerged, then matured to become major regional and in some cases, national and international debates. These debates reflected public concern over large-scale forest industry developments; accelerated agricultural expansion; bituminous tar sand mining and processing in northern Alberta; and the downstream effects on the lower reaches of the Peace River of the W.A.C. Bennett dam including the drying of the Peace Athabasca Delta. Additional issues include concerns by First Nations peoples over resource industry developments in their traditional lands and finally, the concerns of all northerners, including the government of the NWT, regarding the impact of upstream development on the quality of their rivers downstream.

Viewed from a chronological perspective, agricultural developments along the mainstem and tributaries of the Peace and Athabasca Rivers were the first in a series of land use changes that showed downstream impact. Following World War II, the Peace River block in both British Columbia and Alberta saw a rapid and accelerating demand from the farming communities for the release of public, forested lands for agricultural purposes. The demand intensified considerably in Alberta during 1975 to 1985 with the accelerated opening of public lands for agricultural use north

of the town of Peace River. Accompanying the clearing of the aspen forests came increasingly widespread and intensified surface drainage activity with relatively large soil erosion consequences.

Due primarily to the unique combination of easily erodible soils coupled with a distinctly positive slope to the landscape, large amounts of top soil are known to have moved during spring run-off from farmlands into the mainstem and tributary streams of the Peace system in the form of sediment. This sediment has caused damage to fisheries in such streams as the Little Burnt and Notikewin Rivers. More noticeable to the discerning eye though, has been an unfortunate deepening and widening of a great number of agricultural drainage ditches to the point where mitigative measures have become major public work projects. Examples are the Kleskun Hills and Grimshaw drainage control and drop structure projects.

Although the fastest periods of urban growth, and thus the growth in amounts of treated and untreated urban sewage occurred during the 1970s in northern Alberta, a steady growth of urban sewage waste began to be noticed in smaller Northern River Basins Study area streams like the McLeod, Pembina, and Lesser Slave systems during the 1980s. Communities downstream of Fort McMurray along the Athabasca reportedly have detected a noticeable impact of urban sewage on the taste and odour of their drinking water supplies.

The next major impact was the construction of the W.A.C. Bennett Dam in 1969, which introduced regulation of the flow of the Peace River. The dam and attendant Williston Reservoir, which took three years to fill during the late 1960s was built by British Columbia Hydro to provide hydro-electric power for British Columbia and customers in the United States. Known technically as a "swing-plant", the Gordon Shrum Power House at the foot of the dam is BC Hydro's largest power generation facility that provides both a basic, steady flow of power and "peaking power" to most of British Columbia and beyond. The Williston Reservoir is one of the world's largest and best situated strategic reservoirs. Bluntly put, it has an enviable "arm-lock" on the flows of the Peace River such that if this very large reservoir were ever drained, it could absorb all of the flows of the Peace River system above it for 1.4 years in order to refill it. British Columbia Hydro has not operated the structure in this way historically, but owns a licence from the BC provincial government that allows it to constrain flows to as small as 5,000 to 10,000 cubic feet per second at high flow times of the year.

At issue here are the inevitable changes to the natural downstream flow patterns. With the resultant higher winter and lower spring run-off flows, the Peace River below the dam has changed character considerably in the eyes, for example, of the older citizens of the towns of Peace River, Fort Vermilion and the elders of the First Nation communities of Jean D'Or Prairie and Fort Chipewyan. Known effects prior to the Northern River Basins Study were changes to fish migration patterns into tributaries of the Peace, changes to the ice forming and melting characteristics of the river through the town of Peace River, operational difficulties with winter ice bridges and ferry operations at La Crete and finally, the well-documented and oft-studied adverse drying effects on the perched basins of the Peace-Athabasca Delta. Attendant losses in muskrat populations have caused hardship to the aboriginal community of Fort Chipewyan. Unknown effects

on such things as fish habitat have been the subject of inter-provincial joint studies undertaken pursuant to a proposed BC-Alberta transboundary water management agreement for the Peace River.

Two world scale oil-sands extraction plants are situated on the Athabasca River just downstream of Fort McMurray. The first, Suncor development was completed in 1969 while the Syncrude plant was built shortly thereafter. These large operations extract a tar-like, heavy oil from the oil-bearing sands north of Fort McMurray using open pit mining techniques combined with complex oil-water-sand separation technologies. The tailing ponds adjacent to each operation are quite large and contain considerable volumes of waste water, phenolic and poly-aromatic hydrocarbon compounds that could be toxic or harmful to aquatic organisms if released to the nearby Athabasca River. The issue at stake for downstream First Nation and north-of-60° residents is that of potentially severe damage to the water quality of the Athabasca and Slave systems.

The most recent, and probably the largest perceived economic development issue potentially affecting downstream residents of both the Slave and Peace Rivers has been forestry development in northern Alberta. Although logging for lumber in Alberta is a forest land-use dating back to the 19th century, social and media attention was not focused on it until a number of new pulp and paper mills were built and the companies awarded large tracts of public lands by the provincial government for forest management purposes in the latter half of the 1980s.

