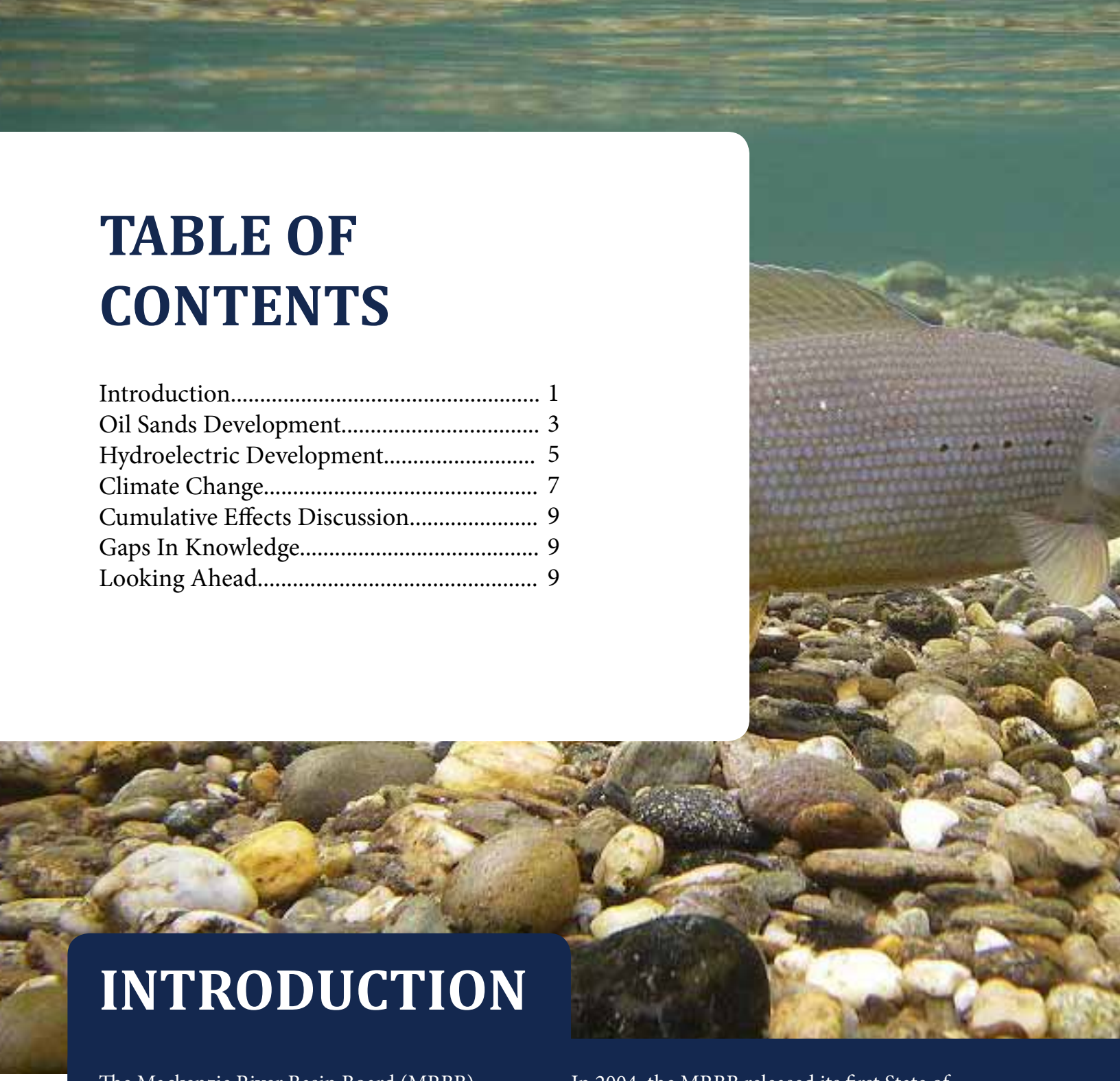
The Mackenzie River Basin Board's

2012 ISSUES REPORT

Oil sands development, hydroelectric development, and climate change in the Mackenzie River Basin

MRBB

MACKENZIE RIVER BASIN BOARD



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INTRODUCTION

The Mackenzie River Basin Board (MRBB) includes representatives from federal and provincial/territorial governments and Aboriginal organizations, and was established under the Mackenzie River Basin Transboundary Waters Master Agreement in 1997 to provide a cooperative forum for managing the water resources of the Mackenzie River Basin.

