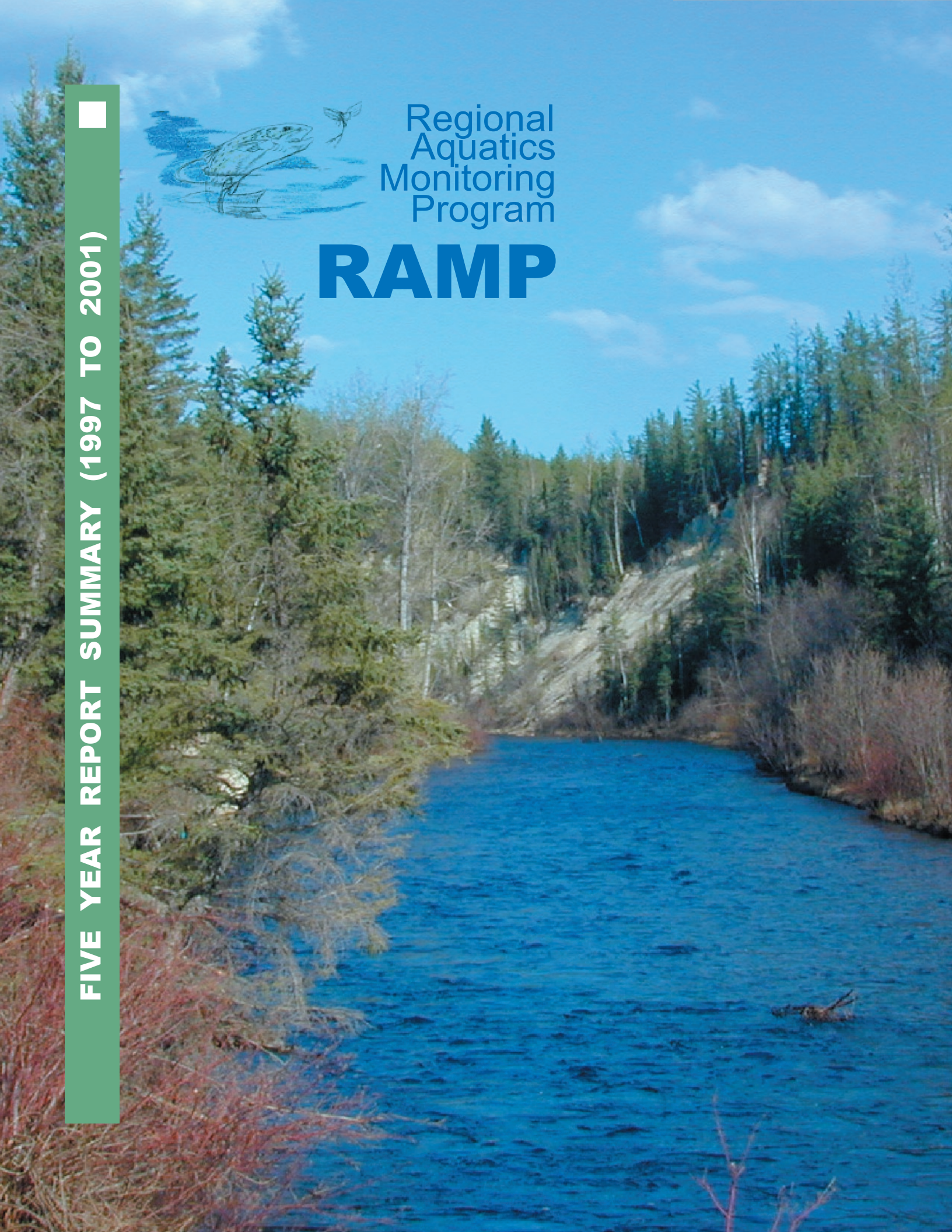

Regional Aquatics Monitoring Program

RAMP

FIVE YEAR REPORT SUMMARY (1997 TO 2001)

ACKNOWLEDGEMENTS

The RAMP Five Year Summary Report was prepared on behalf of the RAMP Steering Committee by Hatfield Consultants Ltd. The report summarizes key findings presented in the RAMP Five Year Report (1997 -2001) written by Golder Associates Ltd.

Thanks to those who reviewed earlier versions of the report, including Syncrude Canada Ltd., Suncor Energy Inc., Canadian Natural Resources Limited, Nexen Canada Inc., Imperial Oil Resources, Albian Sands Energy Inc., and Kemper² and Associates Inc.

Report development, layout and production were conducted by Daniel Moats, Luis Abundo, Leslie Uhlig, Erin Johnston, and Wade Gibbons of Hatfield Consultants Ltd.

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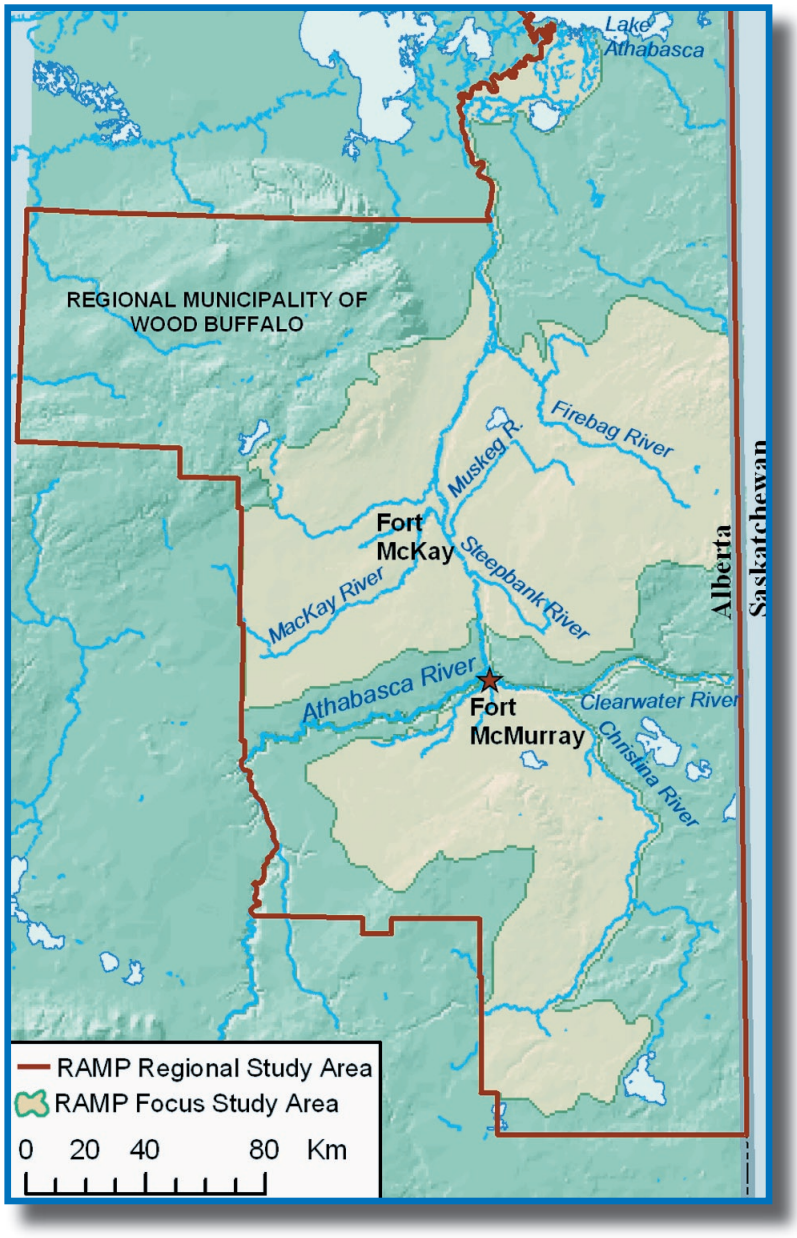
1 INTRODUCTION

This report summarizes the findings of the Five Year Report that examined the data collected during the first five years of the Regional Aquatics Monitoring Program (1997 to 2001). Over this period there has been a rapid increase in oil sands development. RAMP has been adjusting to new developments by evaluating the:

- focus and objectives;
- organizational structure;
- study area; and
- study design of the program.

A responsive monitoring approach is necessary to account for new developments and to investigate the potential ***cumulative effects*** associated with increasing development in the Athabasca River basin.

