

3. *Peace*

Sub-basin



Introduction

Geography

The Peace sub-basin covers an area of 323,000 square kilometres in British Columbia and Alberta.¹¹⁴ This basin contains a diversity of ecosystems: mountains, foothills, parkland, boreal forest, and wetlands. The Peace River itself flows about 2,000 kilometres from its headwaters in the Rocky Mountains in north-central British Columbia, across north-central Alberta, to the lowlands of the Peace-Athabasca Delta in Wood Buffalo National Park (Figure 3–1). It is joined along the way by several major tributaries; the Halfway, Pine and Beaton rivers in BC, and the Smoky and Wabasca rivers in Alberta. There are many lakes in the boreal forest that are typically shallow and eutrophic with lush summer growth of aquatic plants. Peat lands cover much of the northern part of the basin, and the organic matter from these peat lands produces “brown-water lakes”. Many large marshes exist in the basin, primarily in the southern portions but also in the north.

Human Populations

In 2001, approximately 195,000 people lived in the Peace sub-basin. The largest community is Grande Prairie, Alberta with a population of more than 37,000. Fort St. John and Dawson Creek in British Columbia are the next largest population centres, with 16,000 and 10,800 inhabitants, respectively.

About 12% of the population in the Peace sub-basin are Aboriginal, representing nineteen different First Nations and the Métis Nation. There are two Métis Settlements and several First Nations Reserves in this sub-basin. A large portion of the basin is included in the Treaty 8 lands, but treaties are not yet established in some areas of the basin in British Columbia. Several First Nations claim that areas near the Williston Lake Reservoir are within their traditional territories.¹¹⁵

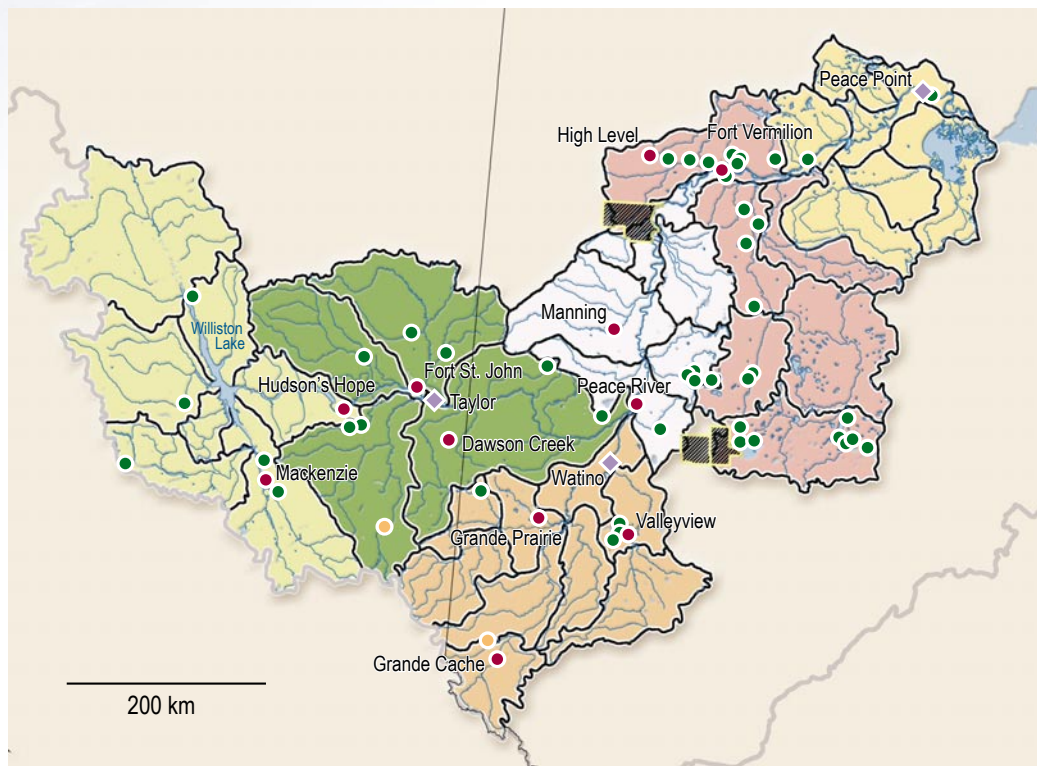
Industry

The Peace sub-basin is rich in non-renewable and renewable resources. The oil and gas industry is very active throughout the sub-basin (Figure 1–4). Coal is mined in this sub-basin. The boreal forest supports large-scale forestry operations, some of

which supply trees to six pulp mills located in the Peace sub-basin (Figure 1–5). Five mills discharge treated wastewater to the Peace River and its tributaries. The sixth mill, at Chetwynd, BC, is a zero-effluent mill. Agricultural land, located primarily in the parkland area of the sub-basin, makes up 23% of all the land in the Peace sub-basin. Commercial fishing and trapping also occur in the Peace sub-basin.

Two major power-generating stations are found

in the upper Peace River (Figure 1–5). The G. M. Shrum Station is located at the W.A.C. Bennett Dam that created Williston Lake in the late 1960s. It has ten generating units producing 2,730 megawatts of electricity. The Peace Canyon Generating Station operates twenty-three kilometres downstream from the Bennett Dam. Built in the 1970s, this generating station has four units producing 700 megawatts. Both stations are owned and managed by BC Hydro.



Legend

□ Mackenzie River Basin

● Community

● Reserve

▨ Metis Settlement

● Past Producing Mine

◆ Other Location of Note

Sub-Basins

■ Williston Lake

■ Upper Peace

■ Smoky

■ Central Peace

■ Lower Central Peace

■ Lower Peace and Lake Claire

Figure 3–1.

Map of the Peace sub-basin.

Improve Water Quality

Water quality reflects the geology, climate, landscape features and land use patterns of an area. It refers, collectively, to the amounts of suspended solids, nutrients, minerals, micro-organisms, chemicals, pesticides and other substances that enter the water from natural sources and as a result of human activities. Within the Peace sub-basin, point sources of substances that affect water quality include industrial operations, communities, and institutions. Non-point sources in the Peace sub-basin include agriculture and forestry.

Traditional Knowledge of Water Quality

Based on information obtained prior to 1995, 75–100% of respondents who lived along the lower reaches of the Peace River and its tributaries reported increases in algae and 25–47% reported increases in turbidity.²⁸ Polluted, dirty and oily water was also frequently reported. In the past, the water in the lower Peace River was turbid during spring break-up, but now turbidity occurs throughout the year. “The elders [from Tall Cree First Nations] indicated that many people stopped using the lake and river water about four years ago because of taste and the concern for its cleanliness.” Others reported that they changed their water use because of algal growth, risk of disease, unusual colour, and increased turbidity.²⁸

Turbidity in water is caused by clay, silt and tiny inorganic and organic particles as well as dissolved organic material and microscopic organisms. It relates to the ‘cloudiness’ of water.

“The Peace River is considered very dirty now, as it is more turbid and has an oily film on it at times. The taste is not as “pure” and people do not consider it healthy water for man or wildlife.”

Bill *et al.* 1996. Northern River Basins Study.

“The elders [from Little Red River First Nations] frequently referred to “poisons” in the water and the effects of stopping the flow of water, as making it unhealthy for the animals and the people. The “poisons” meant effluent put into the river systems by the mills and the towns.”²⁸

Residents of First Nations communities considered pulp and paper mills to be the industry with the worst

effect on water quality. They also blame the deterioration in water quality on hydroelectric plants, oil exploration, and mines. “The elders [from Fort Vermilion] indicated that the river needed to be treated with more respect by preventing further waste and pollutants being put in the river.”²⁸

First Nations people would be supportive of a move towards zero discharge or virtual elimination of pollutants from wastewater.

Overall Assessment – Unfavourable

Based on information collected before 1995, First Nations people living within the Peace sub-basin have raised concerns about increases in turbidity, algal growth, and pollution. They recognize that effluents from pulp mills and other sources have contributed to the pollution of the rivers. Water in some areas is no longer considered healthy to drink. In view of recent upgrades by pulp mills which have resulted in reductions in the release of several pollutants into the Peace River system (see **Organic Matter in Pulp Mill Effluents**), there is a need to update the documentation of traditional knowledge on this topic.

Organic Matter in Pulp Mill Effluents

What is happening?

Pulp mill effluents contain significant amounts of organic matter which can be measured by evaluating biochemical oxygen demand (BOD). Figure 3–2 shows the loading of organic matter from pulp mill effluents from 1990 to 2001. The total load decreased from about 9,700 kilograms per day to about 3,800

kilograms per day, a decrease of 61%. This decrease was achieved mostly after the survey of traditional environmental knowledge that was done as part of the *Northern River Basins Study* (see preceding section –**Traditional Knowledge of Water Quality**). It would be valuable to know whether Aboriginal inhabitants of the sub-basin perceive that water quality has improved subsequent to the recent reduction in the release of organic matter by pulp mills.

Biochemical Oxygen Demand (BOD) is the amount of oxygen that would be used if microorganisms consumed all the organic material in one liter of water. The more organic material there is, the higher the BOD will be.

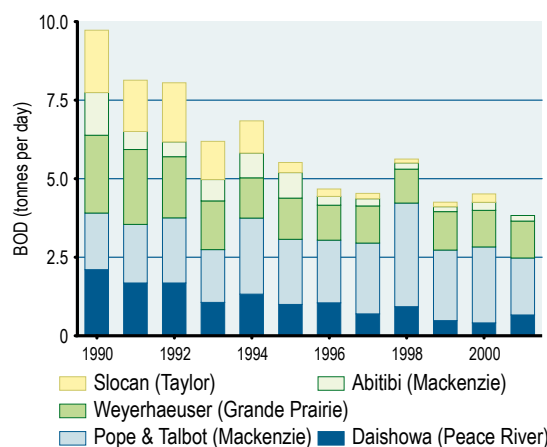


Figure 3–2.

