Ministry of Natural Resources

Ontario

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Background Information for the Development of a Fisheries Management Plan in Fisheries Management Zone 4

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Ontario Ministry of Natural Resources

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1.0 Introduction

With the implementation of *A New Ecological Framework for Recreational Fisheries Management in Ontario* (OMNR 2005a), the Province of Ontario has undertaken a broader, landscape level approach to fisheries management. This approach allows the Ontario Ministry of Natural Resources (OMNR) to more effectively manage the use of our fisheries resources and assess fisheries sustainability at a scale most appropriate given current fisheries objectives, public expectations and Government resources.

The *Framework* follows the principles outlined in *Our Sustainable Future* (OMNR 2005b), *Ontario's Biodiversity Strategy* (OMNR 2005c), *Science for Our Sustainable Future* (OMNR 2005d), and the *Strategic Plan for Ontario's Fisheries II* (OMNR 1992). These documents provide broad, high level policy direction for fisheries management in Ontario, and emphasize both an ecosystem and adaptive management approach to resource stewardship. Ensuring the ecological sustainability of fish populations and aquatic communities is fundamental to realizing social benefit from these resources.

Twenty Fisheries Management Zones (FMZs) provide the geographic basis for implementation of the *Framework* in Ontario. FMZs are defined by similar ecological, physical, social and economic attributes and are intended to delineate areas that are expected to react similarly to external changes, pressures and management actions. An adaptive management planning cycle is employed for each Zone; through setting ecological and socio-economic objectives, applying appropriate management actions, allocations, and performing regular monitoring that focuses on fisheries quality and objective achievement across the entire Zone rather than on individual lakes. This methodology allows fisheries managers to adapt to a changing environment or circumstances, such as climate change or increasing fishing effort, learn from past management actions, and apply the most current science and knowledge to make continual improvements through time.

This document presents specific physical, biological, and socio-economic background data and information related to the fisheries and fisheries management in Fisheries Management Zone 4. As part of the first step towards the development of a Fisheries Management Plan specific to this Zone, it is also intended to provide the current context around the status of the fisheries resource, predicted trends, other factors influencing fisheries management, and the prioritization of potential management issues and challenges.

Starting in early 2010, a Fisheries Advisory Council comprised of members of the public and various stakeholders facilitated by OMNR will use this background information to help frame discussions on developing realistic expectations of the fisheries resource, biological thresholds and objective setting as a FMZ 4 Fisheries Management Plan is written. As more current fisheries data from the Broad Scale Monitoring (BSM) performed in the summer of 2009 becomes available, this information will be incorporated into their decision making.

This Plan will apply to all waterbodies across FMZ 4, with the exception of seven Specially Designated Waterbodies (SDWs) that will have their own Plans and monitoring strategies developed separately from this exercise.

Due to the large size of Fisheries Management Zone 4 and the volume of information to discuss, most maps in this document are presented at two different scales. Smaller large scale maps are embedded in the main text, which highlight the main theme of the Figure. Larger small scale maps are appended to the document which show all data associated with the Figure.

2.0 Physical Description

Fisheries Management Zone 4 extends over a large and varied geographic range, covering an area of approximately 60,440 km^2 including land and water. The Manitoba Border and the Eastern boundary of Woodland Caribou Provincial Park mark the Western extent of the FMZ, with the western boundaries of the Brightsand River Provincial Park and Wabikimi Provincial Park defining it to the East, over 350 kilometres away. The Berens River system and Cat River system, and Highway 17 and the Canadian National Railway line, provide the North and South boundaries of the Zone, respectively (Figure 1).

Located somewhat centrally in the Northwest OMNR Region, FMZ 4 spans across 5 OMNR administrative Districts (Kenora, Red Lake, Dryden, Sioux Lookout and Thunder Bay), and encompasses the larger communities of Red Lake, Ear Falls, Sioux Lookout, and Ignace. A number of smaller communities, including First Nations, are spread across the Zone along main highway corridors. Kenora and Dryden, the Region’s largest centres, lie just to the South along the TransCanada Highway (Hwy 17).

Over three quarters of the land base within FMZ 4 is Crown Land, with approximately 3% of that area located in Provincial Parks and Protected Areas (PAPAs). Areas of private or patent land are generally small but widespread in the Zone, usually found near communities or associated with mining claims, with the exception of the large Wagner Blocks in the Dryden District which account for approximately 1/3 of all private land. Fisheries resources for all waterbodies within the Zone are administered by each respective OMNR District or by Ontario Parks.

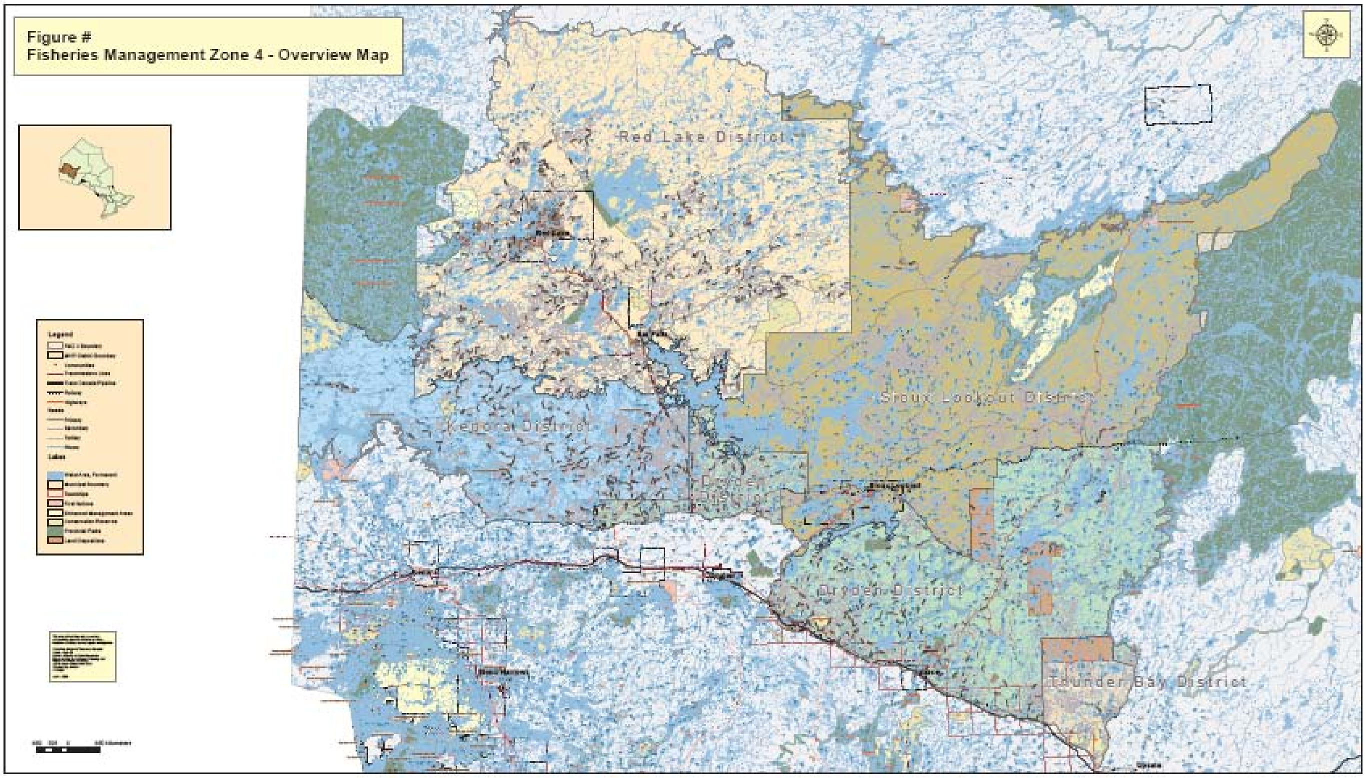

Figure 1. Map – Overview of Fisheries Management Zone 4 extent and MNR Districts, communities (incl. FN), PAPAs, main waterbodies, and main roads etc.

2.1 Surficial Geology and Soils

Like much of the rest of Canada, the current pattern of landform features and interspersion of lakes and rivers across FMZ 4 was defined by the actions of glaciers. Sims and Baldwin (1991), summarize the glacial and post-glacial history of Northwestern Ontario. By the end of the Wisconsinan period, the most recent glaciation event in North America, most of the Canadian landscape had been deeply scoured and was covered in glacial ice. The Laurentide Ice Sheet which covered the entire Northwest Region of Ontario until approximately 13,000 years before present (BP), started to recede across the area of FMZ 4 between 10,000 and 9,000 years ago.

The topographic "grain" of the landscape was laid down during the advance of the ice sheet and was then modified by mineral deposits carried by meltwaters along the ice-front margin. During the next 2000 years the major drainages we see today were created, including the English River system which cuts across the centre of the Zone. Major linear morainal features were laid down in the South and West which, interestingly, provide the base for the primary road access within FMZ 4 ex. Hwy 17, Hwy 105.

During this restructuring of the landscape, the creation of complex temporary drainage systems acted as refugia and dispersal routes for fish and other aquatic species (Gunn and Pitblado 2004) in Northwestern Ontario. Cold water fish species like lake trout (*Salvelinus namaycush*) appear to have persisted in the colder, less productive proglacial lakes and rivers along the receding glacial margins. Cool water species likely recolonized the area from the Mississippi drainage to the South, as well as from areas to the West and Northwest (Wilson and Mandrak 2004). By 7,000 years BP all of Ontario was ice free, and as the land slowly sprung back from the weight of the glaciers by isostatic rebound over the next few thousand years, the present day boundaries and connectivity of our lakes and rivers was established.

Figure 2[1] illustrates the surficial geology of Fisheries Management Zone 4. The Zone is dominated by glacial till and glaciofluvial morainal deposits (composed of sand, gravel and boulders) and bedrock landforms. Both are generally well distributed and together constitute almost 75% of the underlying substrate, with morainal features being more common in the Eastern half of FMZ 4 and bedrock more common in the West. Organic soils, or peatlands, covered by treed fens, bogs and swamps are found on only about 5% of the landbase, with notable concentrations along Hwy 17 in the Ignace/Upsala area at the Southeastern edge of the Zone, and North of Red Lake along the Berens River system in the Northern portion of the Zone.

Glaciolacustrine landforms that accumulated during periods of slower ice recession and the formation of proglacial lakes and rivers with slower water flow are represented on a relatively small portion of the landbase (~11%). However, these deposits of finer textured silts and clays have some significance to fisheries productivity and fish habitat as they contribute to the TDS (Total Dissolved Solids), an important component of the nutrient levels, and therefore productivity, within aquatic ecosystems (Ryder 1965). Deposits of fine-textured silts and clays are for the most part associated with the area along the English River system. Lakes in this system are generally more productive for coolwater fish species such as walleye (*Sander vitreum*), but are also more susceptible to higher risk of sedimentation associated with road networks and water crossings on inflowing rivers and streams (Ward 1992). The influence of soils on productivity and sedimentation risk is discussed further in sections 3.1 and 4.3 respectively.

The various landforms and soils in FMZ 4 have produced a boreal forest cover that is primarily conifer dominated, with jack pine and black spruce the most common species in the Northern 2/3 of the Zone. Boreal forest types generally have a higher susceptibility to forest fire disturbance events (Steedman et al. 2004), and fires have always had a significant role in boreal ecology and productivity, including aquatic habitats in FMZ 4. The influence of natural disturbance events on fish and fish habitat is discussed further in section 4.1.

[1] Landform features were summarized into 6 classifications for the majority of the Zone using Northern Ontario Engineering Geology Terrain Study (NOEGTS) data. Ontario Land Inventory (OLI) data was used for the Northern portion of the Zone where NOEGTS data was not available and was classed differently based on soil texture.

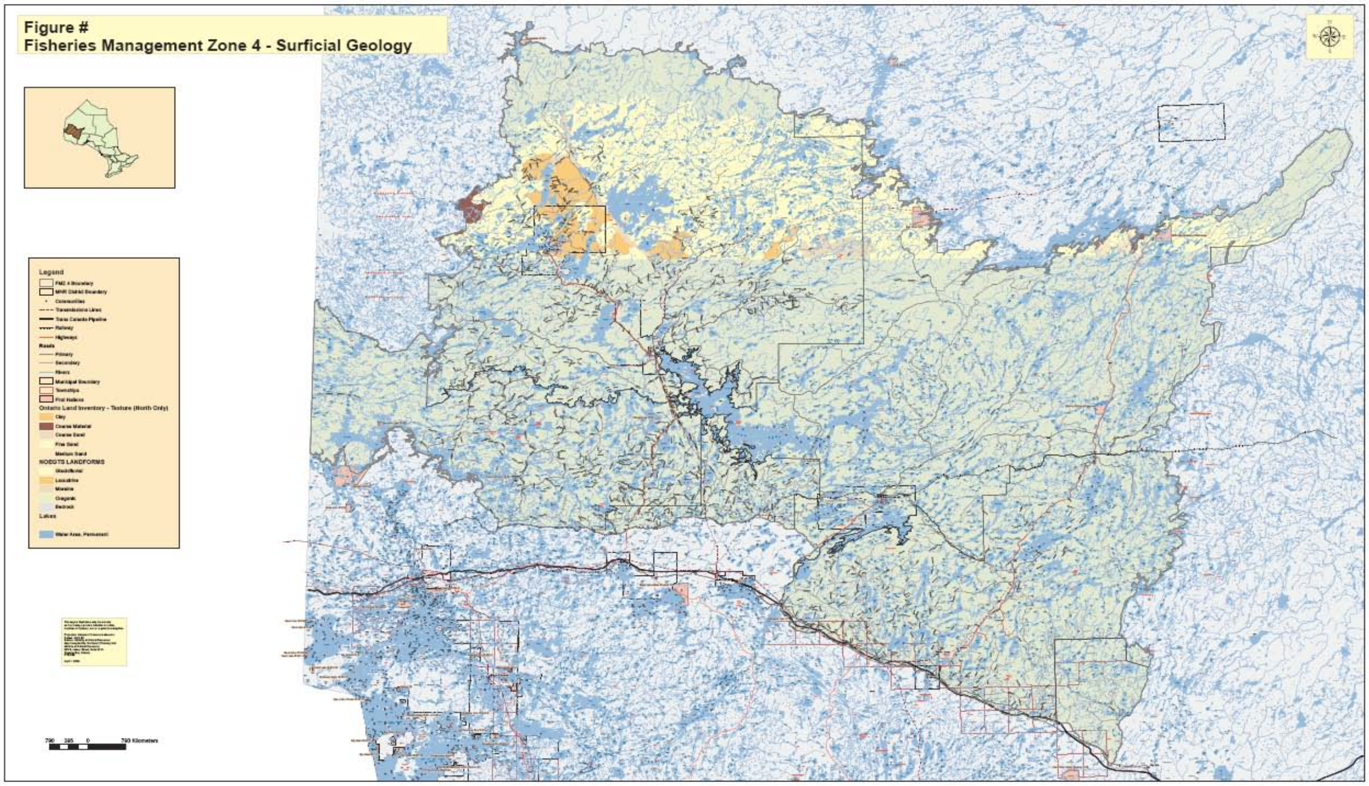

Figure 2. Map - Fisheries Management Zone 4 surficial geology

2.2 Water

FMZ 4 typifies the abundance and wide range of aquatic habitat types found in Northwestern Ontario. Over 22,500 lakes and 44,315 kilometres of rivers and streams cover more than 17% of the total area in permanent water, with an additional 5% in associated wetlands. Of that, the 7 SDWs (Table 1) account for almost 3% of the total area of the Zone. Some of these are included in the 18 lakes that are greater than 10,000 hectares (ha) in surface area (Appendix 1), with Lac Seul standing out as the largest waterbody in FMZ 4.

Table 1. Specially Designated Waterbodies (SDWs) within FMZ 4

Specially Designated Waterbody	Surface Area (ha)	OMNR District
Red Lake/Gullrock Lake	17,677	Red Lake
Lac Seul	140,943	Sioux Lookout
Minnitaki Lake	18,088	Sioux Lookout
Abram Lake	2,041	Sioux Lookout
Pelican Lake	2,342	Sioux Lookout
Botsford Lake	1,447	Sioux Lookout
Big Vermillion Lake	8,266	Sioux Lookout

Most of FMZ 4 falls within the Nelson River primary watershed. Water from approximately 80% of the landbase flows westward via the English River and some smaller systems to the Winnipeg River, Lake Winnipeg, then via the Nelson River to Hudson Bay. The remaining eastern and north eastern portions of the Zone contribute to the Hudson-James Bay primary watershed, with all water again eventually flowing north to Hudson Bay and James Bay. Fifteen whole or partial tertiary watersheds cover FMZ 4 (Figure 3).

Watersheds have been described as the link between upland environmental processes and the water bodies they surround. The condition of soils and the amount and type of disturbance in a watershed strongly influences runoff, water quality and aquatic biota, with various impacts on fisheries and fish habitat (Steedman *et al.* 2004, Carignan and Steedman 2000). The *Ecological Framework for Recreational Fisheries Management in Ontario* (OMNR 2005a) incorporates these broad-level watershed characteristics to guide management and monitoring objectives within each fisheries management zone.

Approximately 700 lakes in FMZ 4 have been surveyed by OMNR (Figure 3) as part of a Provincial lake survey program, or Aquatic Habitat Inventory (AHI), which reached its peak and essentially concluded in the late 1980's and early 1990's. A typical lake survey would include: measuring the physical features of the lake, such as depth mapping, shoreline features, and water clarity (secchi[2]); measuring chemical features, such as temperature and dissolved oxygen profiles, total dissolved solids (TDS), and conductivity; as well as small and large fish identification and sampling.

Lakes in Fisheries Management Zone 4 can be characterized as having intermediate mean depth, medium mean surface area, stained water clarity, and with an intermediate Morphoedaphic Index (MEI)[3] when compared to adjacent FMZs in the Northwest (Cano and Parker 2007). Table 2 provides a summary of some of the physical characteristics of lakes within FMZ 4 (not including SDWs) and provides a comparative view of the differences between FMZ 4 to other FMZ's in the Northwest Region. Each zone in the province was delineated in part by watershed boundaries and climate conditions (OMNR 2005a) as a result, waterbodies in each FMZ contain

[2] Water clarity values are based on the depth (m) at which a black and white *Secchi disk* disappears from view.
[3] The Morphoedaphic Index (MEI=TDS/mean depth) provides a coarse measure of potential fish yield within a lake.

unique physical characteristics that in turn support diverse aquatic communities. Detailed physical information from lakes within zones, as represented in Table 2, along with fish species presence and other environmental metrics, form some of the basic data required to estimate fish yields and trends in fisheries productivity. Some zones have greater productivity potential than others, as physical characteristics such as lake depth, TDS (total dissolved solids) and MEI are directly related to trends in fish yield. Information on how physical characteristics influence aquatic communities is described further in section 3.0.

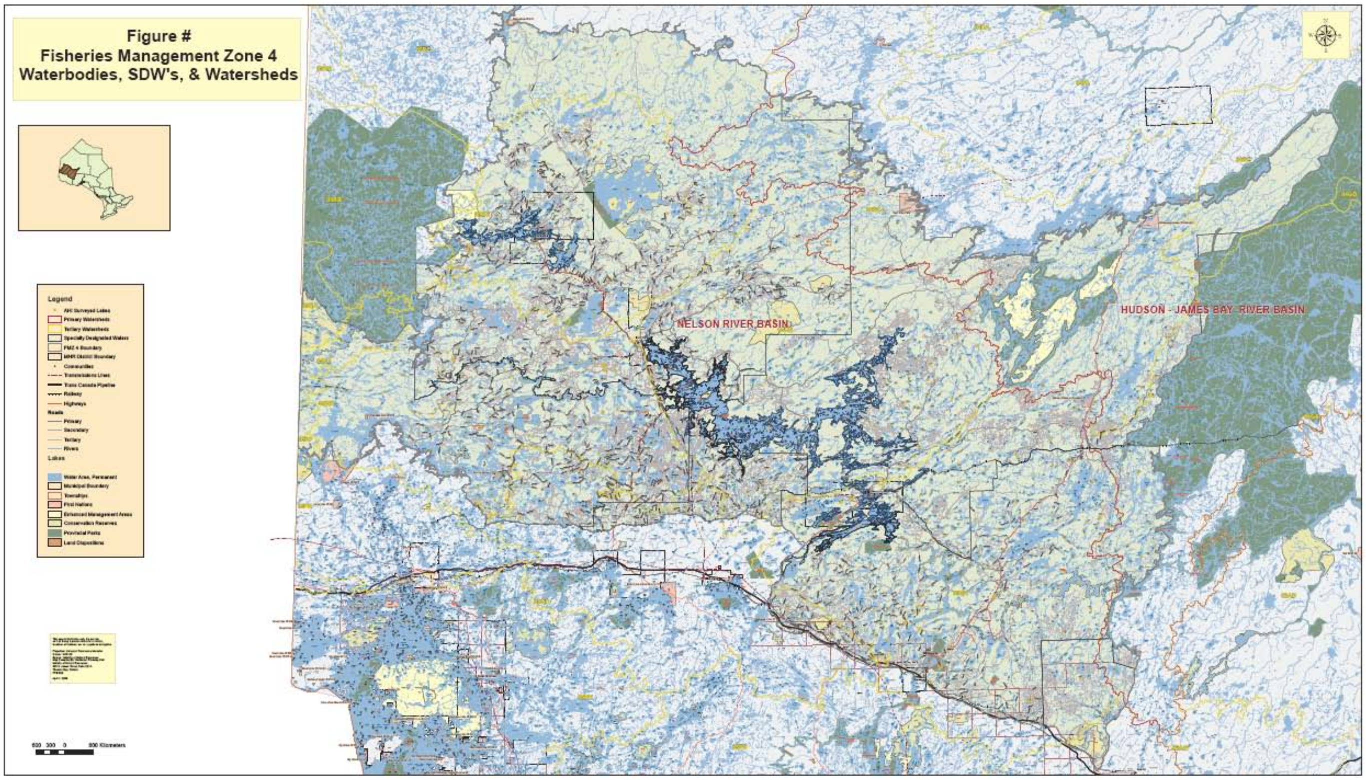

Figure 3. Map - Fisheries Management Zone 4 waterbodies, major waterbodies (lakes > 10000 ha), SDWs, and tertiary watersheds

Table 2. FMZ lake characteristics summary

FMZ	Total Surface Area (ha)*	Mean Surface Area (ha)**	Mean Depth (m)**	Mean Max Depth (m)**	Mean TDS	Mean Secchi (m)*	Mean MEI*
FMZ4	881,038	758.60	11.3	16.9	39.1	2.9	10.1
FMZ5	398,491	437.9	16.2	24.2	30.6	3.8	6.2
FMZ6	210,201	375.4	13.0	18.7	46.1	3.1	13.2

* data from OMNR Natural Resources Values Information System (NRVIS)
** data from OMNR AHI surveyed lakes

FMZ 4 contains over 40,000 kilometres of rivers and streams that make up an important part of the total water area of Zone 4. The major rivers and streams that connect the interior of Zone 4 to Lake Winnipeg, the Winnipeg River and Hudson Bay include the English River, Berens River and Shab River systems. These waterbodies are significant features in Zone 4 as they support native riverine species such as lake sturgeon (*Acipenser fluvescens*) and brook trout (*Salvelinus fontinalis*) and also serve as spawning and nursery habitat for other native fish species. Information on rivers and streams within FMZ 4 is very sparse. At present, no river or stream monitoring protocol for aquatic communities exists for the Northwest Region, and no streams or rivers have been monitored in FMZ 4.

2.3 Climate

Information on climate was collected from weather stations across FMZ 4. Summer temperatures within FMZ 4 (June – August) are noticeably higher in the western portions of the zone (Kenora, Dryden) then the far eastern or northern portions of the zone (Brightsand Provincial Park, Pikangikum First Nation) (Figure 4). Over the past 3 decades (1980-2007) summer temperatures have been increasing in FMZ 4, with warming particularly evident in the eastern and northern portions of the zone. These warming trends are consistent across Northwestern Ontario and raises concerns about the impacts a warming environment associated with climate change will have on fisheries communities.

Average winter temperature across the zone (November – March) varies from east to west, with temperatures being considerably warmer in the western portion of the zone (Kenora) than the far eastern portions (towards Brightsand Provincial Park). Winter temperatures across the majority of zone 4 permit ice cover from November to March, with ice-out occurring earlier in western portions of the zone (Kenora). Over the past 3 decades, winter temperatures have gradually increased with noticeably warmer winter temperatures experienced in 2000-2007 than in 1980-1989 (Figure 5). These changes are associated with a warming climate, which is particularly evident in northern regions across the globe (Racey 2005).

Historically, the area encompassing FMZ 4 has been within the Height of Land climactic region, which typically receives an annual pattern of low winter and high summer precipitation. Data from precipitation normals between 1971-2000 in Kenora, Red Lake, Sioux Lookout and Dryden support this observation with higher average summer precipitation levels (Figure 6) and lower average levels across the zone in the winter (Figure 6). In addition to seasonal fluctuations, average precipitation in FMZ 4 also varies from east to west within the zone, with the western portion of FMZ 4 receiving on average less precipitation than the eastern portions (Figure 6). This east to west variation in precipitation occurs despite an overall increase in precipitation across the entire zone within the past 3 decades.