Cumulative effects *include all factors that influence ecosystem health. These include natural and human-related activities.*

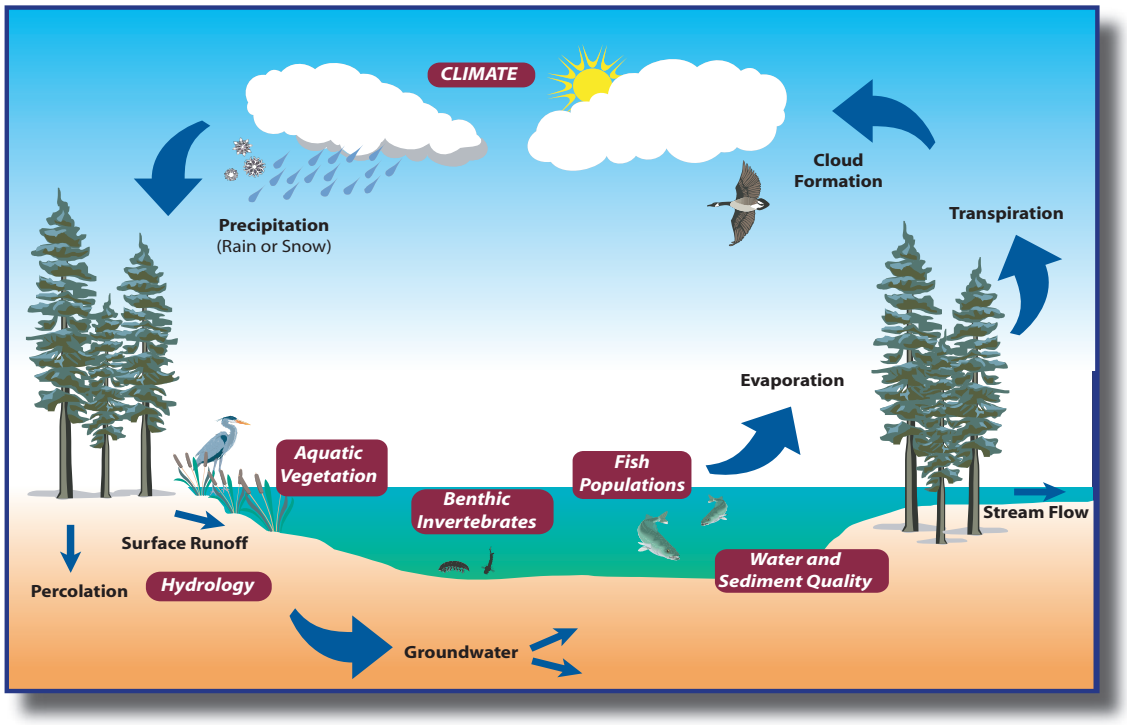


RAMP STUDY AREA

The Five Year Report assessed the ability of RAMP to effectively monitor changes and trends occurring in the region's lakes and rivers. The report examined the frequency and intensity of monitoring to date, the different chemical, physical and biological measurements, and how these different parameters interact in the ecosystem. Data collection methods and parameters were assessed to determine how well they predict changes over time.

Several components of the aquatic ecosystem are monitored by RAMP. The components that will be presented in this report include:

- climate and hydrology (water flow);
- water quality;
- sediment quality;
- benthic invertebrates (insects, snails, clams, and worms at the bottom of lakes and rivers); and
- fish populations.



*THE COMPONENTS OF **RAMP** ARE ALL PART OF THE **AQUATIC** ECOSYSTEM*

PROGRAM DESIGN

Lakes, rivers and wetlands naturally change over time. Understanding the natural variability is the first step in determining whether changes that occur are the result of development activities or natural influences. To address this question, RAMP activities are structured to look at reference or undeveloped areas versus areas potentially impacted by oil sands or other development. This method helps to identify the locations of potential pollution sources.

OIL SANDS DEVELOPMENT NEAR FORT MCMURRAY

RAMP has been designed to identify potential changes associated with oil sands developments, but there are many other activities occurring in the region that also have the potential to impact aquatic environments. Impacts from all development activities result in cumulative effects. RAMP strives to quantify cumulative effects by collecting a wide range of biological, physical and chemical data.

Other development activities in oil sands region:

- *municipal (public) buildings and roads;*
- *aggregate (gravel and other materials) operations;*
- *fishing and recreational activities;*
- *forestry operations;*
- *municipal water consumption and discharges;*
- *natural gas extraction and transportation; and*
- *power generation.*

OBJECTIVES OF THE FIVE YEAR REPORT

The Five Year Report focused on three fundamental RAMP objectives that are relevant to aquatic monitoring:

Objective I:	Collecting scientifically defensible baseline and historical data to characterize existing conditions in the oil sands region.
Objective II:	Monitoring aquatic environments in the oil sands region to detect and assess cumulative effects and regional trends.
Objective III:	Collecting data that can verify predictions made in ***Environmental Impact Assessments (EIAs)***.

These three objectives will be summarized at the end of the report. The following sections discuss each of the ecosystem components that were assessed in the Five Year Report.

BENTHIC INVERTEBRATE MONITORING

Environmental Impact Assessments (EIAs): *Each new oil sands project planned in the Fort McMurray oil sands region must complete an* ***EIA*** *that predicts how the currently operating, approved and planned oil sands developments may impact the regional environment. EIAs must include plans on how potential impacts will be managed and monitored.*

2 CLIMATE AND HYDROLOGY

Data gathered from RAMP climate and hydrology monitoring stations are used to increase our understanding of how streams and lakes react to rain and snow events. Knowing how undisturbed streams function provides important information that can be compared with streams that may be affected by development activities.

RAMP uses continuous monitoring equipment to measure water depth, atmospheric pressure, wind speed and direction, solar radiation (sunshine), snow depth, air and water temperature, and precipitation. In addition, monthly field visits measure stream ***discharge***, ice thickness, and water depth of selected lakes and streams in the oil sands region.

HYDROLOGY MONITORING STATION

Discharge *refers to the volume of water flowing past a specific point over a given time, usually measured as cubic meters per second (m^3/s).*

CLIMATE AND HYDROLOGY OBJECTIVES AND FINDINGS

The RAMP Technical Subcommittee identified the following specific climate and hydrology objectives to be investigated in the Five Year Report. For each objective, pertinent examples of the findings and/or conclusions are provided.

Objective 1: Characterize the natural variation of climatic and hydrological parameters, including ***precipitation***, temperature, ***water yield***, ***flood peak discharges*** and ***low flow discharges*** in the oil sands region.

Precipitation – *the total amount of water transferred from the air to the ground by snow, hail, rain, fog and other events.*

Water yield – *the total amount of water that a* ***watershed*** *contributes to the waterbody within it. Water yield is calculated by dividing the total stream discharge by the area of the watershed.*

Flood peak discharge – *the highest daily discharge of water observed during each year of streamflow monitoring.*

Low-flow discharge – *the lowest daily discharge of water observed during each year of streamflow monitoring.*

Watershed - *the area or basin that is drained by one river system.*

The Five Year Report reviewed short- and long-term data collected for the climate and hydrology program. Findings include:

- total snowfall in the oil sands region is more variable from year to year than total rainfall; and
- winter temperatures vary more than summer temperatures.

Data from Environment Canada Hydrologic Monitoring Stations located on the Athabasca, Steepbank, Muskeg, Beaver, MacKay and Firebag rivers indicated that:

- the total volume of water discharged in a year from these streams was directly related to the measured annual precipitation at the Fort McMurray Airport; and
- the largest annual discharges on the Muskeg, MacKay, Firebag and Athabasca rivers and on Jackpine Creek were all recorded in 1997.

- in 1999, record low water yields and flood discharges were measured on the Steepbank, Muskeg, Beaver and MacKay rivers and on Jackpine Creek.

Objective 2: Define baseline ranges for climatic and hydrologic parameters for the area monitored by RAMP.