Two issues mixed together in the establishment of the new pulp mills were forest land-use management and pulp mill effluent discharge into the mainstem and tributaries of the Athabasca and Peace Rivers. For the purposes of the Northern River Basins Study, the key societal issue was effluent discharge to rivers and in particular, the cumulative impact of such effluents from a series of mills located on the Athabasca River from Hinton to Athabasca.

A major federal-provincial joint environmental impact assessment (EIA) undertaken during 1988/89 on the proposed Alberta-Pacific pulp mill just downstream of the Town of Athabasca focused a large amount of public attention on the proposed liquid effluent issue. Alberta-Pacific ultimately received permission to construct its mill, but not until the EIA Review Panel noted a number of conditions and recommendations. A key recommendation was that the governments undertake a river basin study to ascertain the impacts, both locally and cumulatively, of pulp mill developments (existing and proposed) along the Athabasca River. In short, the Northern River Basins Study is the response to that Panel's recommendations.

10.2.1 Cumulative Effects

"Cumulative effects" is the phrase used to describe the additive and interactive effects of stressors acting at different temporal and geographic scales within the ecosystem Within the northern river basins, the study of cumulative effects is complicated by a number of factors, such as the size of the basins, the meager amount of information on large northern rivers, the variety of environmental stressors and their complex interactions among individual stressors within the ecosystem. The section highlights the cumulative effects of development in the northern river basins. A more thorough examination of this topic can be found in the NRBS synthesis report No. 11, entitled "*Cumulative Impacts within the Northern River Basins*".

Cumulative Effects of Chemicals

Major findings related to cumulative effects of chemicals are illustrated in Figure 45. Environmental concentrations of chlorinated organic compounds, such as dioxins, furans, chlorinated resin acids and chlorophenols, have declined overall since the late 1980s, but are still found in detectable levels in sediments and fish in the basin. These reductions are partly due to improved technologies that have reduced effluent loadings of certain contaminants, especially organochlorine contaminants. Environmental processes have also influenced the distribution of contaminants within the ecosystem; for instance, the annual influx of sediment tends to bury previously contaminated sediments.

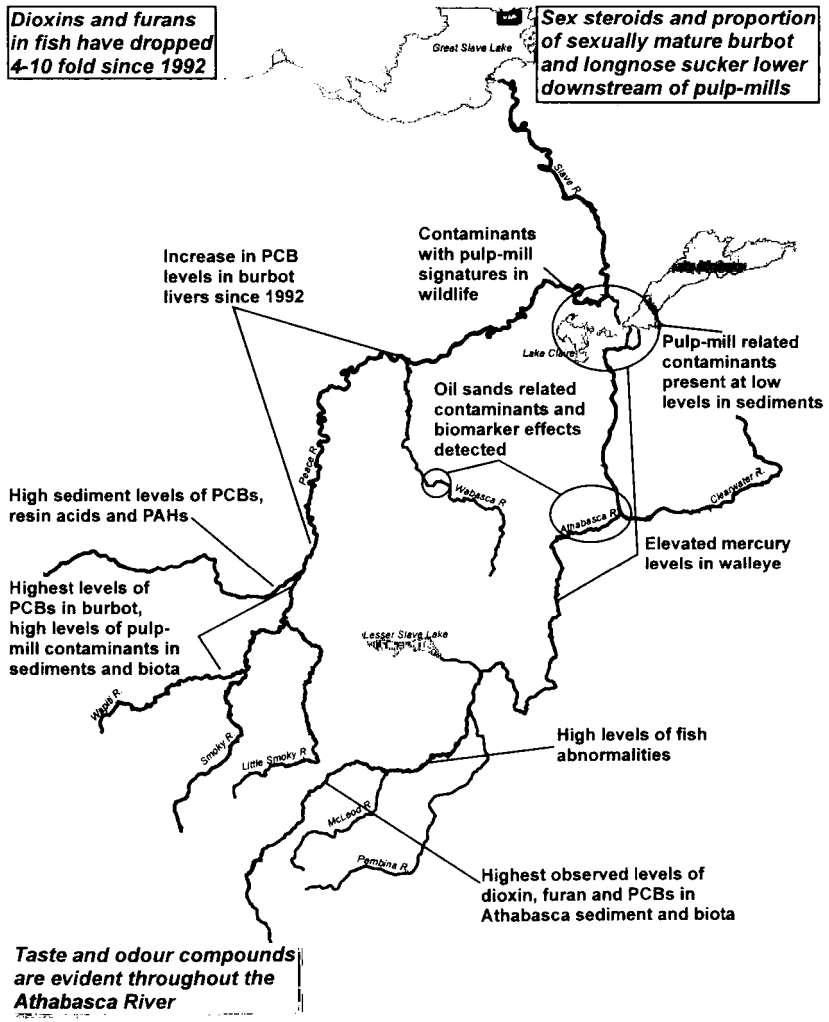


Figure 45. Summary of Key Contaminant Issues and Findings on a Basin-Wide Scale.