Cumulative growing degree days based on 1971-2000 normals (Environment Canada) for Kenora, Ear Falls, Red Lake, Sioux Lookout and Dryden were 1759, 1544, 1489, 1578 and 1592, respectively, indicating a longer growing season in the western portion of the FMZ and a shorter growing season in the northern and eastern portions. The average number of growing degree days for the entire zone is 1460 (AHI data). Growing degree days (GDD) are used to determine the intensity of the growing season by estimating the amount of heat accumulated annually during spring, summer and fall. It is calculated as the sum over the entire growing season of the number of degrees by which the daily mean temperature exceeds exceeds 5˚C (Browne 2007). Lake productivity is directly related to the number of growing degree days, longer growing seasons result in greater development opportunities for fish. For example, fifty percent of walleye females mature between the ages of 3 to 5 in areas with greater than 1400 growing degree days above 5˚C, whereas age at maturity in areas with less than 1400 growing degree days above 5˚C is between 6 and 9 years (Baccante and Colby 1996).

Trends in climate in the Northwest Region have been changing towards a warmer condition. Climate change models suggest that the Northwest Region will experience some of the most acute impacts of climate change in Ontario (Racey 2005). A discussion on the implications of climate change to aquatic communities, fish productivity and habitat can be found in section 4.2.

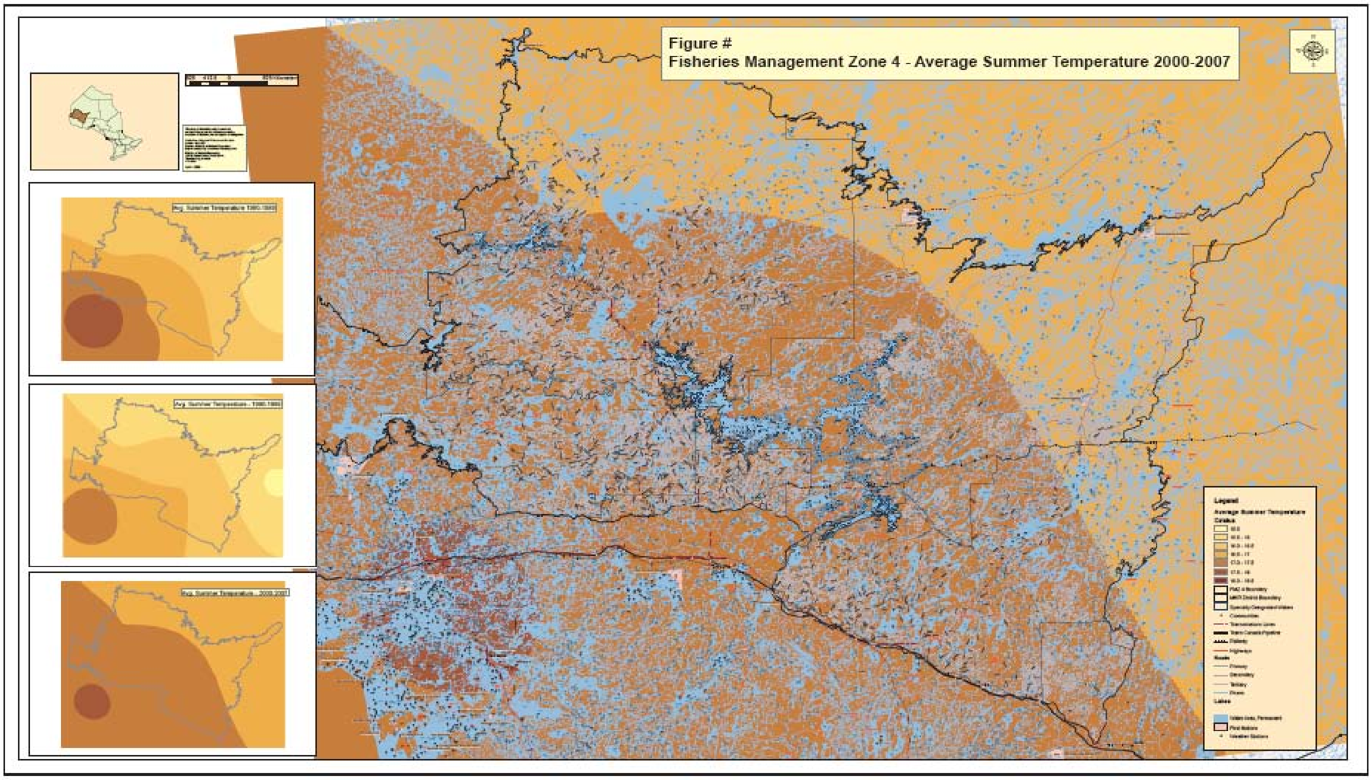

Figure 4. Average summer temperature 2000-2007 in FMZ 4.

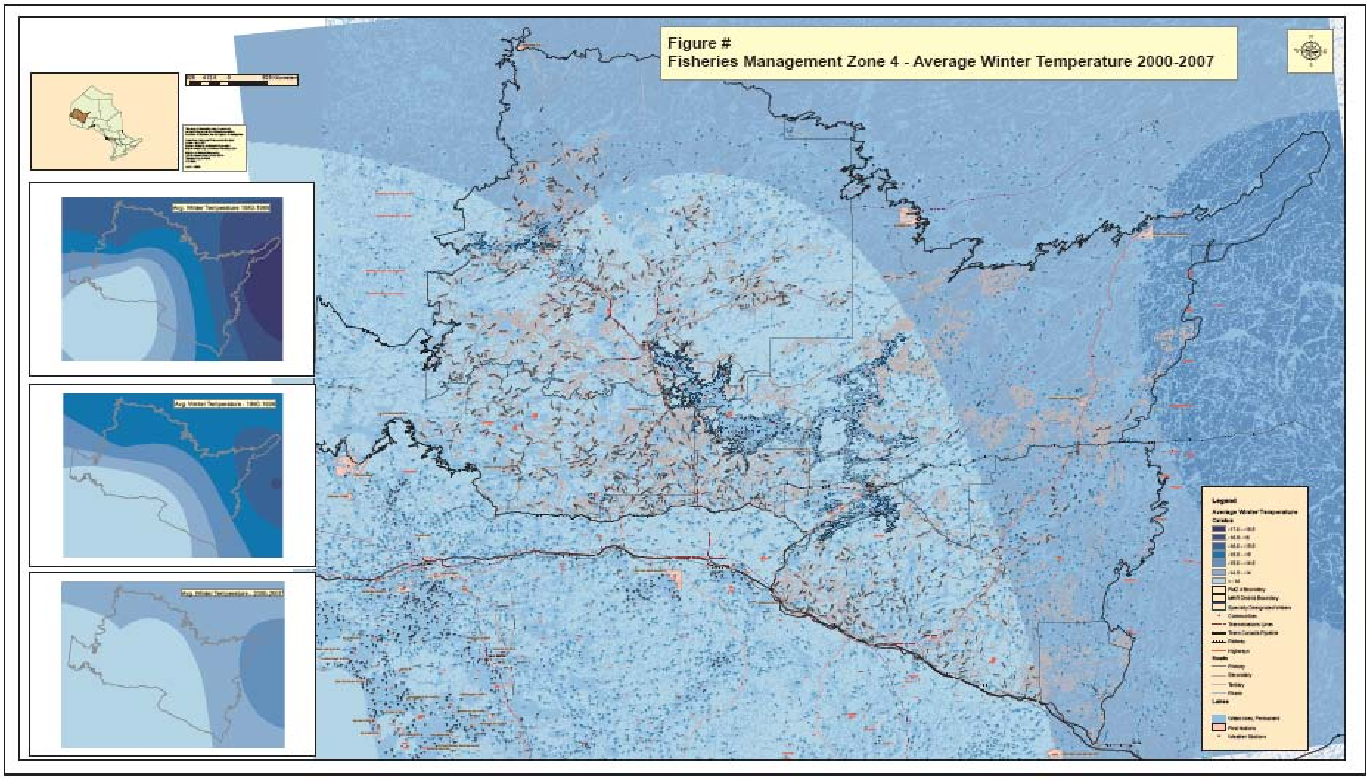

Figure 5. Average winter temperature 2000-2007 in FMZ 4.

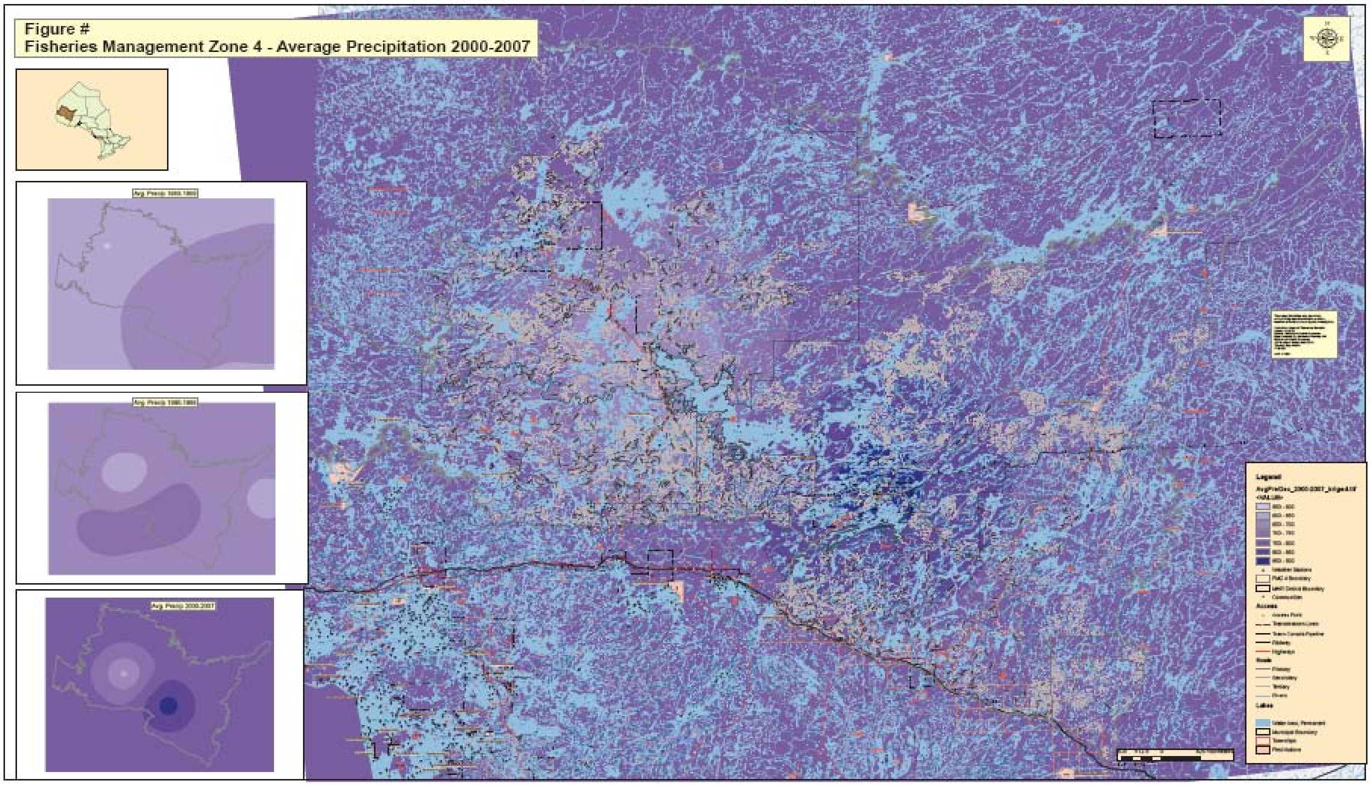

Figure 6. Average precipitation in FMZ 4 2000-2007

2.4 Access

In general, road based access to the fisheries of Fisheries Management Zone 4 is greatest in the southern portions of the Zone. Road density decreases towards the North (as well as in a couple areas on the eastern and western edges), leaving large remote regions that are primarily accessed by air and utilized by the fly-in tourism industry (Figure 7). Major highways that provide primary access include: 17, 105, 72 and 599. Over 28,000 kms of roads[4] extend from these main corridors, approximately 2/3 of which are classed as tertiary or operational roads. Most of these roads were built for the purpose of providing access to forested areas scheduled for cutting by forest management companies, but now also provide fisheries users with the most direct routes to fishing opportunities.

To illustrate this gradient of road based access Figure 7 shows the FMZ 4 landbase classified into 3 zones of relative road density: low, medium, and high (see Appendix 1 for road classification methodology). The majority (60%) of the Zone falls into the low density class, again found in the in the more northern and peripheral areas, while the medium and high density classes (each 20% of the overall landbase area) cover the southern and central areas of the Zone which are most closely associated with major communities and highway access.

[4] Due to various levels of roads data file completeness across the different OMNR Districts actual drivable roads in some areas may be overestimated or underestimated; however the broad trend of road densities across the Zone is accurate.

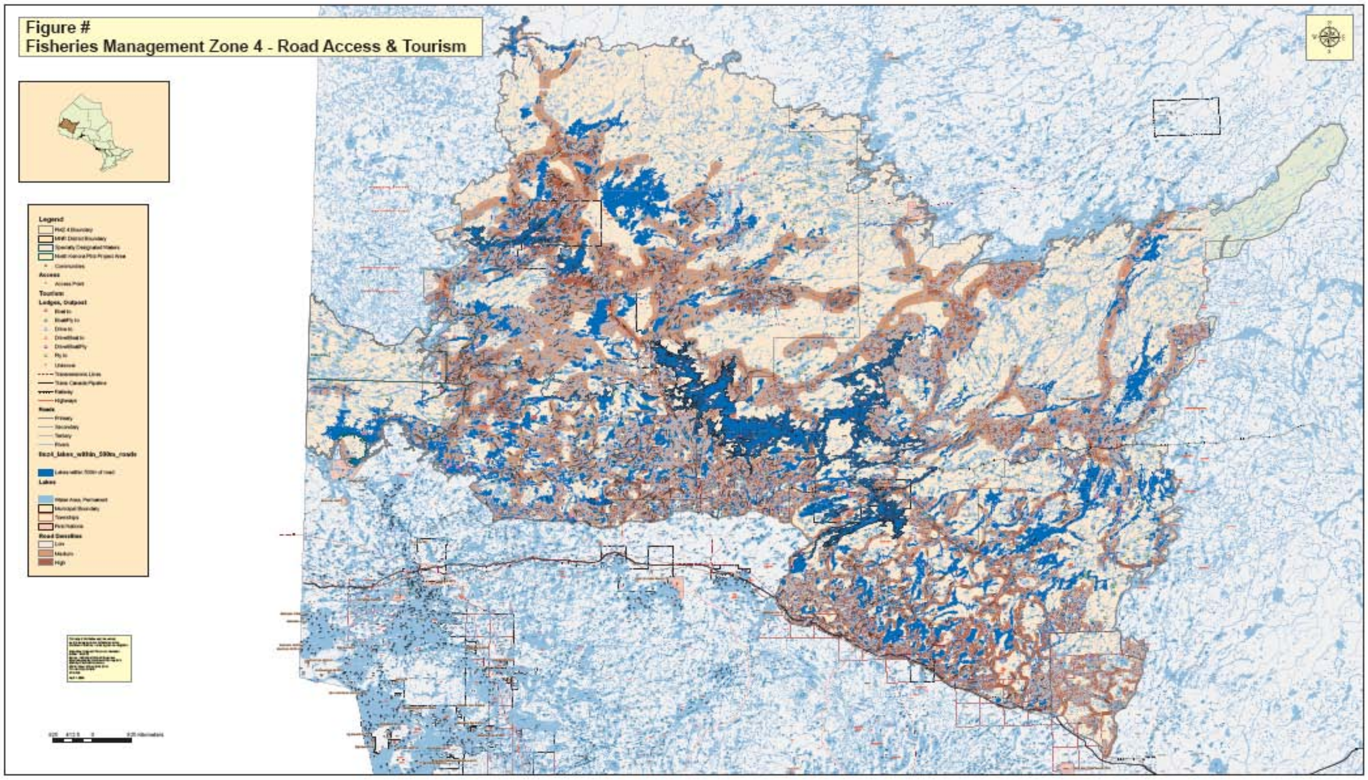

Figure 7. Map - Fisheries Management Zone 4 Road Access and Tourism

Over 8000 lakes in FMZ 4 are currently within 500m of a road, a distance that is considered accessible by anglers or other resource users (Hunt and Lester 2009). With increased use of all terrain vehicles (ATVs), the zone of influence of road based users may now be much wider than in the past. Increased access across an FMZ does diffuse angler effort over a large area, allowing for increased fishing effort (Hunt and Lester). Interestingly, while roads provide the means for users to benefit from the fisheries resource and an opportunity to diffuse angling pressure, increased access also results in higher exploitation and lower quality of fish in the long term (from an unexploited or low exploitation starting condition) (Hunt and Lester 2009). Lakes with lake trout are particularly susceptible to overexploitation and introductions of invasive or introduced species such as smallmouth bass following new access into an area (Kaufman *et al.* 2009). Access within an FMZ is a fine balance between accessibility and diffusion of fishing effort and the prevention of overexploitation and maintenance of sustainable fisheries resources. Lakes within FMZ 4 that are presently associated with medium and high density road zones may be currently most at risk to exploitation. Comparison of current road density data within FMZ 4 to the results from the 2009 Broad Scale Monitoring Program may provide additional data to examine present abundance of specific species (i.e. walleye, lake trout) to current user access within the zone.

There are few limitations to access for most users interested in reaching the majority of lakes and rivers across FMZ 4, these limitations include:

- Large blocks of private land in the Ignace Area owned by Wagner Ontario Forest Management Ltd., which require residents and non-residents of Ontario to purchase permits to use roads and landings.
- Crown land road use restrictions on forest access roads to preserve remoteness and meet Remote Tourism objectives. Access restrictions may be through natural re-vegetation, signage or gate as a condition of the FMP (Forest Management Plan). Specific road use restrictions can be found in Forest Management Planning Documents. Examples:
  - Trout Lake Forest; access restriction of Otter Road and Wenesaga Road.
  - Whiskey Jack Forest
    - Sydney Road closed to public travel to protect remote tourism as a condition of the North Kenora Pilot Project
    - Lennan and Asthetic Road closed (sign) January 1 – September 30.
    - Tide and Unexpected Road closed (sign) to public travel year round
  - North Kenora Pilot Project Area (see Section 6.4)
- Restrictions to access Ontario Parks and Protected Areas to a few specific entry/exit points to preserve remoteness (Scott Ellery pers comm.).

Access, or lack of access, to fisheries resources continues to be a contentious issue between different user groups across the Northwest. In the past, OMNR has restricted access to certain individual lakes or areas usually in association with land use (e.g. parks and protected areas) or socio-economic objectives (e.g. remote tourism). Real or perceived concerns about sustainability of fisheries or declining fishing quality tend to be linked with these decisions, however user conflicts are frequently the ultimate root of the problem as restricting or permitting access may benefit one group while negatively affecting others (Hunt et al. 2009). Creating or limiting access opportunities requires considerable planning. On one hand, reducing or restricting access to fisheries to meet fisheries quality objectives may lead to more user conflicts and problems with enforcement. Alternatively, increasing access may distribute fishing pressure across a zone, but may also create issues surrounding sustainability and fishing quality if fisheries are exploited (Hunt and Lester 2009).

As previously mentioned, maintaining or increasing road densities in areas of FMZ 4 with relatively lower fishing effort and numerous angling opportunities may be an effective way to spread out pressure and maintain high quality fishing opportunities throughout the zone. This was one of the objectives outlined in the Fisheries Management Plans for the Kenora, Red Lake, Sioux Lookout, Dryden and Ignace Districts from 1987 – 2000, which provide some historical management direction regarding the development of access throughout FMZ 4 (Table 3). Management direction to preserve remoteness, remote tourism opportunities or to limit access in areas of greater fishing pressure (i.e. near major roads and communities) were identified within the plans as areas where access would be limited or maintained. Areas of access development were also identified to distribute fishing pressure and provide additional angling opportunities for residential and non-residential anglers associated with the development of roads through forest harvesting activities. New opportunities for access may be explored during the management planning processes, however development would have to occur as part of a larger land use planning exercise that would need to consider other landbase users, policies and objectives, and would eventually form a linkage between Fisheries Management Zone planning and the Crown Land Use Policy Atlas (CLUPA).

Table 3. Direction for the limitation/maintenance or development of access in Fisheries Management Plans (1987 – 2000) for Kenora, Red Lake, Sioux Lookout, Dryden and Ignace Districts.

Fisheries Management Plan	Access Direction – Limit/Maintain*	Access Direction – Development*
Kenora District Fisheries Management Plan 1987 – 2000 (OMNR 1988)	• Division 12 Implement travel restrictions on roads accessing remote, high quality fisheries (Lennan Lake Road, Umfreville Road, Werner Lake Road) • Division 19 remote high quality fisheries.	• Division 10 manage for increased road access.
Red Lake District Fisheries Management Plan 1987 – 2000 (OMNR 1988)	• The Southern portion of Zone 37 (certain fisheries) limited entry.	• Zones 35, 37 and 38 Utilize roads developed in conjunction with the timber management planning process to assist in the provision of new fishing opportunities in the Southern portion of the District. Tactics for protecting tourism values are to be negotiated by the operators and timber companies.
Sioux Lookout District Fisheries Management Plan 1987 – 2000 (OMNR 1988)	• Division 30 (Lac Seul) Continue to apply existing access road guidelines. • Division 22 maintain remote characteristics of lakes with tourism development.	• Division 27 (English River), 28 (Savant River) Provide road accessible angling opportunities through timber management planning. • Exploration of an access point on the east end of Lake St. Joseph.
Dryden District Fisheries Management Plan 1987 – 2000 (OMNR 1988)	• Division 19 reserve areas for remote angling opportunities.	• Division 18 Plan the location of resource access roads to access underutilized lakes.
Ignace District Fisheries Management Plan 1987 – 2000 (OMNR 1988)	• Division 21 and 23 and 26 Manage for existing road accessible recreational opportunities. No new roads are proposed in the near future and are limited within the time frame of this plan. • Establish remote angling areas where road access will be prohibited or controlled: • Division 25 Seseganaga and Shikag Lakes • Division 26 area north of the Sturgeon River • Division 21 near Bending Lake	• Division 21 Some road access may be permitted to some warm water lakes to encourage fishing for alternate species such as smallmouth bass or whitefish. • Division 22, 25 Increase road accessible recreational opportunities for residents and tourism based non-residents to spread out pressure.

* Divisions are based on the 37 fishing divisions described for Ontario

3.0 Biological Description

3.1 Fish Communities

Fisheries management zone 4 is known to have at least 46 species of freshwater fish (Appendix 2) that are widely distributed throughout the lakes, rivers and streams. Fish diversity is spread across 15 different families. The most diverse group in zone 4 are the minnows (C*entrarchidae*) of which there are 15 species. Other diverse groups within the zone include perches (*Percidae*), suckers (*Catostomidae*), sunfish (*Centrarchidae*), and whitefish (*Coregoninae*). Popular sportfish within zone 4 include walleye (*Sander vitreus)*, northern pike (*Esox lucius*), lake trout (*Salvelinus namaycush*), brook trout (*Salvelinus fontinalis*) smallmouth bass (*Micropterus dolomieui*), muskellunge (*Esox masquinongy*), and lake whitefish (*Coregonus clupeaformis*). These species are distributed across the landscape of zone 4 in lakes, streams and rivers in a variety of unique groupings that can be summarized into community types based biotic, abiotic and spatial factors including temperature, lake size, productivity and trophic interactions between predators and prey (Jackson et al. 2001).

Fish community structure can be described and classified in various ways; in some cases communities have been named on the basis of the dominance of a particular species or group of species that are of economic value, a convenient approach for resource managers (Ryder and Kerr 1978). For the purpose of this background report and to reflect a landscape-scale approach to describing fisheries resources, fish communities in zone 4 will be classified broadly as cool water and coldwater assemblages with emphasis on dominant sport fish species for each community type. Cold water and cool water communities exist independently of each other in separate waterbodies within zone 4, and can also be found within the same waterbody depending on the morphology and productivity of the lake, river or stream. Definitions of cool water and cold water communities are based loosely on the productivity, temperature and species found within a waterbody, which lends to the wide diversity of cool water and cold water community assemblages found within the zone.

3.1.1 Cool Water Species

Cool water fish communities are found in highly productive, shallow waters and support species with an optimum growth temperature between 15-25°C, which includes sport fish such as walleye, northern pike, smallmouth bass and muskellunge (Scott and Crossman 1973). The majority of sport fish species within this community spawn during spring, though actual time of spawning depends on water temperature and latitude. In northern lakes, rivers and streams, spawning of sport fish species in cool water communities may occur later in the spring than in southern water bodies. Latitude can also affect growth of species of cool water sport fish. Though initial growth of walleye, northern pike and muskellunge is rapid, populations in northern Ontario exhibit slower overall growth rates, and take longer to reach maturity, then populations in the south (Scott and Crossman 1973). This is in part due to the greater number of growing degree days (GDD) which results in a longer growing season for cool water fish in southern water bodies, as well as the higher degree of exploitation in the south, which can shift populations towards earlier maturation (Sullivan 2003).