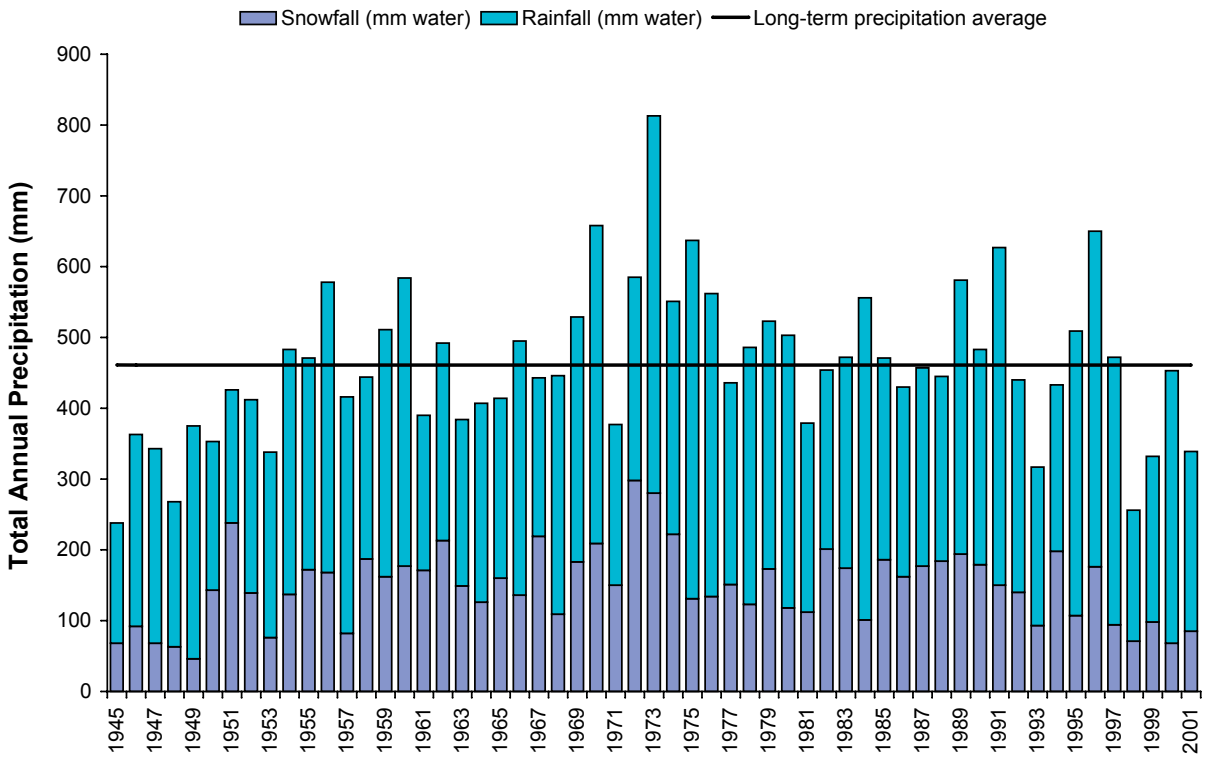
A number of short-term hydrologic stations operated by RAMP were installed to provide baseline data. These stations should continue to gather baseline data for as long as possible to provide data for characterizing the natural variability of streams and lakes in the oil sands region.

HYDROLOGIC MONITORING ON THE MUSKEG RIVER

Objective 3: Investigate trends over time in precipitation, temperature, water yield, flood peak discharges and low flows, based on available long-term climatic and hydrologic data.

Data collected at the Fort McMurray Airport was used to track long-term fluctuations in precipitation and temperature from year-to-year in the RAMP study area. Conclusions drawn during this examination include:

- annual precipitation at Fort McMurray Airport is not increasing or decreasing over time; and
- the first five years during which RAMP operated included four consecutive years of below-average precipitation (1998-2001). This was the longest span of below-average precipitation since 1953.



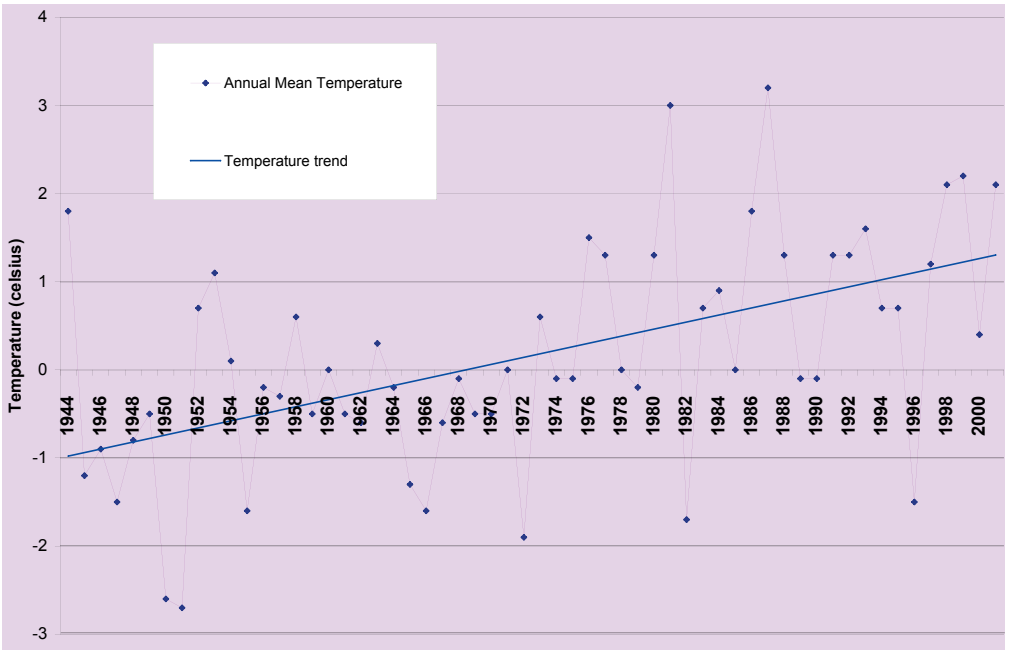
Annual snowfall and rainfall data for Fort McMurray Airport, 1945 to 2001.

Long-term climatic and hydrologic data from the oil sands region were used to make the following regional assessments:

- variations in year-to-year precipitation may be the result of ***El Niño***/***La Niña*** climate events;
- mean annual temperature data showed a warming trend over the monitoring period of 1944 to 2001. This trend may also be related to El Niño/La Niña events;

> ***El Niño*** *(Spanish for "the boy child") is an extensive warming of the Pacific Ocean surface waters, which begins along the coast of Peru and Equador. The warm water evaporates, resulting in large scale cloud formation and rainfall off the South American coast.*
>
> ***La Niña*** *("the girl child") events occur when equatorial trade winds push cold surface water to the coasts of Peru and Equador. This cold water cap limits evaporation and rainfall, resulting in very dry summer weather.*
>
> *The weather patterns created by these events are transported by the tropical jet stream to North America.*

- water yield, flood data and low flow data have not significantly increased or decreased over time; and
- data from long-term climatic and hydrologic stations have been used to calibrate a regional hydrologic model.



Annual Temperature Warming Trend Observed At The Fort McMurray Airport Between 1944 and 2001.

Objective 4: Evaluate whether cumulative effects can be evaluated at this time and whether the data will be appropriate to do so in the future.

Over time, hydrology may be affected as streams and other waterbodies are altered during oil sands development. However, no cumulative effects were identified in the Five Year Report.

Objective 5: Characterize the behaviour of smaller local areas for streamflow and precipitation.

More monitoring of small watersheds is needed to understand the variations in precipitation between watersheds and how precipitation influences water flow in small streams.

Objective 6: Evaluate whether EIA predictions can be proven at this time and whether data collected will be appropriate to do so in the future.

The existing year-round monitoring at stations should continue. These provide baseline data for the general oil sands region and support the validation or rejection of EIA predictions.

The Five Year Report recommended that RAMP:

- conduct winter monitoring at several sites;
- increase the number of tipping bucket rainfall gauges; and
- undertake an intensive precipitation monitoring program on small natural watersheds.

Tipping bucket rainfall gauge

3 WATER QUALITY

Since RAMP began in 1997, the water quality monitoring program has increased in scope with the expansion of oil sands development in the Athabasca oil sands region. In 1997, sampling consisted of three-season sampling at four locations. In 2001, this effort had increased to over 32 sites sampled during various times of the year. The ***water quality parameters*** that are regularly monitored are listed in the table on the right.

Water quality data collected by RAMP between 1997 and 2001 were combined with comparable information from other sources to form one large data set for the lower Athabasca River watershed. A statistical method was used to evaluate potential links between different water quality parameters measured in this complete data set. In addition, parameters were evaluated for links specifically to the Athabasca River or its tributaries.

Water Quality Parameters

pH, conductivity, hardness, dissolved oxygen, total suspended solids and other conventional parameters
major ions
nutrients
chlorophyll *a*
total and dissolved metals
recoverable hydrocarbons
naphthenic acids
total phenolics

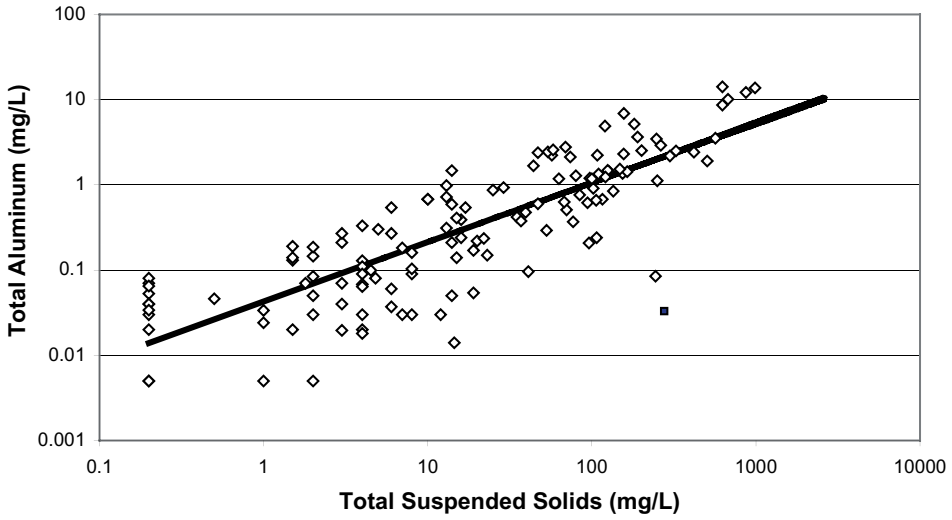
FIREBAG RIVER

WATER QUALITY OBJECTIVES AND FINDINGS

The specific water quality objectives listed below were established to address both the broad objectives of RAMP as well as specific issues raised by the RAMP Technical Subcommittee.