Generally, highest concentrations of chlorinated compounds still tend to occur in reaches immediately below pulp mill effluent inputs. The highest levels of organochlorine compounds (dioxins and furans) associated with sediments and aquatic life were measured in the reach between Hinton and the Emerson Lakes sampling site on the upper Athabasca River. Levels of specific contaminants in sediments from this reach exceed guidelines developed by the Canadian Council of Ministers of the Environment. Higher frequencies of physical abnormalities in aquatic invertebrates confirm that this reach of the Athabasca River has been subjected to the cumulative effects of development.

Research has confirmed that the atmosphere is a source of contaminants (including PCBs). However, the variation on PCB concentrations across the basins suggests the existence of additional point sources. Higher PCB levels in burbot were found in the Wapiti/Smoky rivers, the Peace River and the Athabasca River downstream of Hinton and Whitecourt. Elevated PCB levels in sediments were found in the Wapiti/Smoky rivers and in the Peace River upstream of the Smoky River confluence.

Higher PCB concentrations in some reaches of the Wapiti/Smoky and Athabasca river basins may be related to point source inputs into the environment, such as those occurring from spills. In three locations within the Peace River drainage, observed levels of PCBs in burbot doubled between 1992 and 1994. The reason for this is unclear, but deserves further investigation. Higher PCB concentrations in some fish species may be partly related to different feeding habits.

Cumulative Effects of Hydrology and Climate

Major findings related to the cumulative effects of hydrology and climate change are illustrated in Figure 46. NRBS research has furthered knowledge of how flow regulation has changed the natural flow of the Peace River system. Changes in the flow of the Peace River include:

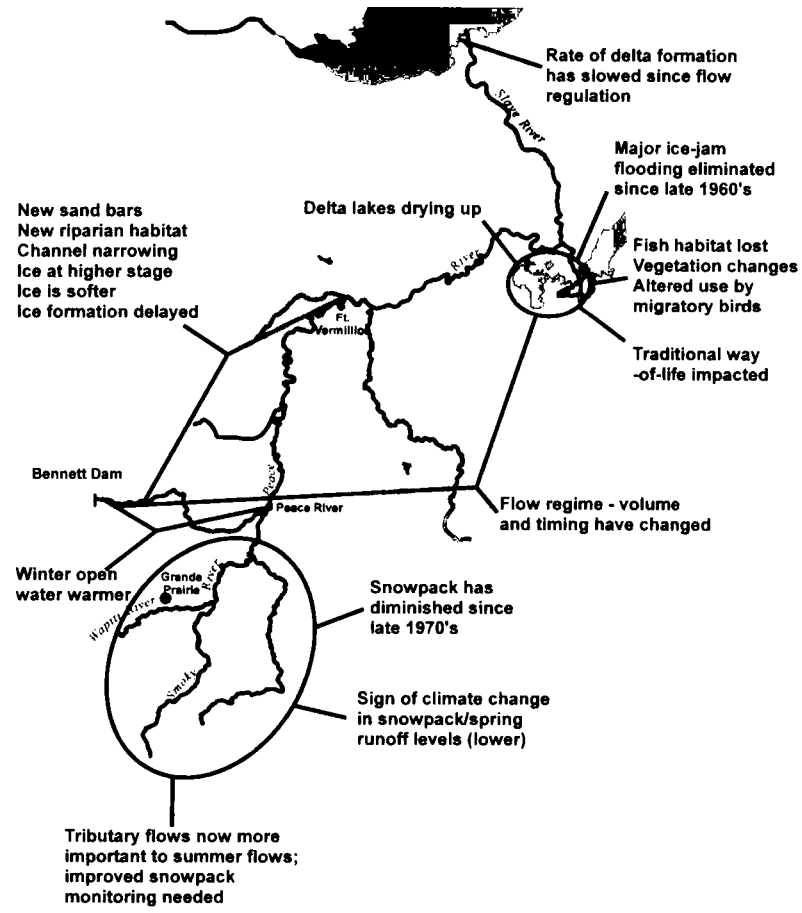


Figure 46. Summary of Key Hydrologic Issues and Impacts on the Peace and Slave River Basins.

- decrease and delay in peak spring flows;
- decreased summer flows;
- increased winter flows;
- ice is weaker, coarser and forms later; and
- tributary flows are now more important to maintaining summer flows.

Many of these effects are dampened with distance from the W.A.C. Bennett Dam in British Columbia. These alterations, combined with climate variability, have had a dramatic impact on the ecology of the Peace-Athabasca Delta perched basins, changes to vegetation and wildlife, and alterations to the geomorphology of the mainstem Peace River.