In 2004, the MRBB released its first State of the Aquatic Ecosystem Report[1] (SOAER 2003), to provide information on the state of aquatic ecosystems in the Mackenzie River Basin. The SOAER 2003 used several environmental indicators to examine whether the MRBB's environmental goals were being met in the Mackenzie River Basin.

[1] Mackenzie River Basin Board (MRBB). 2004. Mackenzie River Basin State of the Aquatic Ecosystem Report 2003. Mackenzie River Basin Board Secretariat, Fort Smith, NWT. 213 pp.

Photo credit: A.K. Smith

Figure 1: Sub-basins of the Mackenzie River Basin

The report concluded that the aquatic ecosystem in the Mackenzie River Basin was generally healthy, but significant information gaps were identified that limited the assessment. The report also noted discrepancies between information based on Traditional Knowledge and information from government and academic scientific research and monitoring.

The MRBB recently assessed three topics identified in the SOAER 2003 as key pressures in the Mackenzie River Basin: oil sands development, hydroelectric development, and climate change. The MRBB considered both published scientific literature and available Traditional Knowledge. This Issues Report 2012 provides an overview of these key pressures, and has been prepared as a follow-up to the State of the Aquatic Ecosystem Report 2003.

OIL SANDS DEVELOPMENT


Photo credit: Hatfield Consultants

The oil sands in the Peace and Athabasca sub-basins hold some of the largest oil reserves on Earth. In the past decade, the pace of oil sands development in northern Alberta has increased substantially, and Fort McMurray has become the largest community in the Mackenzie River Basin. In 2011, there were over 90 active oil sands projects in Alberta. Much of the oil sands development to date has occurred north of Fort McMurray, where bitumen deposits can be mined at the surface using open-pit mining practices. Over 600 km^2 are currently under development, including more than 170 km^2 of tailings ponds. There are six operating surface mining projects and three approved oil sands mines[2]. Outside of the surface mineable area, bitumen is removed from deeply buried oil sands deposits using in-situ methods.

Mining and in-situ oil sands development have impacts on air, water, and land. The terrestrial footprints of oil sands surface mines have modified natural drainage patterns in many tributary watersheds to the Athabasca River, This, in conjunction with airborne emissions, has been shown to affect water quality. In-situ extraction facilities will dominate future oil sands development, as in-situ bitumen production is projected to exceed mined bitumen production by 2015 and will account for 55% of total bitumen produced by 2020. In-situ facilities have much smaller terrestrial footprints than surface mines and do not require large tailings ponds. However, operation of in-situ facilities can create greater terrestrial habitat fragmentation than surface mines through road, seismic-line, and pipeline development, and could affect aquatic habitats through construction-related effects of stream crossings, changes in the water table that could potentially lead to land subsidence or drying of wetlands, influences of aerial emissions, and indirect effects of increased access to fish and wildlife resources that these rights-of-way may provide.

Surface mining requires an average of 2 to 4 barrels of fresh water to produce a barrel of oil; in-situ methods require an average of 0.5 barrels of fresh water per barrel of oil. Thermal in-situ projects often use brackish water as an alternative to fresh water; fresh water is usually from groundwater sources. The remaining water requirements come from recycled water.

The maximum permitted water withdrawal under existing water licenses is 2.7% of Athabasca River average annual flow; under low flow conditions, withdrawals are capped at 1.3% of annual average flow. In 2008, oil sands operations consumed 145 million $metres^3$ of water from the Athabasca River and its tributaries. This represented 0.73% of the Athabasca's mean annual flow as measured at Fort McMurray.

[2]Alberta Oil Sands Information Portal, http://environment.alberta.ca/apps/osip/ accessed December 1, 2011

Figure 2: Location of oil sands development areas in the Mackenzie River Basin

The Athabasca River's rate of flow is considered by some researchers to have remained relatively stable over time while others conclude it has declined. Aboriginal resource users have reported decreasing flows on the Athabasca River that are affecting their ability to access traditional navigation routes and harvesting areas.