Coolwater species communities are the most abundant fish community within zone 4. Prevailing physical and chemical properties of the waterbodies within the zone allow for the second highest percent occurrence of northern pike and walleye in the northwest region, second only to zone 2 (Figure 8). Cool water lakes within the zone are widely and evenly distributed within the zone boundaries, and include a high number of large water bodies, including all of the Specially Designated Waters within zone 4 (Figure 8). In addition to the presence of walleye and northern pike, coolwater communities often also include yellow perch, white sucker and a wide variety of minnows (Brown 2007). In lakes with deeper waters (>8 m) lake whitefish, cisco (*Coregonus artedi*) and burbot (*Lota lota*) are also common species (Brown 2007). Though classified as a warm water species, smallmouth bass are present as a naturalized species in many cool water lakes, rivers and streams where they have been introduced within the zone. A further discussion on the introduction, distribution and spread of this sportfish species in zone 4 can be found in section 3.5.2.

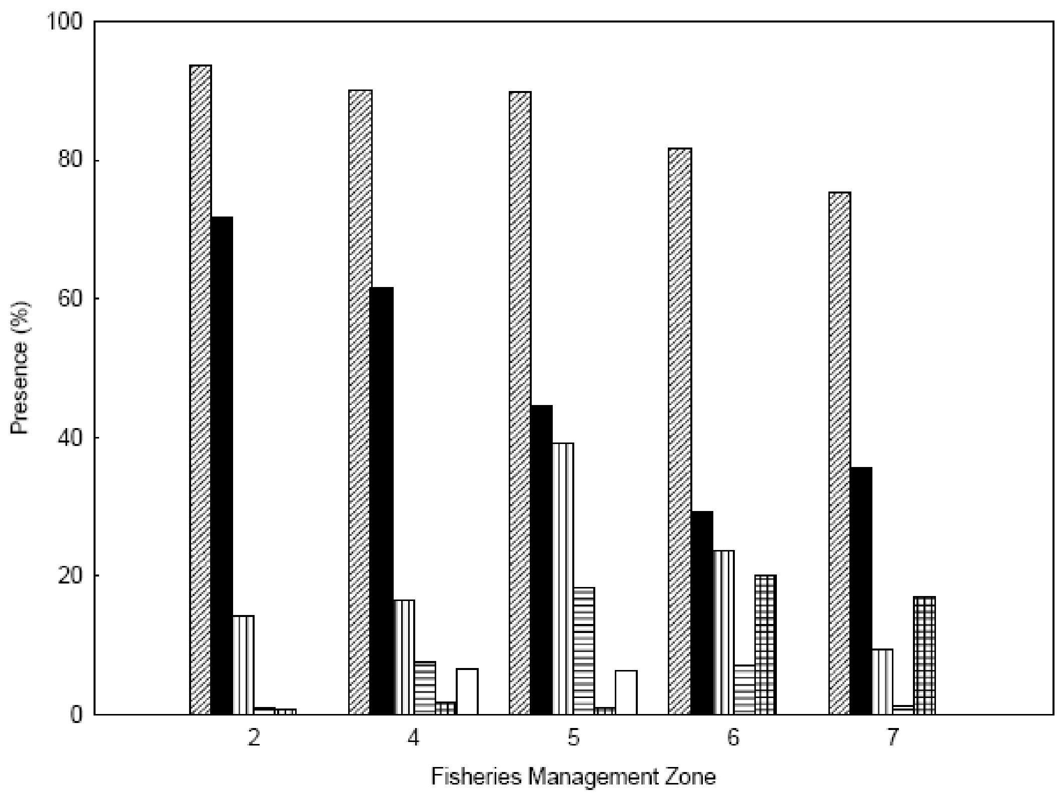

Figure 8. Percent occurrence of northern pike (diagonals), walleye (solid bars), lake trout (vertical bars), smallmouth bass (horizontal bars), brook trout (hatched bars) and muskellunge (open bars) in surveyed lakes by fisheries management zone (Cano and Parker 2005).

Distribution of cool water communities within zone 4 is relatively uniform within the boundaries of the zone (Figure 9). Cool water lakes within zone 4 include lakes such Longlegged, Pakwash, and Nungesser Lake with community compositions including walleye, northern pike, smallmouth bass, muskellunge and yellow perch, burbot, lake whitefish, and suckers. For the purpose of this background report, warm water species descriptions will include walleye, northern pike, muskellunge and yellow perch (sections 3.3.1, 3.3.2, 3.3.3, 3.3.4 respectively). Other species found in cool water communities will not be discussed within the scope of this report, with the exception of smallmouth bass which is described in section 3.5.2, and lake whitefish which is described in section 3.3.6.

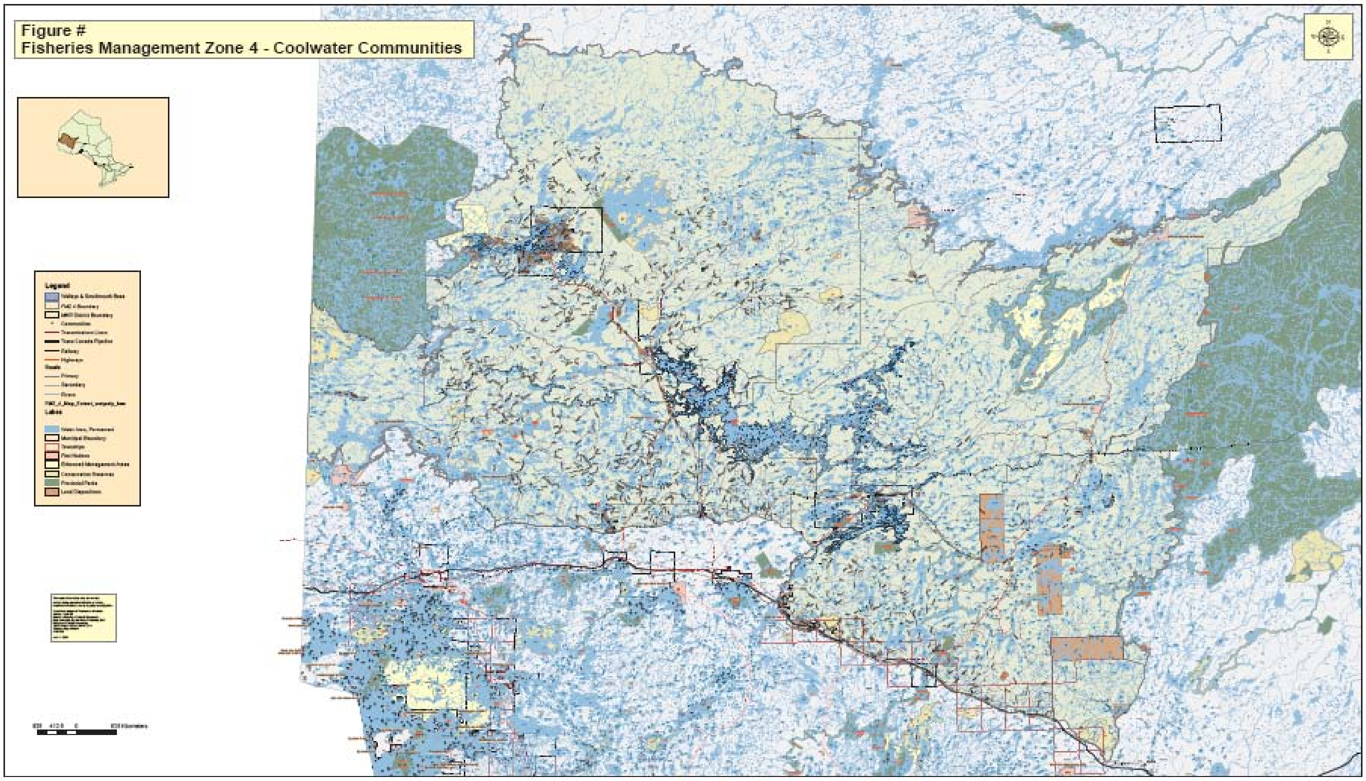

Figure 9. Map - Fisheries Management Zone 4 cool water fish communities distribution

3.1.2 Coldwater Species

Coldwater communities typically exist in less productive, deeper waters and supports species with an optimum growth temperature <15°C such as lake trout, lake whitefish, cisco and occasionally smallmouth bass and walleye. Cold water specific species, such as lake trout and lake whitefish, are restricted to the deep, colder portions of a waterbody during summer months when surface water temperatures become warm (Scott and Crossman 1973) however these species do make occasional forays to warmer, more productive waters to forage. These species are also unable to tolerate low oxygen environments, and factors that reduce deepwater oxygen concentrations, such as high nutrient input from agriculture or sewage point sources, cause declines in coldwater fish populations.

Cold water fish communities are common in zone 4 and are widely distributed within the boundaries of the zone (Figure 10). Cold water lakes within zone 4 include lakes such as Trout and Birch Lake. Communities found within cold water lakes can be diverse in terms of species assemblages and include lakes with containing both cool water and cold water species. In Zone

4 common species assemblages include lakes containing walleye and lake trout, lake trout and smallmouth bass, lakes with lake trout, walleye and smallmouth bass, as well as lakes that contain only lake trout (Figure 10). For the purpose of this background report, cold water species descriptions will include lakes containing lake trout (section 3.3.5) and lake whitefish (section 3.3.6). Other species found in cold water communities including walleye and smallmouth bass are discussed in further in sections 3.3.1 and 3.5.2 respectively.

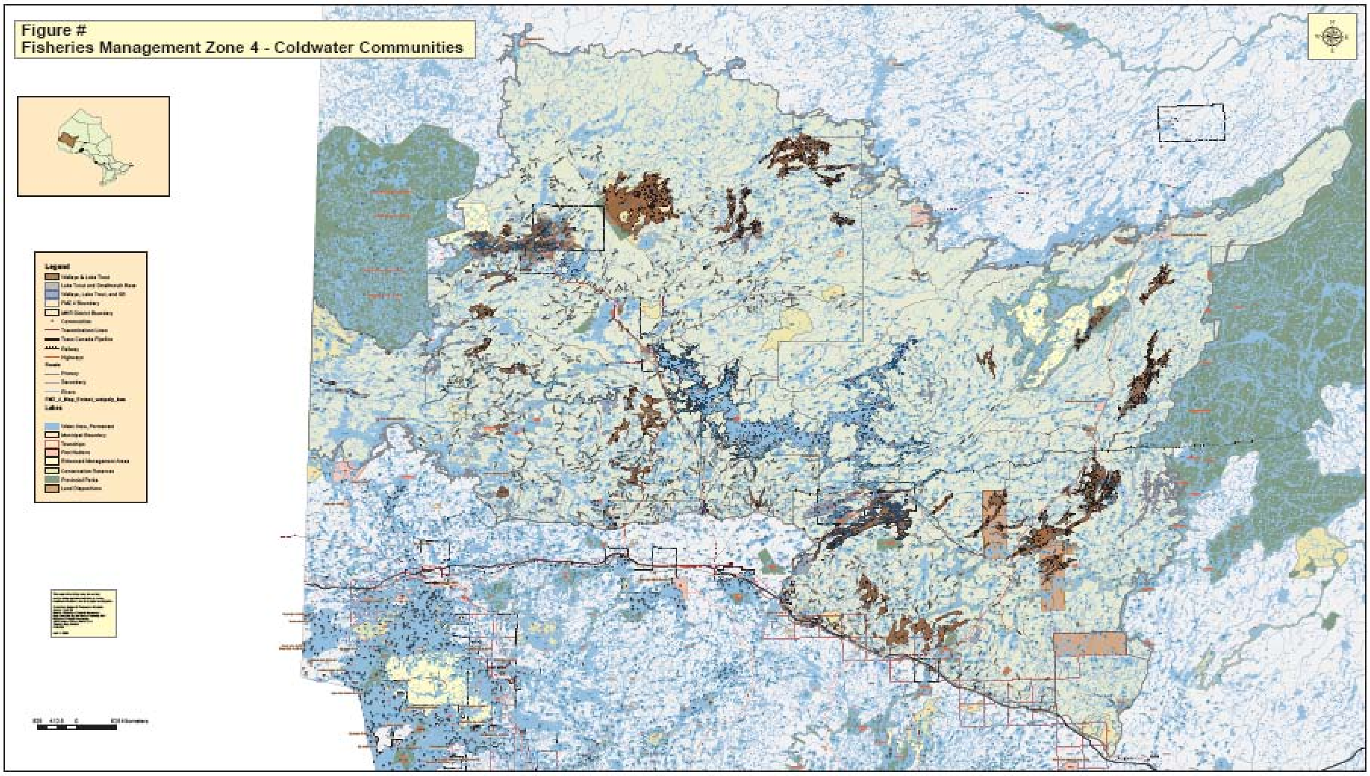

Figure 10. Map - Fisheries Management Zone 4 coldwater fish communities distribution

3.2 Productive capacity

The productive capacity (allowable yield) of fish-bearing waterbodies is an important biological concept in the management of fish populations. Lakes, rivers and streams have a limited capacity to produce fish that is directly linked to the productivity of that waterbody. Many factors influence productivity including climate (i.e. length of the growing season), nutrients, morphometry, natural disturbances on the landscape, forestry and other anthropogenic land use practices. By measuring a combination of these elements of productivity, an estimate of productive capacity can be developed. Knowledge of productive capacity for a group of waterbodies facilitates the setting of goals and objectives surrounding allocation and harvest and is the foundation of fisheries management.

The primary factors affecting productivity of inland lakes are; 1) temperature (measured by growing degree days (GDD); 2) nutrients measured by total dissolved solids (TDS) in the waterbodies which are influenced by geology, soils, topography, vegetative cover and hydrology; 3) morphology (physical characteristics); and 4) water clarity (measured by sechhi depth readings) influenced from dissolved organic matter and particulate matter. Table 4 displays the physical characteristics and associated fish communities typical of lakes found within Fisheries Management Zone 4, 5 and 6.

Growing degree days (GDD) are used to determine the intensity of the growing season by estimating the amount of heat accumulated annually during spring, summer and fall. Lake productivity is directly related to the number of growing degree days, longer growing seasons result in greater development opportunities for fish.

Table 4. Average lake characteristics and associated dominant fish communities for lakes in Fisheries Management Zone 4, 5 and 6 (Cano and Parker 2005)

FMZ	Dominant Fish Community	Mean Depth	Mean surface area	Water Clarity	MEI	Growing Degree Days
4	Walleye Northern pike	Intermediate	Medium	Stained	Intermediate	Warm
5	Walleye Northern pike Lake Trout Smallmouth Bass	Deep	Small	Clear	Low	Warm
6	Walleye Northern Pike Lake Trout Brook Trout	Intermediate	Small	Stained	Intermediate	Intermediate

Nutrients in lakes and rivers depend on the amount of rainfall, topography and soil characteristics of a waterbodies catchment basin (Wetzel 1975). The glacial history, vegetation types, fire and land use practices in FMZ 4 influence the total dissolved solids (TDS) found within its waterbodies. Lakes overlying ancient glacial lakes, such as those in Zone 4, have greater TDS since the finer particles found in lake sediments are more easily transported and absorbed by the water, while lakes overlying coarser materials have lower TDS levels. Organic inputs of carbon result from direct leaf fall and decomposing litter from surrounding vegetation. Large influxes of ash and other nutrients occur following fire disturbances and is an important source of nutrient input in boreal ecosystems. Anthropogenic activities such as forestry practices, agriculture and land clearing also increase nutrient input into lakes and rivers, however these loads can be overwhelming to aquatic ecosystems and often are associated with erosion, sedimentation and increased runoff. As the nutrient levels within aquatic ecosystems increase, so does the productivity of the system.

Lake morphology (lake area and depth) affects nearly all chemical, physical and biological parameters of a waterbody. Morphology is extremely varied and influenced by the mode of origin of the waterbody, water movement and material loading from the surrounding drainage basin. Deep lakes that contain a large volume of water relative to the surface area of the lake are less productive than shallow lakes where the volume to surface ratio is less. This is because shallow lakes with a lower volume of water relative to the surface area have a larger littoral zone than deep lakes with less surface area. This is important to aquatic communities as the littoral zone is the zone of greatest productivity in aquatic ecosystems. The littoral zone is the warm, shallow interface between deeper waters and terrestrial ecosystems where nutrient loading (i.e. from surface runoff, decomposing shoreline vegetation) is highest. In general there is an inverse relationship between mean depth and lake productivity (deeper lakes with less littoral zone tend to be less productive).

Water clarity is influenced by dissolved and particulate matter as well as dissolved organic matter. Turbid lakes with a low secchi depth reading tend to have greater total dissolved solids (TDS) and greater productivity. Lake trout lakes, for example, are generally clear, cold, nutrient poor lakes (low TDS) and light penetrates further into the water column, while walleye lakes tend to be coolwater lakes that contain more nutrients and have darker stained waters.

Simple and complex models utilizing many of the attributes described above (temperature, nutrients, lake morphology, water clarity) have been used to estimate productive capacity of aquatic ecosystems. The productive capacity of a lake can be described using a variety of tools that are often specific to identifying fish production of a particular species or species assemblage. The most common estimate of productive capacity is the Morphoedaphic Index (MEI) which uses lake morphology and the physical/chemical makeup in a simple ratio to predict productive capacity for a wide range of freshwater fish species. MEI = Total Dissolved Solids (TDS)/ mean depth (Ryder 1965). The Lake Trout Life History Model (Shuter *et al.* 1998) uses lake morphology (lake size) and total dissolved solids, two easily measured water body characteristics, to predict productive capacity of lake trout in Ontario lakes. More recently, Lester *et al.* (2004) described a method for determining walleye yield for Ontario lakes based on Thermal-Optical Habitat Area (TOHA) a combination of physical and chemical characteristics including lake morphology, lake strata, water clarity (secchi) and temperature (measured by the number of GDD > 5°C). Inputs required for all three models are gathered routinely during lake surveys that in the past have followed the Aquatic Habitat Inventory Manual (OMNR 1987). The new methodology surrounding the Broad Scale Monitoring Program will collect this same information, however it extends beyond estimating lake specific productive capacity to examining aquatic community dynamics and changes over time at a landscape scale.

Aquatic Habitat Inventory assessment data associated with FMZ 4 is limited as past management practices dictated a lake specific approach that focussed on monitoring problem lakes or lakes with issues such as high pressure/exploitation. Historically within zone 4, lakes requiring monitoring due to exploitation issues were mainly SDW's (Red Lake/Gullrock Lake, Lac Seul, Big Vermillion Lake, Pelican Lake, Botsford Lake, Abram Lake and Minitaki Lake) as well as a small number of additional lakes. As a result, the majority of assessment data is associated with the SDW's and other waterbodies with problem fisheries and is therefore not representative of the status of the entire zone. Introduction of the broad scale monitoring program is significant as it will provide much-needed information on a large number of lakes within a zone, taking a landscape approach to assessment rather than a lake-specific approach. Collection of data in this manner will provide a random sample of lakes within the zone which will be repeated every 5 years, allowing for a more robust data set from which a representational analysis of productive capacity for the entire zone can be developed.

Data that does exist for zone 4 in non SDW waterbodies are from monitoring projects that aim to collect species-specific data on popular sport fish such as lake trout and walleye. Incidental catches provide information on additional species and species assemblages, though caution must be used when examining these data. Incidental catch data may not be representative of populations of non-target species.

3.3 Biological Status

Since the development of standard monitoring techniques, investigations into the status of fisheries within the province of Ontario have increased. Techniques were developed primarily for walleye, lake trout and brook trout populations and include FWIN (Fall Walleye Index Netting), SLIN (Spring Littoral Index Netting), SPIN (Summer Profundal Index Netting), and summer and winter creel surveys (Table 5). The results of these surveys across the Northwest Region were used by Cano and Parker (2006) to summarize the status of fisheries resources. Their results will be presented in this section as it represents the most recent data analysis for the status of fisheries resources in FMZ 4.

Table 5. Fisheries assessment programs in Northwestern Ontario, methodology and application.

Assessment in Zone 4	Methodology	Application
Aquatic Habitat Inventory (AHI)	Data collection focuses on a variety of inventory data including lake morphology (bathymetry), water chemistry, and fish communities (gill net, seine net, electrofishing, etc.; OMNR 1981). Data collection techniques in the AHI may not be the same year to year or between waterbodies.	AHI is no longer in use as it was not a standardized monitoring program. It has been replaced by other monitoring programs such as index netting. AHI was used to monitor individual lakes by acquiring basic chemical, physical and biological conditions. AHI was not intended to answer complex questions or solve problems for long-term management, and was not designed as an effectiveness monitoring tool for the adaptive management process (OMNR 1981).
Fall Walleye Index Netting (FWIN)	FWIN sampling occurs in the fall when surface water temperatures are between 15°C and 10°C. Nets are set for a period of 24 hours and gillnets have 8 mesh sizes (25 to 152 mm); each mesh panel is 1.8 m deep and 7.6 m long. Nets are set perpendicular to the shore. Sites are randomly selected from two depth strata (2-5 m and 5-15 m; OMNR 2002).	The main objective of FWIN index netting is to assess the relative abundance of a fish stock and provide other biological measures or indicators of the target populations status. Data from a FWIN survey is standardized, and as a result can be used to compare stock status over time and/or between lakes for long-term management planning.
Spring Littoral Index Netting (SLIN)	SLIN sampling occurs in spring after ice out when the water temperature is < or = to 13°C. Nets are set for 90 minutes in the littoral zone of a lake during the spring. Nets of six panels each of three small mesh sizes are used (38, 54 and 61 mm). Mortality is low due to gillnet size and 90 minute net sets. Net locations are selected randomly on a daily basis. Gangs are set perpendicular to the shoreline at a starting depth of 2.5 m and extend no deeper than 60 m (OMNR 1999).	SLIN was designed to assess the relative abundance of lake trout (and/or brook trout) in a lake at a given time. The mean number of individuals caught per unit of fishing effort (CPUE) is used as an indicator of abundance. Index values can be compared over time and between lakes as long as the same survey methods have been employed year to year and between lakes (OMNR 1999).
Summer Profundal Index Netting (SPIN)	SPIN sampling occurs in the summer. Nets are set for 90 minutes in the sublittoral zone of a lake after thermal stratification. Three small mesh nets are used. Mortality is low due to gillnet size and 90 minute net sets. Net locations are selected randomly on a daily basis. Three depth strata are sampled and gangs are set perpendicular to the shoreline at a starting depth of 2.5 m and extend no deeper than 60 m.	The SPIN program is very similar to the SLIN index netting program, however is designed to assess lake trout populations during the summer. To assess the relative abundance of coldwater fish species in lakes.

Creel	The MNR conducts routine angler creel surveys to collect data on angler harvest, effort and catch characteristics. These surveys estimate angler effort, catch, harvest and yield as well as target species effort, catch rate, harvest rate, size and age distribution of the harvest. Creels may be completed in the winter or summer. MNR representatives may conduct creels individually or they may be conducted by aerial survey.	Creel surveys are an important tool in describing the use of the resource, but are not necessarily good at measuring populations of fish species. Creel data is often associated with index netting programs.
Assessment in Zone 4	Methodology	Application
Fish Observations	In-field observation of site-specific fish behaviour; i.e. spawning activity. No specific methodology.	In some instances, observational data can be collected to provide information on the fishery. These data can be used to address specific management questions. It is difficult to use this data to assess abundance of populations, but fish observation data is effective at collecting site-specific information to aid in the identification of priority areas for habitat rehabilitation/creation and best management practices for water flows and levels.
Broad Scale Monitoring	Combination of two types of gillnets: “Large Mesh” gillnets that target fish larger than 20 cm and “small mesh” gillnets that target smaller fish. Lake selection is comprised of randomly selected “fixed lakes” which are selected on a regular basis (every 5 years). Fixed lakes are also selected to represent specific species in the zone (walleye, lake trout, brook trout). These lakes provide data to assess both the current state of the resource as well as changes to the fishery over time. In addition “variable lakes” are also selected which are used to provide information on overall fisheries status across the zone. These lakes are selected randomly with each sampling cycle. Both fixed and variable lakes are stratified by size.	A robust and broad monitoring strategy that provides information on fisheries from a landscape perspective. Data can be used from fixed lakes to monitor the fisheries resources over time, however variable lake data also provides a current “snapshot” of the state of the resource. Broad scale monitoring has a diversity of applications that range from state of the resource reporting to long-term scientific research.

3.3.1 Walleye

The standard assessment technique developed for walleye populations is Fall Walleye Index Netting (FWIN) developed by Morgan et al. (2000). This technique is a lethal sampling methodology which provides the advantage of estimating fecundity based on identification of sex and maturity of sampled fish. Non lethal techniques have been developed, but their use tends to be restricted to lakes where lethal sampling is undesirable.

Walleye (*Sander vitreus* formerly *Stizostedion vitreum*) are widely distributed within waterbodies across the zone within FMZ 4 (Figure 11). Fall Walleye Index Netting (FWIN) projects that target walleye have been the primary methodology used to assess walleye populations in the province of Ontario by the OMNR (Morgan et al. 2003). Catch rates and biological data collected from FWIN studies provided a standardized view of the abundance and health of walleye populations and have historically been completed on a lake-by-lake basis in Northwestern Ontario. The primary diagnostics utilized from FWIN monitoring are: catch per unit effort (CUE) expressed as the number of walleye per net, age of maturity, growth rate, and the number of age classes within the sampled population (Morgan et al. 2003).

