

DEVELOPING ONTARIO'S RING OF FIRE: POSSIBLE IMPACTS FROM THE CLIFFS CHROMITE MINE

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CONTENTS

Introduction	1
The Physical Environment.....	1
Mining Impacts on the Physical Environment	4
Species at Risk.....	7
Woodland Caribou	8
Mining Impacts on Woodland Caribou	10
Wolverine.....	12
Mining Impacts on Wolverine.....	13
Lake Sturgeon	13
Mining Impacts on Lake Sturgeon	14
Conclusion.....	15
Literature Cited	16

FIGURES

Figure 1: Map showing the distribution of wetlands across the Canadian boreal forest (PEW, 2012).	3
Figure 2: An image representing the hydrology in the region of the mine site (Cliffs, 2011).	5
Figure 3: Woodland Caribou habitat Range in Ontario (ROM, 2011).	9
Figure 4: Adaptive Management Cycle for Caribou (MNR, 2012).	10
Figure 5: Map showing the location of the proposed mine site and road construction (Cliffs, 2011).	11
Figure 6: Wolverine habitat in Ontario (ROM, 2008b).	12
Figure 7: Habitat range of Lake Sturgeon in Ontario (ROM, 2008a).	14

INTRODUCTION

Approximately 240 kilometres west of James Bay is an area of northern Ontario which has come to be known as the “Ring of Fire”. This area is experiencing an explosion of interest for its mining potential. In 2010 there were 90, 579 mining claims staked in the Far North region—nearly triple the 35, 386 that were claimed in 2007 (Far North, 2010). Presently, two companies have submitted proposals to develop mines in the area, and have thus initiated the required Environmental Assessment process. The chromite mine proposed by Cliffs is still early in the Environmental Assessment process. A Comprehensive Study under the Canadian Environmental Assessment Act is underway—a fact that has upset many stakeholders. Being one of the first projects in the Ring of Fire, demand for a Joint Panel Review is high. Concerns are being raised that adequate consideration will not be given to minimize and mitigate the environmental impacts of the mine. The potential impacts on the physical environment and species at risk posed by the chromite mine proposed by Cliffs Natural Resources Ltd. will be investigated in this paper.

THE PHYSICAL ENVIRONMENT

The boreal forest is the most intact forest ecosystem on earth. Spanning the entire circumpolar world of the north, the environment is highly dynamic and delicately balanced. It is continually responding to and accommodating forest fires, extreme winds, flooding, and permafrost (Chetkiewicz et. al., 2011). Although it is called a forest, the boreal landscape is abundant with aquatic ecosystems. Within Canada, the boreal hosts approximately 800, 000

square kilometres of surface freshwater. This accounts for a large proportion of the global freshwater supply—more than is found anywhere else in the world (PEW, 2012).

The freshwater resources of the boreal affect climate and nutrient cycles at all scales—locally, regionally, and globally. Water flowing through the interconnected forests, lakes, river valleys, wetlands, and tundra eventually drain into the Pacific, Atlantic and Arctic oceans, and Hudson Bay. Boreal freshwater inputs decrease salinity as flows mix with ocean water. This changes the water's density and enables it to freeze more readily. The flow's density differential creates a hydrologic engine that propels ocean currents. The decreased salinity promotes sea ice formation, which reflects large amounts of solar radiation back to space. The result of these processes is a major contribution to weather dynamics and the regulation of global climate (PEW, 2012).

Wetlands, such as bogs, fens, and peat, constitute a significant portion of the water within the Canadian boreal forest. Figure 1 illustrates wetland concentration across the country. The ecosystem services provided by these wetlands have an estimated worth of \$700 billion per year (PEW, 2012). Included in these services are: regulating climate; recharging aquifers; absorbing and filtering contaminants; regulating river flow by absorbing and releasing excess water; providing habitat for waterfowl, fish and other wildlife; storing and releasing greenhouse gases, nutrients and contaminants; and maintaining soil resources, disturbance regimes, and biological diversity (PEW, 2012; Chetkiewicz et. al., 2011; Whittington, et. al., 2012; White, 2011).