On a human scale, one of the cumulative impacts of these changes in related to residents' lifestyles. Residents contacted by the Traditional Knowledge Component reveal that traditionally, basin residents have relied on the rivers for their culture and lifestyle. These hydrological changes have had a pronounced effect on their perceptions of ecosystem health and their quality of life and have caused them to change their use of basin resources.

Cumulative Effects of Nutrient Addition and Dissolved Oxygen

Zones of concern for nutrients and dissolved oxygen are illustrated in Figure 47. Nutrient discharges into the northern rivers have been shown to enrich aquatic communities immediately downstream of point sources, such as pulp mills and municipalities. Currently, the cumulative effect appears to be primarily aesthetic - related to an increase in algae in reaches immediately downstream of nutrient discharges.

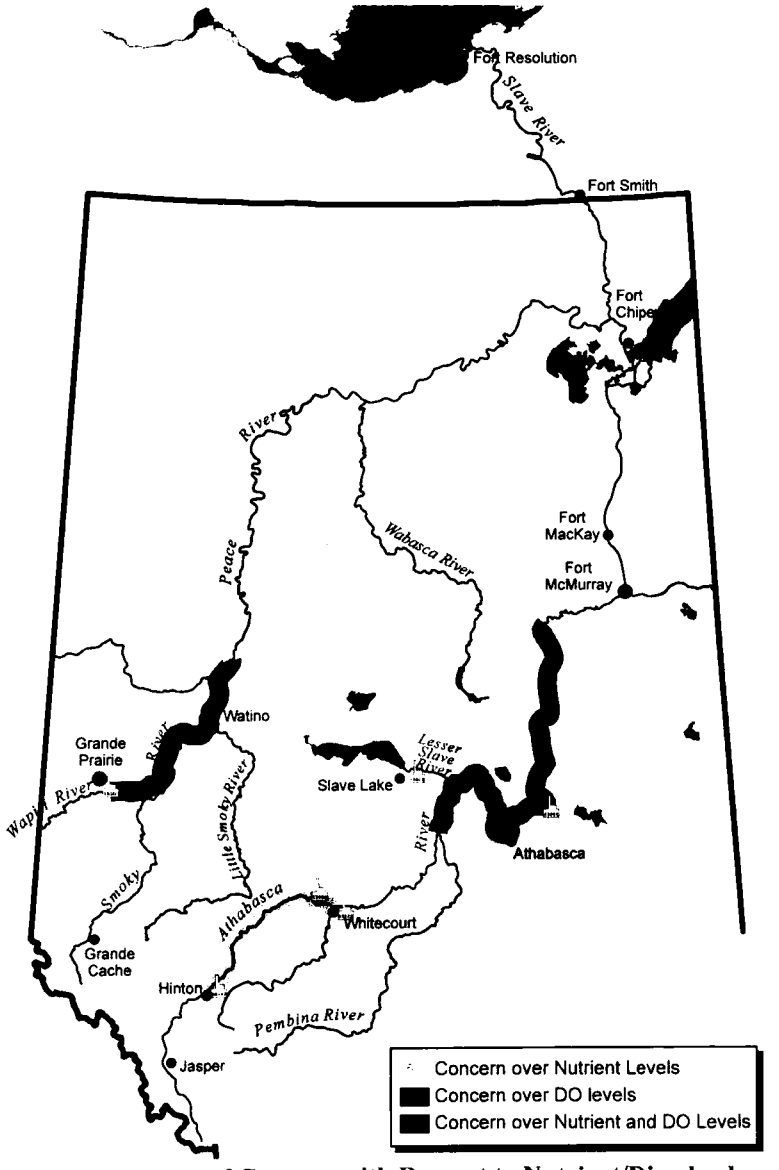


Figure 47. Zones of Concern with Respect to Nutrient/Dissolved Oxygen Issues.

During winter, dissolved oxygen levels tend to decrease naturally along the length of ice covered rivers such as the Wapiti/Smoky and Athabasca. In addition, there are noticeable 'sags' below major effluent discharges from communities and certain pulp mills. Oxygen concerns exist in the Athabasca River upstream of Grand Rapids, and in the Wapiti/Smoky rivers downstream of Grande Prairie to the confluence of the Peace and Smoky rivers. In these areas, the number of developments, combined with ice cover, significantly reduces winter dissolved oxygen levels in specific reaches. The Wapiti/Smoky system has lower flows and the oxygen depletion is much greater than in the affected Athabasca River reaches.

Pulp mills are one of the larger man-made sources of oxygen-demanding substances directed to the aquatic ecosystem. To reduce their discharge of these substances, pulp mills will often add nutrients to improve their effluent treatment process. These nutrients are intended to enhance bacterial breakdown of organic compounds in the effluent prior to its release into the environment. In such cases, any excess nutrients enter the aquatic environment and further enhance aquatic productivity, which can contribute to the use of dissolved oxygen in the aquatic environment.