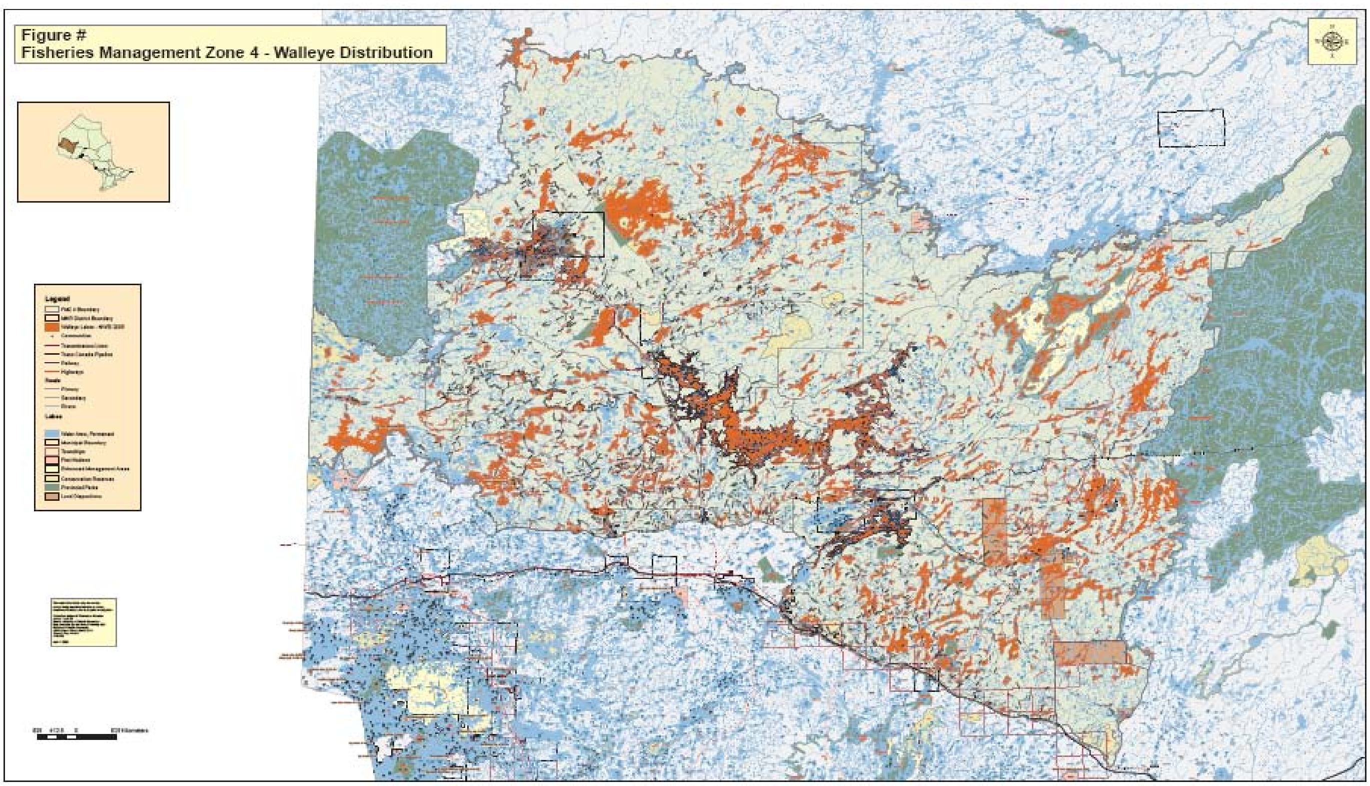

Figure 11. Fisheries Management Zone 4 walleye distribution

In FMZ 4, a total of 45 FWIN projects have been completed on 39 lakes without special regulation (Appendix 3). Forty of those FWIN projects were summarized in Cano and Parker's report (2005) characterizing sport fish populations and exploitation for the Northwest Region. Data on walleye productivity and overall health within the zone is limited and was largely collected to monitor walleye populations of the SDW's and problem lakes within zone 4. Data from lakes without special regulations indicates FMZ 4 has the highest mean catches (CUE) for walleye of any of the zones within Northwestern Ontario, though this difference is not significant (Figure 12). Walleye CUE for FWIN netting projects completed within zone 4 ranged from 1.3 walleye/net to 28.2 walleye/net with an average of 15.8 walleye/net for lakes without special regulations (non-SDW's). Further partitioning of walleye mean catches to express indices of maturity based on total length for the entire Northwest Region, shows that male walleye generally mature at a total length of 350 mm while females mature at a total length of 450 mm (Cano and Parker 2005). Catches of walleye based on these total length divisions (350 mm and 450 mm) showed trends similar to those for total CUE and on the whole were higher for both length classes in FMZ 4 then any of the other zones (Cano and Parker 2005).

Mean age, number of age classes and maximum age of fish sampled through the FWIN program provide indicators of a population's ability to reproduce and sustain itself. FMZ 4 had the second highest mean number of age classes greater than 10 years in lakes without special regulation indicating that populations in FMZ 4 have a greater number of older fish than other FMZ's (6, 5 and 7) in the Northwest Region (Cano and Parker 2005). Mortality rates in zone 4 were also lower than zone's 6, 5 and 7, though not as low as mortality rates in zone 2 (Figure 13).

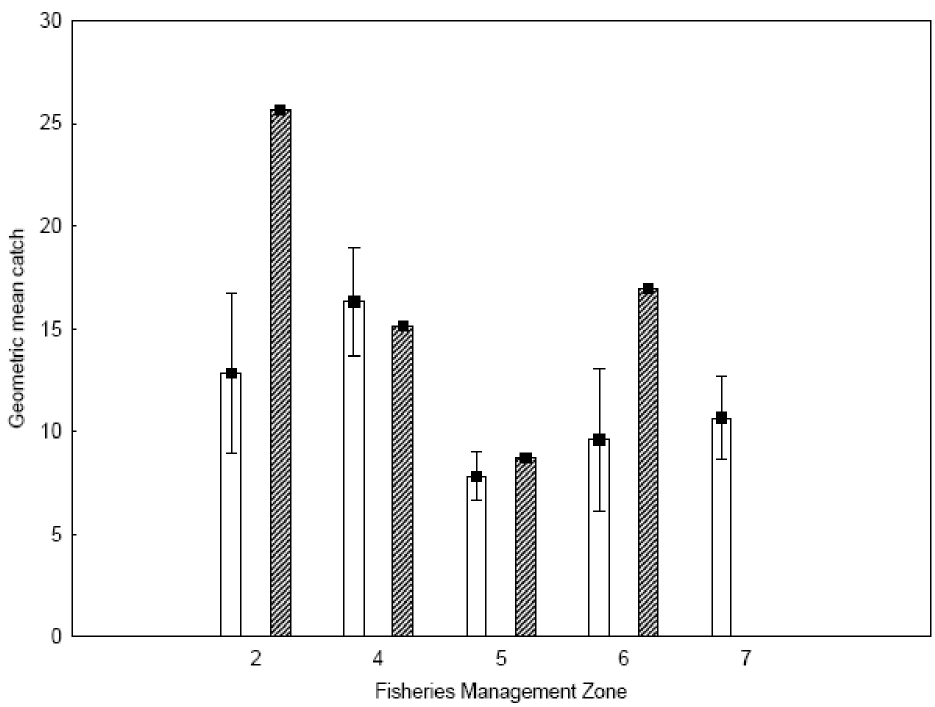

Figure 12. FWIN walleye catch per unit effort (CUE) by fisheries management zone in specially designated waterbodies (shaded bars) and lakes without special regulation (open bars). Error bars indicate 95% confidence intervals.

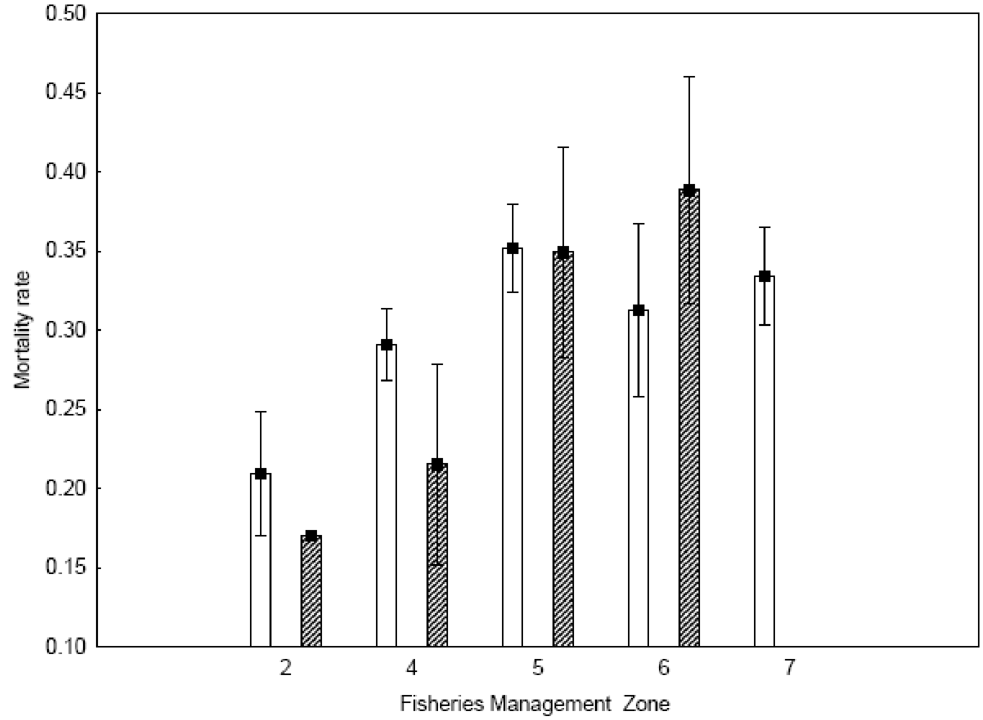

Figure 13. Mean walleye mortality by fisheries management zone in specially designated water bodies (shaded bars) and lakes without special regulation (open bars). Error bars indicate 95% confidence intervals.

In summary, walleye abundance as measured by walleye CUE from the fall walleye index netting projects in zone 4 were the second highest observed in the Northwest Region (Figure 12). Walleye within zone 4 also had the second highest number of age classes greater than 10 years in lakes without special regulations, suggesting these populations are relatively long-lived compared with the rest of the northwest Region, possibly due to less exploitation. Total mortality was low in zone 4 compared to most of the other zones in the northwest which also suggests lower exploitation within the zone. Findings from Cano and Parker (2005) suggest that walleye populations in FMZ 4 are stable and, though not statistically significant, appear to be healthier than other walleye populations within the Northwest Region.

3.3.2 Northern Pike

Northern pike (*Esox lucius*) are an important predatory fish species found in cool water habitat throughout Ontario. Northern Ontario populations are slower growing and longer lived then those in southern Ontario. Sexual maturity in northern populations is not reached until 6 years for females and 5 years for males, with southern populations reaching maturity at 3-4 years and 2-3 years respectively (Scott and Crossman 1973). Females of this species are typically larger and longer lived then males.

Northern pike are the most abundant sport fish species found in zone 4 and are widely and evenly distributed throughout the zone (Figure 14). No standardized sampling technique currently exists that targets northern pike, however this species has been sampled incidentally through the FWIN protocol as they are susceptible to the gill nets used in the monitoring process. However, it must be noted that northern pike are often found entangled in the small mesh where prey species are found, which suggests these fish may not be encountering sampling gear randomly.

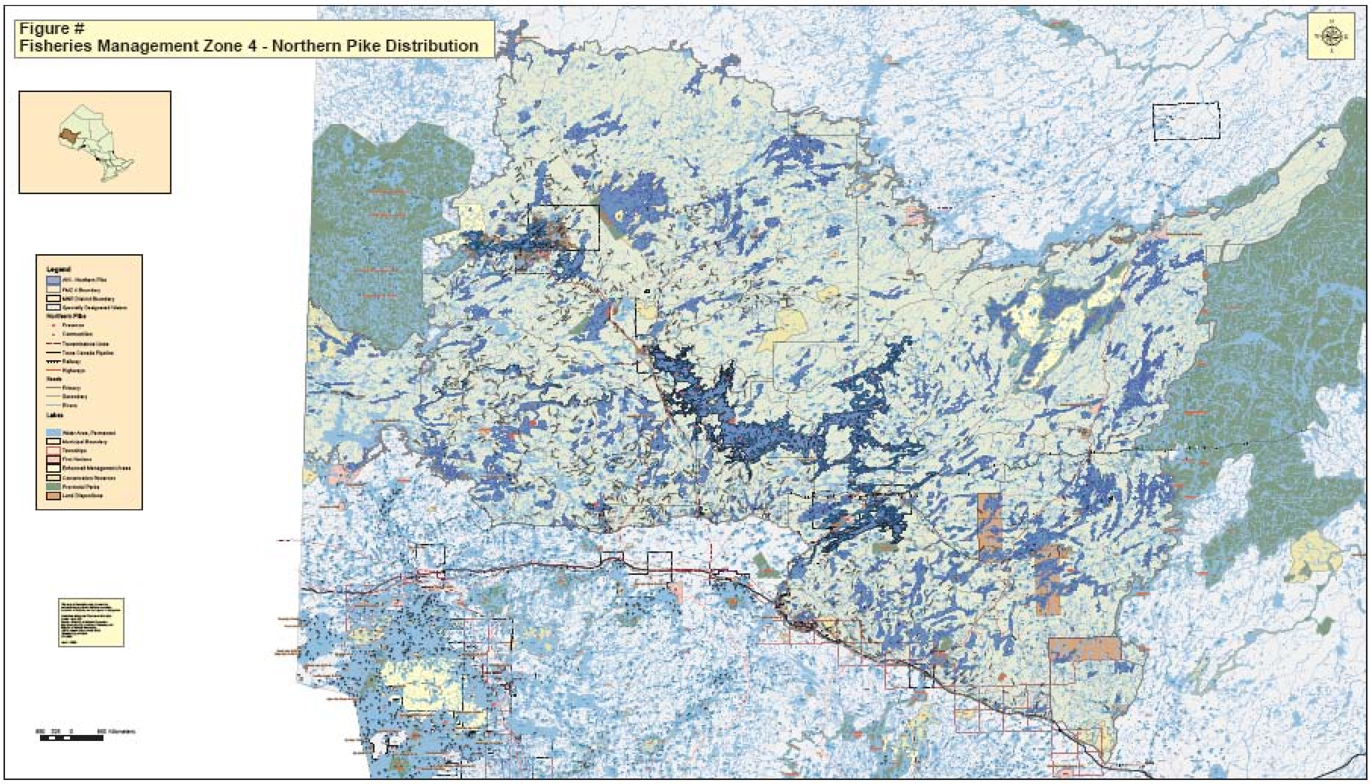

Figure 14. Fisheries Management Zone 4 northern pike distribution

Based on results from FWIN data, northern pike abundance in zone 4 was the second highest abundance of the zones in Northwestern Ontario, second only to zone 2 (Figure 15). Catch per unit effort (CUE) averaged 2.3 per net for lakes without special regulation within zone 4 (Cano and Parker 2005). Average age of northern pike in lakes without special regulation within zone 4 was 4.2 years, which was not significantly different from other zones within the Northwest. The mean total length of northern pike within the zone was 610 mm which was about the average for the Northwest Region. Mean mortality of female northern pike in zone 4 was higher in SDW's than any other zone with an average mortality rate of 48%. Mortality of female pike in non-SDW lakes was similar to all other zones (31%). Mortality rate of female pike in SDW lakes is currently higher than the provincial benchmark of 36% calculated by Malette and Morgan (2005), but lower then the SPOF 15 mortality rate suggestion for the province (65%) (OMNR 1983). This data does need to be interpreted with caution since the method used to collect the data was developed for indexing walleye populations and not designed to target northern pike. Based on the data collected, and considering this caveat, northern pike populations in zone 4 appear to be similar if not more robust than other zones within the Northwest Region.

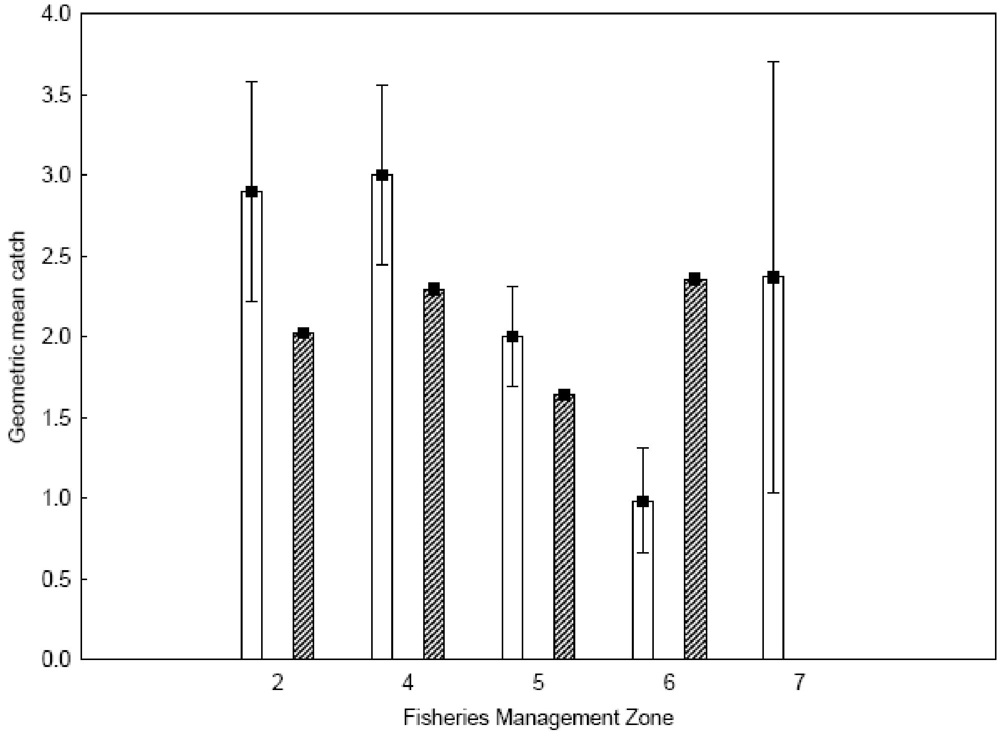

Figure 15. FWIN northern pike catch per unit effort (CUE) by fisheries management zone in specially designated waterbodies (shaded bars) and lakes without special regulation (open bars). Error bars indicate 95% confidence intervals.

3.3.3 Muskellunge

Muskellunge (*Esox masquinongy*) is a large, predatory fish found in coolwater habitats with heavy vegetation. This species exhibit sexual dimorphism (physical difference between males and females) in growth, females grow faster, are larger in all age classes and live longer than males; consequently all trophy-sized fish within populations are generally large, older females. Growth of muskellunge, and in particular females of trophy size, appears to be related to availability of suitably sized prey. As a result, fish of trophy size are not possible in all lakes where muskellunge occur, as growth is limited in lakes where there is an abundance of small prey and fewer large-bodied prey species (Scott and Crossman 1973).

Fisheries management zone 4 and zone 5 are the only zones in Northwestern Ontario to have populations of muskellunge within their borders (Figure 16). In zone 4, distribution of muskellunge is limited mainly to cool water lakes and rivers in the western and southern portions of the zone. Data on muskellunge within FMZ 4 is very limited, and knowledge of this species within the zone is largely presence/absence data acquired through incidental catch from FWIN projects. To date there are no standardized monitoring protocol that target this fish species within the province.

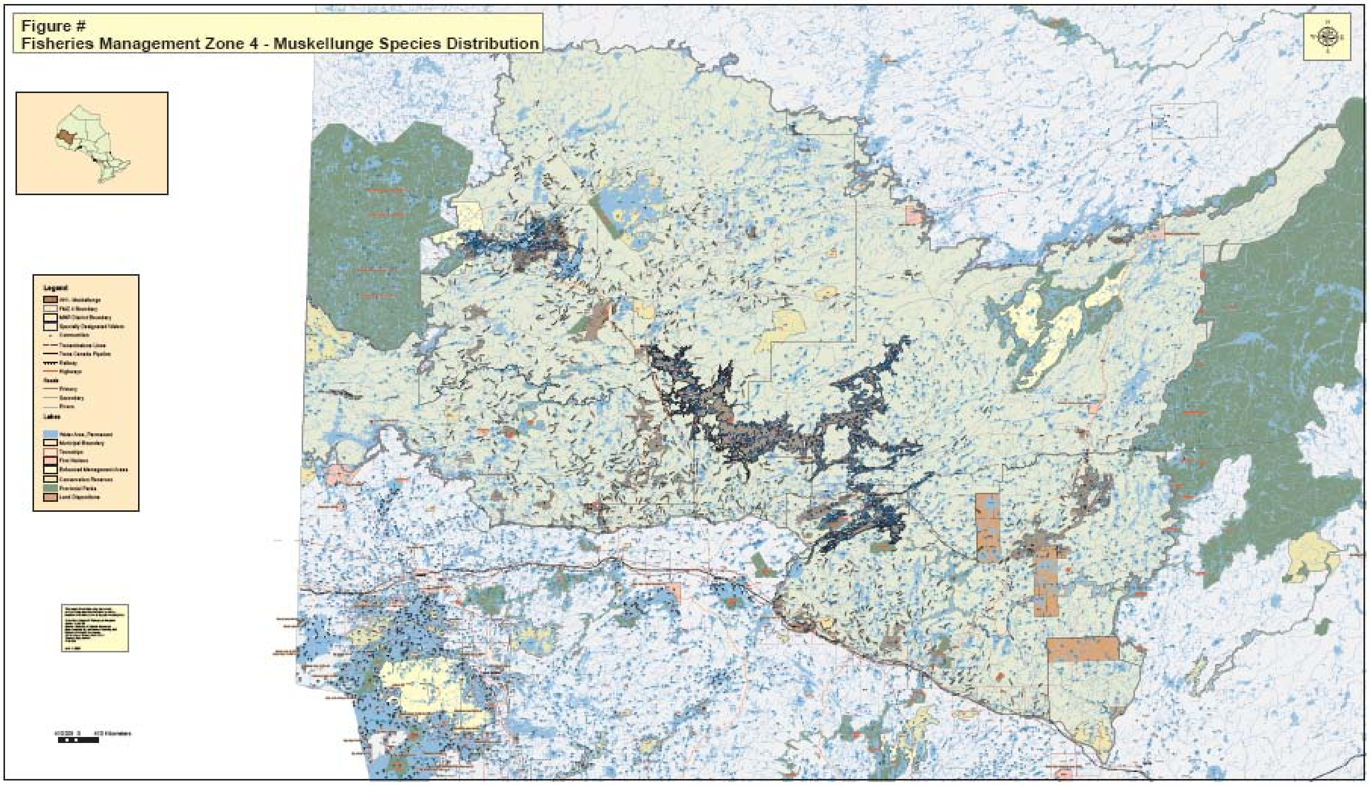

Figure 16. Fisheries Management Zone 4 muskellunge distribution

3.3.4 Yellow Perch and Smallmouth Bass

Other cool water sport fish within zone 4 include yellow perch and smallmouth bass, both of which are valued sport fish that are widely distributed in zone 4. A detailed discussion of smallmouth bass can be found in section 3.5.2. Yellow perch (*Perca flavecens*) is found in many of the cool water lakes in association with walleye and northern pike and is an important prey species in cool water communities (Scott and Crossman 1973). Incidental catches of yellow perch do occur during FWIN sampling projects, however sampling techniques are not designed to target this species. As a result, data on yellow perch is not representative of population status within the zone, and only reflects presence/absence of this species in sampled lakes. The new monitoring protocol associated with the broad scale monitoring program, including the use of equipment and methodology designed to sample near-shore fish communities, will provide information on population status of yellow perch within the zone.

3.3.5 Lake Trout

Lake trout (*Salvelinus namaycush*) are the third most frequent sport fish species in FMZ 4 (Figure 17) and are found primarily in deep cold lakes within zone 4. Populations of lake trout within the zone are diverse, some may exist exclusively as the top predator in association with other cold water fish species (i.e. lake whitefish, cisco), they may be found in small cold waterbodies with little to no additional fish community structure where they feed on zooplankton and invertebrates, and they may also be found in waterbodies containing both cool water and coldwater habitat where they exist alongside other predatory fish species such as northern pike and walleye (Scott and Crossman 1973). All of these community types have the capacity to produce sustainable lake trout populations; however it is within the simple cold water fish communities often found in small, deep lakes that lake trout populations perform best in the absence of cool water competitors and predators (Vander Zanden et al. 1999).

Lake trout are able to survive in environments with low productivity due to a variety of unique adaptations such as slow growth, late maturation, longevity and large body size that allows them to survive on limited resources. They have also adapted a highly flexible and opportunistic feeding behaviour and can shift their forage from zooplankton to insect larvae to fish depending on the availability of prey. As a result, lake trout may be found at various levels within the food chain depending on the community of prey within a waterbody (Vander Zanden and Rasmussen 1999). Lake trout that are found in lakes with prey fish species such as cisco or yellow perch are piscivorous (fish eating), while lake trout found in lakes without prey fish species are planktivorous (zooplankton eating) and are generally smaller and have lower growth rates. Despite such plastic foraging behaviour, lake trout are very susceptible to disturbances and populations in Northwestern Ontario have been impacted over the years by non-native fish introductions, eutrophication (increased productivity due to nutrient runoff from agriculture or sewage), and overexploitation.