Approximately one-third of the world's peatlands are found in Canada, covering 35% of the global surface area (PEW, 2012; Far North, 2010). Miller (2011) defines a peatland as an

ecosystem where more than 40 centimetres of peat has accumulated. Peat forms when vegetative inputs accumulate at a rate faster than decomposition can occur. Decomposition is

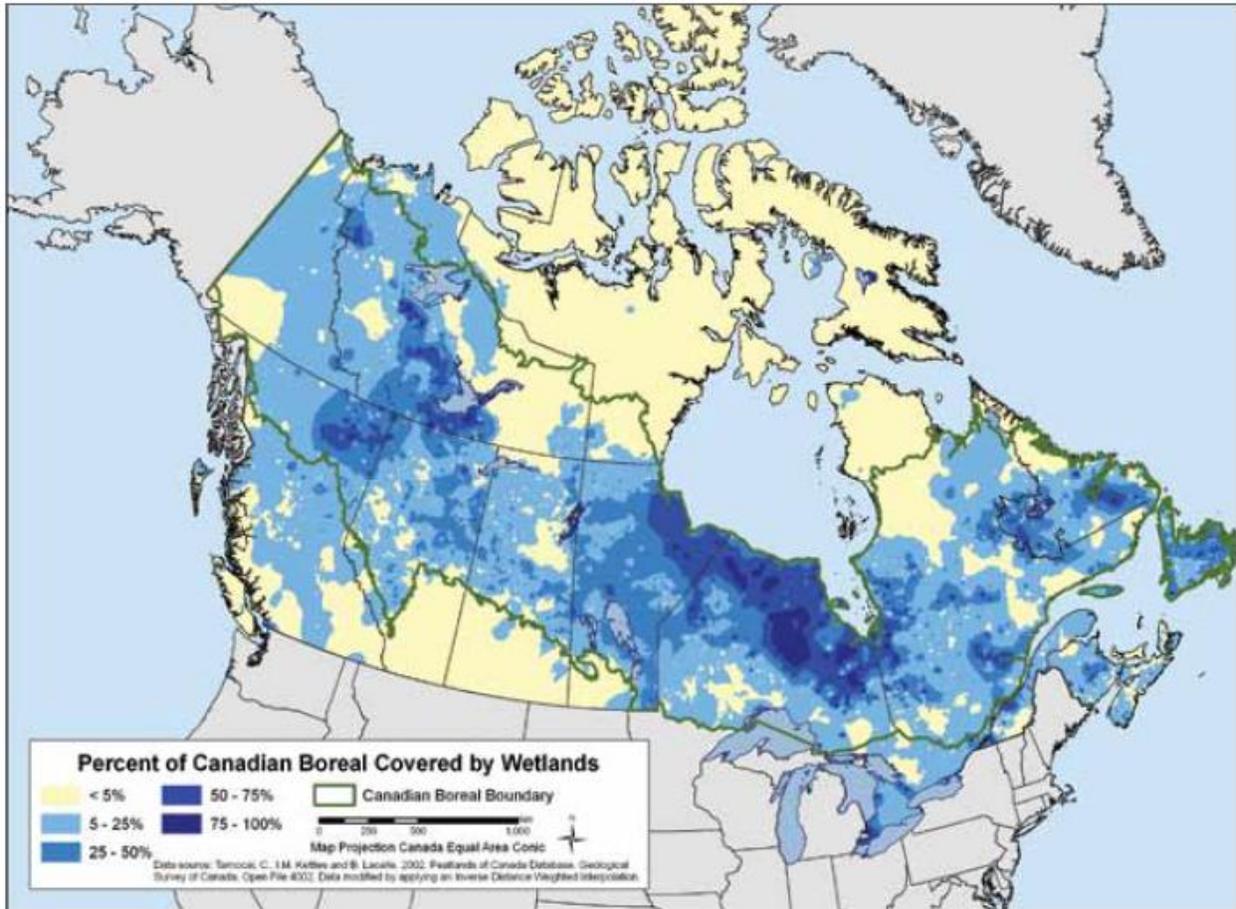


Figure 1: Map showing the distribution of wetlands across the Canadian boreal forest (PEW, 2012).

minimized because the saturated conditions do not allow oxygen to infiltrate and break down the organic material (Far North, 2010). Ecosystem services provided by peatlands include: climate regulation, water quantity and quality, erosion control, and carbon sequestering (Chetkiewicz et. al., 2011).