Pulp mills reduced the amount of organic matter (measured as Biochemical Oxygen Demand) that they discharge into rivers of the Peace sub-basin by about 60% between 1990 and 2001.

Data Sources: BC Water, Land and Air Protection; Alberta Environment.

Why is it happening?

Reductions in loading of organic matter, as measured by BOD, are largely due to technological upgrades at the pulp mills. In particular, mills have made vast improvements in their secondary treatment lagoons. Upgrades have also led to reductions in the loading of total suspended solids and chlorinated organic compounds (see next section – **Adsorbable Organic Halides**). In contrast, the advanced biological treatment of wastewater at pulp mills has resulted in increased phosphorus loading into rivers. This may promote eutrophication and lead to a reduction in oxygen in the river water (see Chapter 2 – **Dissolved Phosphorus**).

What does it mean?

Micro-organisms use a lot of dissolved oxygen as they break down organic matter. Depletion of dissolved oxygen can stress an aquatic ecosystem since most forms of aquatic life require oxygen to survive. Pollution loading from pulp mills in the Peace sub-basin has declined despite growth in pulp production. Moreover, winter dissolved oxygen concentrations on the Peace and Smoky rivers have been within Canadian Environmental Quality Guidelines for the protection of aquatic life (6.5 milligrams per litre).

What is being done about it?

Pulp mills are regulated under federal and provincial laws to ensure that organic matter loads do not pose significant risks to the environment, and that oxygen is not depleted in water bodies into which treated effluent is pumped. Mills must operate within the conditions of their approvals, which stipulate how

much treated effluent they are permitted to discharge and how “clean” the effluent must be before it is discharged.

Overall Assessment – Favourable

Pulp mill effluents discharged into rivers of the Peace sub-basin contain significant amounts of organic matter which can be measured by assessing BOD. As a result of stringent government regulations and technological upgrades by the mills, the total load of organic matter entering rivers has decreased substantially during the past decade.

Adsorbable Organic Halides

Adsorbable organic halides (AOX) are a group of mainly chlorinated organic chemicals that are found in bleached kraft pulp mill effluents, and to a lesser extent in treated sewage. In bleached kraft mills, they are formed during the bleaching process when chlorine reacts with certain organic compounds. Alternatively, they can be formed when chlorinated water from community water supplies combines with organic matter in sewage effluent.

What is happening?

Long-term monitoring for AOX occurs in the lower Peace River at Fort Vermilion and near the mouth of the Smoky River at Watino. By 2001, AOX at these sites had declined to levels that were between one-quarter and one-third of their 1990 levels (Figure 3–3).

Why is it happening?

The major sources of AOX in the Peace and Smoky

rivers are bleached kraft pulp mills and municipal sewage effluent. Chlorinated organic compounds that are deposited into the sub-basin's lakes and rivers from the atmosphere are another source of AOX. One reason why AOX declined during the 1990s was that bleached kraft pulp mills substantially reduced their use of chlorine in the pulping process and improved the way they treated effluent before releasing it into aquatic ecosystems in the Peace sub-basin. As a result, the AOX loading from pulp mill effluents in the Peace sub-basin has decreased by 70% since the early 1990s (Figure 3–4).

What does it mean?

AOX chemicals include dioxins and furans, chlorinated phenolics, and residual chlorinated organic material from wood digestion in pulp mills. Some of these chemicals have been linked to the toxic effects of pulp mill effluents on aquatic wildlife.

Some AOX compounds bioaccumulate in aquatic ecosystems and have harmful effects on living organisms. It is encouraging that the concentrations of these chemicals are declining in the rivers of the Peace sub-basin.

What is being done about it?

AOX and many chlorinated compounds in bleached kraft pulp mill effluent are strictly regulated. This means that limits are placed on the amounts of chlorinated compounds that the mills are permitted to discharge. The objective of the federal Toxic Substances Management Policy is the virtual elimination of persistent, bioaccumulative and toxic

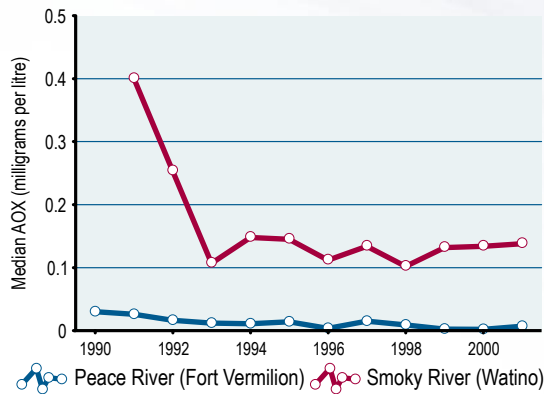


Figure 3–3.

Concentrations of adsorbable organic halides (AOX) declined three- to four-fold on the Smoky River at Watino and on the Peace River near Fort Vermilion between 1990 and 2001.

Data Source: Alberta Environment.

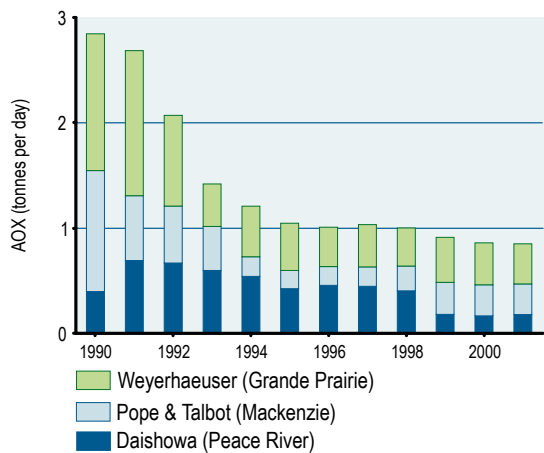


Figure 3–4.

Pulp mills have reduced the amount of adsorbable organic halides (AOX) that they discharge into the Peace and Smoky rivers by about 70% since 1990.

Data Source: Alberta Environment.

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substances, including some of the compounds that contribute to AOX. Alberta will continue to pursue reductions of these contaminants and to progress toward their elimination.

Pulp mills are continuing to review their technology in order to reduce the amount of AOX and other contaminants in their effluent.

✔ Overall Assessment – Favourable

The concentrations of AOX in rivers of the Peace sub-basin declined between 1990 and 2001. The decline was greatest during the early 1990s. In the Smoky and Peace rivers, AOX are produced primarily by bleached kraft pulp mills. The decline in the AOX concentration in the rivers is likely due to a decline in the AOX loading from pulp mill effluents.

Water Quality Indices

Water quality indices are based on measurements of chemical, physical and microbiological substances in water. These measurements are compared to water quality guidelines and objectives that are established by various government agencies. The guidelines and objectives are concentrations of different substances that are deemed to be safe for freshwater aquatic life or for different uses of water, such as swimming. From the comparisons between measured values of water quality and guideline values, a water quality index can be derived for a given site. Water quality indices rate water quality as excellent, good, fair, marginal or poor, depending on how often and by how much, measured values of water quality exceed the guidelines and objectives.

What is happening?

Water Quality in the Peace and Smoky Rivers in Alberta

Alberta's Water Quality Index is based on measurements of metals, nutrients, bacteria and pesticides in water samples. It is calculated for two sites in the Alberta portion of the Peace sub-basin; one site at the mouth of the Smoky River at Watino and one in the lower Peace River at Fort Vermilion.

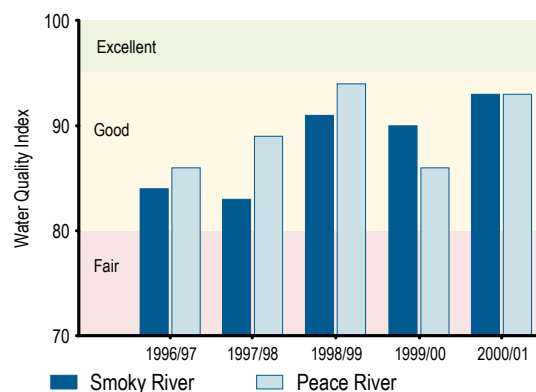


Figure 3-5. Between 1996-2001, water quality in the Peace and Smoky rivers has been consistently "good" as determined by Alberta's Water Quality Index.

Data Source: Alberta Environment.

In 2000, the City of Grande Prairie upgraded its sewage treatment facility to provide improved wastewater treatment and to reduce the release of nutrients into the Wapiti River.

Water quality at the two stations in the Peace sub-basin has been consistently “good” (Figure 3–5). Water samples collected from the Peace sub-basin occasionally exceed guidelines for nutrients and metals.¹¹⁶

Water Quality in the Peace River in British Columbia

In British Columbia, water quality in the Peace River is measured below industrial inputs at a site upstream from the Alberta border near Taylor, BC. At that site, the Canadian Water Quality Index has been calculated for each decade since the 1980s. The index is based on measurements of nutrients, bacteria, metals and other common water quality parameters such as sodium, calcium, sulphate and colour. The quality of water in the Peace River in British Columbia is closely matched with river flows. As a result, increased amounts of suspended sediment occur during the spring freshet, when melting snow and ice enter rivers. Suspended sediment carries with it elevated levels of dissolved organic carbon. The large quantities of dissolved organic carbon produce high measurements of colour, a water quality parameter that is used in the calculation of the Canadian Water Quality Index.

The Canadian Water Quality Index fluctuated from “fair” to “poor” to “fair” between the 1980s and the current decade (Figure 3–6). Colour was the most important water quality parameter that affected the rating. As colour values increase, the rating becomes poorer. This is less of a concern than if other variables reduced the rating, because colour is only an aesthetic concern, not a safety issue and, as stated earlier, results from high flows.