Lake trout monitoring by the OMNR has been composed of two monitoring protocols; spring littoral index netting (SLIN) and summer profundal index netting (SPIN). Both of these projects have been carried out to a much lesser extent in the Northwest Region than FWIN projects. In addition, data is difficult to compare on a year to year basis within these projects due to differences in data collection protocol over time. As a result, the current status of lake trout within zone 4 is much less clear than the status of cool water species such as walleye or northern pike. In total 5 completed SLIN projects and no completed SPIN projects were included in the Cano and Parker report (2005). An additional 8 SLIN projects on 4 lakes exist for zone 4, as well as an additional 3 SPIN projects, however these results are not included in the zone averages found in Cano and Parker (2005) (Appendix 4).

To date, there is a significant data deficiency for lake trout within zone 4. The broad scale monitoring program that was initiated in FMZ 4 in 2009 will provide some much needed data benchmarking of the current condition of lake trout populations which will contribute to filling this gap. Additional monitoring efforts that will be conducted on a 5 year schedule will further contribute to this data set and provide management teams and the Advisory Council with quality spatial and temporal data on the status of lake trout to guide future management decisions.

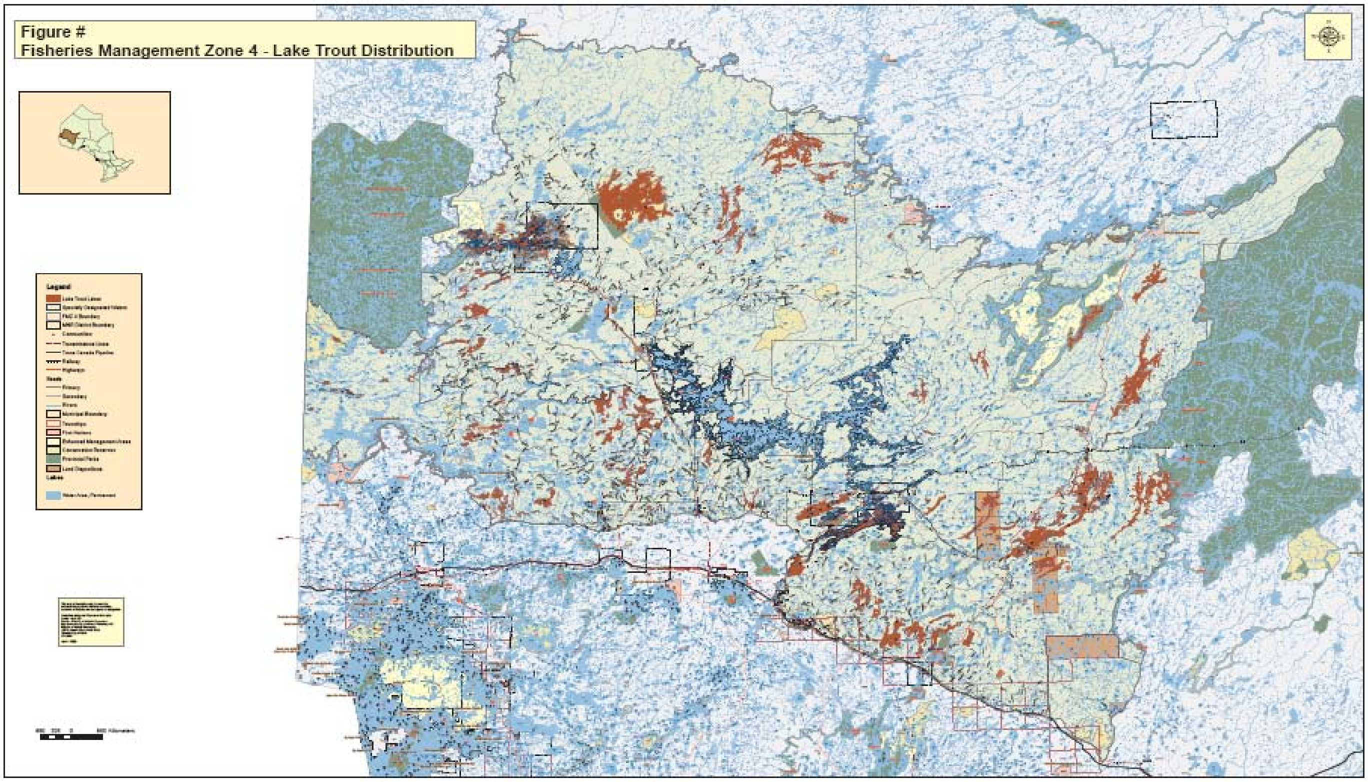

Figure 17. Fisheries Management Zone 4 lake trout distribution

3.3.6 Lake Whitefish

Lake Whitefish (*Coregonus clupeaformis*) are a widely distributed species within FMZ 4 (Figure 18). An important sport and commercial fish species, lake whitefish are found in both cool water and cold water communities, though for the purpose of this report they have been classified within the cold water fish community as they cannot tolerate warmer waters in the summer months, and descend into deeper water (Scot and Crossman 1973). Data on lake whitefish within FMZ 4 is very limited, and knowledge of this species within the zone is mainly from incidental catch data from FWIN, SLIN or SPIN projects and reported catch from the commercial fishing industry. To date there are no standardized monitoring protocol that target this fish species on inland lakes.

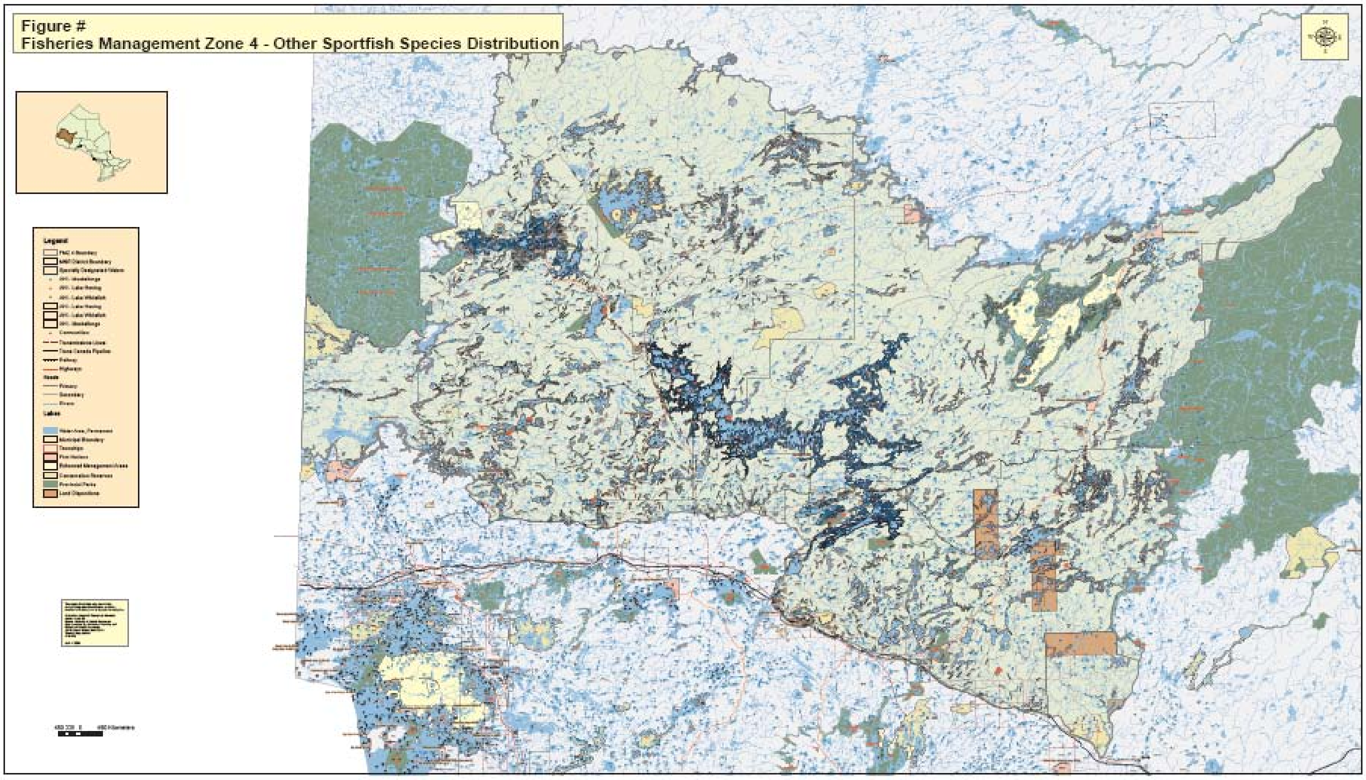

Figure 18. Fisheries Management Zone 4 other sportfish species distribution

3.4 Species at Risk (SAR)

The Endangered Species Act, 2007 (ESA 2007) came into effect on June 30, 2008 and provides protection to species listed as extirpated, endangered or threatened on the Species at Risk Ontario (SARO) list. The ESA Act prohibits damaging or destroying the habitat of any species designated as threatened or endangered. In addition, killing, capturing and possessing a threatened species is prohibited. The ESA requires that a recovery strategy be prepared for a species within 3 years of its designation. There are currently two fish species within FMZ 4 that are on the SARO list, lake sturgeon (*Acipenser fulvescens*) and shortjaw cisco (*Coregonus zenithicus*) (Appendix 5).

3.4.1 Lake Sturgeon

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has proposed eight designatable units (DU's) for lake sturgeon nationally (Figure 19). Two of these units, the Red-Assiniboine Rivers-Lake Winnipeg (DU 4) and the Winnipeg River – English River (DU5), and part of the Southern Hudson Bay – James Bay Lowlands (DU7) overlap FMZ 4. The lake sturgeon populations are considered "endangered" within these designatable units. The "endangered" designation indicates that the species is facing imminent extirpation or extinction.

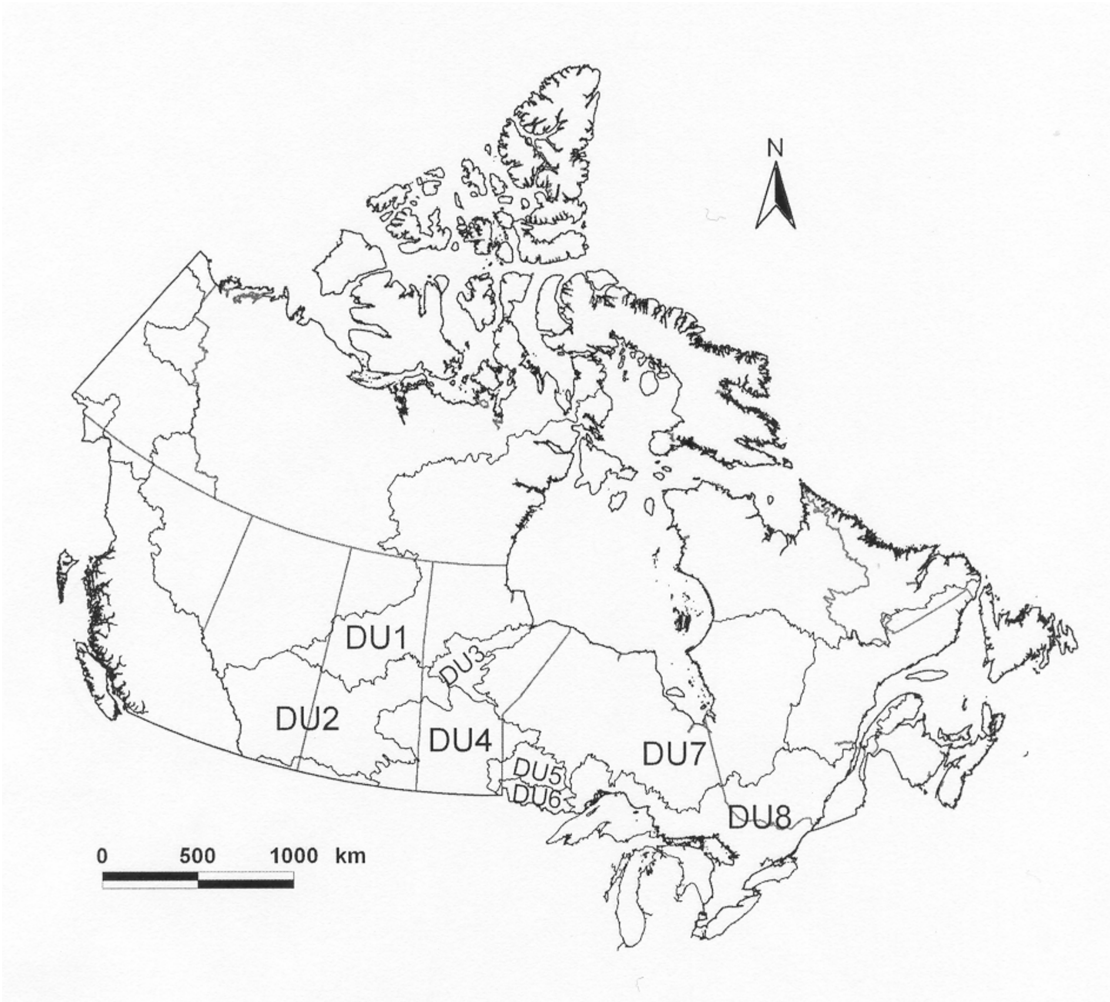

Figure 19. Designatable units (DU) used by COSEWIC, 2006. Designated Endangered: DU 1 Western Hudson Bay, DU2 Saskatchewan River, DU3 Nelson River, DU4 Red Assiniboine Rivers – Lake Winnipeg, DU5 Winnipeg River – English River. Designated Threatened: DU8 Great Lakes Upper St. Lawrence. Designated Special Concern: DU 6 Lake of the Woods – Rainy River, DU7 Southern Hudson Bay – James Bay.

On September 10, 2009 the Committee on the Status of Species at Risk in Ontario (COSSARO) changed the status for lake sturgeon in three regions in Ontario (Figure 20). The status of Northwestern Ontario populations was been revised to ‘threatened" from ‘special concern". Therefore, we possibly have lake sturgeon designated as "endangered" and "threatened" within FMZ 4. Suffice to say that there is significant concern regarding the long term sustainability of lake sturgeon within FMZ 4 and other fisheries management zones within the Northwest Region.

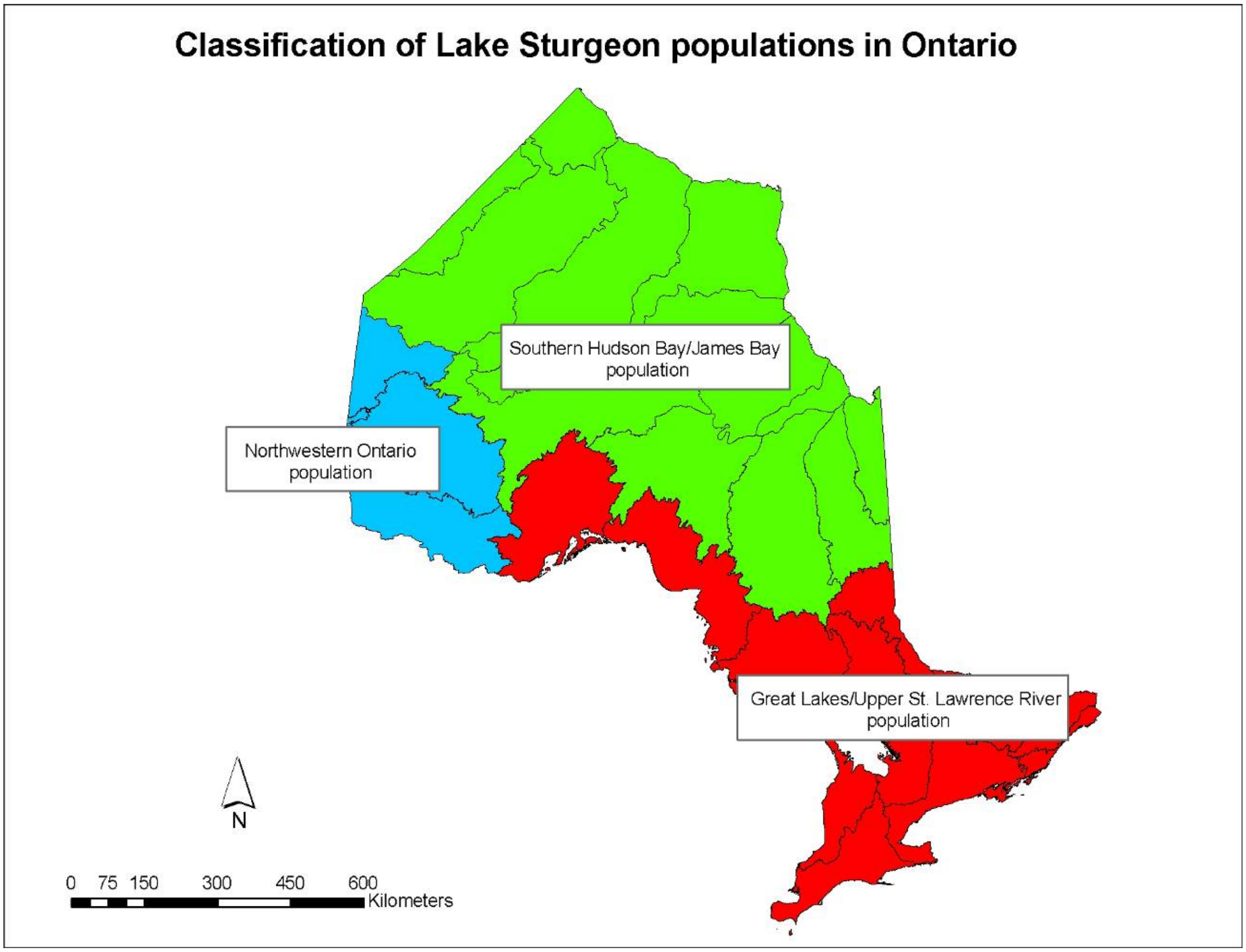

Figure 20. Classification of lake sturgeon populations in Ontario

Figure 21. Describes the distribution of lake sturgeon within FMZ 4. Current data suggests that lake sturgeon is found primarily in the western half of the zone. Lake sturgeons are found in the English River, Pikangikum Lake and the Berens River and in Birch Lake (Shabumeni/Springpole Lakes – Shab River system). It is suspected that sturgeon may have a wider distribution within the zone but index netting work has not been undertaken to confirm this.

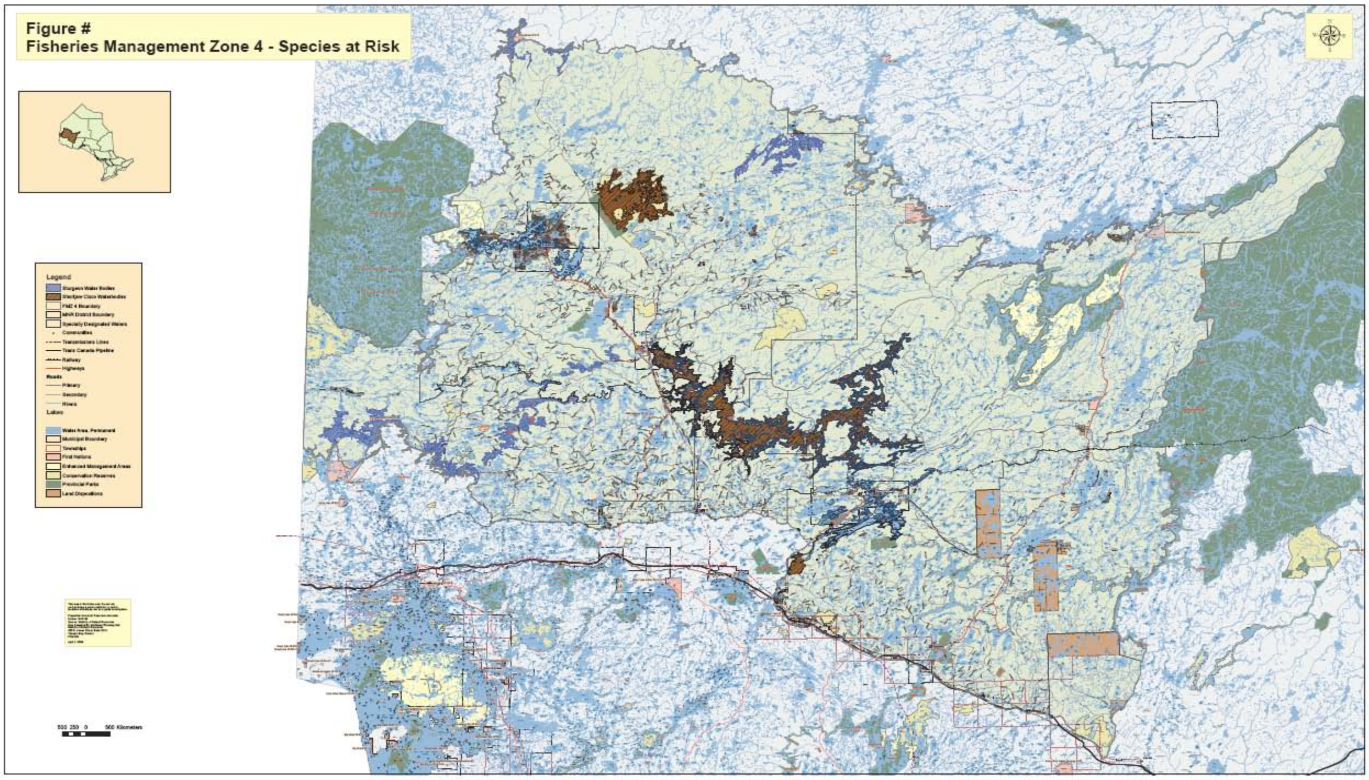

Figure 21. Fisheries Management Zone 4 Species at Risk Distribution

The life history characteristics of lake sturgeon are quite unique. The growth of lake sturgeon is relatively fast for the first 5 to 10 years and then slows down (Harkness 1923, Scott and Crossman 1973). Male and female sturgeon grow at very similar rates until approximately 20 years of age. After that age female growth rates tend to exceed the growth rates of males (Brusch 1999).

Sexual maturity of male and female lake sturgeon occurs between 12 and 20 years and 14 to 33 years respectively (Scott and Crossman 1973, OMNR 2009). Egg production is low and ranges from 8.744 to 12.264 eggs per kg of body weight and is correlated with weight (Bruch et al. 2006). Spawning does not occur every year. Males appear to spawn every 2 to 3 years while females appear to spawn every 4 to 9 years (Mosindy and Rusak 1991, Scott and Crossman 1973).

Spawning occurs in the spring from early May to late June at water temperatures between 13 and 18 degrees C (Harkness 1923, Scott and Crossman 1973, Nicholls et al. 2003). Lake sturgeon spawn in rivers in areas of fast flowing water at water depths between 0.6 and 4.5 m (OMNR 2009). Spawning substrate is typically gravel, rubble and angular rock (Seyler 1997). Two separate spawning sessions may occur within a single season (Auer and Baker 2002).

Lake sturgeon demonstrate migratory behavior, moving upstream in rivers to spawn in the spring and then downstream following spawning to lakes and deeper water. Migration to spawning areas can occur across vast distances. Movements of 200 to 400 km have been documented for some populations (Kempinger 1988, Rusak and Mosindy 1997, Scott and Crossman 1973). Lake sturgeon appear to exhibit a relatively high degree of fidelity to spawning sites (DeHaan et al. 2006).

The main threats to lake sturgeon are exploitation and habitat alteration and fragmentation. The slow growth rate, late maturation, low egg production and spawning periodicity of lake sturgeon make them very vulnerable to exploitation. Even low levels of exploitation can exceed sustainable levels. Annual sustainable yields for lake sturgeon have been estimated at 0.20 to 0.28 kg/ha (MacRitchie 1983, Brousseau 1987). Prior to their designation as "threatened" lake sturgeon could be harvested by recreational, commercial and aboriginal subsistence fisheries. While quantification of recreational and subsistence harvest levels within FMZ 4 has not occurred observations by Conservation Officers and other Ministry of Natural Resources staff suggest that relatively low harvest levels were occurring. Commercial fisheries that have sturgeon quotas have been largely inactive due to poor market conditions.

Lake sturgeon are highly valued by many First Nations. Subsistence fishing for sturgeon continues at traditional sturgeon spawning sites although harvest levels are unknown. In addition, sturgeon can have immense cultural significance especially where the clan system is in place. Sturgeon are often used as food in gatherings that involve the chiefs and elders from different bands.

Lake sturgeon have been subjected to extensive habitat alteration throughout their range (OMNR 2009). The construction of dams for water control and hydroelectric power generation appear to be the forms of development that most affect sturgeon. Dams fragment sturgeon habitat by preventing or restricting access to historic spawning, nursery and rearing habitats. Ebener 2007 identified that hydroelectric development was the greatest problem for sturgeon rehabilitation at 12 or 21 historic Lake Superior spawning sites. This threat to sturgeon will increase in magnitude as the Province of Ontario implements its new renewable energy program.