The scale of these wetlands within the Canadian boreal forest impacts global climate. It is estimated that over 200 billion tonnes of carbon (approximately 25 years of anthropogenic

emissions) are stored in the peatlands. This is more carbon than is sequestered anywhere else in the world; it accounts for 25% of all terrestrial carbon. Per area, this equates to roughly twice as much as can be found in a tropical forest (PEW, 2012; Far North, 2010). Peatlands contain 150 to 200 kilograms of carbon per square metre; an area of boreal or tropical forest, on the other hand, would not exceed a carbon density of 75 kilograms per square metre. The carbon can remain stored thousands of years. This equates to avoided atmospheric carbon dioxide, and thus a cooling of the climate (Far North, 2010).

The proposed mine site is located within the second largest continuous peatland system in the world—that of the Hudson and James Bay Lowlands. The peatlands constitute nearly 90% of this landscape, covering approximately 300, 000 square kilometres (PEW, 2012; Pickett-Heaps et. al., 2011; Whittington et. at., 2012). Figure 2 provides an example of what the site looks like. The area where the mine will be developed is within the catchment of a tributary to the Attawapiskat River, which flows into James Bay (Cliffs, 2011). This river is one of the last undeveloped rivers in Ontario (Chetkiewicz et. al., 2011). It is poorly drained, consisting of bogs, fens, and peat up to 3.4 metres in depth (Cliffs, 2011). The unique hydrology in this area consists of high water tables, formed from very low relief and thick underlying, low permeability marine sediment deposits. The sub-Arctic climate promotes peat formation by minimizing evapotranspiration (Whittington et. at., 2012; White, 2011).

MINING IMPACTS ON THE PHYSICAL ENVIRONMENT

Despite the fact that the Hudson and James Bay Lowlands constitute nearly half of Ontario's area, research within this remote area is limited. It is therefore difficult to precisely

forecast the impacts of development when making decisions about the region. To hypothesize, impacts that may occur include: degradation of the ecosystems, acid mine drainage, tailings



Figure 2: An image representing the hydrology in the region of the mine site (Cliffs, 2011).

leaks or spills, climate change and drying of the peatlands. Cliffs began collecting baseline information around the mine site in 2010. Water quality is being tested from 40 surface water locations and 9 groundwater wells; sediment samples are also being collected (Cliffs, 2011).

Long-term data sets are essential to properly manage an ecosystem (AGC, 2011; Hemond and Benoit, 1988). The studies conducted will not provide sufficient baseline data to identify long-term trends.

Cliffs is pioneering in two major areas with the proposed project: chromite mining and developing in the Ring of Fire. Neither Cliffs, nor any Canadian federal or provincial agencies, have experience mining chromite—especially not in a sub-Arctic boreal region. This contributes

further to the difficulty of predicting and mitigating the impacts of the project (Chetkiewicz et. al., 2011).

A road, which Cliffs has identified as a necessary component of this project, will make the Ring of Fire accessible for future development. The likelihood of more mining projects will greatly increase, and thus, so will the potential for environmental degradation. The cumulative effects, which will certainly be significant, are unknowable at this point (PEW, 2011).

One of the most significant impacts from mining is acid mine drainage (Environmental Mining Council of BC, 1998; MiningWatch Canada, 2001). Although precautions will surely be taken to prevent effluent from entering the regional ecosystems, accidental discharge may occur. Resultant impacts can last long after the mine has closed—sometimes for centuries after (Environmental Mining Council of BC, 1998; MiningWatch Canada, 2001). The project description states that up to 20% of the waste rock that will be generated by the mine may be acid generating. Preliminary testing done by Cliffs “has indicated a potential for metal leaching of the waste rock”. The mine is also expected to discharge liquid containing ammonia, hydrocarbons, and minor amounts of metals, such as chromium (Golder Associates, 2011).