Cumulative Environmental Effects

Cumulative environmental effects manifest themselves at a variety of spatial, temporal and organizational scales within the ecosystem. Figure 48 summarizes overall cumulative effects within the northern river basins on a reach-specific basis. This figure provides a mechanism for illustrating priority areas for environmental management and identifies issues of concern based on a weight-of-evidence approach. Within each reach, a

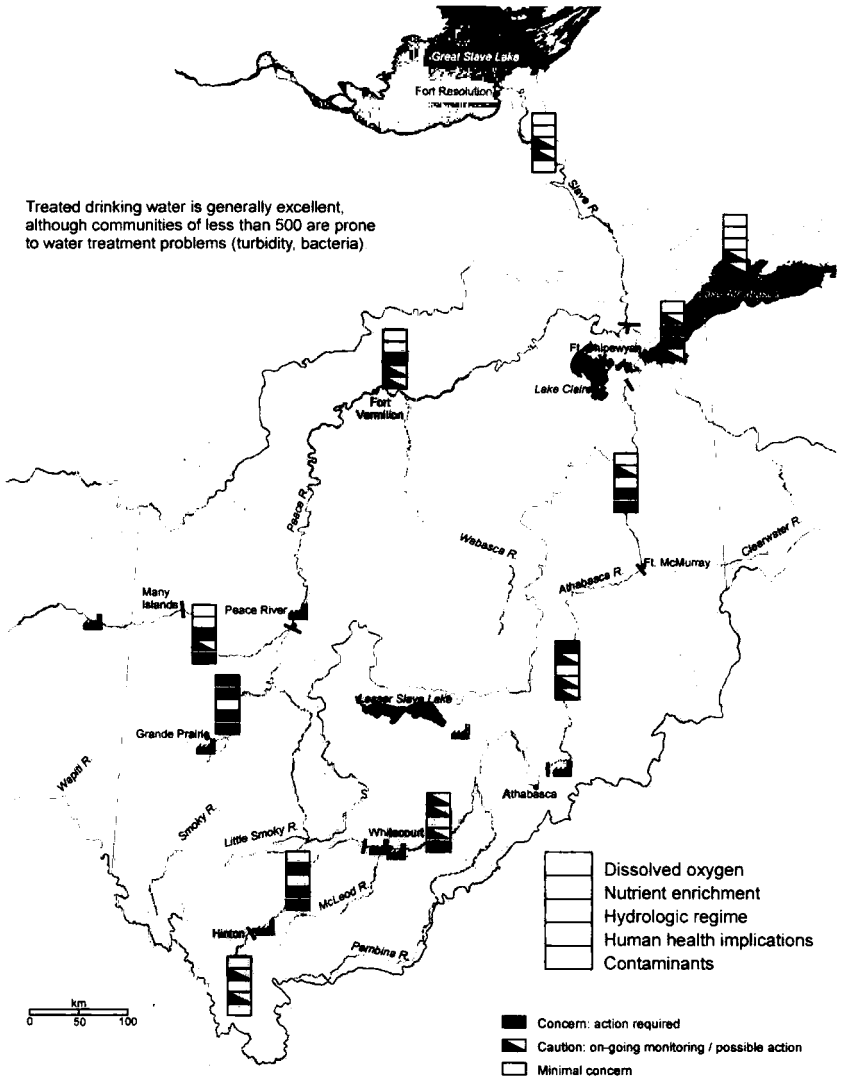


Figure 48. Summary of Cumulative Environmental Effects.

histogram consisting of five stacked boxes, is provided. Each box represents one of the five major issues in the basins (*i.e.* dissolved oxygen, nutrient enrichment, hydrologic regime, human health implications and

contaminants) and the shading of the box reflects the level of concern for that issue in that reach. A completely dark box indicates significant concern and a need for action. A partially shaded box indicates caution and a need for ongoing monitoring and/or further investigation. A clear box indicates that, based on current information, the issue is of minimal concern. In most cases, ongoing routine monitoring should be adequate for those issues designated as being of minimal concern; however, further investigation may result in a change of designation for some of these issues.

The purpose of Figure 48 is to provide a general overview of cumulative effects in these basins.

Changes in Water Quality

Traditional basin inhabitants recognize water as central to the support and quality of their lives. In the past, traditional inhabitants of the basins generally viewed the waters as abundant and clean except during drought periods. Since then, residents have witnessed a number of changes in both the quality and quantity of waters in the northern portion of the basins (Figure 49).