3.4.2 Shortjaw Cisco

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has designated the shortjaw cisco (*Coregonus zenithicus*) as "threatened" in 1987. Despite this designation no specific protection has been afforded the shortjaw cisco in Canada beyond general protection afforded in the Fisheries Act (Todd 2003).

No single factor has been identified as being responsible for the decline of the shortjaw cisco in the Great Lakes (Todd 2003). Factors that contributed to the decline of shortjaw cisco in the Great lakes include eutrophication, alteration of the biological community, exploitation for food, competition and predation from invasive species such as smelt an alewives, weather and thermal changes (Todd 2003). Whether or not these factors would affect populations of shortjaw ciscoe in small lakes is unknown. However, Todd (2003) warns that there may be consequences to shortjaw cisco if smelt and shortjaw cisco exist in small lakes because of the destabilizing effect that smelt can have on the ecosystem.

Current records indicate that shortjaw cisco exist only in Lac Seul in FMZ 4. There was a record from Trout Lake northwest of the community of Red Lake but it has recently been determined that this record actually refers to Trout Lake which is found near North Bay, Ontario. Since shortjaw cisco are found in a number of lakes in central Canada and as far west as Great Slave Lake it is possible that other populations may exist in lakes in FMZ 4. Population trends in Lac Seul are unknown.

Both sexes appear to have similar growth in terms of length but females grow faster than males when weight is examined (COSEWIC 2003). Maturity of both sexes occurs in the fifth year.
Egg production appears to be similar to other deepwater species such as bloater with egg numbers ranging from 3230 eggs for a fish 241 mm total length to 18768 for a fish 305 mm total length (Emery and Brown 1978).

Habitat preferences in smaller lakes are unknown. In Lake Nipigon Shortjaw ciscoes were found to inhabit waters in the range of 10 to 60 m (COSEWIC 2003). Spawning has been observed to occur in the fall in Lake Michigan, Huron and Erie (Scott and Smith 1962). However spring spawning has also been reported for this species (Todd and Smith 1980). Spawning preferences of shortjaw cisco in inland lakes, other than the Great Lakes, is unknown.

Shortjaw ciscoes are an important prey item for predators such as lake trout (*Salvelinus namaycush*) and burbot (*Lota lota*). Todd (2003) suggests that in smaller Canadian lakes that this species may be the main forage for predators in some situations.

3.5 Invasive and Introduced aquatic species

The Ontario Ministry of Natural Resources describes an alien species as any introduced, non-native or exotic plant, animal and micro-organism introduced into areas beyond their normal range by human actions. Introductions of alien species may be deliberate or accidental, beneficial or harmful, from other continents, neighbouring countries or from other ecosystems within Canada (OMNR 2008a).

Invasive alien species are those harmful alien species whose introduction or spread threatens the environment, the economy or society including human health. Invasive alien species can originate from other continents, neighbouring countries, or from other ecosystems within Canada (Environment Canada 2008). Alien species are sometimes introduced intentionally to provide benefits to ecosystems and to society. In these cases, alien species are considered to be “introduced” rather than invasive. Examples of intentional introductions include habitat restoration activities, authorized fish stocking and biological control of pests (OMNR 2008a).

For the purpose of this background report, alien species within zone 4 will be presented as two distinct groups (invasive alien species and introduced alien species) based on the definitions found in Table 6. The discussion on invasive species will focus on those non-native species that are currently threatening the ecology, economy and society of FMZ 4. The discussion on introduced species will focus on those species within FMZ 4 that have been introduced intentionally and provide social and economical benefits to residents and non-residents.

Table 6. Fisheries management zone 4 background report definitions of invasive alien species and introduced alien species.

Invasive Alien Species Description (Environment Canada 2008)*	Introduced Alien Species Description (OMNR 2008a)*
Those harmful alien species whose introduction or spread threatens the environment, the economy or society including human health. I.e. Rainbow smelt, rusty crayfish	Alien species that have been introduced intentionally to provide benefits to ecosystems and to society. Once established in an ecosystem, these species are often referred to as being *naturalized*. I.e. Rainbow trout, brook trout, smallmouth bass, splake

The ways in which both invasive and introduced alien species are spread throughout an ecosystem are called pathways. Introductions of alien species through pathways can be both intentional and unintentional, and they can be also be authorized, such as through government stocking programs, or unauthorized. There are many pathways to introduction, including ballast water of large ships, recreational boating, aquarium trade, pet trade, horticultural trade, stowaways in various modes of transportation, disease in wildlife, and use of bait for angling (Environment Canada 2008, Ricciardi and Rasmussen 1998).

Due to the sensitivity and complexity of aquatic communities, all cases of the establishment of invasive/introduced species will have impacts to some degree on native aquatic communities. The main method to prevent the unwanted introduction and spread alien species is by limiting the pathway of introduction. Education and awareness are key resources to use in the prevention of unwanted introductions of invasive species, and can extend to the unwanted spread of introduced species as well. Removal of alien species from an ecosystem where they are causing ecological damage after they have become established is expensive and nearly impossible to accomplish.

Intentional introduction of non-native species such as smallmouth bass, rainbow trout, brook trout and splake through programs such as stocking can provide additional angling opportunities and can reduce angling pressure on other native species. However, unwanted introductions of these same species can have significant impacts to native fish populations, depending on the community structure. Prior to identifying waterbodies for the introduction of species, managers need to seriously consider the ecosystem in question and complete a detailed risk analysis that integrates environmental, socio-economic and human health considerations.

Controlling and preventing the spread of invasive alien species requires cooperation and collaboration at the local, zone provincial, national and international scale. The Broad Scale Monitoring program will contribute to the current knowledge of invasive species and distribution of those species within zones across the province. Though detection and monitoring is important, the priority to prevention should be education and awareness in order to reduce the threat of introduction of invasive species before it occurs.

3.5.1 Invasive Species in Zone 4

Invasive alien species are the second most significant threat to biodiversity, after habitat loss (Sala et al. 2000). In their new ecosystems, invasive alien species become predators, competitors, parasites, hybridizers and diseases of native flora and fauna. In addition to significant ecological impacts, invasive species can result in considerable social costs, especially to communities that are dependent on agricultural and natural resources (Environment Canada 2008). The impact of invasive species on native ecosystems, habitats and species is severe and often irreversible. Prevention is the most effective management strategy for invasive species, because once an invasive species becomes established, range expansion is almost inevitable and elimination is rarely a viable option (Lodge 1993).

The threat of invasive species to Northwestern Ontario is a relatively new management consideration for fisheries management planning. Northern Ontario has historically had lower potential sources of introduction of invasive species due to the low number of smaller, dispersed towns and communities, fewer roads accessing waterbodies, cooler temperatures with lower numbers of growing degree days, and reduced access to the great lakes watershed to facilitate the introduction (Krishka et al. 1996). However with the advent of climate change, warmer temperatures combined with escalating resource development interests in the north, and associated additional road access to new waterbodies are all contributing to the increasing likelihood that new invasive species will be introduced.

At present, the only known invasive species present in FMZ 4 is rainbow smelt (*Osmerus mordax*), which are found in 16 known lakes, all of which are near communities and major roads within the zone (Figure 22, Appendix 6). Rainbow smelt were originally introduced into the Great Lakes Basin in 1912 when they were intentionally introduced into Crystal Lake Michigan as forage for lake trout (Krishka et al. 1996). Rainbow smelt introduction and spread to inland lakes in Northwestern Ontario occurred sometime between 1970-1990 as a result of unauthorized and unintentional introductions as well as downstream dispersal (Krishka et al. 1996). Smelt are generally introduced into lakes inadvertently by people cleaning smelt or using freshly caught smelt from another water body as bait. The eggs can be fertilized when mixed together with milt in the container used to carry smelt caught during the spring spawning run. Fertilized eggs can live fore several days out of water and can thus be easily introduced into suitable waters. A regulation prohibiting the use of smelt for bait and the possession of smelt for use as bait was introduced within Zone 4 based on recommendations from the 1987-2000 fisheries management plans for Kenora and Red Lake to reduce further transfer of smelt between inland lakes (Table 7).

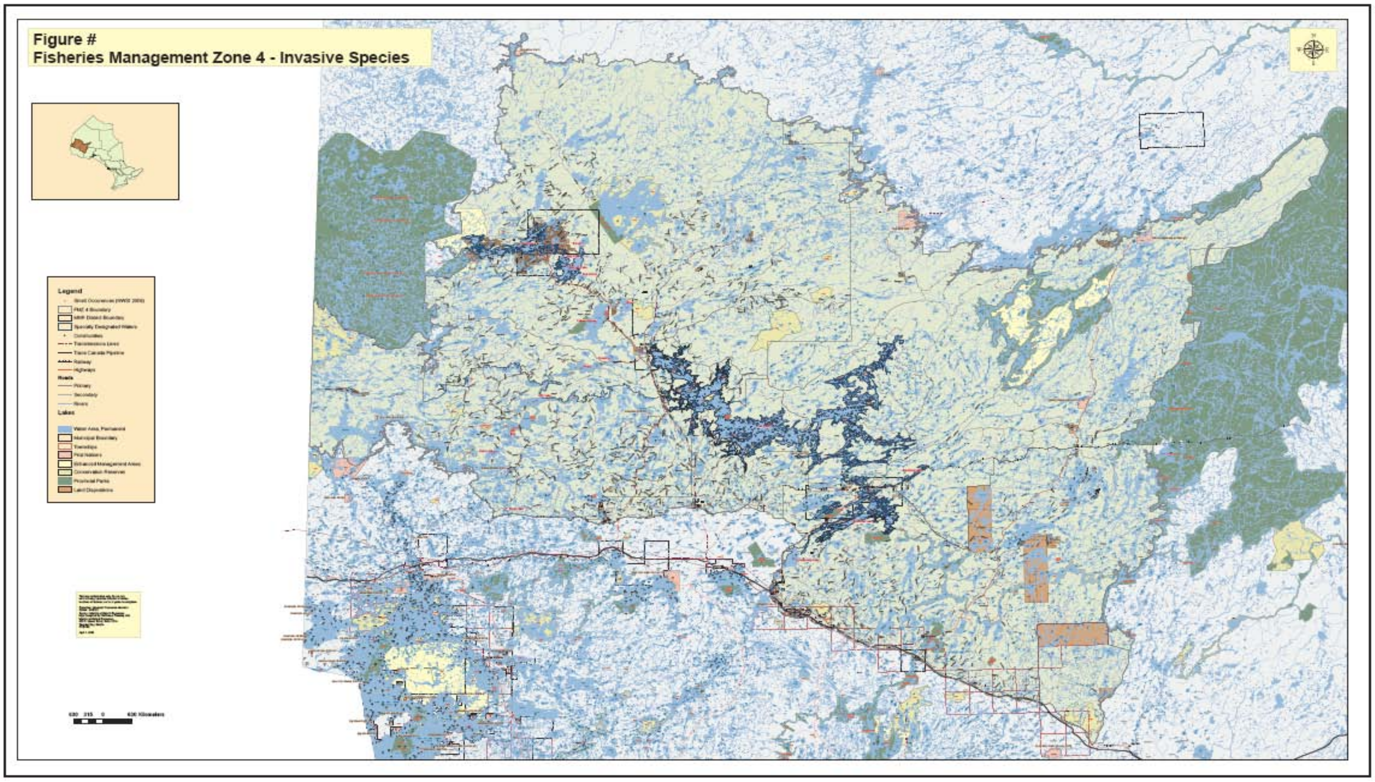

Figure 22. Map - Fisheries Management Zone 4 invasive aquatic species distribution

Though smelt have become valued to some degree in zone 4 for consumption, the existing and potential impacts that introductions have had to fish communities far outweigh the benefits associated with this species. Introduction of rainbow smelt into inland lakes can lead to the extirpation of native fish species (e.g. yellow perch, cisco) through competitive and predatory interactions (Hrabik and Magnuson 1998, Hrabik et al. 2001). Rainbow smelt may also have negative impacts to walleye populations. A study by Mercado-Silva et al. (2007) observed a decline in walleye recruitment in a small number of lakes after rainbow smelt invasions due to competition and predation of walleye young of year. Rainbow smelt in lakes have a eurythermal life history; young-of-year smelt occupy warm-water habitats, yearlings cool-water habitats and adults cold water habitats. This aspect of their life history allows rainbow smelt to occupy the entire water column and potentially interact with a wide variety of fish species (Krishka et al. 1996). Rainbow smelt are opportunistic feeders that prey largely on invertebrates, however small fish, including juvenile sport fish species, are often important components of their diet at certain times of year. Combined with the pressures of exploitation on popular sport fish species, presence of rainbow smelt in lakes can have significant impacts on sustainability of native fish populations (Mercado-Silva et al. 2007).

Table 7. Direction in Fisheries Management Plans (1987-2000) on invasive species within zone 4.

Fisheries Management Plan	Problem	Strategy	Tactics
Kenora Fisheries Management Plan 1987-2000	Smelt – a fish potentially harmful to natural fisheries are almost always inadvertently introduced by people cleaning smelt or using freshly caught smelt for bait.	Prevent people from spreading smelt to waters where smelt presently do not exist.	Control the use and harvest of smelt in North Western Ontario Have a public education campaign each spring to inform and remind people how not to introduce smelt to new waters.
Red Lake Fisheries Management Plan 1987-2000	Smelt have been introduced to waterbodies which support lake trout populations	Control the introduction of smelt into other district waterbodies	Increase public awareness of the impact of smelt introductions through brochures, seminars feature stories and news releases. Other methods to control smelt will be investigated.

The threat of introduction of new invasive alien species to zone 4 is always present. Invasive species that have a high potential of introduction into the zone include spiny water flea (*Bythotrephes longimanus*) and rusty crayfish (*Orconectes rusticus*), both of which are present in adjacent zones (5 and 6) in Northwestern Ontario.

Spiny water flea, a predaceous zooplankton species, was introduced to the Great Lakes in the ballast waters of Eurasian ships in 1982 and has since spread to all of the Great Lakes as well as to many inland lakes in Ontario. Presence of spiny water flea has been directly linked with decline in the number of small fish, including juvenile sportfish. This is due in part to the inability of small fish to feed on spiny water flea as the long spine makes them inedible to fish smaller than 10 cm (3.9 in).

Spiny water flea also feed voraciously on native zooplankton, and in waterbodies where populations are high consumption can be significant. This in turn places additional pressure on fish populations, including many juvenile fish that feed on zooplankton. Pathways for introduction of spiny water flea adults and eggs include unwashed boats, trailers, boating equipment, fishing tackle, nets and lines as well as bait buckets, live, bilge and transom wells. Properly cleaning all equipment after use, draining wells and bait buckets on land and leaving equipment out to dry before use helps contribute to reducing potential pathways of introduction for this species.

Rusty crayfish are an example of a species native to North America which has become invasive. Rusty crayfish originated from streams in Ohio, Kentucky and Tennessee and were introduced as bait to Ontario by non-resident anglers in the 1960’s. Since then they have spread rapidly throughout Ontario and are now found in areas of the Northwest Region including Lake of the Woods, Quetico Provincial Park and Lake Superior. It is estimated that rusty crayfish have a high metabolic rate, and consequently consume aquatic plants much faster than native species of

the same size. Loss of aquatic plants in areas where this species has become established results in reduction of habitat and food for many aquatic invertebrates and juvenile fish that depend on vegetated littoral areas for habitat. Rusty crayfish also feed on large quantities of aquatic invertebrates, fish eggs and young fish and compete directly with native species including juvenile game fish and forage fish species.
Once introduced, rusty crayfish are difficult to control. They are more aggressive then native species of crayfish and have harder shells making them less vulnerable to predation. The main pathway for rusty crayfish introductions are through overland transport of bait buckets to new waterbodies. Crayfish should only be used in the same waterbody where they were caught, and any unused live crayfish bait should be dumped in the trash.

Viral Hemorrhagic Septicemia (VHS) is an infectious disease of fish and is a relatively new threat to the province of Ontario. At present, VHS is found in Lake Ontario, Lake Huron, Lake Michigan, Lake St. Clair and Lake Erie, with recent reports of VHS occurring in Lake Superior. Clinical signs of VHS vary substantially and can be categorized into three forms; some fish show obvious signs and rapid mortality in acute infection (rapid onset); delayed signs and high mortality in chronic infection; and no signs and low total mortality in latent (dormant) infections. All forms of the virus are infectious. The virus affects many fish species including sport fish such as smallmouth bass, muskellunge and walleye, however mortality varies by species as well as by environmental conditions. Stress, such as spawning, low dissolved oxygen, and changes in water temperature (spring and fall) can cause outbreaks in waterbodies where the virus exists. Transmission of the virus can occur in different ways, fish to fish transfer can occur by contact from one infected fish to another fish or by contact with bodily fluids from infected fish. The virus can also be spread from one waterbody to another through the movement of fish, fish eggs, water, boats or equipment that has come into contact with the virus. The MNR has put in place a VHS Management Zone that identifies the infected area within the province, and places restrictions on the transportation of bait, the collection of sport fish eggs from virus-positive waters and restrictions on stocking. Though VHS is not an immediate threat to zone 4 the potential for introduction does exist. Therefore it is important to promote awareness of pathways of introduction to reduce the threat of establishment in inland lakes.

3.5.2 Introduced Species in Zone 4

For the purpose of this background report, introduced species in Zone 4 are described as species that are native at a variety of scales (i.e. locally, provincially and nationally) that have become established in ecosystems outside of their natural historic range though methods such as stocking, unauthorized introduction and accidental introduction. Once established, introduced species considered desirable, such as sport fish species, are often referred to as being *naturalized* (Williamson and Fitter 1996) though they are technically not native to a particular location of introduction. Reasons for the introduction of non-native and native species into new waterbodies can vary, and have included such goals as (Kerr and Grant 2000):

- Restoring degraded fish communities including the recovery of rare, threatened or endangered fish species (*has been implemented in FMZ 4 – Red Lake lake trout program*)

- Creating new or diversified fisheries for associated social and economical benefits (*has been implemented in FMZ 4*)
- Creating brood stock for fish culture purposes (*has been implemented in FMZ 4*)
- Providing forage species for important sport or commercial fisheries (*not previously implemented in FMZ 4*)
- Establishing biological control agents for aquatic macrophytes, undesirable fish species, mosquitos, etc. (*not previously implemented in FMZ 4*)

The majority of authorized introductions in Ontario have involved the desire to create new or enhanced fisheries for social and economic benefits (Kerr and Grant 2000). For example, species of economic and social value have been introduced to zone 4 through stocking programs by the OMNR. Some of these species exist naturally at the local scale (i.e. walleye, lake trout) while others exist naturally at the provincial (i.e. brook trout, smallmouth bass) or national scale (i.e. rainbow trout). Splake, a brook trout x lake trout hybrid does not exist naturally and are raised in captivity specifically for introduction purposes.

Some of these species continue to be stocked within FMZ 4 (walleye, brook trout, splake, lake trout (only in Red Lake) and rainbow trout). Stocking of these species requires consideration of a class Environmental Assessment in order to comply with recommendations within the fish stocking guidelines that aim to protect the genetic integrity of indigenous communities, reduce potential impacts of introduced species on existing fish communities and favour the management of natural populations through regulations to preserve native fish communities (OMNR 1992). Continued stocking of walleye, brook trout, splake and rainbow trout occurs in Zone 4 largely due to the social and economic benefits these additional angling opportunities provide to resident and non-resident anglers within the zone, however it must be noted that these introductions are not without ecological impacts to native fish communities.

Risk management of social and economic benefits versus ecological impacts is a major consideration when fisheries managers make choices regarding stocking programs (see section 6.3 on Stocking). Caution needs to be exercised when introducing any species into an ecosystem where they are not established naturally, particularly when establishment may result in competition with native species that are already stressed due to habitat loss, development pressures and overexploitation. The OMNR has adopted a class environmental assessment to assess the risk involved with introducing fish through stocking in order to take a precautionary approach to fish introductions. Considerations include the uniqueness of the waterbodies selected, habitat overlap of stocked fish versus native fish species and the impacts of introductions on native aquatic communities (OMNR 1992). A complete list of lakes stocked within FMZ 4 can be found in Appendix 8.

Though introduced species may provide social and economic benefits, the ecological impacts of introductions must be considered. Traditionally, OMNR has introduced top predators such as walleye, rainbow trout, smallmouth bass etc. to create or enhance angling opportunities. Past experiences have shown that all introductions will have some sort of impact to existing fish communities. These can range from reducing prey and forage species abundance to competing with and possibly eliminating other sport species. Before introducing a new species, the risk to the existing fish community and adjacent water bodies must be thoroughly understood and justified. OMNR's mandate has expanded beyond providing increased angling opportunities and includes the protection of biodiversity. The following is a brief summary of the ecological implications of fish introductions for popular sport fish species within FMZ 4. Some of the interactions described are not local examples relevant to FMZ 4, however they do provide perspective of the impacts introductions of popular sport fish can have on native fish communities. Much of the data provided herein can also be found in greater detail in Kerr and Grant (2000) publication *Ecological Impacts of Fish Introductions: Evaluating the Risk.*

3.5.2.1 Walleye

Walleye are one of the most valued sport fish species in FMZ 4 and provide considerable economic and social benefits to resident and non-resident anglers who target this species almost year round. The second most abundant sport fish species in terms of distribution within Zone 4, walleye have historically been stocked by the OMNR as well as by the public through the OMNR supported Community Fisheries and Wildlife Involvement Program (CFWIP) within Zone 4. Historically, stocking through the OMNR occurred in new lakes where walleye were not originally present, and in lakes where overexploitation depleted native fish populations. Though the OMNR no longer stocks walleye in Zone 4, walleye stocking does still continue in FMZ 4 in new lakes where walleye have not previously existed through the CFWIP program.

Some of the best known interactions of walleye are with yellow perch. There are several examples of declines in yellow perch abundance following the introduction of walleye in Wisconsin (Christenson et al. 1988), eastern Ontario (Siep 1995), Idaho (McMahon and Bennet 1996), Wyoming (McMahon and Bennett 1996) and Minnesota (Pierce and Tomcko 1998). Similarly other studies have shown that walleye predation results in the decrease in abundance of other forage species including golden shiners and suckers (Green 1994), native minnows, darters, crayfish and suckers (McMahon and Bennet 1996), and cisco (Crossman 1991)

In studies of lakes where both walleye and smallmouth bass occurred, it was observed that walleye often became dominant in lakes with sand, gravel or detritus substrates, exposed shoals and suitable areas for spawning and feeding, and a large population of forage fishes (Kerr and Grant 2000). Smallmouth bass were found to be more dominant in lakes a high degree of shoreline irregularity including rocky substrate, sheltered bays for spawning, a moderate degree of shoreline development and smaller populations of small fish (Kerr et al. 1996). Potential interactions between these two species are likely to be greatest in small lakes where the habitat is more favourable for one species over the other Kriska et al 1996) Interactions between these two species are not well understood (Kerr and Grant 2000), but in some instances the introduction of walleye have been implicated in the decline of native smallmouth bass (Eschmeyer 1950; Kempinger et al 1975; Krishka et al 1996).

Walleye introductions into waters with salmonids have generally been negative (Kerr and Grant 2000). Walleye illegally introduced into the Columbia River basin had a negative impact on native salmonids, which had already been depressed by habitat alterations (Li et al. 1987). There is also evidence that the abundance of lake trout is negatively correlated with walleye (Carl et al 1990), and lake trout populations in small southeastern Ontario lakes are believed to have been extirpated from widespread walleye introductions to the area (Evans et al. 1991). Oliver et al. (1991) concluded that walleye should not be stocked into small lakes with native lake trout populations.

3.5.2.2 Smallmouth Bass

Smallmouth bass are valued sportfish species provincially, nationally and internationally. Smallmouth bass are considered an introduced species in one-third of the 2,421 known smallmouth bass lakes in Ontario (OMNR 1878b). Some areas in Northwestern Ontario offer world-class fishing opportunities for this species providing social and economic benefits to the region. In Zone 4, smallmouth bass are an established introduced species that were originally introduced for additional angling opportunities by the OMNR, and have since spread throughout the zone via natural introduction pathways, as well as through unauthorized introductions.

In northern Ontario smallmouth bass introductions were made in the Kenora area in 1902 and in Sioux Lookout in 1933 (Krishka et al. 1996) by provincial government agencies to increase angling opportunities for newly established residents and to promote tourism. Bass have a low harvest rate compared to effort (mainly a catch and release fishery), and may be able to support higher amounts of angling effort than other fisheries that are traditionally consumptive. Bass also provide an additional angling opportunity within the zone, particularly in the summer when other species such as lake trout become more difficult to catch (Jackson 2005).