Hexavalent chromium is a toxic by-product of chromium mining. Unfortunately, not enough information exists to predict what the impacts may be once this toxin has entered the ecosystem (CBC News, 2012). The transport, transformation, and thus fate of chromium are not well understood; its behaviour once in the soil is difficult to predict (Palmer and Wittbrodt, 1991). The impacts to water quality and wildlife can only be observed after the fact.

The enormous amount of carbon stored in the region’s peatlands implies the threat of climatic changes is imminent. Mine development will change the storage capacity, carbon

sequestration, emission and cooling services provided by the ecosystem. Changes to the present water regimes will alter the capacity for carbon storage, the impacts of which are, again, unpredictable. If modifications occur faster than the system adjusts, sudden changes in peat structure may be widespread. This has been observed in Sweden, and can therefore be anticipated for northern Ontario (Far North, 2010).

It is very important to prevent or minimize degradation to these ecosystems before it occurs. Attempting remediation afterward can be a very expensive process. For example, it is estimated that since 1990, the United States have spent nearly \$15 billion dollars on restoring degraded rivers (PEW, 2012). To degrade these ecosystems will reduce the natural benefits of this area, and inevitably require costly clean-up.

SPECIES AT RISK

According to the project description, the mine site will be located in the Ontario Shield and Hudson Bay Lowland Ecozones (Golder Associates, 2011). There are a number of species that may be living in the proposed mine area, as classified under the Ontario Species at Risk Act. The project description states that there is the potential for five federally listed species at risk, five provincially listed species at risk, and one locally sensitive species to occur in the region containing the mine site. Cliffs (is currently collecting habitat information to confirm this (Golder Associates, 2011).

The golden eagle is the only endangered species listed. The woodland caribou, wolverine and lake sturgeon are listed as threatened, while the monarch, black tern, bald eagle, common nighthawk, olive-sided flycatcher and short-eared owl are listed as special concern.

(OMNR, 2012). According to the Canadian Species at Risk list, the olive-sided fly catcher, common nighthawk and woodland caribou are threatened in the area. The rusty blackbird, short-eared owl, lake sturgeon, monarch butterfly and wolverine are listed as special concern (Government of Canada, 2011).

Cliffs' report mentions that after one hundred and twenty eight vegetation plots were conducted, no plant species at risk were observed. They did observe four bird species—the olive-sided flycatcher, the rusty black bird, common nighthawk and bald eagle. The habitat was also characteristic for woodland caribou and wolverine (Cliffs, 2011).

This report will focus on three species of special concern in Ontario that may be directly affected by the mine site: the woodland caribou and wolverine, which can be affected by habitat loss, and the lake sturgeon which, can be affected by water quality. It must also be noted that the project has the potential to affect many other species at risk found in the region of the proposed road development.

WOODLAND CARIBOU

The woodland caribou (*Rangifer tarandus*) is a unique subspecies that inhabits mature jack pine forests. They live in small herds and are less migratory than other caribou species. They have a requirement for large areas of mature conifer forest ranging in size from 200 to 400 square kilometres. They consume ground lichens during winters and herbaceous plants and leafy shrubs during the summer. They do not respond well to human disturbances. Caribou are protected under the Species at Risk Act from being killed, harmed, possessed, harassed, collected or sold (ROM, 2011). Figure 1 indicates their habitat range in Ontario.

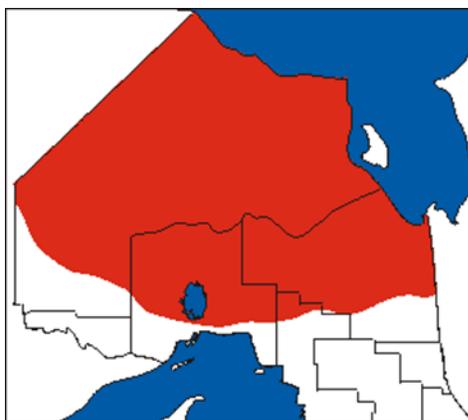


Figure 3: Woodland Caribou habitat Range in Ontario (ROM, 2011).