Objective 1: Determine which water quality parameters are related, and establish whether these relationships are common to all lakes and rivers sampled by RAMP.

The concentration of many chemical compounds in water vary together. For example, the level of aluminum in the Athabasca River is higher when there is a higher amount of suspended solids in the water.



Solid square points are outliers that were excluded from the analysis.

RELATIONSHIP BETWEEN TOTAL SUSPENDED SOLIDS LEVELS AND TOTAL ALUMINUM CONCENTRATIONS IN THE ATHABASCA RIVER

As well, the presence and concentration of one metal can be used to estimate the levels of other metals in a water sample. For example, water samples containing high concentrations of aluminum also generally contained high concentrations of other metals (e.g., cobalt, nickel and vanadium).

Objective 2: Establish if any water quality parameter is influenced by the amount of water present.

Stream flow is linked to many water chemistry parameters. Increasing flow generally resulted in increased levels of metals, total suspended solids and dissolved organic carbon.

Objective 3: Evaluate whether there are seasonal changes between fall and winter water quality in the lower Athabasca River watershed.

Natural differences in water quality of the Athabasca River and Muskeg River exist between fall and winter. With lower winter water flow, concentrations of major ions increased as expected. However, other parameters (such as total suspended solids) decreased during the winter.

Objective 4: Assess whether there are any regional trends in the existing water quality data set.

RAMP was developed to be a long-term monitoring program. At the time of the Five Year Report, there were still not enough data in the existing water quality data set to establish long-term trends. Only five years of data exist for some areas, and more data are required over time to determine whether changes in water quality are natural or potentially related to development.

Athabasca River

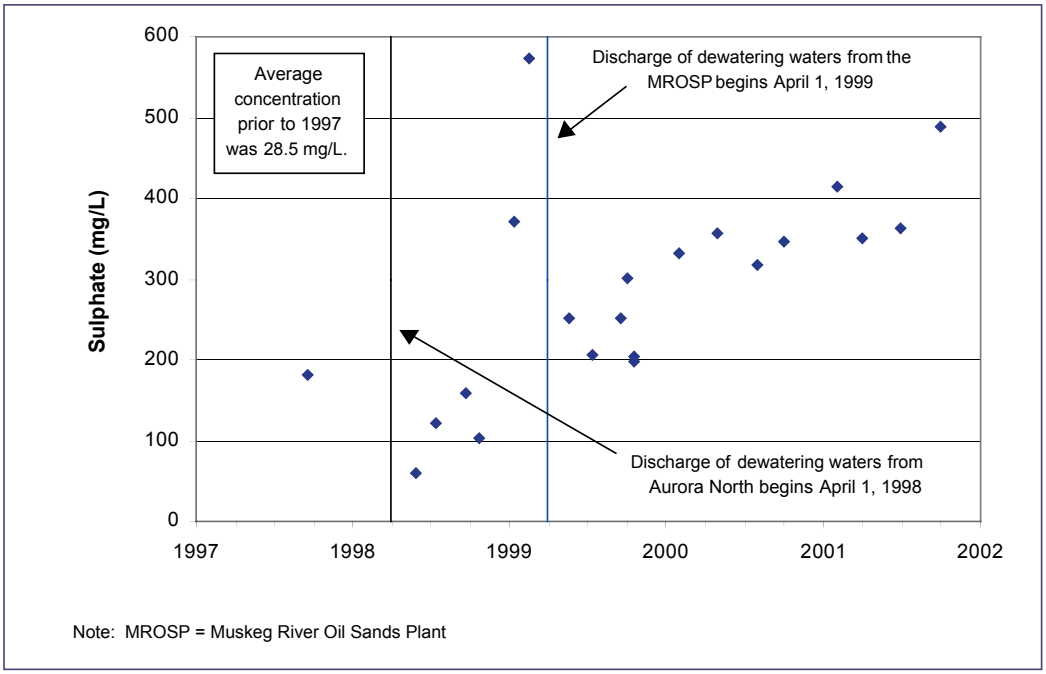
There are two long-term (1976 to present) monitoring stations on the Athabasca River. The first station is located upstream of Fort McMurray, and the second station is located downstream of all oil sands development near Old Fort. Based on these data, the increase in development downstream of Fort McMurray has not degraded the water quality in this stretch of river.

Muskeg River

The Muskeg River has been receiving ***dewatering*** flow from developments along the Alsands Drain since April 1998. The following trends have been observed compared to baseline studies conducted before April 1, 1998:

> ***Dewatering*** *– the process of removing water from a waterbody or wet area.*

- total phosphorus, pH, total alkalinity, and total dissolved solids have increased since April 1998;
- total chromium has increased since April 1998; and
- increased sulphate levels were observed downstream of development in the Muskeg River after April 1, 1998. This increase resulted from the discharge of high sulphate waters through the Alsands Drain. These sulphates were either the result of unique water quality characteristics in the areas being dewatered to the Alsands Drain, or they were present in other unknown sources of water.



SULPHATE CONCENTRATIONS OBSERVED IN THE ALSANDS DRAIN BETWEEN 1997 AND 2001.

Overall, development within the Muskeg River watershed has not resulted in substantial changes in water quality since the initiation of RAMP in 1997.

Objective 5: Determine if three years of baseline data, collected at the current sampling frequency, is adequate to identify changes in water chemistry.

Three years of baseline data do not appear to be sufficient to identify changes in water chemistry that may occur due to oil sands development. A recommendation was made to extend baseline studies to more than five years.

Objective 6: Test to see if the information collected by RAMP can be used to verify EIA predictions.

It was determined that RAMP monitors the appropriate water quality parameters at the appropriate locations. However, for lakes and rivers where historical data are not available, more baseline data needs to be collected.

Objective 7: Evaluate if and how the water component of RAMP may be improved.

Several recommendations were made in the Five Year Report:

- recommended additional winter sampling in areas experiencing a high degree of development. This will help to determine whether mine-affected waters are impacting water quality during low flow periods.
- recommended that further studies be conducted to identify the exact source of sulphates in the Muskeg River.
- recommended increasing the baseline water quality sampling from three to more than five years to allow trends and natural variations to be identified and documented prior to development.

4 SEDIMENT QUALITY

The RAMP sediment quality monitoring component has continued to expand in response to the ongoing development in the Athabasca oil sands region. In 1997, the first year of RAMP sediment monitoring, 11 stations were sampled. By 2001, the number of stations had increased to 22.

Sediments collected by RAMP were sent to an independent, accredited laboratory for the analysis of parameters listed below:

Sediment Quality Parameters

carbon content
percent sand, silt and clay
total metals
recoverable hydrocarbons
total volatile hydrocarbons
total extractable hydrocarbons
Polycyclic Aromatic Hydrocarbons

Polycyclic Aromatic Hydrocarbons (PAHs): *a series of petroleum-related chemicals composed of at least two fused benzene rings. The size and makeup of PAHs dictate how toxic they are in the oil sands region. In the oil sands region, PAHs originate from natural sources such as oil sands deposits.*

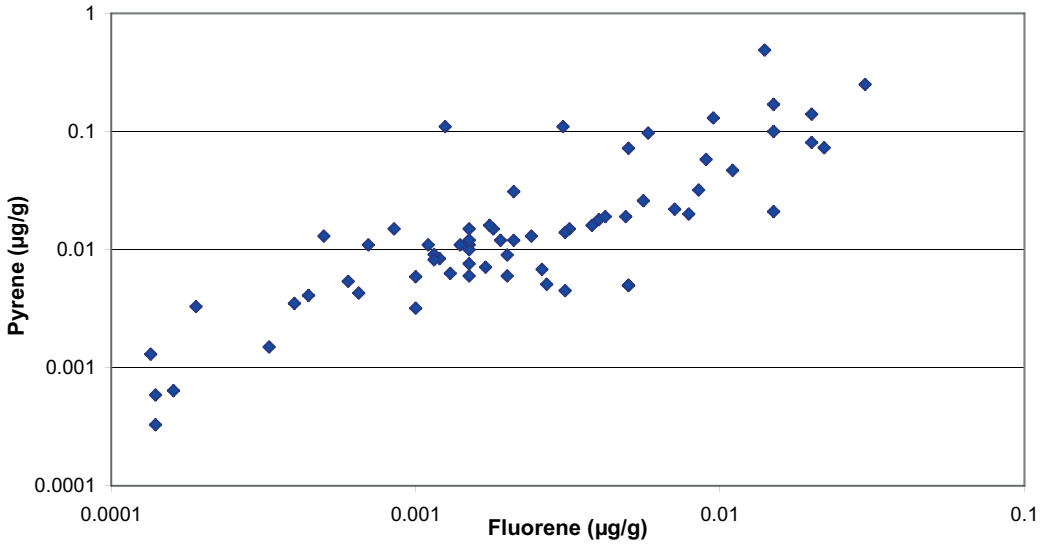
SEDIMENT QUALITY OBJECTIVES AND FINDINGS

Specific sediment quality objectives were established to address sediment issues raised by the RAMP Technical Sub-committee. These objectives are outlined on the next page.