Why is it happening?

Geology, slope, vegetative cover and climate as well as human activities and industries determine the water quality of a watershed. Surface soils in the Peace sub-basin are easily eroded, and therefore are washed into water bodies during periods of high runoff. In the Peace River, water quality guidelines are occasionally exceeded during periods of high flow, when large quantities of dissolved organic carbon are washed into the river, producing measurements of colour and metals that sometimes exceed guideline values.

There are several industrial and community effluent discharges along the course of the Peace River and its tributaries. However, these effluents are treated in various ways to remove most of the harmful material, and the large volume of flow of the Peace River provides considerable dilution of effluents.

What does it mean?

Water quality in the Peace and Smoky Rivers in Alberta

Alberta’s Water Quality Index rated water quality in the Peace and Smoky rivers of Alberta as good. This

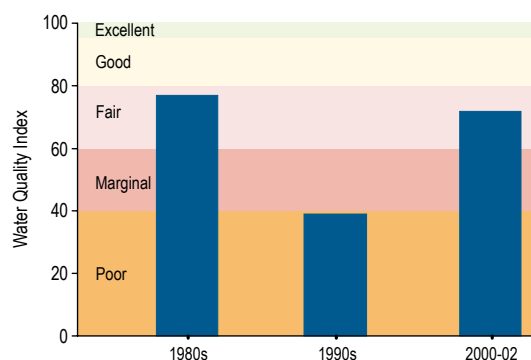


Figure 3–6.

Between 1996 and 2001, water quality in the Peace River in British Columbia ranged from “poor” to “fair” as determined by the Canadian Water Quality Index.

Data Sources: BC Water, Land and Air Protection; Environment Canada.

rating indicates that metals, nutrients, bacteria and pesticides are not present in excessive amounts that could harm the aquatic ecosystem. This does not mean that water in the Peace and Smoky rivers is safe for drinking without treatment. Even water that is pristine in appearance needs to be properly treated before drinking it, if its safety has not been proven. The finding that water quality in the Peace and Smoky rivers is good contrasts with traditional knowledge of water quality in the Peace sub-basin. Traditional knowledge, based on information collected prior to 1995, indicated that water quality in the Peace sub-basin was poor (see earlier section – **Traditional Knowledge of Water Quality**). However, Alberta's Water Quality Index has only been calculated since 1996, so it is not directly comparable with the Traditional Knowledge indicator. Traditional knowledge of water quality needs to be updated to determine whether this discrepancy still exists.

Water quality in the Peace River in British Columbia

The Canadian Water Quality Index rated water quality in the Peace River in British Columbia as “poor” to “fair”. These ratings indicate that water in the Peace River in British Columbia is sometimes not of a sufficient quality to support a wide diversity of aquatic life or to be used for a wide variety of different water uses. This is the result of natural conditions in the river – the high suspended sediment loads during periods of high flow – and is not because of human activity.

Different water quality indices are not comparable

The set of water quality parameters used to calculate the Canadian Water Quality Index for the Peace River in British Columbia was different from that used for the Alberta Water Quality Index for the Peace and Smoky rivers in Alberta. Also, the methods used to calculate each index were slightly different. Therefore, water quality in these rivers should not be directly compared by using these two indices. The different ratings for water quality in the British Columbia and Alberta portions of the Peace River do not necessarily mean that water quality differs between those sites.

What is being done about it?

Water quality will continue to be monitored at long-term monitoring sites in the Peace sub-basin. It will also be measured at regular intervals near community and industrial discharges. To improve reporting on water quality, experts across Canada are refining water quality indices to produce better indicators of general water quality. Water quality indices will continue to be used to determine trends in general water quality, and a wide range of specific water quality parameters will continue to be evaluated to determine whether specific concerns exist.

Overall Assessment – Favourable

Water quality indices serve as indicators of general water quality by incorporating information on physical, chemical and microbiological substances in water. The Alberta Water Quality Index has rated water

quality as good at two sites in the Alberta portion of the Peace sub-basin since 1996. This contrasts with the evaluation of water quality based on traditional knowledge. Reasons for this discrepancy need to be determined. The Canadian Water Quality Index has rated water quality in the British Columbia portion of the Peace River as poor to fair since the 1980s. The different ratings obtained by using the Alberta and Canadian water quality indices are due to methodological differences in the way the indices are calculated. They do not indicate that water quality differs between the British Columbia and Alberta portions of the Peace River.

Ensure Sufficient Water Quantity

Traditional Knowledge of Water Quantity

People from the Fort Vermilion, Little Red River, and Tall Cree First Nations reported, in 1994, that water levels had been declining for about fifteen years, or since the late 1970s. Water levels in the Peace River were noticeably lower, and some smaller bodies of water had dried up entirely. Although some of this decline in water level was attributed to less precipitation, it was also assumed that the control and release of water by the Bennett Dam was partially responsible.²⁸

It was also observed that the dam had affected flooding. The Peace River was known to be very turbulent and often flooded during the spring prior to the construction of the Bennett Dam. This is no longer the case, due in large part to the regulation of flows.²⁸

A substantial decrease in water level was the most significant environmental change identified within the Peace-Athabasca Delta. Inland lakes had disappeared as a result of low water levels. Egg Lake and other perched basins that were normally filled by flooding no longer existed. According to local Elders, “floods were known to occur on a regular cycle of every two to three years. The last major flood the elders recalled occurred in 1974. . .” The floods, which typically occurred in the spring and summer, flooded lowlands and rejuvenated perched basins. It is important to note that these observations and comments were made prior to 1996, the first year since 1974 during which there was a major spring flood in the Peace-Athabasca Delta.

Overall Assessment – Unfavourable

First Nations people living in the Peace sub-basin noticed a significant decrease in water levels in the Peace River itself and in inland lakes up until 1994. Some small lakes had disappeared entirely. Flooding occurred less frequently than in the past. As a result, the ecosystem of the Peace-Athabasca Delta was greatly affected. It would be valuable to document current traditional knowledge, and observations made since the flooding that occurred in 1996.

Flow in the Peace River

What is happening?

Filling the Williston Lake Reservoir reduced average annual flows during the period of 1968 to 1971 (Figure 3–7). The flow at Hudson’s Hope was less than half the normal flow and even 1,100 kilometres downstream at Peace Point the flow was only about two-thirds of normal. Since 1971, however, the dam has not dramatically altered the total volume of water flowing in the Peace River during an entire year, although it has changed the natural flow cycle.

Like most northern rivers, the flow in the Peace River is lowest during the winter and is highest in early summer. These seasonal fluctuations have been dampened by operation of the Bennett Dam. Summer flows are not as high and winter flows are not as low as they were before the dam was built. This effect is most apparent in the Peace River immediately below the dam, but changes are still evident at Peace Point (Figure 3–8).

Peak flows on the Peace River generally occur in late May or early June and are dependent on snowmelt in the mountainous headwaters of the Peace sub-basin. Peak flows can affect water levels in lakes and wetlands in the Peace-Athabasca Delta. Figure 3–9 shows the flow for the day with the highest flow each year (one-day high flow). Using computer models, scientists have estimated what the highest flow on the

Peace River at Peace Point would have been like without the dam.¹¹⁷ Such estimates are referred to as “naturalized” flows. Keeping in mind the uncertainty associated with estimates of “naturalized” flows, they may have been high enough in 1972 and 1990 to overtop the levees of the lower Peace River and flow into the delta.¹¹⁷ The actual peak flows observed in those two years were much lower than the “naturalized” flows. The actual peak flows observed after construction of the dam were, on average, lower than the “naturalized” flows.¹¹⁷

Climate has been another important influence on the flow in the Peace River. An examination of climate data from 1950–1998 revealed that winter precipitation has decreased in the upper portion of the Peace sub-basin.¹⁹ This reduced the early spring runoff from tributaries to the Peace River, especially from the mid-1970s until the mid-1990s. (For more information about the potential effects of climatic variability on flow in the Peace sub-basin, see the following section-**Flow in the Smoky River**). Low, early spring runoffs from unregulated tributaries of the Peace River generally reduce the likelihood of ice jam-induced floods in the lower Peace River near the Peace-Athabasca Delta. The numerous elevated wetland basins (perched basins) of the Peace-Athabasca Delta depend on such floods to periodically replenish their water supplies. The lack of large, ice jam-induced floods on the lower Peace River from 1975 until 1996 corresponded with a prolonged period of drying of the Peace-Athabasca Delta. The perched

basins were replenished by floodwaters in 1996 and 1997. Since then, they have started to dry again.

Why is it happening?

The Bennett Dam regulates flows on the Peace River principally to generate 30% of the power needs in British Columbia and to help provide flood protection to several communities located downstream from the dam. The dam stores water during the high inflows of spring and summer and releases less water than would flow under natural conditions. In the winter, when demand for electricity is high, the dam releases more water than would flow under natural conditions.

Changes in climate since 1950 have also affected flow patterns in the Peace River. In particular, they have reduced spring runoff in major tributaries of the Peace River, thereby decreasing flow in the lower Peace River at the time of ice break-up. Consequently, major ice-jam floods into the Peace-Athabasca Delta did not occur between 1975 and 1996. Some areas of the delta dried substantially during that period. For more information on why our climate is changing, see Chapter 1 - Climate Change).