The Ontario government has a Woodland Caribou Conservation Plan (OMNR, 2012), which was developed under Ontario's Endangered Species Act, 2007. The purpose of the Plan is to:

- *Provide broad policy direction regarding caribou conservation and recovery*
- *Summarize the actions the government intends to take in response to recommendations in the Ontario woodland caribou recovery strategy and the government priorities in taking those actions and*
- *Outline initiatives to support woodland caribou recovery (OMNR, 2012).*

The Plan outlines an adaptive management approach. Figure 2 outlines how that approach should be considered.

The Cliffs chromite mine project description states that five caribou have been observed within the study area, but outside the mine site. The study area was defined as a 16 kilometre radius centered on the mine site (Golder Associates, 2011).

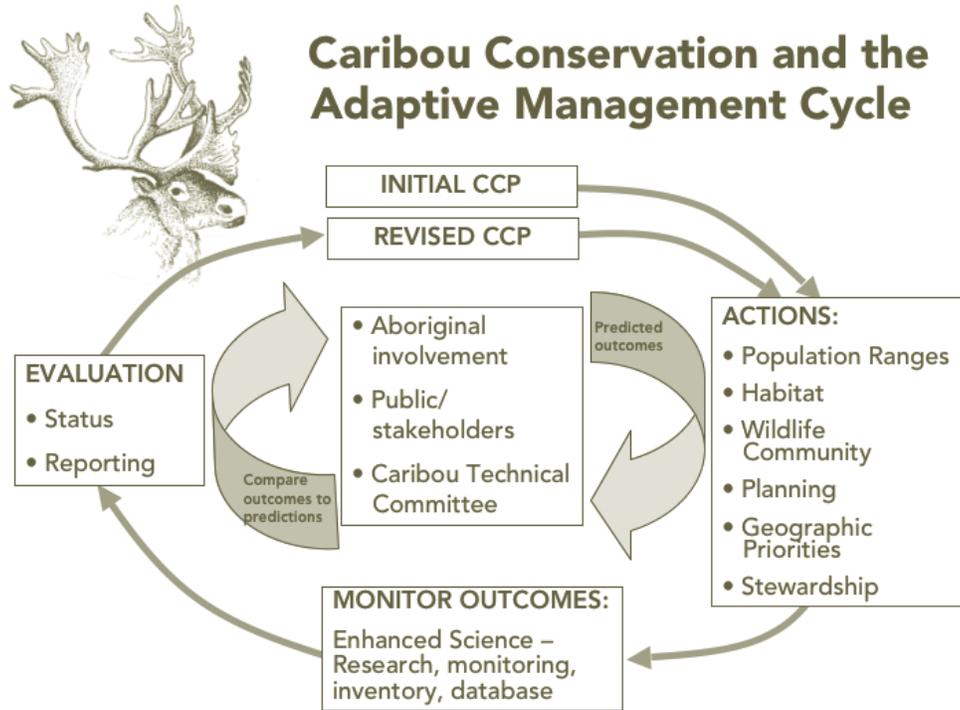


Figure 4: Adaptive Management Cycle for Caribou (MNR, 2012).

Mining Impacts on Woodland Caribou

The introduction of mining in the region can affect caribou habitat in many ways. One of the biggest issues will be habitat fragmentation due to road corridors. As proposed, the Cliff's mine will see the construction of new road corridors on a large scale. The map of the mine site (Figure 3) illustrates the new transportation corridor and proposed winter roads. The permanent road would be 260 kilometres long and be utilized by between 50 and 100 trucks, each weighing 70 tonnes, every day (Cliffs, 2011).