Changes in Fish and Wildlife Populations

With some exceptions, residents of traditional northern communities have observed that fish (Figure 50) and wildlife (Figure 51) populations have generally declined (Bill et al. 1996). In addition, species that follow predictable population cycles (e.g. rabbit and lynx) are thought to have longer periods between cyclic low and high populations. Traditional inhabitants of the basins feel that the quality and quantity of fish has deteriorated to a large extent over the last 50 years. A number of traditional fishing sites are now sparsely populated or dried up. Overfishing resulted in the near extinction of goldeye in the Peace-Athabasca Delta, and populations of whitefish are also declining. Traditional fishermen have commented that fish are generally smaller, have poorer taste and texture, and appear unhealthy at some sites. Deformities are often observed in jackfish caught in the vicinity of Pine Creek, NWT. Residents observe that there are fewer songbirds than in the past. Many native elders have also note that drier lands have increased the frequency and severity of forest fires, which has reduced the winter range for caribou.

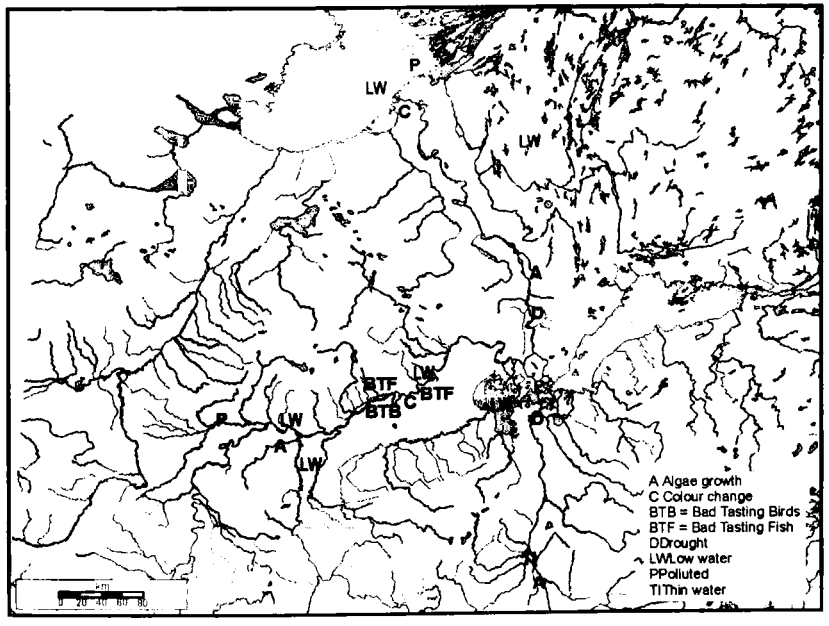


Figure 49. Changes to Water Quality - Based on Interviews though the Traditional Knowledge Component.

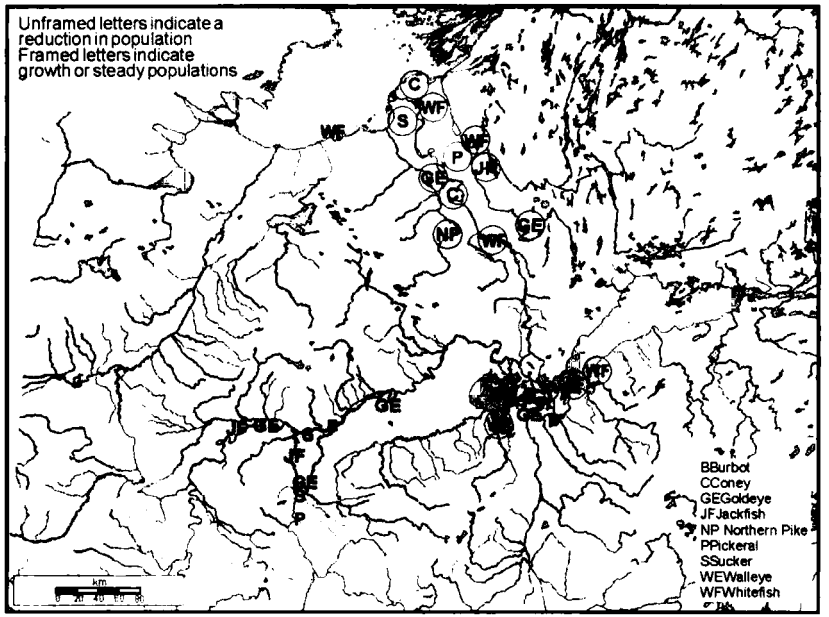


Figure 50. Changes to Fish Populations - Based on Interviews though the Traditional Knowledge Component.