Objective 1: Determine if certain substances in sediment are related and are typically found together.

Sediment results analyzed by the Five Year Report exhibited the following patterns:

- sediments with a high level of one PAH generally had high levels of other PAHs as well. The same was true for metals. Because of these trends, the number of PAHs and metals that RAMP monitors could be reduced.



RELATIONSHIP BETWEEN PYRENE AND FLUORENE CONCENTRATIONS IN SEDIMENT.

- sediments with high silt or clay content generally contained higher metal levels than sediments with larger amounts of sand and less silt or clay.

Objective 2: Identify trends in the existing sediment quality data set.

Metal and PAH concentrations in sediments have been ***declining*** in all areas sampled by RAMP although oil sands development has increased since monitoring began in 1997. The areas sampled include:

- the mouth of the Muskeg River;
- the Athabasca River upstream of Fort Creek; and
- the Athabasca River upstream of Donald Creek.

According to RAMP data, PAH concentrations vary over the length of the Athabasca River with no clear geographic pattern.

Based upon the five years of RAMP sediment data, metal levels in sediments from the Muskeg River watershed tend to be lower than those in the Athabasca River, whereas sediment PAH concentrations tend to be comparable between the two systems.

Objective 3: Determine whether three years of baseline data is sufficient to assess natural variability.

Three years of baseline data do not appear to be sufficient to identify changes in sediment chemistry that may occur due to oil sands development. A recommendation was made to extend baseline studies to more than five years.

Objective 4: Establish whether RAMP data is sufficient to verify EIA predictions and to detect development related changes in sediment quality.

RAMP monitors the appropriate sediment quality parameters at the appropriate locations. However, RAMP does not currently collect sufficient baseline data prior to development to detect changes over time.

Objective 5: Assess whether the sediment component may be improved.

As insufficient data are available to determine trends and natural variability, it is recommended that the period of baseline characterization and sample collection be extended from three to more than five years.

The Athabasca river

5 BENTHIC INVERTEBRATES

Benthic invertebrates, or benthos, are aquatic organisms that spend part or all of their life in or on the bottom of rivers, lakes and wetlands. Typical benthos include insects, snails, clams and worms. These animals are a food source for many species of fish and are an important part of fish habitat.

CHIRONOMID (MIDGE)

Benthic invertebrates living within a specific location in a stream or lake are referred to as a benthic invertebrate community. The numbers and types of benthic animals in a community reflect the characteristics of their surroundings, which makes them sensitive indicators of environmental effects.

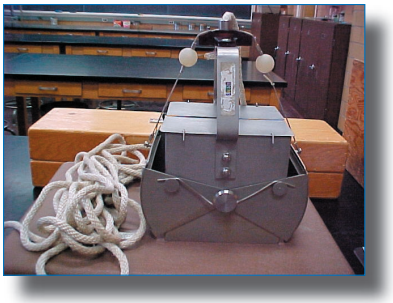
Benthic invertebrate communities were evaluated according to:

- abundance - the average number of organisms per square meter at a site; and
- richness - the number of different species of invertebrates captured at a site.

SAMPLING WITH THE NEILL SAMPLER

Two sampling methods were employed during invertebrate sampling:

- the Neill sampler for erosional habitat (fast flowing, rocky bottom); and
- the Ekman grab for depositional habitat (slow flowing, soft bottom).



EKMAN GRAB

BENTHIC INVERTEBRATE OBJECTIVES AND FINDINGS

The following specific benthic invertebrate objectives were investigated for rivers and lakes for the Five Year Report.

Objective 1: Characterize the benthic invertebrate communities and describe how they differ from waterbody to waterbody.

Differences in community composition within individual waterbodies were detected, but no links between community structure and environmental variables, such as water chemistry, were identified. It appeared that each river sampled in the oil sands region sustains a unique benthic community.

The unique communities observed in each river indicate that data from one river are probably not suitable for use as reference data for detecting effects in other rivers.

Objective 2: Define baseline ranges for key benthic invertebrate community variables.

The abundance of benthic animals observed in baseline datasets was more variable than the number of species present. However, there are insufficient data currently available to characterize the natural variability in benthic communities at this time.

Objective 3: Determine how species presence and abundance naturally vary over time.

Long-term trends in major tributaries of the Athabasca River were not detected; however, more data are needed to establish baseline trends.

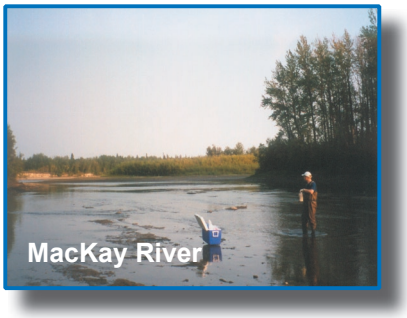
Objective 4: Compare and contrast 2000 and 2001 sampling results.

Where adequate information existed, RAMP compared 2000 and 2001 data to determine how certain waterbodies are changing over the short term. Waterbodies selected for analysis were:

- Shipyard Lake;
- MacKay River;
- Clearwater River; and
- Muskeg River.

Shipyard Lake

Benthic richness and abundance were different between years, with lower values observed in 2001. There were no substantial changes in mine activities that may have affected the lake between the two years. The observed differences may have resulted from decreasing dissolved oxygen and vegetation cover between the two sampling periods.



MacKay River

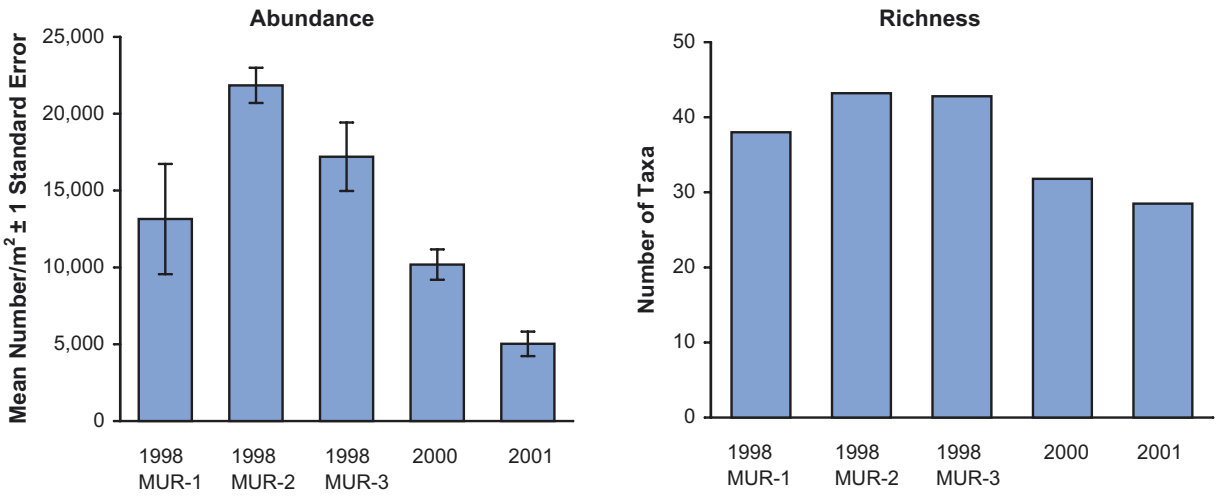
Compared to 2000, total abundance was lower in 2001 in the MacKay River, but richness showed only a minor difference between years. Since there was no change in development in the MacKay River basin between these years, the observed differences may reflect natural variation, possibly related to stream flow conditions.

Clearwater River

There were differences between samples collected upstream and downstream of where the Christina River joins the Clearwater River. Habitat features (e.g., river flow, depth and substrate) were similar in both reaches, suggesting the existing differences may be influenced by physical and/or chemical parameters specific to the Christina River.

Muskeg River

Compared to 2000, abundance was lower in 2001 while richness was not different between the two years. These results are similar to the differences witnessed in the MacKay River, and may also be attributable to natural variation, possibly related to changes in river hydrology.



BENTHIC INVERTEBRATE ABUNDANCE AND TAXA RICHNESS IN THE LOWER MUSKEG RIVER, 1998 TO 2001.