Until recently, it was widely believed that flow regulation by the dam and the amount of water flowing in tributaries at the time of the spring thaw have influenced the occurrence of ice jams in the lower Peace River.⁹⁷ In particular, some scientists expressed concern that operation of the dam may make the formation of major ice jams more

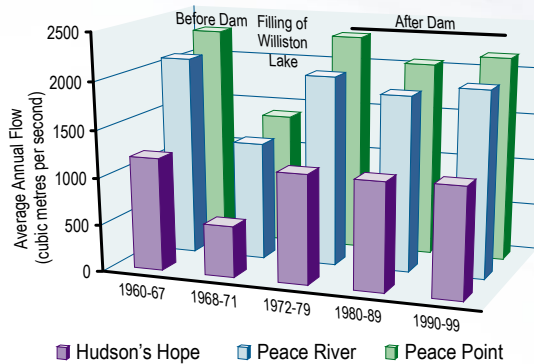


Figure 3-7.

The filling of the Williston Lake Reservoir behind the Bennett Dam substantially reduced annual flows in the Peace River between 1968 and 1971. Since then, total annual flows in the Peace River have been similar to flows before the dam was built.

Data Sources: Alberta Environment; Environment Canada.

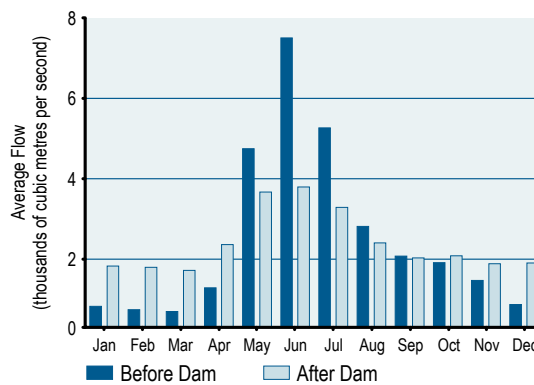


Figure 3-8.

Summer flows have been lower and winter flows have been higher on the Peace River since the Bennett Dam was built, as shown by these monthly average flows at Peace Point, near the mouth of the Peace River.

Data Sources: Alberta Environment; Environment Canada.

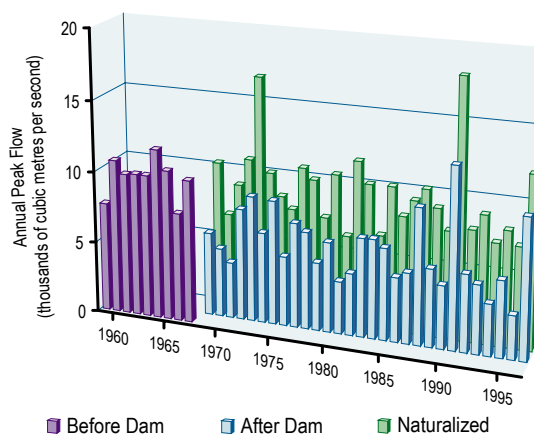


Figure 3-9.

A comparison of actual peak flows after construction of the dam and those that would have occurred under 'naturalized' conditions (if the dam had not been built), shows that peak flows in the Peace River have been reduced by the operation of the Bennett Dam.

Data Source: Peters and Prowse, 2001.

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dependent on tributary inflow, particularly from the Smoky River.¹¹⁸ Flows from unregulated tributaries during the period 1975-1995 were not large enough to produce a large ice-jam flood in the Peace River near the Peace-Athabasca Delta. However, even in the absence of a dam, it remains unclear whether tributary flows during that period would have been high enough to cause an ice jam. Whether the dam plays a role in reducing the likelihood of ice-jam floods has recently been questioned. In particular, through calculations that relate flow conditions and ice conditions to water level, and hence flooding potential, it was estimated that flow regulation by the dam has had a negligible effect on the occurrence of large ice jam-induced floods in the lower Peace River.¹¹⁹

What does it mean?

Changes to the flow of the Peace River, particularly the reduction in peak flows, are affecting the Peace River ecosystem. As peak flows decline, the river's capacity for transporting large amounts of sediment decreases. Instead, sediment should gradually build up on the river bed, resulting in a slow narrowing and in-filling of the river.¹²⁰ In many places, old floodplains are becoming low terraces. Terrestrial vegetation is expanding into these areas, particularly on islands, sandbars, and riverbanks. Wetlands that are only connected to the river during high water events are drying out and becoming overgrown with vegetation. These wetland habitats are important to waterfowl, other water birds, and amphibians. Areas

The W.A.C. Bennett Dam
and G.M. Shrum generating station,
on Williston Lake Reservoir, BC.

Courtesy of: BC Hydro.



British Columbia's pending Peace River Water Use Plan will create new operating rules for BC Hydro's facilities. The plan, currently being developed by BC Hydro, government agencies, First Nations and major stakeholders, will improve the health of the aquatic ecosystem, enhance flood protection, and provide recreational opportunities while continuing to use the waters of the Peace River to generate hydroelectricity. BC Hydro's facilities on the Peace River meet approximately 30% of the power needs of British Columbia.

The Alberta – BC Joint Task Force (JTF) on Peace River Ice makes recommendations about how to operate the Peace River hydro facilities so as to reduce the risk of spring break-up ice jams and flooding at the Town of Peace River.

along the river margin, such as side channels, backwaters and shoals, provide important habitat for fish but are the most vulnerable to changing flows.¹⁸ These changes may become even more prevalent as a result of future climate change which is expected to reduce annual and peak flows in the Peace River system.¹²¹

Within the Peace-Athabasca Delta, reduction in the peak flows of late spring can lower water levels in the channels and in the large, low-lying lakes that are connected to the Peace River. In years with very high peak flows, the Peace River can act like a temporary dam, preventing water from draining out of Lake Athabasca and the Peace-Athabasca Delta. In some years, short-term flow reversals have been observed. Such conditions can raise water levels on channels and low-lying lakes in the delta. Since the dam was built, flow reversals have been estimated to have

occurred relatively less often and to have been of shorter duration and smaller size than those that occurred prior to its construction. In addition, scientists have estimated that actual flow reversals have been smaller, on average, than those that would have occurred if the dam and weirs had not been built.¹²² To compensate for the reductions in peak flow, weirs were constructed in the mid-1970s on two channels that connect the Peace-Athabasca Delta to the Peace River. These weirs have nearly restored peak water levels to the delta's channels and low-lying lakes in most years. However, they have raised average and minimum water levels, thereby reducing the natural season-to-season fluctuations in water levels that these water bodies experienced before the dam was built.⁹⁷ Water level fluctuations are considered to be important in maintaining productive near-shore habitat. However, the ecological impact of stabilized water levels on near-shore habitat in the delta has not been investigated.

Periodic overland flooding is necessary to fill the perched ponds and lakes in the delta, which are not connected to the system of open-water channels and rivers.¹²² Flooding can result from early spring ice-jams and, occasionally, from the high flows of early

summer. The lack of large-scale floods during the period 1975–1996 resulted in a period of drying in the delta. While this dry period lasted longer than those in the recent past, it was similar in length to other dry periods that the delta has experienced over the past several hundred years.^{97, 123} The dry period from 1975–1996 brought about changes in habitat conditions, specifically an increase in shrubby vegetation and a decrease in wet meadows and emergent vegetation that typically borders shorelines.¹²⁴ Alternating periods of wet and dry conditions are needed to maintain wetland habitat preferred by some species of wildlife, such as muskrats and waterfowl. Scientists have estimated that a typical perched basin dries out five to nine years after flooding.^{122, 125} It has been predicted that the climate of the Peace sub-basin might become warmer in the future. Warming will increase evaporation of water in the perched basins, leading to a more rapid drying, and hence a drier, more terrestrial ecosystem.^{122, 125} Furthermore, climate change may result in lower water levels in large delta lakes that are connected by channels to the Peace or Athabasca rivers.¹²¹ Prolonged periods of drying will likely alter plant communities in the Peace-Athabasca Delta.^{126, 127} At present, there is uncertainty and some disagreement as to whether operation of the Bennett Dam could exacerbate any future drying trend that results from climate change.^{97, 119}

Further upstream, the Town of Peace River and other communities have experienced ice-jam floods throughout their history. Operation of the Bennett

Dam has contributed to the reduction of unwanted ice jams, but may result in larger ice-jam floods when they do occur. This is because operation of the dam has increased flow during the periods of freeze-up and break-up. In those rare years when late winter and early spring flows down the Smoky are sufficiently high to cause a premature ice break-up and possible ice jamming at the Town of Peace River, the high ice levels may cause water to overflow the riverbanks into the town. BC Hydro, in consultation with Alberta Environment, regulates flow releases from the Bennett Dam during the freeze-up and break-up periods to reduce the risk of flooding. This cooperation will be critical in the future if mid-winter thaws and break-ups become more common, as has been predicted by climate change experts.¹²⁸

What is being done about it?

Flows downstream from the Bennett Dam are regulated according to licenses and in consultation with Alberta Environment. Further operational changes are being contemplated under the Peace River Water Use Plan. Minimum flows are specified for Taylor, BC to protect fish habitat and to assure domestic water supply. As well, winter flows below the Peace Canyon Generating Station are managed by BC Hydro to reduce the potential for ice jams and flooding of downstream communities, which is an important benefit of river regulation.⁷

BC Hydro recently settled a lawsuit with the members of the Athabasca Chipewyan band, which had alleged that changes in water levels in the Peace-Athabasca Delta as a result of dam operation, had

infringed upon their treaty rights. The lawsuit was settled without admission of liability by BC Hydro.

Two weirs were built during the 1970s at the outflow of Lake Athabasca to the Peace River. Their purpose was to offset low lake levels that resulted from the operation of the Bennett Dam on the Peace River. It has been reported that the weirs have nearly restored peak summer water levels in Lake Athabasca and in low-lying water bodies of the Peace-Athabasca Delta, which are connected by channels to the lake.⁹⁷ However, they were not intended to affect water levels in the ecologically-important perched basins of the delta (see Chapter 2 – **Water Level in Lake Athabasca**).