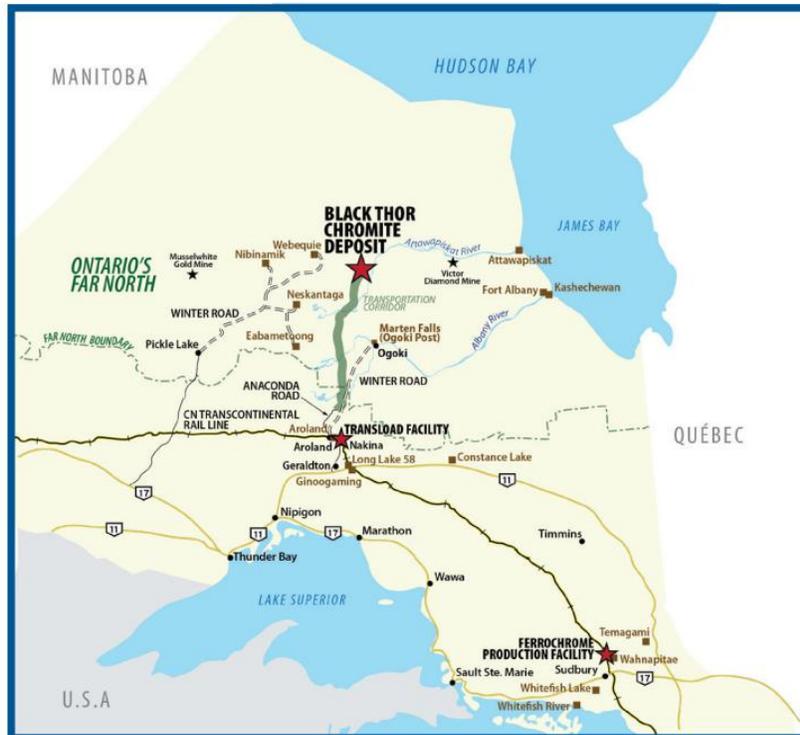


Figure 5: Map showing the location of the proposed mine site and road construction (Cliffs, 2011).

Roads can act as a partial barrier to the movement of woodland caribou. The road divides an unbroken habitat patch; this means that patches will be smaller and have higher edge ratios. Roadways can result in the abandonment of migration routes (Dyer et al., 2002). Higher forest edge ratios can also lead to more predators. Predation by wolves and humans is increased close to roadways, which suggests a growth of mortality due to road (Schindler, 2006). In their paper, Dyer et al. (2001) outline that caribou show a tendency to avoid roadways, regardless of the amount of traffic. This tendency to avoid roads may displace caribou into habitat that is less suitable and may result in population decline. Dyer et al. (2001) also links this decline to caribou crowding into smaller habitat areas, which would allow for increased predation.

In a case study of the Prudhoe Bay and Kuparuk oilfields in northern Alaska, caribou exhibited the largest change in behavior within 600 metres of linear structures (e.g. roadways and mine site). These caribou exhibited energy costly behaviour. It was also concluded that moving objects were more disruptive to caribou behavior than stationary objects (Murphy et al., 1986).

As prescribed under the Environmental Impact Statement guidelines, Cliffs will use aerial surveys to collect seasonal baseline data on caribou in order to predict and mitigate the project's effects (CEAA, 2011). They will also use the proposed federal recovery strategy for the boreal woodland caribou (EnvCan, 2011) to outline population ranges and critical habitat.

WOLVERINE

The wolverine (*Gulo gulo*) is a large weasel and is a predator and scavenger. They have large home ranges and live in the northern boreal forest. Figure 4 shows their habitat range in Ontario. They rely on caribou as a main food source—therefore, as caribou populations decline, so does the wolverine (ROM, 2008b).

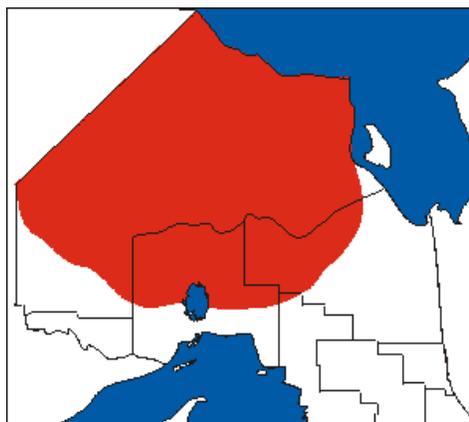


Figure 6: Wolverine habitat in Ontario (ROM, 2008b).