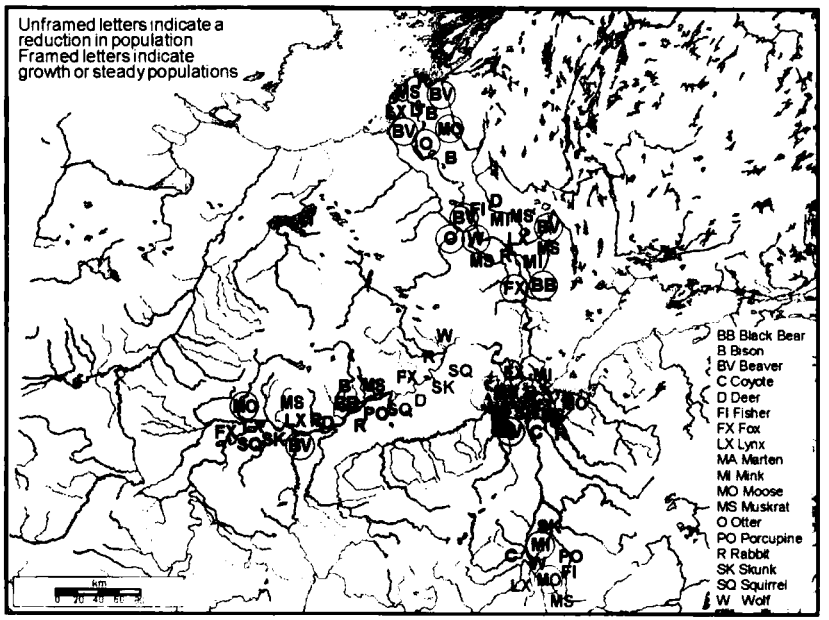


Figure 51. Changes to Wildlife Populations - Based on Interviews though the Traditional Knowledge Component.

Alterations to Peace River flows, and the resulting changes in habitat within the Peace-Athabasca Delta, are seen to have impaired the health and numbers of various animals in the region. Traditional inhabitants have observed a significant decline in the health and population of muskrats during the last ten years. The loss of sedge meadow habitat has caused buffalo populations to decline. At the same time, moose populations have increased and stabilized due to the availability of willows and shrubs that are a primary food source. Fewer migratory birds use the delta as a staging area and nesting site.

Populations of migratory birds in the Slave River Delta also seem to have declined (Figure 52). In 1791 Peter Fidler noted that flocks of geese on the Slave River were so thick "they appeared at a little distance as if the river was quite choked up with floating driftwood". This abundance has not been observed in many years. In 1870, "egg gathering activities succeeded in collecting 1,000 eggs at Buffalo Lake, NWT". Eggs are no longer gathered on this lake and no mention was made regarding the plenitude of eggs. Elders believe that the fall migration of many bird species has shifted from the Peace-Athabasca and Slave deltas to the Peace River agricultural region to take advantage of grain crops.

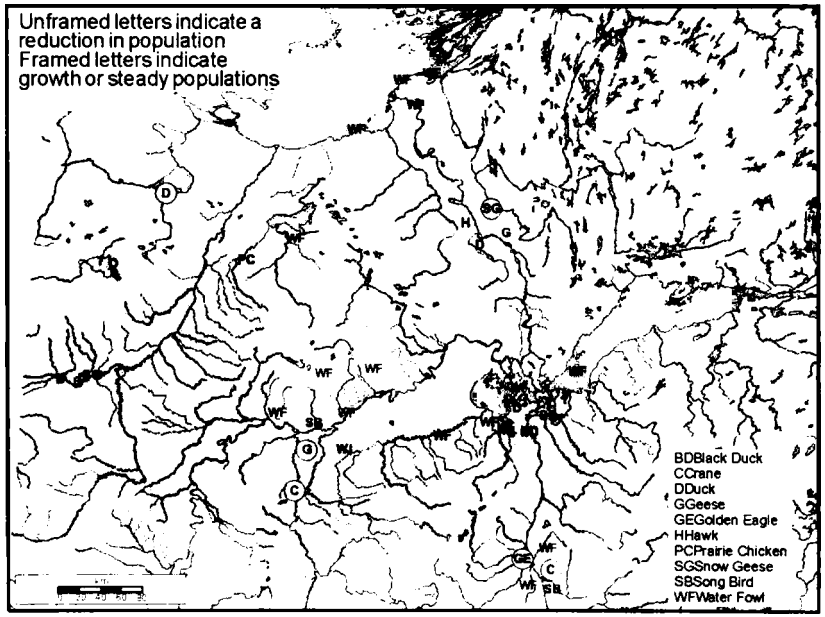


Figure 52. Changes to Bird Populations - Based on Interviews though the Traditional Knowledge Component.

Athabasca River, upstream of Hinton Source: C.L. Podemski

Stream in the Northern River Basins
Source: NRBS

10.3 Changes Seen During the Study

During the course of the Northern River Basins Study, a number of key public policy, regulatory, industry and environmental events occurred. These events combined to have the effect of slightly changing the general context in which the study was conducted.

In chronological order, the ten key events were:

1. A major ice jam flood during the third week of February 1992, along the Peace River caused some $5 million of residential damages in the town of Peace River. Considerable intergovernmental discussion occurred between Alberta and British Columbia regarding the cause of the flood and who should compensate the town residents. After a two year debate, the Government of British Columbia paid an out-of-court settlement to Alberta to contribute to the total damage compensation package first paid by Alberta.