Governments and several multi-stakeholder organizations have conducted environmental monitoring in the oil sands area and downstream. Based on several independent panel reviews commissioned by the governments of Alberta and Canada, there is a general consensus that current monitoring efforts are not adequate to assess cumulative impacts of oil sands development. The governments of Canada and Alberta are working collaboratively to implement a world-class monitoring system for the oil sands to provide for improved scientific measurement of impacts of oil sands development, including transboundary effects. The Joint Canada-Alberta Implementation Plan for Oil Sands Monitoring will have increased ability to detect change, and will ensure a better understanding of natural variability and system responses to oil sands development activities.

Although there has been uncertainty about the environmental effects of oil sands development based on the results of existing monitoring programs, recent studies have identified effects on water quality due to atmospheric emissions and land-use change. Aboriginal residents of the area have reported deteriorating colour, taste, and odour of river water. People no longer drink directly from these waters as they once did, for fear of contaminants. Aboriginal residents have also reported poor fish health and palatability, relative to historical conditions. Similar observations have been made about waterfowl and aquatic mammals in the region.

To date, environmental contaminants from oil sands development have not been linked to major health impacts for the general population. The Government of Alberta is currently working with Health Canada and the Fort McKay First Nation and Fort McKay Métis Community to conduct a community health assessment in Fort McKay communities, downstream of the oil sands.

HYDROELECTRIC DEVELOPMENT

Hydroelectric power is an important source of energy for much of the Mackenzie River Basin. British Columbia, Yukon and the Northwest Territories derive most of their electricity from hydroelectric generation. There are two main types of hydroelectric facilities in the Mackenzie River Basin – "large storage," where reservoir water is stored and downstream flow is regulated to match peaks and lulls in power demand and can also be regulated to provide flood protection for downstream communities, and "run-of-the-river," which do not materially alter flow regimes. A hydroelectric facility typically requires a dam and reservoir.

The creation of hydroelectric reservoirs changes terrestrial and river riparian aquatic habitats to lacustrine (lake) habitats and can influence water chemistry and temperature. Regulated flow regimes can affect downstream ecosystems because they alter the natural flow patterns to which the downstream river reaches, the riparian habitat and wildlife, and long term resource users have adapted. Typically, the magnitude of these effects decreases downstream because of inputs from tributary river systems.

In the Mackenzie River Basin, the largest effect of hydroelectric power development on the aquatic environment and resources occurs from ongoing flow regulation from the existing W.A.C. Bennett Dam and associated Williston Reservoir. Flow regulation in the upper Peace River has influenced the natural hydrograph of downstream reaches as far as Peace Point, and the influence on the natural hydrograph of downstream reaches as far as the Slave River decreases with distance, reducing seasonal flooding on the Peace River mainstem, and increasing minimum flows. Flooding of Williston Reservoir changed the pre-existing terrestrial and river riparian aquatic habitats into a (lake) lacustrine habitat. This flooding is believed to have initially mobilized naturally occurring mercury into the aquatic ecosystem following construction of the dam. The effects of the other, smaller hydroelectric facilities in the Athabasca and Great Slave drainages are comparatively minor. For example, the cumulative effects of the four Snare River hydroelectric facilities, north of Great Slave Lake, on water volume in the Mackenzie River Basin are not perceptible based on available data.

Changes in the Peace River flow regime have been identified in the past as the cause of ecological changes in the Peace-Athabasca Delta. However, recent studies have suggested that these ecological changes are the result of a variety of natural and anthropogenic factors, such as flow regulation, land use change and developments, increasing water consumption, natural and man-made changes to the Athabasca River channel, and warmer and drier climatic conditions.

Figure 3: Location of major, existing and proposed hydroelectic develpoments in the Mackenzie River Basin

There is little first-hand data available on the effects of hydroelectric facilities on water quality and contaminant levels in fish of the Mackenzie River Basin. Water quality effects are believed to follow the same pattern as other northern reservoirs for which data are available. For example, mercury and other contaminants may initially increase after flooding due to leaching and vegetation decay, but levels stabilize and decline over time as leaching slows and the rate of vegetation decay declines.