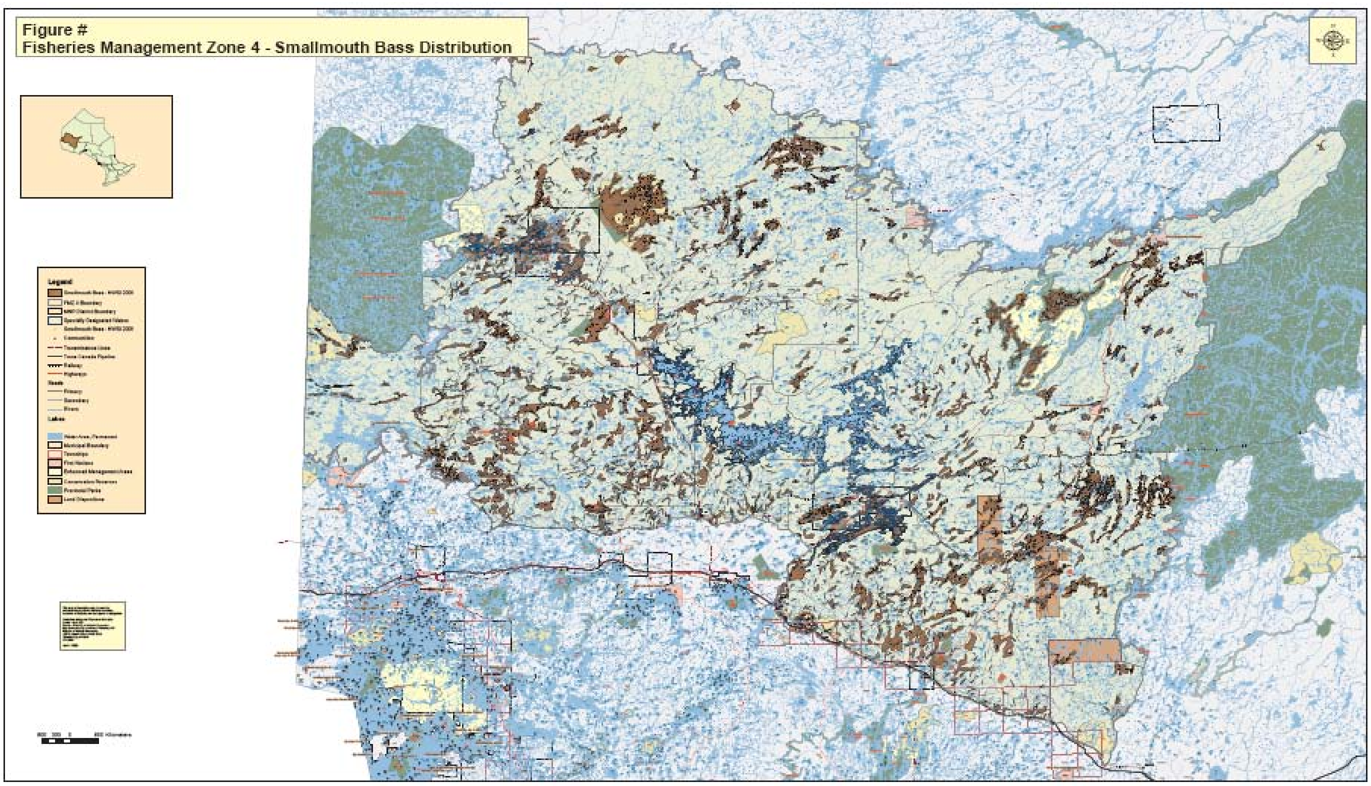

Figure 23. Fisheries Management Zone 4 smallmouth bass distribution

At present, smallmouth bass are found in over 100 known lakes within the zone, however it is suspected that the actual number of lakes, rivers and streams with populations of smallmouth bass is considerably higher (Figure 23). Although Krishka (et al 1996) found no evidence of smallmouth bass introductions being directly responsible for the decline of walleye populations, they did document that smallmouth bass populations often increase when walleye populations are depressed. It is therefore recommended that smallmouth bass should not be introduced into water bodies where walleye populations are suppressed due to over exploitation or irregular recruitment. Some research on smallmouth bass in northern lakes have found that this species can impact fish communities, primarily cyprinids, in waterbodies where it does not exist naturally, displacing other fish species through competition and predation (Vander Zanden et al. 2004, Kaufman et al. 2009). There is some evidence that smallmouth bass introductions can reduce littoral prey fish abundance and diversity in north-temperate lakes in Ontario (Vander Zanden et al. 1999, MacRae and Jackson 2001, Jackson 2002). Loss of littoral prey species from predation of introduced smallmouth bass could in turn impact growth rates of top predators including lake trout (Vander Zanden et al. 2004) and brook trout (Vander Zanden et al. 1999) in some lakes. This risk has been identified primarily in lakes that lack a pelagic forage base such as ciscoes or rainbow smelt (Vander Zanden et al. 1999, Vander Zanden et al. 2004). Further expansion of smallmouth bass in zone 4 has been largely through unauthorized introductions, accidental bait bucket transfers, and natural dispersal through drainage networks (Krishka et al. 1996, Vander Zanden et al. 2003).

3.5.2.3 Black Crappie

Black crappies are an opportunistic species whose habitat and foraging behaviour overlap with a number of other fish species. Introductions of black crappies into new waterbodies have been known to influence the structure and dynamics of existing fish communities, particularly those involving yellow perch and walleye (Kerr and Grant 2000).

Black crappie (*Pomoxis nigromaculatus*) have not yet been found within FMZ 4, however black crappie has been introduced to zone 5 waterbodies and distribution of this species has been expanding since their original introduction into Rainy Lake and Lake of the Woods in the 1920's (B. Jackson Pers. Comm.). Some intentional introductions by OMNR have occurred, for example black crappie were released into Big Sawbill Lake by the MNR in the Fort Francis area in 1990 to create forage for northern pike (Krishka et al. 1996). Some range expansion in the northwest may also have been through natural dispersal through connected waterbodies. However, many of the introductions in zone 5 are the result of intentional unauthorized introductions by commercial fishermen, guides, tourist outfitters or anglers attempting to create new fishing opportunities (Krishka et al. 1996). Introductions such as these are thought to be continuing as reports of more lakes with black crappie continue to be received within zone 5 (B. Jackson Pers. Comm.).

Crappie introductions can have significant impacts on native fish communities when they become established. Black crappie occupy similar habitats to yellow perch, walleye and smallmouth bass and have been linked to significant alterations in percid communities after introductions. Competition for food, loss of yellow perch forage, and direct predation of fry and fingerlings combined with angling exploitation of walleye and perch can lead to dramatic declines in perch and walleye abundance in lakes where black crappie are introduced (Schiavone 1983, Schiavone 1985).

3.5.2.4 Lake Trout

Lake trout are found throughout FMZ 4 and are a popular sport fish species year round for both residential and non-residential anglers. Native to FMZ 4, lake trout were once stocked by the OMNR in lakes where lake trout were not originally present, as well as lakes where overexploitation depleted native fish populations. Lake trout are no longer stocked in Zone 4 due to recommendations within fish stocking guidelines that aim to protect the genetic integrity of indigenous communities and favour the management of natural populations through regulations to preserve native fish communities (OMNR 1992). One exception is the native lake trout stocking program that occurs at Red Lake to for restorative purposes. Stocking of lake trout by the OMNR also occurs in other parts of the province where fishing pressure is high and development and habitat alteration have impacted populations.

Lake trout are spatially segregated from many other fish species for a portion of the year, which tends to reduce the amount of interspecific interactions (Kerr and Grant 2000). Examinations of lake trout introductions in Sweden did not find any negative impacts to native fish populations (Gonczi and Nilsson 1984), however subsequent studies have found that lake trout can have serious impacts on native salmonid species, particularity in the Southern United States (Kerr and Grant 2000). Introduced lake trout have been identified as the species responsible for extirpation and dirastic reductions of cutthroat trout populations in the US (Cordone and Frantz 1966, Kaeding et al. 1996). Introduced lake trout can also have impacts on resident lake trout populations (Benson et al. 1961, Dean and Varley 1974, Behnke 1972).

In Ontario, introduced lake trout have been found to impact resident white sucker populations in Haliburton (Marcogliese and Cassleman 1997), as well as compete with burbot for the same food sources (Clemens et al. 1924, Dymond 1928). Some evidence has also found competition between introduced lake trout and northern pike (Johnson 1972) but due to spatial segregation through much of the year this is likely limited (Kerr and Grant 2000).

3.5.2.5 Rainbow Trout

Rainbow trout (*Oncorhynchus mykiss*) have been introduced to lakes within FMZ 4 through OMNR stocking programs aimed at providing additional angling opportunities to residential and non-residential anglers within the zone. This species has been stocked within the zone as a put-grow and take fishery with no intent on establishment of self sustaining populations due to the lack of appropriate habitats within Zone 4. This species is native to the west coast of North America, and no native populations exist within Ontario, though there are a number of naturalized populations that can be found province-wide. An up to date stocking list of species and lakes stocked by the OMNR can be found in Appendix 8.

Interactions between rainbow trout and native salmoinids, particularly brook trout, have been well studied. There are a number of examples where native brook trout stocks have declined after the introduction or encroachment of rainbow trout due to interspecific competition between the two species in areas throughout North America (King 1937, Moore et al. 1983, Larson and Moore 1985, Rose 1986, Elser et al. 1995). Generally, rainbow trout are superior competitors to brook trout (Fasuch 1988) having several advantages including faster growth rates in their first year, greater fecundity, more balanced sex ratios, fewer year class failures and the attainment of a larger body size. There is also considerable overlap in habitat requirements, particularly in stream environments (Kerr and Grant 2000).

Rainbow trout have been shown to have similar impacts other native salmonids including bull char (Boag 1987), lake trout in Michigan (Leonard and Leonard 1946), cutthroat trout in British Columbia (Nilsson and Northcote 1981) and coho salmon in laboratory experiments (Laarman 1968).

3.5.2.6 Brook Trout

Brook trout (*Salvalinus fontinalis*) have been introduced to lakes within FMZ 4 through OMNR stocking programs that aim to provide additional angling opportunities to residential and non-residential anglers within the zone. This species has been stocked within the zone as a put-grow and take fishery with no intent on establishment of self sustaining populations due to the lack of appropriate habitats within Zone 4. Though brook trout are native to Ontario, no native brook trout populations exist in waterbodies within FMZ 4. An up to date stocking list of species and lakes stocked by the OMNR can be found in Appendix 8.

Similar to rainbow trout, research to date has indicated that brook trout introductions have significant impacts on populations of native salmonids in Midwestern North America (Kerr and Grant 2000) including cutthroat trout (Varley and Gresswell 1988) and bull trout (Fuller et al 1999) through either direct competition or hybridization. Data on impacts of introduced brook trout to lake trout populations is limited, however is possible that introduced brook trout may hybridize with native lake trout populations (Kerr and Grant 2000).

3.5.2.7 Splake

Splake are currently stocked within waterbodies of FMZ 4. For a complete list of waterbodies containing splake, refer to Appendix 8.

Relatively few studies exist on the impacts of splake introductions on other species (Kerr and Grant 2000). Splake are often stocked in lakes with remnant brook trout populations, and though forage of both species differs widely (Fraser 1980) there has been some evidence for competition for spawning habitat (Hansen 1972, Berst et al 1980) and hybridization of introduced splake with native brook trout populations (Fuller et al 1999).

4.0 Habitat Status

Fish populations within FMZ 4 have evolved in a stochastic or variable environment and have some natural resilience to change, showing increases or decreases in year class strength over time (usually climate related). This means that the fish populations are inextricably linked to habitat. Therefore, the management of fish populations cannot be uncoupled from the management of their habitats.

The majority of stressors on fish habitat in FMZ 4 are primarily anthropogenic (man-made) in nature, impacting adjacent watersheds as well as waterbodies and watercourses directly. Major stressors on fish habitat in FMZ 4 include roads and water crossings, water power development, mineral exploration, extraction and rehabilitation and cottage development. Man made stressors may induce habitat changes that exceed the natural resilience of fish populations and aquatic communities. While fish habitat in FMZ 4 is considered to be in good shape there have been no studies to quantify habitat condition and the cumulative impacts of development on a landscape scale.

Resource managers need to be able to evaluate the interaction of current activities with those of the past and future and assess their combined effect on other existing or potential uses or values (Reid 1993). The interaction and subsequent environmental effects of current, past and future activities within a watershed, need to be considered if fisheries resource managers are to avoid significant "cumulative watershed impacts" (Reid 1993). The Council on Environmental Quality (CEQ) in the United States provides a useful definition of cumulative impacts:

> "Cumulative impact" is the impact on the environment that results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. (CEQ Regulation 1508 Subsection 1508.7 1971)

While there seems to be recognition in many jurisdictions of the need to monitor development activities within a watershed and to understand cumulative impacts of those developments, there is no work being conducted in FMZ 4 or generally in Ontario to address this management issue.

The federal government has a constitutional responsibility for inland fisheries. The *Fisheries Act* (*FA*) is the principal statute which protects fish and fish habitat in Canada, and is administered by the Department of Fisheries and Oceans (DFO). Specific responsibilities include ensuring fish passage (Sections 20 and 22), the protection of fish (Sections 30 and 32), the protection of fish habitat (Section 35) and prevention of pollution (Section 36). These sections are described in more detail in Table 8. In addition, DFO has policy guidance that is described in the "Policy for the Management of Fish Habitat "(DFO 1986). An important component of this policy is the principle of "no net loss". DFO also has the legislated responsibility for the protection and recovery of aquatic species at risk under the *Species at Risk Act* (SARA) and to conduct environmental assessments under the Canadian Environmental Assessment Act.

The Ministry of Natural Resources (MNR) is responsible for managing the fisheries resources of Ontario. Specific responsibilities include administering and enforcing the Ontario fishery Regulations, fisheries management, fisheries management planning, fish and fish habitat information management and fish habitat rehabilitation (ARMAC 2009). MNR and a number of other agencies in Ontario have permitting responsibilities under a wide variety of provincial legislation that provide protection to the aquatic environment. MNR also has the legislated responsibility for the protection and recovery of aquatic species at risk under the *Endangered Species Act* (ESA).

A protocol entitled "Fish Habitat Referral Protocol for Ontario" has been prepared that describes the responsibilities of DFO and other agencies in Ontario and how these various agencies work together to streamline the approvals process and avoid duplication. (ARMAC 2009)

Table 8. Fish passage, protection of fish, protection of fish habitat and, prevention of pollution provisions of the Fisheries Act.

Section	Intent
Section 20	The Minister may require fishways to be constructed
Section 22	The Minister may require sufficient flow of water for the safety of fish and flooding of spawning areas as well as free passage of fish during construction.
Section 30	The Minister may require fish guards or screens to prevent the entrainment of fish at any water diversion or intake.
Section 32	Prohibits the destruction of fish by any means other than angling.
Section 35	Prohibits works or undertakings that may result in harmful alteration, disruption or destruction of fish habitat unless authorized by the Minister or under regulations.
Section 36	Prohibits the deposit of deleterious substances into waters frequented by fish unless authorized under regulations.

4.1 Natural Disturbances

Natural disturbance events in the boreal forest, such as fires and blowdown, are required for the release and movement of nutrients from terrestrial to aquatic ecosystems within watersheds (Carignan and Steedman 2000). Increased nutrient loads within aquatic ecosystems resulting from fire disturbance contributes to trophic interactions, including fish populations, by increasing productivity at a variety of trophic levels (St-Onge and Magnan 2000). Movement of mercury from soils into waterbodies is also associated with natural disturbances, and natural sources of mercury found in fish flesh are often a result of past forest disturbance events (see section 4.5.1 on forestry). Though fire and blowdown disturbances can negatively impact fish communities by increasing sediment load that may adversely effect spawning habitat or impact fish recruitment, and mobilizing natural mercury (Newcombe and MacDonald 1991), these impacts are generally short term in nature. Over the long-term, natural disturbance events within the boreal forest benefit aquatic ecosystems by introducing nutrients to lakes and river systems over time (St-Onge and Magnan 2000).

The landscape of Fisheries Management Zone 4 has been subject to extensive natural disturbance from fire and blowdown. The wide distribution and frequency of these disturbance events is characteristic of disturbance regimes in the boreal forest, and is part of the natural regeneration process in boreal ecosystems. In general, forest fires have tended to be larger and more frequent in the western and southern areas of FMZ 4 (Figure 24) which may be one of the factors contributing to the greater productivity of lakes and rivers in these areas within the zone.

Fire activity between 1978-1988 was particularly high, indicated by the large number of forest fires on the landscape, especially in the west and southern portions of Zone 4 (Figure 24). Notable fires from this decade include fires within the vicinity of Separation Lake in the Kenora District, fires near Red Lake in the Red Lake District, and a major fire near Sturgeon Lake in the

Dryden District (Figure 24). Fire activity in within Zone 4 in 1989-1998 was also high and widely distributed across the zone, with many smaller fires than were experienced between 1978-1988. Fewer fires occurred between 1999-2008 than in previous decades in Zone 4.

Blowdown within Zone 4 is has historically occurred in isolated patches with light, moderate or severe impacts. Of particular importance are the light to moderate blowdown events that occurred in the Kenora District, and widespread events that occurred surrounding and east of Lac Seul in the Sioux Lookout District.

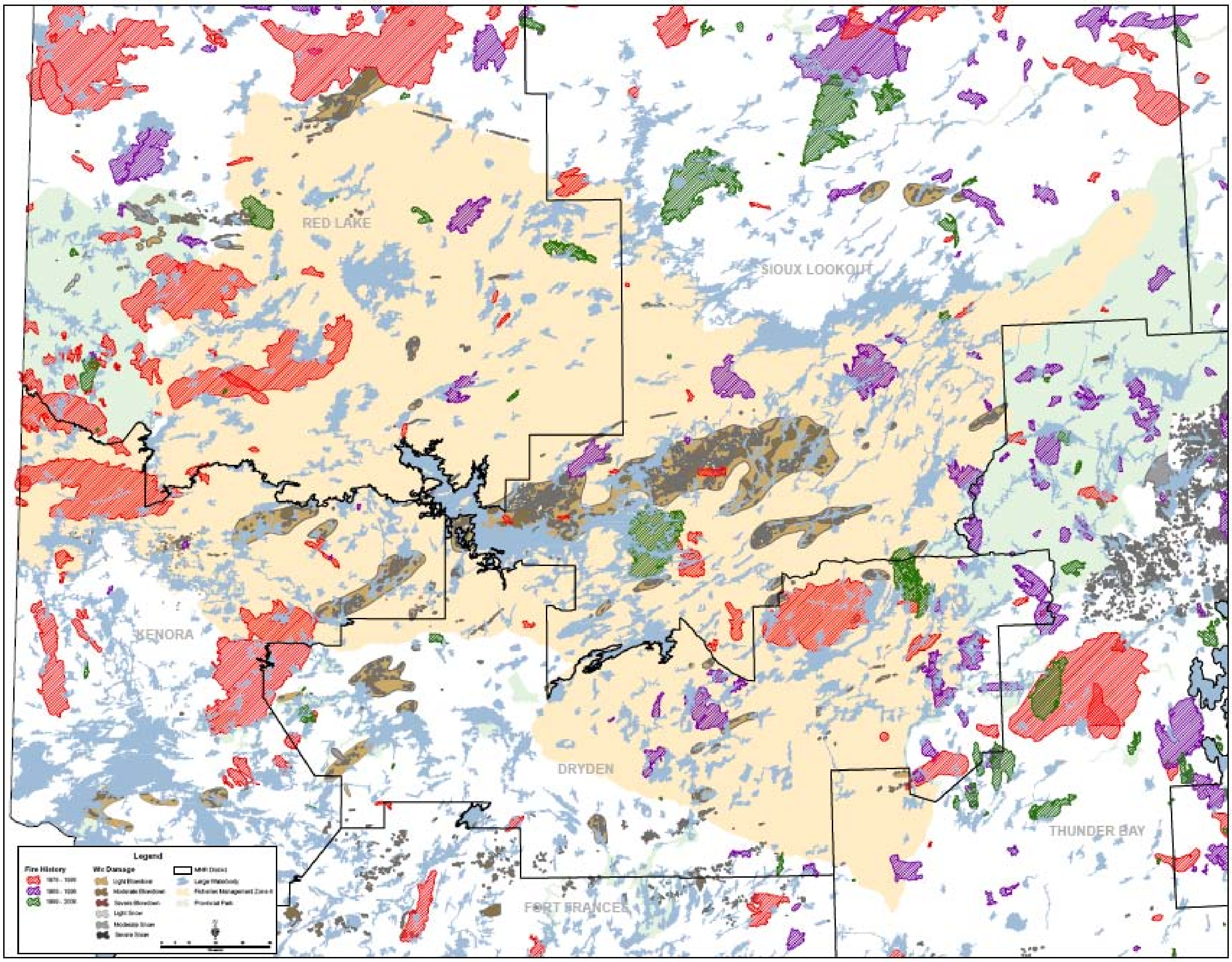

Figure 24. Natural Disturbances within fisheries management zone 4 including fire history (1978-2008) and blowdown and snow damage.

4.2 Climate Change

An overarching threat to freshwater ecosystems within Fisheries Management Zone 4 are the impacts to fisheries habitat and community assemblages associated with global climate change. These threats are global in scope. Global warming is caused by increased levels of atmospheric carbon dioxide and other gasses and impacts are predicted to include global temperature increases of between 1.4°C and 5.8°C, with the greatest temperature changes experienced in northern boreal and arctic ecosystems.

Temperature changes and changes in precipitation have already been observed within the Northwest Region of Ontario within the past 50 years (Gerry Racey Pers. Comm.). Models that describe the effects of climate change suggest the Northwest Region will experience some of the most acute impacts of climate change in Ontario. These predictions include increases of approximately 5°C in growing season temperature over the next 90 years, changes to annual precipitation patterns and an increase in the frequency of extreme weather events (Racey 2005). A warming of 1.8°C has already taken place over the past 150 years and lake and river ice patterns have demonstrated significant trends over this time frame towards earlier breakup and shorter duration of ice cover in the northern boreal forests (Benson et al. 2001). It is predicted that climate change will continue to impact boreal freshwater ecosystems by affecting ice cover, water temperatures, total water volumes (due to decreases in precipitation and increases in evaporation), and water quality with the magnitude of these impacts differing depending on existing waterbody characteristics and impacts associated with existing anthropogenic disturbances (Brown 2007). These changes, in turn, are expected to have significant impacts on aquatic ecosystems, including freshwater fish communities.

At the time this background report was drafted, climate data for FMZ 4 was only available up to the year 2007 (Environment Canada). It is important to note that the years 2008 and 2009 have experienced colder than normal winter and summer temperatures and GDD, and the winter and spring of 2010 were considerably warmer than normal. Data collected from Environment Canada show average summer temperatures observed in June (Figure 25) and July (Figure 26) as well as growing degree days (GDD) (Figure 27) for Fisheries Management Zone 4. These figures indicate warming trends across the zone through the last three decades. Temperatures appear to be consistently warmer in the western and southern portions of the zone, however warming trends are apparent throughout all of FMZ 4 within the last thirty years.

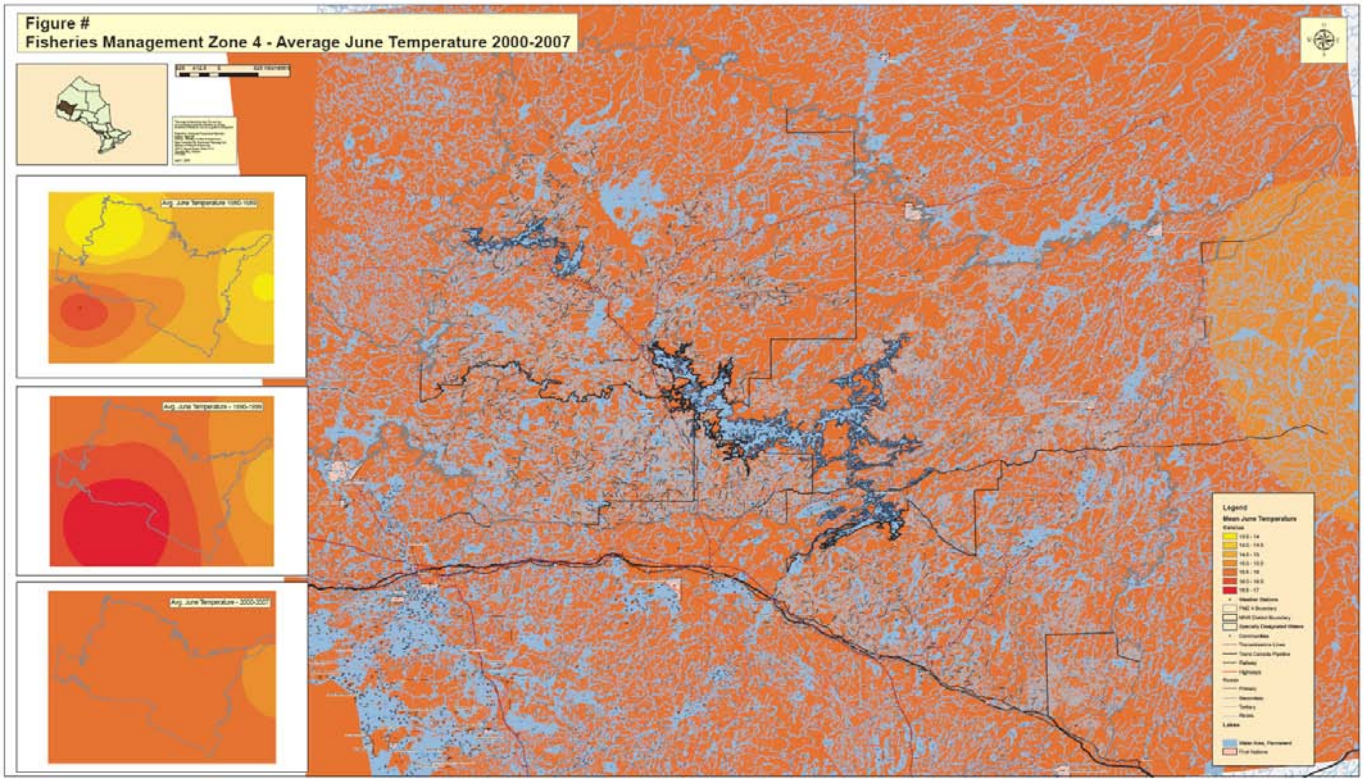

Figure 25. Map - Fisheries Management Zone 4 and average June temperature, trend by decade.