Wolverines can have a home range between 73 and 1506 square kilometres; the main characteristic of the habitat is its isolation from human populations (The Wolverine Foundation, 2012). In Ontario, wolverines tend to be found in bog areas and mature conifer stands. They are indicators of ecosystem integrity and changing climates (Ontario Wolverine Recovery Team, 2011).

Mining Impacts on Wolverine

Wolverines are one of the first species to disappear when there is human disturbance—they are greatly impacted by development. In 1998, Austin discovered that wolverines avoided areas within 100 metres of the Trans-Canada highway in British Columbia, preferring areas that are greater than 1100 metres away. The intensification of roads increases the incidental harvest. Studies in Ontario show that populations require refuge free from human disruption to ensure their perseverance in the broader landscape (OMNR, 2011). Human disturbances also have impacts on denning. In Ontario, it is recorded that the denning sites are seven kilometres away from active logging roads, and five kilometres away from human access (Dawson et. al., 2010).

LAKE STURGEON

The lake sturgeon is Canada's largest freshwater species. They inhabit the bottom of large freshwater lakes and rivers. Figure 5 illustrates the range map of sturgeon in Ontario. They migrate from early May to late June into swift-flowing water to spawn (ROM, 2008a). Lake sturgeons are bottom feeders that rely on benthos for food. This means they can easily become exposed to contaminants and pollutants (OMNR, 2009).

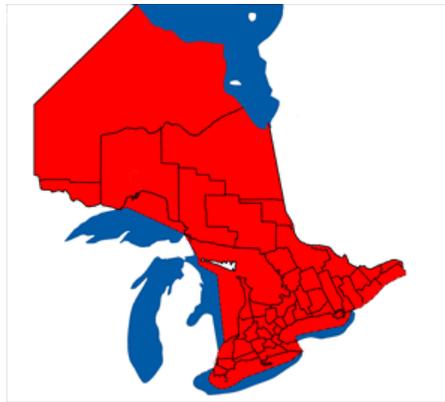


Figure 7: Habitat range of Lake Sturgeon in Ontario (ROM, 2008a).

Mining Impacts on Lake Sturgeon

Lake sturgeon can be affected in a number of ways by mining activities. The development of roadways can significantly impact spawning streams. The proposed road development would cross three major rivers, traverse 3 provincial parks, and intersect 50 wetlands (Cliffs, 2011). According to the baseline project, out of all the water crossings recorded, only 2 will require in-stream work. Some streams will require the installation of culverts, which can have detrimental impact if incorrectly installed. Cliffs (2011) plan to use arch-type culverts on small to mid-sized fish water crossings, and single span bridges for mid to large-sized fish crossings.

Culverts can have a number of impacts on streams that are sensitive habitat for sturgeon. The installation can cause sedimentation in water, which will degrade spawning areas (CTRI, 2006). Fish will not be able to reach spawning habitat if culverts are blocked or if water levels are too low. The project description outlines how Cliffs intends to protect fish during construction, including: “placing fish in buckets and returning them to suitable habitat” (Golder

Associates, 2011). Mining can also introduce pollutants into waterways. Tailing dams can fail and lead to leaching of minerals into the water stream (Hemond, et al. 1988).

CONCLUSION

The pristine state and ecological importance of the region where the Cliff's chromite mine will be developed demands the obligation to properly manage the developments. The physical environment and endangered species of the area are vulnerable to the modifications that will be made for the mine. The interconnected peatlands may lose their ability to provide valuable ecosystem services, and may become contaminated. The threatened woodland caribou, wolverine, and lake sturgeon inhabiting the area will be affected by habitat loss and degraded water quality. Regional and cumulative impacts need to be carefully considered before approvals are granted. It is impossible to determine how much development is possible before the tipping point of an ecosystem has been reached. As the anthropogenic modification increases, the complex dynamics of these ecosystems will respond in unknown ways. The extent of the changes will depend on the land use decisions that are made in the near future (Far North, 2010).

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