Traditional resource use patterns around hydroelectric facilities, regardless of their size, have changed. Harvest disruption may occur because access to hunting, fishing, and trapping areas becomes difficult or impossible because of reservoir flooding, debris, increased discharge, or unstable ice conditions.

There are 11 existing hydroelectric facilities in the Mackenzie River Basin. Several hydroelectric developments are proposed (in either the approved, feasibility or regulatory assessment phase), including in northeastern British Columbia, northern Alberta, northern Saskatchewan, and at locations throughout the Northwest Territories. Dunvegan, a proposed run-of-the-river dam on the Peace River, was approved by Alberta in 2009. The proposed Site C facility in British Columbia, downstream of the Peace Canyon Dam, like Dunvegan, would flood a narrow reach of the Peace River valley. According to information prepared by the proponents, neither project is expected to cause major changes to the river's downstream hydrograph because as proposed, they would not alter the daily average flow regime controlled by W.A.C. Bennett Dam.

CLIMATE CHANGE

Photo Credit: S. Wolfe, NRCan

Climate change is an ongoing phenomenon in the Mackenzie River Basin and is expected to continue in response to increasing greenhouse gas concentrations in the atmosphere. Northern latitudes are warming at a faster rate than most other areas on Earth because of increasing levels of greenhouse gases in the atmosphere, decreasing surface albedo[3], changes in cloud cover, and enhanced transport of heat energy poleward by atmospheric weather systems. While changes in seasonal and annual air temperatures and changes to the timing of annual freeze-thaw regimes have been clearly documented, predicted changes in other climate variables such as precipitation and the associated effects on river flows and lake levels have not been consistently observed to date.

Baseline environmental data of any kind is in short supply in much of the Mackenzie River Basin, particularly in remote northern areas. This lack of data currently limits the ability to examine or track long-term changes in environmental conditions in the basin. The effects of climate change on aquatic environments of the basin will therefore not always be readily apparent.

The average annual temperature has increased by 2°C in the Mackenzie River Basin and the average winter temperature has increased by 4°C. The average temperature in southern Canada increased between 0.5 and 1.5°C. The number of extreme warm days has increased while the number of extreme cold days has decreased in the Mackenzie River Basin. This has meant that spring thaw happens earlier and fall freeze-up happens later. Warmer temperatures have also shifted spring runoff and peak river flows to earlier in the season.

Permafrost degradation is an indicator of climate change that will likely have the greatest single effect on aquatic environments and on lives and livelihoods of people living in the Mackenzie River Basin. Permafrost temperatures are generally increasing. Changes to basin hydrology from melting permafrost will directly affect aquatic environments and human use of the aquatic environment. Moreover, melting permafrost will directly affect development in the basin, infrastructure and community activities that are dependent on stable frozen ground.

[3] The fraction of solar radiation reflected by a surface or object.

Figure 4: The permafrost zones of the Mackenzie River Basin

Although climate change may occur most strongly in the northern portions of the basin, the entire basin will be affected by climate change. As aquatic resource availability and usability changes, people living in the Mackenzie River Basin will need to adapt and learn to manage climate-related changes, including new or greater hazards to human health and safety. Human health may be affected by changes in water and air quality, changes in the physical environment, and changes in resource availability that will come with climate change.

CUMULATIVE EFFECTS DISCUSSION

The effects of oil sands development, hydroelectric development and climate change in the Mackenzie River Basin are, and will continue to be, cumulative. For example, decreased upstream river flows during the summer caused by warmer, drier conditions may decrease the resiliency of aquatic and terrestrial ecosystems. On the other hand, more winter precipitation falling as rain instead of snow during the winter could increase winter river flows but decrease spring freshet flows. This could influence, for example, the potential for ice-jam flooding in the Peace-Athabasca Delta. The Peace-Athabasca Delta is a clear example where cumulative effects have generated ecological change on a landscape scale.

However, there is a great deal of uncertainty associated with any climate change scenario when it is related to water management strategies. Many positive feedback loops (when phenomena work together to generate or amplify an effect) and negative feedback loops (when phenomena work against one another to mitigate an effect) are as yet poorly understood. It is also important to recognize that there are other factors that will contribute to cumulative ecological change in the basin, including but not limited to population growth, species range shifts, and forestry, oil and gas, mining and other resource based activities.