The *Northern River Basins Study* recommended that BC Hydro release more water from the Bennett Dam during springtime to increase the probability of ice jamming near the Peace-Athabasca Delta. This was to be done in years when conditions appeared conducive to ice-jam formation. When such conditions occurred in the spring of 1996 and after first ensuring that the release of extra water would not flood downstream communities, BC Hydro increased the release of water from the dam for about one week. This augmented the first major flooding of the Peace-Athabasca Delta in over twenty years.¹²⁹

The Northern Rivers Ecosystem Initiative has funded research that is examining the effects of flow regulation and climate change on the Peace River and the Peace-Athabasca Delta. BC Hydro is conducting research to address a wide range of issues, including the effects of flow regulation on the delta, the flood history of the delta and processes that govern

habitat characteristics and habitat change in the delta. Information generated from this research will improve our understanding of the effects of climate change and flow regulation on the Peace River and Peace-Athabasca Delta.

▼ Overall Assessment – Mixed Signals

Construction and operation of the W.A.C. Bennett hydroelectric dam, together with climate variability have altered patterns of water flowing in the Peace River. Although the average annual flow has not been affected since the Williston Lake Reservoir was filled, there continue to be significant effects on seasonal fluctuations and peak flows. Consequently, the river ecosystem downstream from the dam has changed. A long interval from 1975–1996 passed without the occurrence of a major ice-jam flood in the lower Peace River. During that period, the Peace-Athabasca Delta experienced significant drying and traditional use of some aquatic resources was disrupted.²⁸ There is concern that climate change and flow regulation by the dam may lead to longer dry periods in the delta. These concerns need to be addressed.

Flow in the Smoky River

What is happening?

The Smoky River is a large tributary of the Peace River and is a major source of spring and summer runoff to the lower Peace River. The flow from the Smoky River and other tributaries contributes to spring break-up on the Peace River which, under

3. P e a c e S u b - b a s i n - M a c k e n z i e R i v e r B a s i n

certain conditions, may lead to flooding in the Peace-Athabasca Delta. Spring flow in the Smoky River was low from the late 1970s through the early 1990s (Figure 3–10). It was high in 1974 and somewhat elevated in 1996, the two most recent years in which major spring floods occurred in the Peace-Athabasca Delta.

Why is it happening?

Spring flow in the Smoky River is influenced by spring melt runoff, which depends on the size of the spring snow pack. The spring snow pack at Grande Prairie, reported as the total winter precipitation, was low during the period of low flow in the Smoky River

(Figure 3–11). This decline in the amount of snow pack available for spring runoff may have been due to a reduction in the frequency of snow-producing storms in the late-1970s and throughout most of the 1980s.

What does it mean?

Flow in tributaries such as the Smoky River influences water levels in the Peace-Athabasca Delta. Very high spring runoffs from the Smoky River and other tributaries are required to produce ice jams in the lower Peace River. Such jams can produce over-bank flooding into the delta and are the major source of water for the delta's elevated perched basins (see previous section – **Flow in the Peace River**). The decline in spring flow and snow pack may be indicative of global climate change or natural long-term climate cycles. While the effects of climate change on the hydrology of aquatic ecosystems have received attention, less is known about how climate change may affect the plant and animal communities that live in aquatic ecosystems.

What is being done about it?

Environment Canada continues to monitor stream flow at several sites throughout the Peace sub-basin. The issue of climate change is a global concern and all levels of government are involved; see **Chapter 1 – Actions on Climate Change** for more information on what is being done about climate change.

Overall Assessment – Mixed Signals

In general, the Smoky River has had relatively low spring flows during the past few decades. This is related to low amounts of winter precipitation, which may be due to global climate change or natural long-

Figure 3–10.

The Smoky River, a tributary of the Peace River, has experienced large year-to-year fluctuations in flows during the spring, as indicated by this graph depicting stream flow in the Smoky River at Watino. Flows from the Smoky at this time of year are important in affecting the peak water levels on the lower Peace River.

Data Source: Prowse *et al.* 2002.

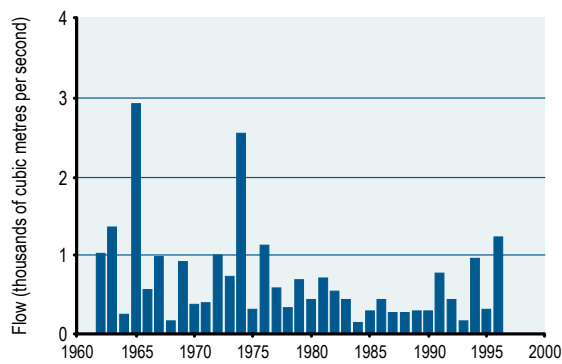
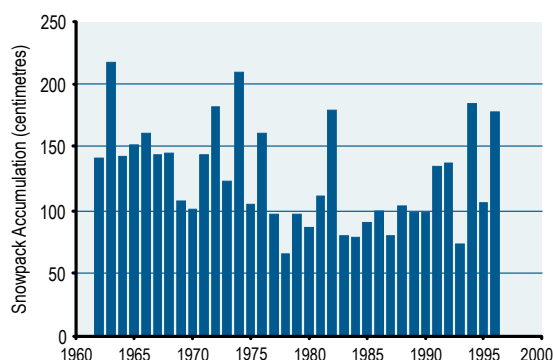


Figure 3–11.

The spring snowpack at Grande Prairie, reported as total winter precipitation, was low most years from approximately 1975 to 1993, a period of low spring flows in the Smoky River.

Data Source: Prowse *et al.* 2002.



term climate cycles. Efforts must be made to better understand the impacts of climate change on aquatic ecosystems.

Sustain In-Stream Water Uses

Traditional Knowledge of In-Stream Water Uses

Based on information collected prior to 1995, people from Fort Vermilion reported using the water for travelling, 88% used water for work, and 84% used water for recreation. Although subsistence fishing was a traditional activity of the Little Red River First Nations, it is no longer practised because of concern with fish health and the general scarcity of fish. The reasons for the scarcity of fish were not described.²⁸

A high percentage of people living near the Peace-Athabasca Delta used its waters for travelling and recreation, but these uses were impaired to some extent by the decreasing water levels. The loss of water bodies and the disappearance of sandy beaches where people beached their boats impaired travel by traditional users of the land.²⁸

Overall Assessment – Unfavourable

Aboriginal inhabitants of the Peace sub-basin rely on the water for travel, work, and recreation. Concerns about the quality and abundance of fish have affected the use of this resource, and low water levels have interfered with travel.

Water Allocations

What is happening?

Nearly forty billion cubic meters of water per year are allocated to the BC Hydro and Power Authority for storage in the Williston Reservoir in the BC portion of the Peace sub-basin. This water is not withdrawn from the river. Rather, it is released from storage in a controlled fashion to meet the demand for electricity. Other users within the sub-basin are allocated an additional 347 million cubic meters of water annually, which corresponds to 0.5% of the total flow in the Peace River at Peace Point.

Why is it happening?

Most of the water allocated to hydroelectric development is temporarily stored in the Williston Lake Reservoir. Other major water allocations are for industrial cooling water, pulp mills, habitat development, and communities (Figure 3–12).

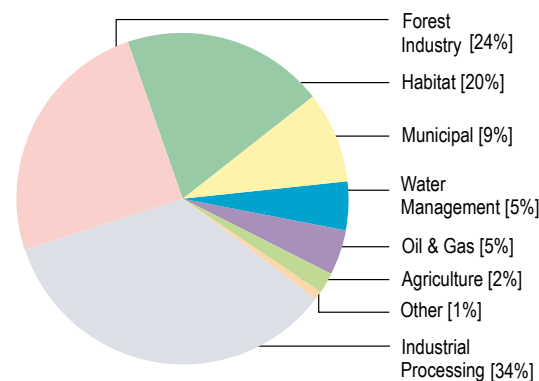


Figure 3–12.

Water allocations in the Peace sub-basin, not including water allocated for hydroelectricity.

Data Sources: Alberta Environment; BC Sustainable Resource Management.

What does it mean?

A large amount of water that is stored in the Williston Lake Reservoir is eventually used to generate 30% of the power needs of British Columbia, at which time it is released into the Peace River. This use of water has changed seasonal flow patterns in the Peace River, the effects of which are examined earlier in this report (see **Flow in the Peace River**). A large portion of the water allocated for other uses also remains in the river system. For example, habitat development projects use water to create and maintain wetland habitat for waterfowl and other species. In addition, much of the water used for industrial processing, pulp mills and communities is returned to the river system as treated wastewater.

What is being done about it?

Federal and provincial laws and regulations govern the use of water in the Peace sub-basin. They stipulate conditions under which water users must operate, such as the amount of water that can be withdrawn and the quality of water returned to the river system. Flows downstream from the G.M. Shrum power plant at the Bennett Dam are regulated to generate hydro power, provide flood protection, facilitate ice formation, jamming and break-up, protect fish habitat and assure domestic water supply.⁷ The Peace River Water Use Plan is being developed in British Columbia. Its goal is to ensure that hydroelectricity is generated in an environmentally sustainable manner that respects the needs of all water users along the Peace River in British Columbia.

▼ Overall Assessment – Mixed Signals

The BC Hydro and Power Authority is the largest water user in the Peace sub-basin. Operation of the W.A.C. Bennett Dam has altered flow on the Peace River, which has the potential to interfere with other water uses. To deal with this issue, the flows downstream of the generating stations are managed to ensure that adequate water is available to other users downstream. The amount of water allocated to users other than the BC Hydro and Power Authority is a small percentage of the total flow of the Peace River. The Peace River Water Use Plan, currently being developed, will balance the needs of water users along the Peace River in British Columbia, in an environmentally sustainable manner.

Commercial Fishing

What is happening?