Summary of Observations for 2000 and 2001 Data

Changes in benthic community structure between 2000 and 2001 are attributed to natural variability in physical habitat characteristics, such as bottom material, stream velocity, cover and depth. In general, benthic communities became more diverse as sampling distance from the mouth increased.

Objective 5: Compare how river communities differ upstream and downstream of current oil sands developments or other influences.

The only analysis of upstream-downstream trends was for the Clearwater River discussed above in comparisons between 2000 and 2001.

Objective 6: Determine if the benthic invertebrate data collected are suitable to verify EIA predictions.

The Five Year Report listed several conclusions about monitoring for EIA predictions for different areas:

- north of Fort McMurray, all regionally important water bodies are monitored by RAMP;
- currently, RAMP monitors some rivers that will be lost to development (for example, Tar and Calumet rivers). Monitoring these rivers beyond the baseline period will be of little value.
- new monitoring stations will be required near all planned developments south of Fort McMurray.

Objective 7: Evaluate the appropriateness of the current study design and make recommendations.

The current study design could be adjusted to be more cost-efficient without the loss of important information. Recommendations include:

- more data should be collected to establish baseline conditions; and
- the study design may be improved by assessing the areas that require the most intensive study, establishing permanent monitoring stations where appropriate and modifying the number of samples and stations within each area.

MAYFLY

6 FISH POPULATIONS

The general objective of the fisheries program is to evaluate the health and sustainability of fish populations within the oil sands region, with monitoring focused on the Athabasca River and tributaries potentially influenced by current or future oil sands development. The health and abundance of fish populations are used as indicators of overall ecosystem health and integrity.

Between 1997 to 2001, the RAMP fisheries program consisted of studies focused on fish community inventories, ***radiotelemetry*** studies, fish tissue analysis, ***sentinel fish species*** monitoring, counting fences, an assessment of fish-habitat associations and spawning surveys. Not all of these topics were addressed on an annual basis, but all have been included in at least one year of monitoring activities.

Information used to supplement RAMP data included historical studies conducted by Alberta Oil Sands Environmental Research Program (AOSERP) and more recent data collected for EIAs and other initiatives such as the Northern River Basins Study (NRBS).

Radiotelemetry *studies involve surgically inserting a radio transmitter into relatively large, healthy fish and tracking fish movements over time.*

Sentinel fish species *are fish species chosen for monitoring because they are good indicators of what is happening in their environment. They are usually non-sportfish species that will stay in an area instead of migrating.*

FISH POPULATION OBJECTIVES AND FINDINGS

The following fisheries-specific objectives were developed to focus study efforts of the Five Year Report.

Objective 1: Combine RAMP data with other historical information to better characterize variability in fish species composition, abundance, population structure, growth, health, reproduction and suitability for human consumption.

The following sections provide information regarding fish populations in the Athabasca oil sands region.

ATHABASCA RIVER FISH POPULATIONS

According to historic literature, thirty species of fish have been identified in the Athabasca River. As of 2001, eleven of these species, including three rare, large-bodied species (bull trout, lake cisco and lake trout) had not been captured during RAMP inventories. These species are typically not present in high numbers. As such, the lack of capture is not considered an indicator of declining populations.

WALLEYE

NORTHERN PIKE

ARCTIC GRAYLING

Walleye and lake whitefish numbers in the Athabasca River appear to have declined in recent years, although more data are required to verify these observations. The recent fluctuations observed in goldeye, northern pike, longnose sucker and white sucker capture numbers are not likely associated with any long-term changes in abundance.

Comparison of RAMP inventories and historical data indicate that species composition, and population parameters related to age and growth for large-bodied species in the Athabasca River have remained relatively unchanged since sampling began in the 1970s. However, the relative abundances of the ***six dominant large-bodied fish species*** have shown some variability in recent inventories (1995 to 1999).

Six dominant large-bodied fish species:

longnose sucker
white sucker
walleye
goldeye
northern pike
lake whitefish

Athabasca River Fish Health

Overall, the incidence of external abnormalities was low for fish captured in the Athabasca River. For most species, and in most years, the percentage of fish with one or more external abnormality was <25%. However, some exceptions exist. In 1995, the presence of abnormalities (mostly skin lesions, eroded fins and external parasites like lice), for lake whitefish, longnose sucker, goldeye and white sucker was high (i.e., greater than 30%).

In 1999, walleye showed a high incidence of eroded fins and body wounds when compared to previous years (1995, 1997 and 1998).

There was no indication that these relatively minor abnormalities were related to development or affecting the well-being or abundance of any species in the oil sands region.

Athabasca River Fish Tissue

In 1998 and 2001, fish were collected and tested for chemicals to see if they were safe to eat. Testing was conducted on large-bodied Athabasca River fish species used in local subsistence, commercial and sport fisheries, or employed as RAMP sentinel species. Fish were tested for metals, PAHs and tainting compounds. Mercury was also measured because mercury levels in fish is a historical issue for the region and a concern for local stakeholders.

Negative effects on Athabasca River fish health by metals exposure are considered unlikely because the maximum metal concentrations found in fish tissues were lower than levels that have been shown to have adverse effects.

Mercury is the only metal where Canadian health consumption guidelines exist.

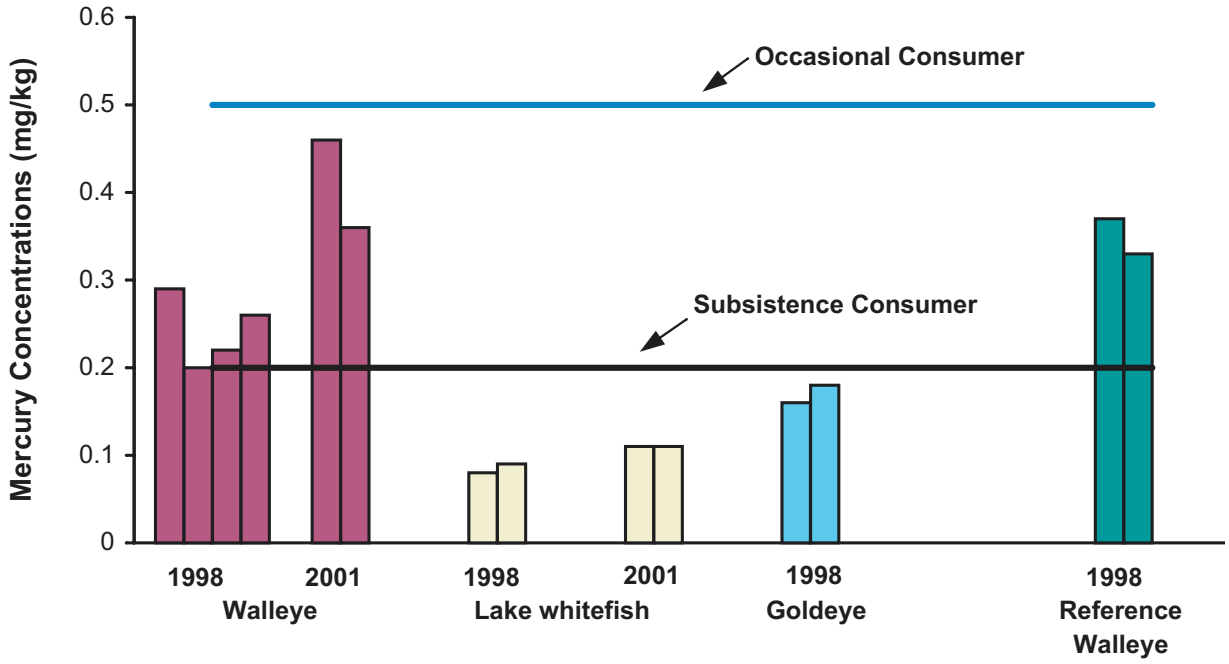
FISH TISSUE SAMPLING

MERCURY CONSUMPTION LEVELS

Occasional Consumer *(three (3) 100 g-servings per week)*	Fish should contain, at a maximum, 0.5 milligrams of mercury per kilogram of fish tissue
Subsistence Consumer *(eight (8) 100 g-servings per week)*	Fish should contain, at a maximum, 0.2 milligrams of mercury per kilogram of fish tissue

Mercury concentrations in 1998 walleye composite samples (several fish combined into one sample) ranged from 0.20 to 0.29 mg/kg and from 0.36 to 0.46 mg/kg in 2001. None of the samples collected by RAMP in 1998 and 2001 had mercury levels above the "occasional consumer" guideline of 0.5 mg/kg. However, all composite walleye samples contained mercury levels above the "subsistence consumer" guideline of 0.2 mg/kg. All other fish species analyzed under RAMP contained mercury at a concentration below the subsistence guideline.

The mercury concentrations in fish tissue from 1998 and 2001 appear to be representative of both regional and historical fish tissue levels, and are indicative of natural variability in fish of the RAMP study area. Current data are insufficient to determine whether mercury and other tissue chemical concentrations are increasing or decreasing over time.