Ecological change triggered by cumulative effects will be felt most keenly in the Mackenzie River Basin by those who still directly rely on the land, water, and its resources – Aboriginal residents – as a source of food, livelihood and cultural sustainability. Many Aboriginal residents, not all of them Elders, already have seen striking changes to the landscape and to their way of life during their lifetimes.

The uncertainty associated with cumulative ecological effects means that water managers in the Mackenzie River Basin cannot assume that the state of the aquatic ecosystem will remain stable over the long term. Proactive and adaptive water resource management, based on the precautionary principle, will help ensure that the Governments of Alberta, British Columbia, Saskatchewan, Northwest Territories, Yukon and Canada which share the Mackenzie River Basin can cooperatively manage the water resources to maintain the ecological integrity of the aquatic ecosystem, and cooperatively manage the use of the water resources sustainably for present and future generations, as set forth under the Mackenzie River Basin Transboundary Waters Master Agreement.

GAPS IN KNOWLEDGE

Oil Sands

There is a general consensus that current monitoring efforts are not adequate to reliably assess cumulative impacts of oil sands development. The Governments of Alberta and Canada are working to implement a world-class monitoring system for the oil sands; this system will begin to fill crucial knowledge gaps.

The Government of Alberta is currently working with Health Canada and the Fort McKay First Nation and Fort McKay Métis Community to conduct a community health assessment in Fort McKay communities.

For future reports on the state of the aquatic ecosystem, the MRBB will be able to draw on the information resulting from these important initiatives.

Hydroelectric Development

Water quantity data is generally available in watersheds that host hydroelectric facilities in the Mackenzie River Basin. However, there is very little information on water quality and aquatic ecosystem health data for hydroelectric facilities and their downstream reaches in the Mackenzie River Basin, regardless of the jurisdiction in which it is located.

Climate Change

Climate change is affecting and will continue to affect all aspects of water management in the Mackenzie River Basin. Limited baseline climatic data remains an important challenge, which is intensified by the scale and complexity of the climate change issue.

Traditional Knowledge

The number of research projects that involve Traditional Knowledge in the Mackenzie River Basin is increasing but there are significant gaps in documented Traditional Knowledge. When compared with the availability of western science, Traditional Knowledge is underrepresented in all areas of the Mackenzie River Basin.

There are significant gaps in the available documented Traditional Knowledge, particularly with respect to climate change. Available information on the effects of climate change is growing however, particularly in the extreme northern part of the basin. Traditional Knowledge related to hydroelectric development has been documented in the Northwest Territories, British Columbia, and Alberta; however most of the information predates the year 2000. Holders of Traditional Knowledge are concerned about the human health effects of oil sands development, particularly in relation to downstream effects on the Athabasca River. This has been a growing area of concern and study for communities in the region for some time.

The integration of Aboriginal Traditional Knowledge and science-based assessments can be challenging, but each has different, complementary strengths. These include the systematic, structured nature of scientific investigations and the subtle, comprehensive understanding of long-term baseline conditions provided by Traditional Knowledge. In the Mackenzie River Basin, a vast, long-settled territory experiencing rapid, basin-wide changes not previously experienced by its inhabitants, both types of knowledge need to be considered to effectively detect, monitor, and manage environmental change.

LOOKING AHEAD

Commitments by the Governments of Alberta and Canada to improve environmental monitoring in the oil sands will lead to an improved understanding of the state of the aquatic ecosystem in the Mackenzie River Basin. Efforts being undertaken by the Governments of Alberta, British Columbia, Saskatchewan, and the Northwest Territories to negotiate bilateral water management agreements for the Peace, Athabasca and Slave River Watersheds are encouraging as these provide an opportunity to incorporate consistent water management protocols between jurisdictions.

This Issues Report 2012 is intended to increase understanding of some of the pressures in the basin to inform future activities of the Board and others. In support of continued improvement to understanding the basin, the Board is completing a hydrologic model for the basin, and is working to enhance the application of Traditional Knowledge.

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