A commercial fishing industry operates in the Alberta portion of the Peace sub-basin, but there is little freshwater commercial fishing in British Columbia. Up to thirty-one lakes in the Alberta portion of the Peace sub-basin were fished commercially during the 1990s. The majority of commercial fishing is done on Utikuma Lake. Harvests fluctuate from year to year. Whitefish is the most important species for the commercial fishery, with large numbers of northern pike and cisco also being harvested (Figure 3–13).

Why is it happening?

The amount of fish harvested changes from one year to the next in response to changing environmental, social and market conditions. Quotas are set annually for each species and lake. Commercial catches are rarely allowed to exceed the quota. Year-to-year changes in harvest also reflect changes in quotas.

What does it mean?

Fisheries managers must balance the competing demands of commercial, subsistence and sport fishers for a finite resource. Conservation is the top priority of fish management in Alberta, followed by subsistence, sport and commercial fisheries. The use of quotas enables fisheries managers to ensure that fish are harvested in a sustainable manner. Nevertheless, concerns have been raised by First Nations people about a scarcity of fish in some part of the Peace sub-basin (see **Traditional Knowledge of In-stream Water Uses** and **Traditional Knowledge of Aquatic Species and Habitat**). These concerns need to be addressed.

What is being done about it?

In recent years, there have been about 800 commercial fishing operators in Alberta, using a total of 37,000 nets. The provincial government hopes to reduce the number of operators to approximately 200 and the number of nets to about 18,000 through licensing adjustments and compensation. Such measures are designed to make commercial fishing

more economically viable for those who remain in the fishery and to reduce competition for a finite resource among commercial, subsistence and sport fishers.

Overall Assessment – Favourable

Commercial fishing occurs in Utikuma Lake and at other sites in the Alberta portion of the Peace sub-basin. The current management challenge is to ensure that adequate stocks are available for the subsistence and sport fisheries and that fish populations are not adversely affected by harvest. The provincial government is working to meet this challenge by periodically adjusting quotas to balance the demands of other users against those of commercial fishers, and by reducing the number of commercial operators and the number of nets. There is a need to collect detailed information on the population status of species that have been identified as being scarce by traditional knowledge (see following section on **Traditional Knowledge of Aquatic Species and Habitat**).

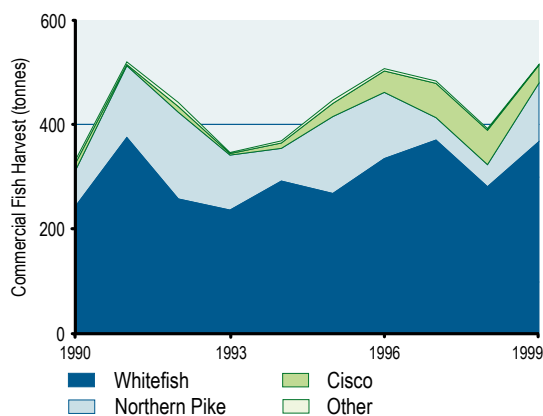


Figure 3-13.

Size of the commercial harvest of fish in lakes of the Peace sub-basin, 1990-1999.

Data Source: Alberta Sustainable Resource Development.

Ensure Healthy, Abundant and Diverse Aquatic Species and Habitat

Traditional Knowledge of Aquatic Species and Habitat

First Nations inhabitants of the Peace sub-basin have noticed changes in the populations of some fish, bird, and mammal species.²⁸ Based on data collected prior to 1995, they reported that populations of several species of fish in the Peace River had declined over the past twenty years. In addition, people noticed that some fish caught recently were thin and had an unusual taste.

First Nations people reported several changes to the habitat and wildlife communities of the Peace-Athabasca Delta, many of which were related to the lack of flooding and the drying of the landscape.²⁸ During the 1970s and 1980s, there was a substantial increase in willow growth in areas that had historically been flooded. Elders noticed a considerable reduction in the use of the delta by migratory birds. In the past, thousands of birds would be seen feeding on the flats of the delta or flying in large flocks during fall migration. In addition, muskrat populations declined from the mid-1970s to the mid-1990s. Experienced hunters and trappers in the area indicated that muskrat habitat and

populations typically thrive for about two years after a flood. The decline in waterfowl and muskrat numbers was attributed to the lack of flooding in the delta ever since the Bennett Dam was built. Although muskrat populations decreased, beaver numbers increased substantially over the 25-year period preceding 1995. This increase was attributed to a less demanding fur market and a reduction in trapping pressure.

Overall Assessment – Unfavourable

First Nations people along the Peace River and near the Peace-Athabasca Delta noticed declines in the populations of certain fish species, waterfowl, and muskrat. In the case of waterfowl and muskrat, these changes were attributed to deterioration in habitat caused by a lack of flooding in the delta. They also reported increases in beaver populations.

Aquatic and Riparian-Dependent Wildlife Species at Risk

Alberta and BC have their own classification systems for species at risk. Species on the “red list” in BC are endangered, threatened, or extirpated from BC or are species that are candidates for these designations. Species on the “blue list” are not immediately threatened but are particularly sensitive to human activities or natural events.¹³⁰ In Alberta, endangered and threatened species are considered to be at risk and are the equivalents of red-listed species in BC, while there are others that may be at risk of extinction or extirpation and are the equivalents of blue-listed species in BC.¹⁰⁰

What is happening?

Based on provincial classification systems, fifteen species of aquatic and riparian-dependent wildlife that live in the Peace sub-basin are considered to be at risk (red) or may be at risk (blue) in Alberta or British Columbia. These include seven fish, one amphibian and seven bird species (Figure 3–14).

Why is it happening?

In the Peace sub-basin, habitat degradation is a key threat to some species at risk, such as the bull trout and the Williston Watershed population of arctic grayling.¹³¹ Excessive harvest may also be a threat to the recovery of some species, including the bull trout. The Peace sub-basin may serve as one of the last refuges for other species, whose populations have been decimated by a variety of factors in other parts of their range, outside of the sub-basin. The trumpeter swan is an example of such a species.¹³² Other species, such as the sandhill crane and spottail shiner are naturally rare in parts of the Peace sub-basin, but are not under imminent threat from various human activities there.^{131,133}

What does it mean?

The number of species at risk is an indicator of the ability of an ecosystem to support a diversity of wildlife. Although it is natural for some species to become extinct, the current global extinction rate is higher than what is expected naturally, and thus concern about biodiversity has increased in recent decades. The loss of a species reduces the biodiversity of an ecosystem, making the ecosystem less stable and less capable of adapting to environmental change.

There are a few more species at risk in the Peace sub-basin than in most of the other sub-basins of the Mackenzie River Basin.

What is being done about it?

The *Wildlife Act* and the *Forest and Range Practices Act* of British Columbia may confer special protection to species at risk. In Alberta, the Endangered Species Conservation Committee recommends measures to the Minister of Sustainable Resource Development concerning the management and recovery of threatened and endangered species. The federal *Species at Risk Act* (SARA) was recently passed, giving legal protection to Canadian species at risk. SARA is one component of a three-part strategy for protecting species at risk that also includes the Habitat Stewardship Program and the *Accord for the Protection of Species at Risk*, a Canada-wide agreement on federal-provincial-territorial cooperation.

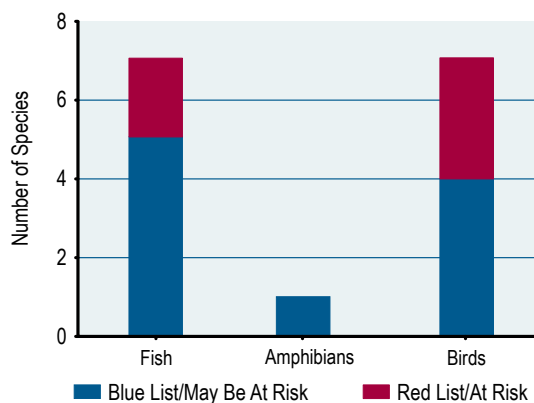


Figure 3–14.

There are fifteen species of aquatic and riparian-dependent wildlife considered to be “at risk” (red) or “may be at risk” (blue) in the Peace sub-basin.

Data Sources: Alberta Sustainable Resource Development; Conservation Data Centre of the BC Ministry of Sustainable Resource Management.

▼ Overall Assessment – Mixed Signals

There are fifteen aquatic and riparian-dependent wildlife species considered to be at risk in the Peace sub-basin. Populations of some species are naturally rare while populations of other species are threatened by a variety of factors including habitat loss and excessive harvesting. New legislation at the provincial and federal levels will enhance protection of these species.

Ensure Human Health and Safety

Fish Consumption Advisories

What is happening?

There are several lakes and rivers in British Columbia and Alberta with fish consumption advisories based on concentrations of mercury, dioxins and furans measured in fish tissues (Figure 3–15).

Bull trout and Dolly Varden from Williston Lake Reservoir in British Columbia may have elevated levels of mercury. Although occasional consumption of these fish does not pose a significant risk to human health, high levels of consumption may be hazardous. In Alberta, women of childbearing age and children under the age of 15 should not eat walleye or northern pike from Muskwa Lake because of elevated mercury levels. Other people should not eat more than one meal of these fish per week.

Concentrations of dioxins and furans have decreased substantially during the past decade in fish from the Smoky River and its tributaries. Consequently consumption advisories have been eased for fish caught from these rivers. For burbot, the organs should be discarded and only the fillets should be eaten. Pregnant women and young children should not eat mountain whitefish caught in these rivers, and others should not eat more than four - 4 oz. (112 gram) servings per week. Prior to November 2000, there had been a total ban on the consumption of mountain whitefish. Fillets from rainbow trout, lake whitefish, arctic grayling, walleye, northern pike and goldeye have been tested and consumption guidelines are not required for these species.