MERCURY CONCENTRATIONS IN WALLEYE, LAKE WHITEFISH AND GOLDEYE IN THE ATHABASCA RIVER, 1998 AND 2001.

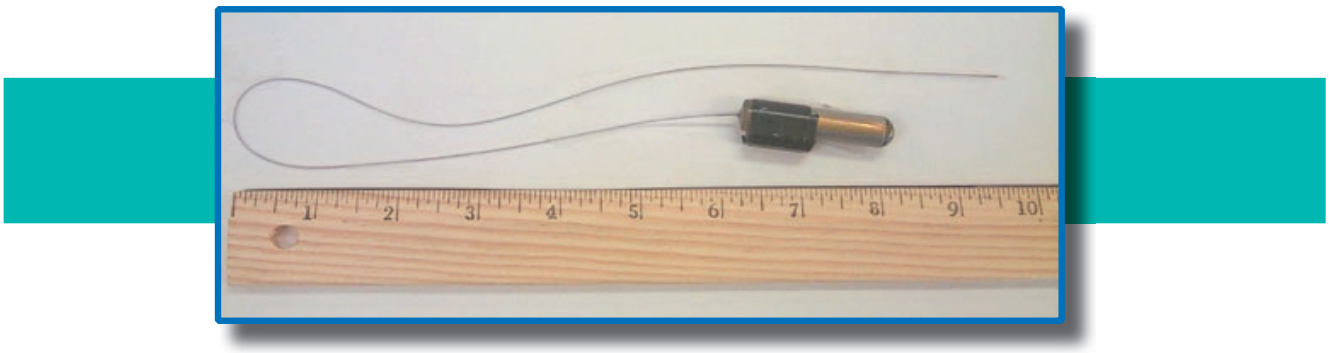
Athabasca River Sentinel Species Monitoring

Sentinel species monitoring is commonly used to see if industry is having any effect on wild fish populations. The approach compares the growth, survival and reproduction of a specific sentinel species that lives in an area influenced by industry relative to fish from an area not influenced by industry. RAMP conducts sentinel species monitoring because the status of a sentinel species is a sensitive indicator of the health of its surroundings.

Longnose sucker was identified as an optimal sentinel species for the Athabasca River due to:

- its intermediate life span;
- fast growth rate;
- large number of eggs per spawn;
- quick maturation rate; and
- the important role it plays in the aquatic food web.

Initially, there was some concern that longnose sucker move around too much to be used as a sentinel species for the oil sands region. However, radiotelemetry studies indicated that longnose sucker movement was not extensive enough to impact its suitability as a sentinel species.



RADIOTELEMETRY TAG USED FOR LONGNOSE SUCKER

To date, one year of sentinel species monitoring data has been collected (1998). Collection of this baseline information is the first step in determining natural variability. More data are currently required to evaluate trends over time.

ATHABASCA TRIBUTARIES FISH POPULATIONS

Muskeg River Fish Inventory

This inventory was conducted to provide information about local fish populations by assessing the type and number of large-bodied fish species in a regionally important tributary to the Athabasca River - the Muskeg River. A secondary focus of this study was to check for the presence of various life stages of Arctic grayling. Fish were captured using a portable boat electrofisher.

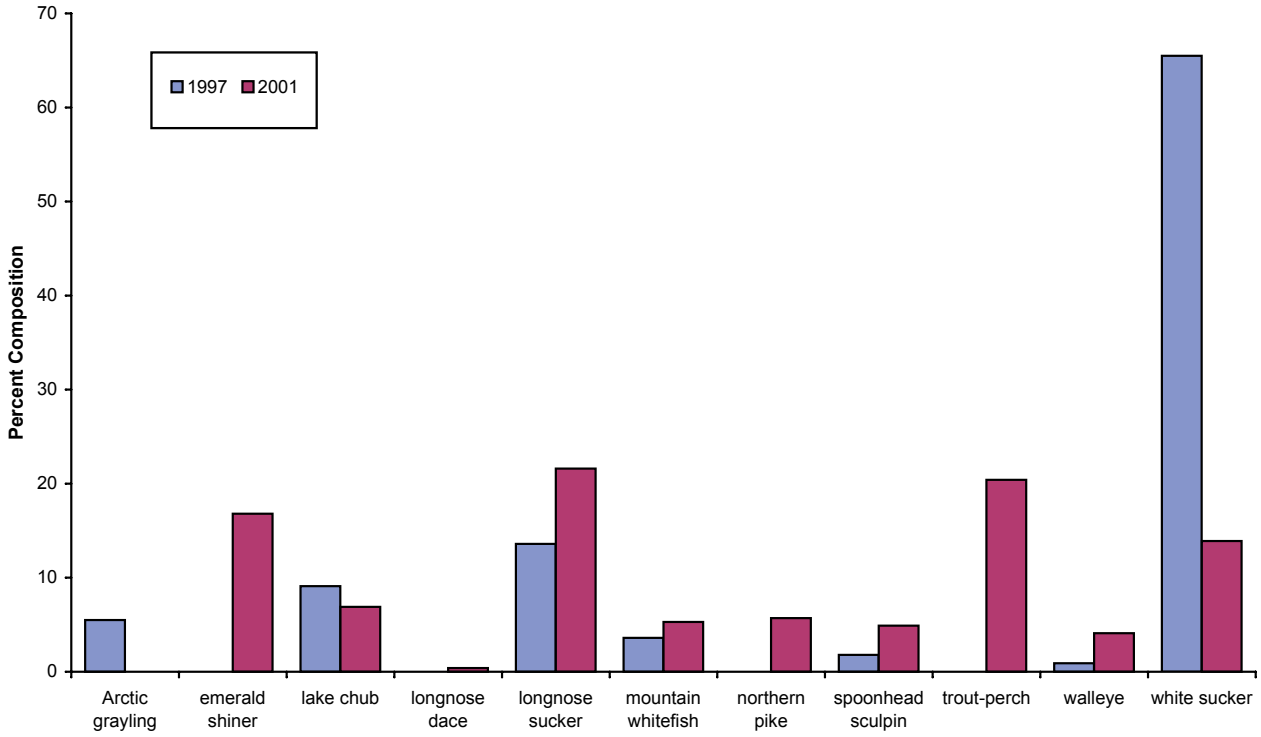
Total fish abundance was slightly higher in 2001 than 1997. The percent species composition and ***catch-per-unit-effort (CPUE)*** were higher for all species in 2001, with the exception of Arctic grayling and white sucker.

Catch-per-unit-effort (CPUE) is the number of fish caught over a period of time. It can be used to estimate abundance of fish species in a study area.

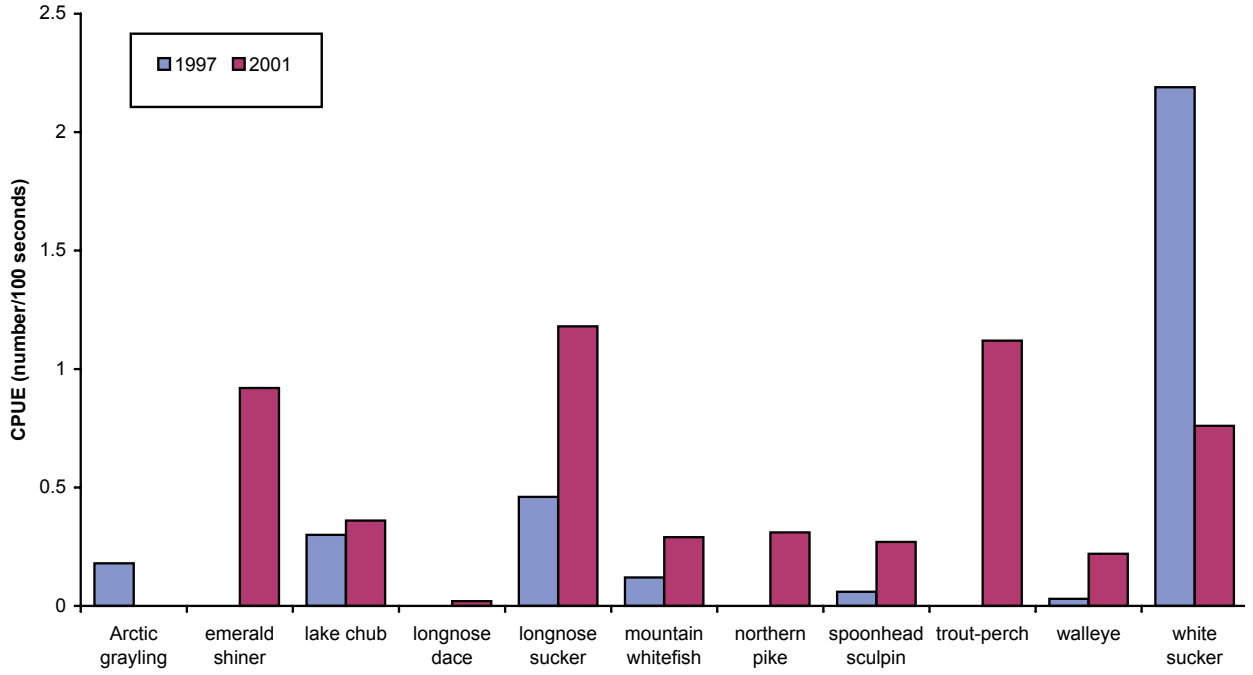
No Arctic grayling were captured in the 2001 inventory; however, a small number were captured by a local angler in 2001, indicating the species is still present in the system, but in very low numbers.