2. Considerable media attention was paid to a Northern River Basins Study discovery in June 1992 of radionuclides in the bottom sediments of Lake Athabasca. These radionuclides appeared to be a result of lake currents moving radionuclide-bearing sediments west from old uranium mines in the Uranium City area along the north shore of Lake Athabasca in Saskatchewan.

3. A very important additional or companion ecosystem planning study of the Peace Athabasca Delta (PAD) was initiated on April 01, 1993. This PAD study is currently underway with the support of Parks Canada, Environment Canada, Alberta Environmental Protection, British Columbia Hydro and the First Nations and Métis community of Fort Chipewyan. The active help of BC Hydro is of significance.

4. The Mackenzie River Basin Committee was finally able in March, 1993 to develop a draft water management agreement that all federal, territorial and provincial negotiators (including British Columbia) signed off, for transmittal to their respective ministers. To date, this draft agreement has yet to be signed by all six potential signatories. The significance of this initiative is that it can provide a transboundary umbrella agreement over a future Alberta-NWT

bilateral aquatic ecosystem management agreement for the waters of the Northern River Basins Study area.

5. The Alberta-Pacific pulp mill, under construction since spring 1991, started production in September 1993 with a short-term water quality permit.

6. During 1992-1994, most of the kraft pulp mills in the study area began eliminating elemental chlorine from their pulp bleaching operations in favour of chlorine dioxide. The move was in response to three factors:

   (i) A major public concern over the potential carcinogenic effects of two organochloride compounds, furans and dioxins. These compounds, produced in the kraft bleaching process if elemental chlorine is used as the bleaching agent, were being released in the mill effluents to the streams of the basin.

   (ii) The regulatory initiatives of both the federal and provincial governments to eliminate these organochloride compounds.

   (iii) The background presence of the Northern River Basins Study.

7. Changes have occurred in public perceptions and attitudes concerning public and community involvement in environmental health monitoring. Members of the public that came to the Northern River Basins Study's community gatherings during the course of the study increasingly emphasized that governments must involve communities and local governments more in designing and undertaking future environmental monitoring assessment and related decision-making in the Basin.

8. A related development was the design and application of new methods for assessing the health of large river ecosystems such as artificial stream bioassays, SPMD's, nutrient-diffusing substrates and fish physiological biomarker studies. These new approaches have helped us develop a better understanding of some of the ecological effects associated with nutrient and contaminant input to some of the northern rivers.

9. Following a three year review process, the first reading of the new Alberta Water Act occurred in the autumn of 1995. The bill was the culmination of an extensive public consultation process that included many workshops and public meetings in the Northern River Basins Study area. Some considerable reinforcement for building basin planning and other environmental concepts into the new Act was obtained during the public meetings.

A final, and perhaps not well-recognized change, was a gradual move on the part of governments to resolve resource management and ownership issues with the aboriginal or First Nation peoples. The concept of co-management began to be examined seriously by both sides of the debate resulting in a number of formal agreements with various bands in northern Alberta. Changes in this area have in turn, changed the scope required of the Northern River Basin Board in terms of the types of recommendations it may choose to develop for government consideration.

10.4 References

Bill, L., J. Crozier and D.C. Surrendi. 1996. A report of wisdom synthesized from the traditional knowledge component studies. Northern River Basins Study Synthesis Report No. 12. Northern River Basins Study, Edmonton, Alberta. 366 pp. + appendices.

MacLock, B. and J.P. Thompson. 1996. Characteization of aquatic uses within the Peace, Athabasca and Slave rivers. Northern River Basins Study Synthesis Report No. 7. Northern River Basins Study, Edmonton, Alberta. 80 pp.

Praxis Inc. 1985. Northern Alberta Today. Prepared for Northern Alberta Development Council. Craftsman Printing & Graphics Ltd. 83 pp.

Wrona, F.G., Wm.D. Gummer, K.J. Cash and K Crutchfield. 1996. Cumulative impacts within the northern river basins. Northern River Basins Synthesis Report No. 11. Northern River Basins Study, Edmonton, Alberta. 101 pp.

The Northern River Basins Study was established to examine the relationship between industrial, municipal, agricultural and other development and the Peace, Athabasca and Slave river basins.

Over four and one half years, about 150 projects, or "mini studies" were contracted by the Study under eight component categories including contaminants, drinking water, nutrients, traditional knowledge, hydrology/hydraulics, synthesis and modelling, food chain and other river uses. The results of these projects, and other work and analyses conducted by the Study are provided in a series of synthesis reports.

This Synthesis Report documents the scientific findings and scientific recommendations of one of these component groups. This Synthesis Report is one of a series of documents which make up the Northern River Basins Study's final report. A separate document, the Final Report, provides further discussion on a number of scientific and river management issues, and outlines the Study Board's recommendations to the Ministers.

Project reports, synthesis reports, the Final Report and other NRBS documents are available to the public and to other interested parties.