Why is it happening?

Elevated levels of mercury in fish in the Williston Reservoir likely resulted from the increased production of methyl mercury that is known to occur when terrestrial, organic soils are flooded to create reservoirs. Increased production of methyl mercury leads to a greater uptake of mercury by fish (see **Chapter 1 – Mercury**).

The occurrence of high levels of mercury in fish from Muskwa Lake is likely a natural phenomenon, having to do with characteristics of the watershed.

Dioxins and furans are produced as by-products by bleached kraft pulp mills and released in their effluents. Substantial reductions in the release of dioxins and furans by the bleached kraft mill located on the Wapiti River caused concentrations of these substances in fish to decline during the 1990s (see **Chapter 1 – Dioxins and Furans**). As a result, the

fish consumption advisory in the Smoky River and its major tributaries has been eased.

Mercury, dioxins and furans biomagnify along food chains. Therefore, predatory species like bull trout, burbot, walleye and northern pike tend to have higher concentrations of these contaminants than non-predatory species. See **Chapter 1 – Contaminants** for more information.

What does it mean?

Mercury, dioxins and furans are toxic chemicals that can harm people's health. Fish consumption advisories are designed to protect humans from consuming harmful levels of contaminants by limiting their consumption of highly contaminated fish. By following fish consumption advisories, people can safely enjoy the health benefits of eating fish they have caught themselves.

What is being done about it?

Pulp mills are required to use the latest technologies to reduce their output of dioxins and furans. In the last decade, all mills in the Peace sub-basin significantly reduced their discharge of these chemicals. Government agencies regularly monitor mercury levels in fish and update fish consumption advisories as needed. As follow-up to the *Northern River Basins Study*, work is underway with First Nations to develop better protocols for fish consumption advisories.

Overall Assessment – Mixed Signals

There are fish consumption advisories for the Williston Lake Reservoir, Muskwa Lake and rivers near a bleached kraft pulp mill on the Wapiti River, a

tributary of the Smoky River, because of unacceptably high levels of mercury, dioxins and furans in some fish species. These fish consumption advisories are meant to protect people from consuming harmful levels of environmental contaminants. In November 2000, the consumption advisory on the Smoky River and its tributaries was eased in response to reductions in concentrations of dioxins and furans in fish. These reductions were attributable to substantial decreases in concentrations of these contaminants in pulp mill effluent.

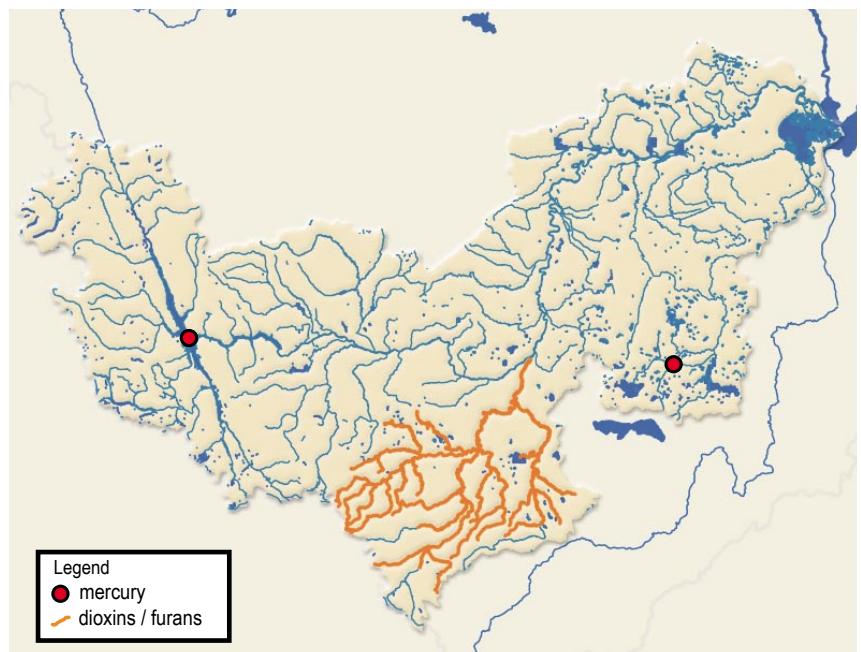


Figure 3–15. Locations where fish consumption advisories were issued in the Peace sub-basin.

Data Sources: Alberta Sustainable Resource Development; Northern Health Authority..

Peace-Athabasca Delta

Peace-Athabasca Delta

With an area of 3,900 square kilometres, the Peace-Athabasca Delta in northern Alberta is one of the largest freshwater deltas in the world.⁹⁷ It is formed by the convergence of the Peace, Athabasca, and Birch rivers at the western end of Lake Athabasca. The Peace-Athabasca Delta is a dynamic, complex, and productive ecosystem driven mainly by short- and long-term fluctuations in water levels.¹²⁷ It contains large shallow lakes, countless smaller wetlands, and an extensive network of channels. The shallow lakes and wetlands provide excellent habitat for a diversity of wildlife including fish, waterfowl and muskrat. The fish stocks are healthy and support productive commercial, subsistence, and sport fisheries.⁹⁹ Expansive grasslands and meadows support large herds of bison, while moose inhabit the more stable areas of the delta where tall shrubs and trees are present.

Eighty percent of the Peace-Athabasca Delta lies within Wood Buffalo National Park, 10% forms the Chipewyan Indian Reserve 201, and the remaining 10% is Alberta Crown land.⁹⁹ Residents of Fort Chipewyan, on the perimeter of the delta, use the area for fishing, hunting, trapping, and recreation. The delta has been recognized as a wetland of

international significance by the RAMSAR convention and was one of the principal reasons that Wood Buffalo National Park was designated as an UNESCO World Heritage Site.

Importance of Wet and Dry Cycles

The Peace-Athabasca Delta, like other large temperate wetlands, is a dynamic, complex ecosystem, shaped primarily by short- and long-term wet and dry cycles. Prolonged flooding creates lake-like conditions and a consequent decline in productivity and habitat complexity favoured by many marsh-dwelling species of wildlife. In contrast, prolonged drying brings about more terrestrial conditions, denser vegetation and dominance by shrubs and other types of woody vegetation.¹²⁷ Alternating wet and dry conditions help to shape patterns of plant succession and favour the wet meadows and emergent vegetation typically associated with marshes.

Wet and dry cycles within the delta are driven mainly by changes in flows and ice conditions on the Peace and Athabasca rivers. Although peak flows usually occur during the open water season, the highest water levels typically result from ice jams during spring break-up.¹²⁹ Ice jams can block

Peace-Athabasca Delta - continued

river channels, obstruct flows, and cause backwater effects that may result in over-bank flooding of the adjacent landscape (Figure 3–16). Most of the major floods affecting the delta have

been associated with spring ice jams. These floods bring water to isolated perched basins and, when combined with a subsequent drying period, shape conditions that provide abundant habitat for

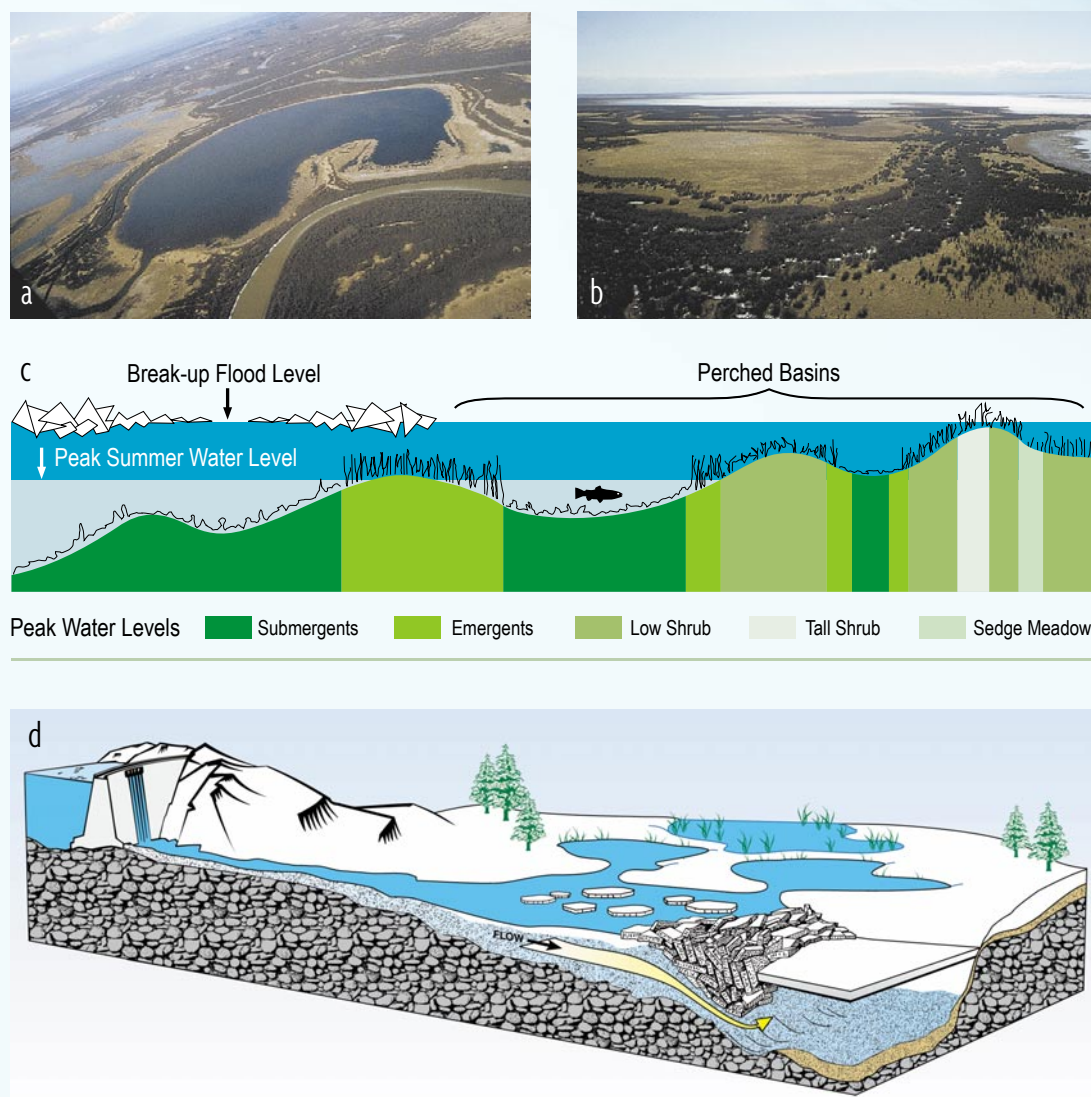


Figure 3–16.
(a) Typical flooded perched basin in the Peace-Athabasca Delta; (b) dry perched basin with willows and other vegetation; (c) vegetation communities as affected by spring and summer floods; (d) schematic illustrating ice-jam flood event.