RAMP data collected from the Muskeg River currently spans too few years to identify definite trends over time. RAMP data are not comparable to historical information because of differences and refinements in collection methods.

BOAT ELECTROFISHING



PERCENT COMPOSITION OF SPECIES CAUGHT DURING MUSKEG RIVER INVENTORIES (1997, 2001).



CATCH-PER-UNIT-EFFORT FOR SPECIES CAPTURED DURING MUSKEG RIVER INVENTORIES (1997, 2001).

SENTINEL SPECIES IN TRIBUTARY WATERCOURSES

Sentinel species monitoring focusing on slimy sculpin was conducted on the Muskeg and Steepbank rivers in response to oil sands development. The health of slimy sculpin in these rivers was compared to sculpins from undeveloped rivers in the region.

Sentinel monitoring in the Muskeg and Steepbank rivers has been conducted in 1999 and 2001. Some differences in age and gonad size have been identified; however, additional monitoring will be undertaken over time to see if these differences are natural or related to development.

SLIMY SCULPIN

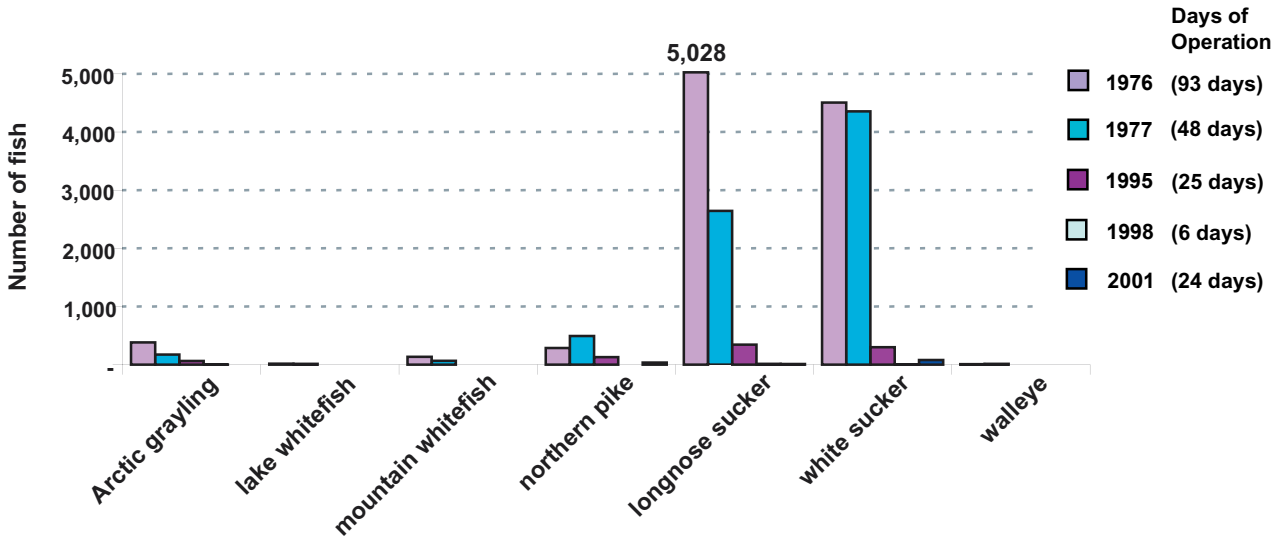
MUSKEG RIVER FISH COUNTING FENCE

In the past, non-RAMP counting fences were deployed in the Muskeg River in 1976, 1977 and 1981. Data collected during these studies were compared to RAMP fish fence studies conducted in 1995, 1998 and 2001.

Because of differences in study objectives, study design (related to fence location, timing of fence installation relative to ice-out and duration of fence monitoring) and year-to-year variation in flows, it is difficult to make specific conclusions regarding population trends over the past 25 years.

MUSKEG RIVER FISH COUNTING FENCE

Results do indicate that most of the large-bodied fish species known to use the Muskeg River watershed (Arctic grayling, longnose sucker and white sucker) have declined in recent years. Reduced abundance of these species may be due, at least in part, to increased beaver activity. The increase in the number of beaver dams on the Muskeg River during drier years has made it difficult for fish to access spawning areas and has degraded available spawning grounds.



SUMMARY OF SPRING FISH FENCE RESULTS FOR LARGE-BODIED SPECIES ENTERING THE MUSKEG RIVER.

Objective 2: Evaluate whether the existing RAMP study design is suitable for characterizing natural variability.

To date, only a limited number of years of data are available for each component of the fish program. As well, there have been changes in sampling design between years for some components. It was concluded that additional data would be required to determine if the small number of apparent changes observed for fish populations represents trends outside the range of natural variability.

Objective 3: Identify cumulative effects and regional trends affecting the health and sustainability of regional fisheries resources.

A small number of potential trends were identified, but specific conclusions were not possible due to variations in sampling procedures among years.

Objective 4: Evaluate the ability of the present study design to detect cumulative effects or regional trends.

The present study design is adequate, but more data are needed.

Objective 5: Evaluate whether the information collected by RAMP is suitable for verifying EIA predictions regarding fish populations.

The Athabasca and Muskeg rivers inventory programs do not assess biodiversity because the main sampling technique (boat electrofishing) is size selective and is only suitable for assessing species composition and relative abundance for large-bodied fish.

Objective 6: Evaluate if and how the RAMP fisheries program may be improved.

The following recommendations were made in the Five Year Report:

- additional data are required to determine what is influencing the apparent declines in walleye and lake whitefish abundances in the Athabasca River;
- additional data are needed to determine trends related to chemical concentrations in fish tissues;
- the frequency of sentinel species monitoring in the Athabasca River should be increased to every two years;
- the number and location of beaver dams should be determined for the lower Muskeg River, lower Jackpine Creek and Muskeg Creek, along with spawning habitat information; and
- analysis of the quality of fish tissues relative to tainting (changes in fish flavour and odour) should be undertaken.

7 REVIEW OF RAMP OBJECTIVES

Objective I: Collecting scientifically defensible baseline and historical data to characterize existing conditions in the oil sands region.

For each of the components assessed by the Five Year Report, data have been collected to assess baseline conditions. These data have been compared to historical data, where possible, given differences in station locations and collection methods. However, more data are needed for some components to determine the natural variability in the oil sands region, such as water quality data for waterbodies where there are no historical data; and metal concentrations in fish tissues. (See recommendations for each component.)

Objective II: Monitoring aquatic environments in the oil sands region to detect and assess cumulative effects and regional trends.

This objective depends upon having a sufficient historical data set to allow statistical analyses to be undertaken. For many components, data are currently not available to assess long-term trends. Trends have not yet been established for water quality in some areas, and sediment quality, benthic invertebrate communities, fish population studies, tissue concentrations, and sentinel species growth and health indices in general.

Objective III: Collecting data that can verify predictions made in Environmental Impact Assessments (EIAs).

The following three general questions have been proposed for this evaluation:

1) ***Are RAMP monitoring stations located at appropriate sites?***

   All of the stations assessed in the Five Year Report were located at appropriate locations for assessing predictions made in EIAs. However, additional sites are recommended and incorporated as the development area expands.

2) ***Are monitoring periods sufficient, or is sample collection sufficient, to assess the predictions in the EIAs?***

Some additions to the existing RAMP program are recommended for each of the components as presented in the previous component sections.

3) ***Is RAMP collecting, or otherwise, obtaining data required to differentiate natural variability from changes due to human activity?***

Although no attempt has been made to undertake this type of assessment, the data collection effort and methodology are considered adequate to tell the difference between natural and human influences.

In waterbodies where historical information is not available, RAMP is ***not*** currently collecting sufficient baseline data to determine if, for example, significant variations in water quality over time can be detected prior to development.

RAMP needs to ensure sufficient sediment baseline data are collected to detect potential trends prior to the initiation of oil sands developments.

The benthic invertebrate program study design could be improved to assess the impacts of development versus natural variability.

All aspects of the fish program would benefit from more baseline studies.

RAMP has recommended increasing the baseline sampling from three to more than five years to allow trends and natural variations to be identified and documented prior to development.

For more information on the RAMP program, past or present, visit the website at:

www.ramp-alberta.org

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