Source: Prowse and Conly 2000.

Peace-Athabasca Delta - continued

marsh wildlife. Waterfowl and muskrat populations fluctuate in response to flood-induced changes in habitat conditions. Maximum numbers of waterfowl and muskrats usually occur in the first year or two following flooding of perched basins and decline as perched basins dry. Flooding is especially important for the delta's large number of isolated perched basins. For example, scientists have estimated that a typical shallow wetland would usually dry out after a period of five to nine years without flooding.^{122, 125}

The high water levels in late spring and summer are due to high flows from runoff generated by rainfall and mountain snowmelt. High water levels on the Peace River can obstruct and, occasionally, reverse the northward flow of water out of the delta. This causes the water in Lake Athabasca and

the large delta lakes, connected by channels to the Peace River, to rise to peak levels. The summer high water levels, in combination with low winter flows, create water level fluctuations conducive to the development of productive near-shore habitat on the large lakes and channels.

The frequency of flooding in the Peace-Athabasca Delta has varied widely over the past two centuries. Since approximately 1850, floods have occurred on average about once every seven or eight years.¹²³ The period 1860–1880 was a time of unusually few floods, and the period 1915–1950 was a time of frequent floods (Figure 3–17). This flood history indicates that the delta has been subjected to extensive periods of drying and flooding in the past.⁹⁷

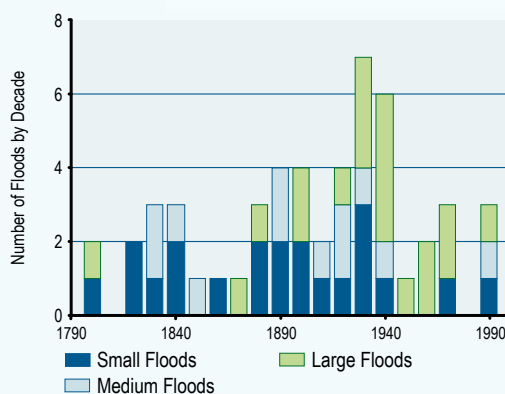
Recent Drying of the Delta

Forty-one billion cubic meters of water were retained in the Williston Lake Reservoir behind the newly constructed W.A.C. Bennett hydroelectric dam from 1968 to 1971.⁹⁷ During this period, flow on the Peace River was significantly reduced and the delta dried substantially. The size of the area covered by water decreased by 38% and perched basin shoreline decreased by 36%.⁹⁷ Newly-exposed mudflats became meadows, and productive sedge

Figure 3-17.

History of flooding in the region of the Peace-Athabasca Delta rated by the size of the event.

Data Source: Peace-Athabasca Delta Technical Studies 1996.



Peace-Athabasca Delta - continued

meadows were overgrown by willows and poplars.¹³⁴ During this period, the muskrat population declined substantially, since water level is a key factor influencing the suitability of muskrat habitat.¹³⁴ While this drying period in the delta has been attributed primarily to the storage of water behind the Bennett Dam,⁹⁷ low flows in the Athabasca River and unregulated Peace River tributaries in 1968 and 1969 may have exacerbated the drying, at least during those years.

Major ice-jam floods occurred in 1972 and 1974, but the delta ecosystem experienced another drying period from 1975–1996. The isolated perched basins were the most affected by the prolonged period without flooding, but Lake Athabasca, the large delta lakes, and the major channels also experienced a decline in water level.⁹⁷ Some perched basins dried out completely. There was a decline in the area covered by open water, emergent vegetation, mudflats, immature fens, and meadows.⁹⁷ Aboriginal users of the delta reported changes in vegetation and declines in muskrat and waterfowl populations, which they attributed to the drying of the delta.²⁸

Ice-jam floods in the lower Peace River are believed to be dependent on spring flows from upstream sources.⁹⁷ Some scientists are concerned that the formation of major ice jams has become

more dependent on tributary inflow since the dam began operations.¹¹⁸ Tributary flow during the spring thaw depends on the amount of snow pack and the rate of snowmelt. Warmer, drier winters in the upper portion of the Peace sub-basin have resulted in reduced early spring runoff from unregulated tributaries to the Peace River, especially from the mid-1970s until the mid-1990s.¹¹⁸ Early spring flows from tributaries were not large enough to produce a major ice-jam flood in the Peace River near the Peace-Athabasca Delta during the period 1975–1995. However, even in the absence of a dam, it remains unclear whether tributary flows during that period would have been high enough to cause an ice jam. Whether the dam plays a role in reducing the likelihood of ice-jam floods has recently been questioned. In particular, through calculations that relate flow conditions and ice conditions to water level, and hence flooding potential, it was estimated that flow regulation by the dam has had a negligible effect on the occurrence of large ice jams in the lower Peace River.¹¹⁹

Dam operation has decreased the late spring and early summer peak flow on the Peace River and reduced the seasonal fluctuations in flow. The lower peak flow can affect water levels in the delta, since high flows on the Peace River at this time of

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year are required to raise water levels in the large, low-lying lakes and channels of the delta. These effects have been largely offset by construction of two weirs on major channels flowing out of Lake Athabasca.^{97, 135, 136} In most years, the weirs have nearly restored peak summer water levels to low-lying delta lakes that are connected by channels to the Peace River. However, they have increased annual average and minimum lake levels, thereby reducing the annual fluctuations in water level. Such fluctuations are important in maintaining productive near-shore habitat. Furthermore, the weirs were not intended to affect water levels in the isolated perched basins, which continue to depend largely on ice-jam floods to replenish their water supplies.¹²²

Recent Flooding of the Delta

A major ice jam formed on the Peace River in the spring of 1996 and much of the central portion of the Peace-Athabasca Delta was flooded. The flood was due in part to the high tributary runoff that resulted from the combination of high winter precipitation and a late, rapid spring melt.

Flooding was enhanced by the release of additional water from the reservoir behind the dam. Although the extra water only amounted to six percent of the total flow while the ice jam was in place, some research suggests that it enhanced flooding because water levels had been nearly as high as the river banks, even before the release of additional water.¹²⁹ A few weeks later, the discovery of a structural problem in the W.A.C. Bennett Dam necessitated an emergency release of water from the reservoir, which produced unusually high flows. Together with high precipitation, this caused high flows on the Peace River for most of the summer, and is believed to have reversed the flow of water in some of the delta channels. The high flows on the Peace River and high inflows from the Athabasca River raised the level of large delta lakes, and caused subsequent flooding of the adjacent perched basins, some of which had not been affected by the spring flood.^{122, 136} High runoff occurred again in 1997, producing further flooding of the Peace-Athabasca Delta.

The 1996 and 1997 floods were excellent examples of the importance of periodic flooding to

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waterfowl and muskrat populations in the delta. Waterfowl populations were very high in 1998 and 1999, following the flooding, but began to decline again in 2000 and continued to decline in 2001, as the delta dried again.¹³⁷ The use of the delta by fall-staging birds was particularly high in 1999 (surveys were not done in 1998). Their numbers were much lower in 2000 and 2001. Muskrat populations showed a similar trend, peaking in 1998, after the flooding and declining in each subsequent year after that, as the delta dried again. Disease also likely contributed to the decrease in muskrat numbers.¹³⁸ Other species, such as moose, prefer drier habitats consisting primarily of tall shrubs and trees, and therefore may benefit from dry periods.

In summary, the Peace-Athabasca Delta is a large, complex and dynamic northern wetland, driven mainly by alternating wet and dry cycles. The wet and dry cycles are influenced primarily by ice-jam floods and changes in flow in the major rivers that form the delta. Habitat conditions and marsh-dwelling wildlife populations respond naturally to the wet and dry cycles. Recent changes

in climate have reduced spring runoff from major tributaries of the Peace River and contributed to a prolonged period of drying in the delta. That dry period ended abruptly in 1996, but since 1998, the delta has started to dry again. In addition, construction and operation of the W.A.C. Bennett Dam have contributed to changes in water level fluctuations on low-lying lakes and channels in the delta. Whether the dam plays any role in reducing the probability of ice-jam floods remains uncertain. It may have no effect or at worst, it may reduce the probability of an ice-jam flood in years when medium-sized tributary runoffs occur. Many studies have been conducted over the past thirty years and some aspects of the delta ecosystem are well understood. Nevertheless, the overall understanding of the delta would benefit from a synthesis of those studies. Furthermore, scientific consensus about what is known and what remains uncertain would be useful in guiding the development of future research. It would also assist in the development of an action plan, which is needed to ensure conservation of this important wetland ecosystem.