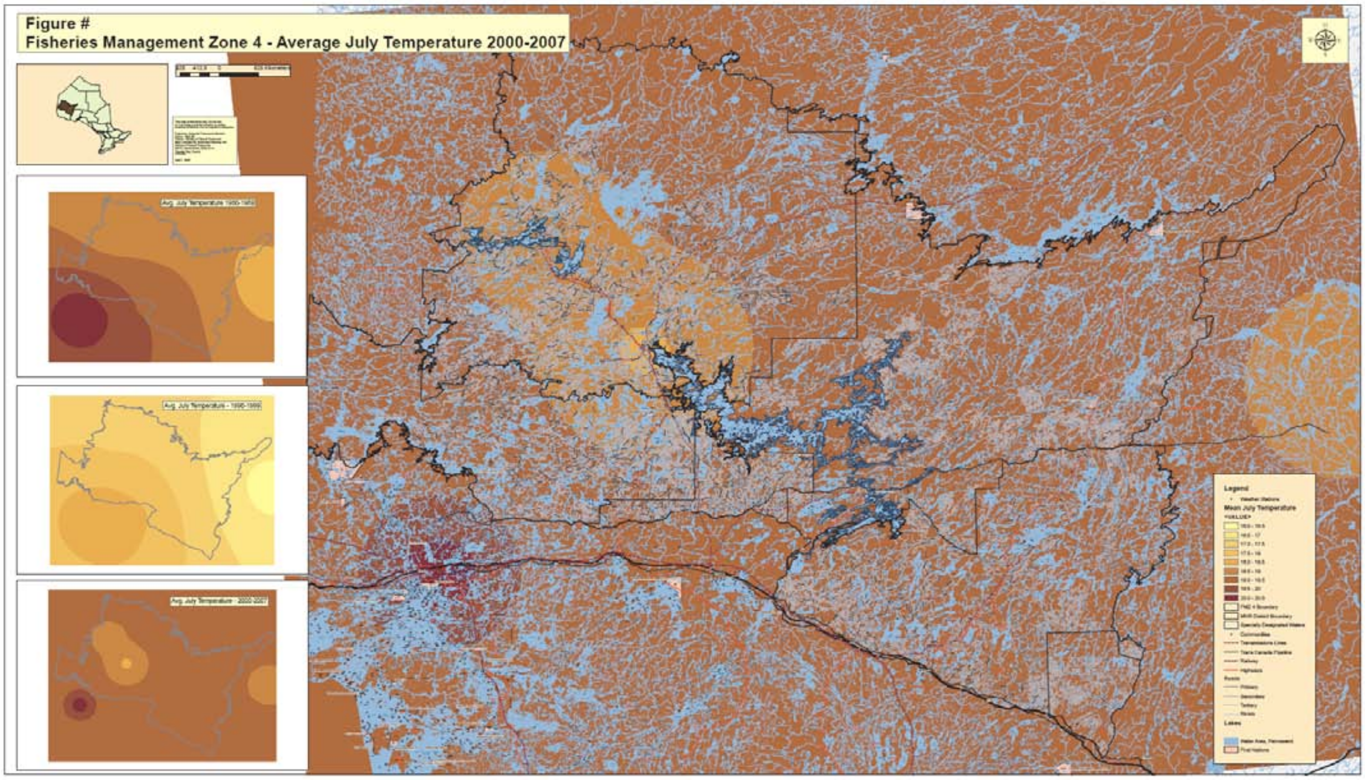

Figure 26. Fisheries Management Zone 4 and average July temperature, trend by decade.

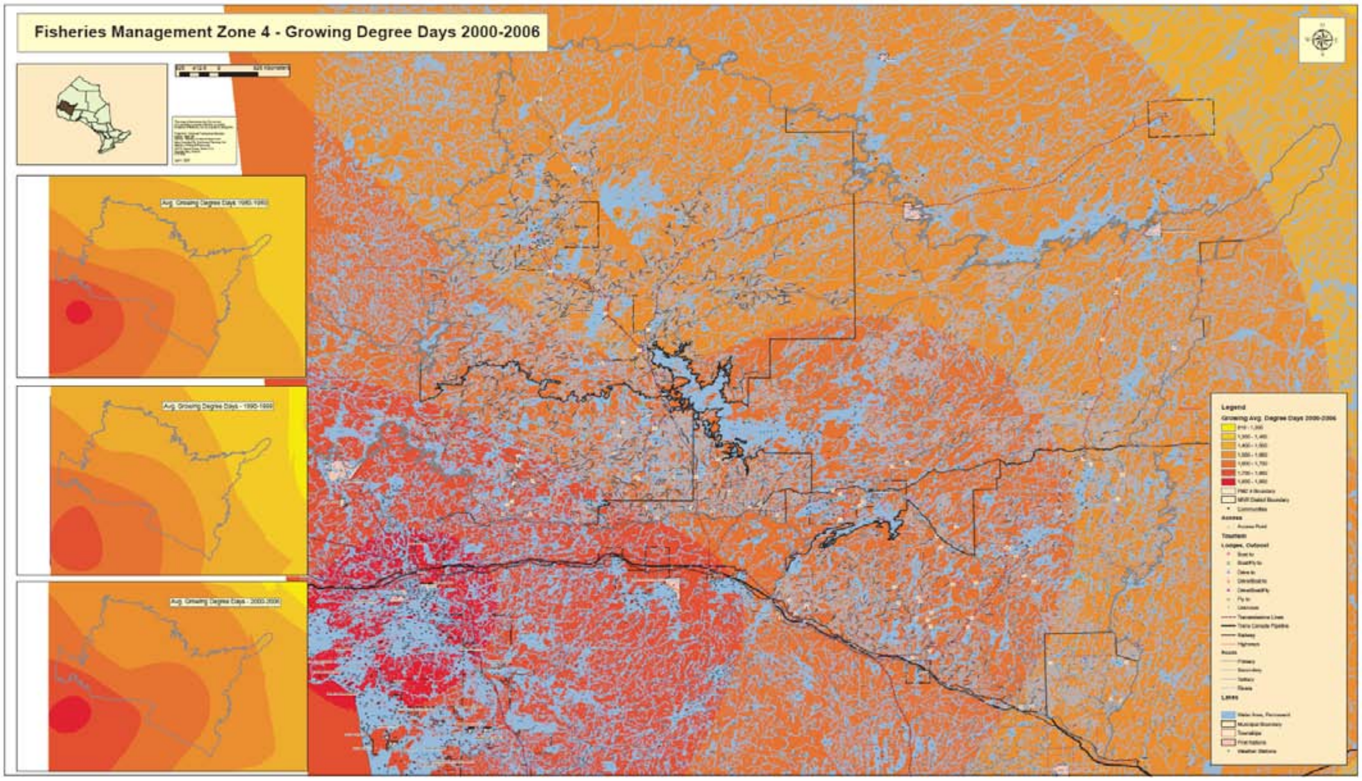

Figure 27. Map - Fisheries Management Zone 4 and Growing Degree Days >5^{o}C, trend by decade

Fish are directly affected by the temperature of their environments, as it plays an important role in the regulation of all of their physical processes; foraging, reproduction (i.e. spawning) and growth. Temperature also affects geographic distribution of fish, and they are often found at temperatures close to their optimal preferences; which is usually close to their optimum temperature for maximizing growth (McCauley and Cassleman 1981). In addition, strong relationships also exist between year-class strength and specific temperature conditions; and this relationship can be used to forecast the occurrence of large year classes (Venturelli et al. 2009).

Impacts to freshwater ecosystems as a result of warming associated with climate change are currently the focus of concern for many researchers. Considerable data exists supporting the threat of climate change to marine ecosystems and studies have shown that impacts associated with climate change are currently exhibited in marine ecosystems (i.e. coral bleaching, declining fish stocks, impacts to zooplankton abundance) (Cassleman 2002). Data on climate change impacts to freshwater ecosystems is minimal, however studies that have been undertaken show that threats are real and changes to waterbodies and aquatic communities, specifically those in northern biomes, are imminent.

Lakes in temperate climates generally undergo a process known as thermal stratification as water warms from spring into summer. As the temperature of the air increases, the surface of waterbodies warm while bottom layers remain relatively cool. A thermocline separates these two layers, the transition area between the warmer surface water layer and the colder, deeper water layer. During the summer periods, the warmer water layer reaches its maximum depth (depth of the thermocline is specific to each individual water body) and stratification of these two layers is maintained for the remainder of the summer. As air temperatures increase as a result of climate changes, associated warming in surface water temperatures are predicted to take place. This could result in changes to the length of seasonal stratification of lakes and the depth of the thermocline.

A number of hypotheses exist on the impacts of climate change to thermocline development and water temperatures. Shallower thermoclines have been predicted due to the rapid onset of spring stratification as a result of earlier, warmer temperatures (Snucins and Gunn 2000). Rapid warming of the surface layer, versus gradual warming, is predicted to create a more extreme thermocline, with surface waters increasing in temperature as the spring and summer progress and amplifying the divide between the warmer and cooler layers. This would have major implications on aquatic communities, particularly in cold water lakes, as the warm layer of water within a waterbody (epilimneon) is the greatest zone of productivity. A reduction in the depth of this layer would have significant impacts on productivity of the entire lake and the ability of that lake to support complex food webs.

Alternatively, Shindler et al. (1990) suggests that reduced runoff due to less surface water (less precipitation and more evaporation) will result in reduced DOC (Dissolved Organic Carbon) inputs and increased water clarity which would cause thermoclines to form at greater depths. Shindler (2001) also predicts that deepening of the thermocline will occur as a consequence of warmer water generated from increased air temperatures and longer ice-free seasons, resulting in a deeper warmer layer of water within lakes.

Total water volumes are also expected to be impacted by climate change. Predicted warming will result in greater evaporation of surface waters, which is expected to exceed precipitation (Lofgren 2002). Water loss through evaporation will have major impacts to watersheds, estimates of approximately 1m drops in water levels could result in loss of wetland surface area, decreased river and stream flows and reduced connectivity between waterbodies (Schindler 2001). Decreased flow from streams and rivers would result in fewer nutrient inputs and increased water clarity, which could have significant negative impacts to primary producers and result in a cascading trophic impact throughout the food web.

The advent of climate change and the associated physical impacts to aquatic communities will vary greatly depending on lake characteristics and community assemblages. It is expected that responses to climate change in freshwater species will be directly associated with temperature requirements of individual species; and that impacts to species will vary according to temperature guilds; warmwater (preferences greater than 25°C), coolwater (15-25°C) and coldwater (below 15°C) communities. However these impacts may range widely from beneficial to adverse for all community guilds depending on the combination of environmental variables at play. What is known and generally agreed upon across the scientific community is that impacts will be diverse and widespread, potentially positive for some guilds (warmwater) and negative for others (cold water).

Warming air temperatures, changes in ice cover patterns and lengthening of the growing season will increase growth and productivity of all temperature guilds if suitable thermal habitat is available and nutrients are not limited. For example, an increase in yield and productivity (Shuter et al. 2002) of walleye north of 51° is predicted to occur as air temperatures increase. Much of these predictions are dependent on existing lake characteristics and unique impacts to each individual water body. If warming temperatures are accompanied by changes in water quality (decrease in DOC and an increase in water clarity) and dropping water levels it is likely that there would instead be a decline in walleye productivity. Decreases in dissolved organic carbon (DOC) has also been predicted to lead to increased UV penetration which may negatively impact survival of fish eggs, fry and photosensitive fish species such as walleye (Huff et al. 2004).

Coldwater fish species such as lake trout and brook trout will be most adversely affected by climate change with predicted range recession expected as water temperatures increase (Shuter et al. 2002). Increased evaporation and potential decreases in thermocline depth means that there will be decreased subthermocline habitat available for coldwater species for foraging and spawining, leading to an overall decrease in productivity in coldwater lakes (Schindler 2001, Cassleman 2002). Lakes that remain unstratified and shallow may warm to greater than optimum temperatures for cold water species (greater than 15°C) such as lake trout (Schindler 2001) resulting in an overall decline in populations due to habitat loss.

Climate change is also expected to have indirect effects on fish species through impacts such as changes in fish species geographical distribution and associated changes to community interactions and competition for resources. Warm-water fish species such as smallmouth bass and rock bass are expected to benefit the most from the warming of shallow waters and are predicted to exhibit a northward range expansion as the climate warms. Climate warming may also accelerate the spread of non-native species. A number of invasive and introduced species are currently at the northern edge of their geographic range (i.e. zebra mussels, round goby, VHS), and many of these species have the potential for range expansion with climate warming. Smallmouth bass are currently held at the northernmost extent of their zoogeographic range by climate, however it is predicted that this species will advance 120 km for every degree Celsius of air warming that occurs (Shuter and Post 1990). Northward expansion of smallmouth bass not only adversely impacts coldwater species, such as lake trout, through competition for food and resources (Vander Zanden et al. 1999) but could also lead to the extirpation of cyprinid species found in littoral habitats that are often utilized by invasive and introduced species (Jackson and Mandrak 2002).

Impacts to aquatic communities as a result of a changing climate must be considered in association with existing impacts including overexploitation, development of hydroelectric facilities, habitat loss and impacts associated with introductions of invasive and introduced species. There is considerable need for continued research to interpret impacts to fish and fisheries due to complex ecosystem and community interactions.

4.3 Development

Development on the shores of lakes and rivers can have an impact on fish habitat and water quality through the introduction of sewage effluent (via private septic tanks and associated tile fields), riparian and upland deforestation and littoral habitat modifications such as beaches, landings, docks and boathouses (Steedman et al. 2004). Elevated phosphorous input into lakes, specifically those on the boreal shield, from sewage or agricultural runoff have been associated with algal blooms, hypolimnetic oxygen depletion and pollution of spawning habitat (Steedman et al. 2004).

To reduce impacts of shoreline development on aquatic habitat and fish productivity, Ontario's policy from 1970 – 1998 was to regulate shoreline development to reduce total phosphorous concentrations. In 2008, an amendment to the Land Disposition Process identified that lakes in the *Inland Ontario Lakes Designated for Lake Trout Management* (OMNR 2006) document would be protected from the disposition of vacant, undeveloped Crown Land that could otherwise lead to impacts to habitat or lakeshore carrying capacity for Lake Trout. Disposition of Crown Land on such lakes would need to follow the process defined in the *Class Environmental Assessment for MNR Stewardship and Facility Development Projects* (MNR 2003) in order to protect lake trout habitat within the province of Ontario.

Threats to lake trout habitat as a result of shoreline development in FMZ 4 are minimal. Shoreline development within FMZ 4 is very limited and development that does exist is largely associated with cottage developments, either as singular developments or multiple developments on cottage lots.

In the Dryden District portion of FMZ 4 there are no major cottage lot developments and no cottage lot development proposals currently underway. The main existing cottage lot developments in the Ignace area include Camp Lake, Wintering Lake, Savoy Lake, Encamp Lake, Sturgeon Lake, Robinson Lake, Sowden Lake and Elva Lake. Scattered road accessible and remote single camps exist on many area lakes within the Ignace area, including many camps along the privately owned Buchanan Road. In the late 1980's a proposal was put forward under the *Crown Land as a Development Tool* program with the aim of developing approximately 100 cottage lots on Indian Lake. This proposal did not go forward due to concerns surrounding water quality and limited lake trout habitat in the north basin, and the potential impact of nutrient loading from development.

In the Kenora District there are no cottage subdivisions within the boundaries of FMZ 4. A small number of patented properties that may be used as individual cottages or lodges for the remote tourism industry do exist within the boundaries of the Zone. Scattered road accessible and remote single camps also exist on many lakes within the Zone.

4.4 Mining Exploration, Extraction and Rehabilitation

Mining has the potential to have long-term impacts on aquatic ecosystems due to habitat destruction and water pollution associated with mine development, mineral extraction, mine effluent production and tailings and slag disposal/storage. Currently, there is high potential for mining activity in Northwestern Ontario, and a number of new claims and mining developments have been made within the Northwest Region. Compared to other anthropogenic impacts to fish habitat such as forestry, mining has the potential for greater acute and chronic environmental impacts due to the potential release of toxic contaminants into the environment. However, on a landscape scale mining tends to impact smaller areas than forestry or hydroelectric development unless mines occur within close proximity to existing developments, or increase the potential for additional development through improved access to sites.

The primary impact of mines on aquatic ecosystems is a result of the discharge of mine effluent to surface and ground water. Effluent from mining activities is produced through two main activities. The first is the contamination of water used in the mining and milling process by metals, acids, salts, fine particles and/or synthetic chemicals. The second is through the contamination of surface water (precipitation) when it falls on or runs through waste rock and mine tailings stored on the surface. Effluent, known as "acid mine drainage" enters the watershed through surface water runoff or ground water discharge which has been contaminated by either or both of these processes. Contaminants are either diluted or accumulated in receiving bodies of water or aquifers within the watershed.

Current policy surrounding mine development and environmental assessments for new mining projects need to consider the effectiveness of mitigation measures at compensating lost fish habitat and preventing impacts to aquatic communities through pollution events such as acid mine drainage. Regulations for mine closure plans within Ontario through the Mining Act (1990) require mine operators to submit a detailed remediation plan. Mine closure and reclamation measures currently attempt to contain, rather than remove, potential sources of water pollution such as tailings and waste rock. Policy recommendations identified by Brown (2007) include 1) the prevention of cumulative effects of mining in northern Ontario by considering new mine development in the context of comprehensive land-use planning and incorporating consideration of cumulative effects in the environmental assessment process; 2) improvement of methods used for the collection of fish production data prior to mine development to allow for assessment of habitat compensation measures; 3) requirement of permanent containment of mine tailings or removal of tailings from the site prior to mine closure in order to prevent long term contaminant risk in remote locations. At present, no policy exists regulating the extraction of peat within Ontario.

Current mine and peat extraction activity within the boundaries of FMZ 4 is limited, but has the potential to increase. Old mine sites exist in the Ignace and Red Lake areas (Table 9) which are dealing with acid mine drainage issues. Limited information on mitigation from past mining activities or the impacts associated with current mining activities and exploration is available, however the majority of the impacts associated with these activities on the local and landscape scale are currently unknown.

Table 9. Current mining and extraction activity in FMZ 4

District	Activity	Mitigation
Dryden/Ignace	Mining exploration activities (various companies)	Impacts unknown. Extent of exploration unknown.
Dryden/Ignace	Active investigation into potential peat resources (most of this area falls within the Zone 5 boundary).	Impacts unknown.
Dryden/Ignace	Decommissioned Mine site on the shore of Sturgeon Lake which is actively dealing with acid mine drainage that is treated and discharged into Sturgeon Lake.	Impacts unknown.
Dryden/Ignace	Pacific Iron Ore (Sturgeon Lake) is in the exploration stage for gold deposits on the former St. Anthony Mine site.	Pacific Iron Ore has been in contact with the District office regarding road development and access.
Sioux Lookout	None known	Impacts unknown.
Kenora	Mining exploration activities (various companies)	Impacts unknown. Extent of exploration unknown.
Kenora	Historic mining patents in the Werner Lake Area with a Restricted Area Order applied through the Public Lands Act. These sites have not yet been developed.	Not Applicable
Red Lake	Griffith Mine (Rehabilitated), a iron ore open pit mine which closed in 1986. No known impacts of this mine site to the aquatic environment. Two pit lakes are nearing capacity and may equalize with water levels in the Bruce Lake and English River System.	No known impacts.
Red Lake	Mining exploration activities (various companies)	Impacts unknown. Drilling activity uses sediment control and grey water control however monitoring is self compliant and no impacts to fisheries have been assessed. Mining exploration may also be creation additional access and impacting erosion/sedimentation.
Red Lake	South Bay Mine (Rehabilitated), a deactivated base metal mine (Cu/Zn) which has a history of acid mine drainage.	Some mitigation measures in place for some time, additional work needs to be done to address long term acid mine drainage issues.

4.5 Forest Management Activities

Forestry results in two major changes to the landscape that may affect aquatic ecosystems. The removal of vegetation through forestry activities alters groundwater flow and surface runoff which has been documented to lead to the release of mercury, nutrients, decaying organic matter and sediment to adjacent water bodies with associated impacts on fish and other aquatic organisms (Brown 2007). The creation of logging roads associated with forestry activity may fragment aquatic habitat due to poorly constructed water crossings which increases sedimentation from erosion of the road surface. Logging roads also present the potential for increased human exploitation of fish resources due to enhanced access to lakes and rivers. The following discussion explores some of the potential cumulative impacts associated with forest removal activities on a landscape scale.

4.5.1 Mercury

Mercury loading in aquatic communities has been associated with forest removal through a number of processes. Mercury is a toxic metal that is widely distributed in the environment and occurs naturally in both aquatic and terrestrial environments, generally in low concentrations. During forestry activities, mercury is liberated through soil erosion and transformed into more soluble forms through the decay of organic matter (Porvari et al. 2003). Mercury is then able to leach into waterbodies through surface waters (runoff, streams and rivers). Uptake of mercury may be hastened in aquatic communities impacted by forestry as associated nutrient loading from erosion and runoff may increase primary productivity resulting in an increased rate of mercury incorporation into aquatic organisms (Kelly et al. 2006). Mercury is biomagnified upwards within the food chain, it is found in low concentrations in primary producers and high concentrations in predators such as walleye or northern pike. Mercury is the most common contaminant found in the flesh of sport fish in Northwestern Ontario (OMOE 2009). To date, there is little research that differentiates the impacts of fires and forestry activities on mercury contamination into boreal aquatic ecosystems (Brown 2007). Increased mercury concentrations in fish appears to be a common outcome of forest disturbances regardless of the instigating agent.

4.5.2 Nutrient Input

Removal of vegetation through forestry activities is commonly followed by an influx of nutrients, minerals and organic matter into lakes and rivers as there is reduced vegetation cover and root mat structure to secure soils (Brown 2007). Research on the impacts associated with increased erosion and runoff associated with forestry activities in boreal ecosystems is often varied in its findings. In some cases, nutrient input results in an increase in primary production, which can increase productivity and alter food web interactions through changes in the abundance of primary consumers (ie. Zooplankton) (Planas et al. 2000). However, in some findings, increases in DOC (dissolved organic carbon) concentrations following logging activities can reduce water clarity sufficiently to offset nutrient inputs and primary productivity remains unaltered or declines (McEachern et al. 2000).

Impacts to fish as a result of increased nutrient input are not well understood. Increased DOC concentrations results in lower light penetration and shallower thermoclines (the line of transition between cool water and coldwater habitat), which may impact associations between cold water and cool water fish species. Current research indicates that impacts are highly dependent on the characteristics of each individual water body and the surrounding landscape.

Logging and forest fire disturbance have often been compared in terms of impacts associated with nutrient inputs into aquatic ecosystems (Brown 2007). Total nutrient input appears to be similar for both disturbance events (McEachern et al. 2000). Logging does appear to be associated with greater inputs of DOC as well as nitrogen and phosphorous (Lamontagne et al. 2000). While forest fires generally result in higher inputs of cations and anions found in ash such as calcium, magnesium and sulphate (Carignan et al. 2000).

4.5.3 Runoff and Sedimentation

Forestry activity can result in increases in total runoff and changes to the flow regime of forest streams, which in turn can impact physical stream habitat, species distributions and primary productivity (Poff et al. 1997). Sedimentation associated with runoff and erosion can also alter stream environments and impact biota, including fish species. Sedimentation associated with forestry activities, through both harvesting and the development of forestry access roads is the most dominant impact of logging on stream and river ecosystems (Croke and Hairsine 2006). Increased loading of fine sediments have been demonstrated to impact invertebrate communities and negatively impact spawning and nursery habitat of riverine spawning species (Kiffney et al. 2003).

Sedimentation as a result of logging events is generally greater than from natural disturbances, largely due to the creation of roads and the disturbance of soils by forestry machinery (Martin and Hornbeck 2000). Roads associated with logging activity are often a greater source of sedimentation and erosion of forest soils than the act of harvesting (clear-cutting) (Croke and Hairsine 2006). Persistence of sedimentation due to erosion after logging or road development activities is dependent on the rate of vegetation re-growth, placement of roads and suitable construction of water crossings. Impacts can last 3-10 years in areas with rapid re-growth, or can persist for decades in areas with steep slopes or poor road placement and ineffective water crossing design (Martin and Hornbeck 2000).

Ontario forestry guidelines require that an uncut buffer strip around lakes and rivers (OMNR 2009) be established during forest management planning to reduce the impacts of sedimentation from surface runoff and erosion (lakes 30-90 m, rivers and streams 30-90 m). However, roads placed near water bodies and road water crossings can continue to cause sedimentation despite the presence of buffer zones. Due diligence during forest management planning requires contentious placement of roads, connectivity of hydrology, consideration of slope when delineating the width of buffers (OMNR 2009) and the effective design and installation of water crossings that will reduce the impacts of sedimentation to forest streams and rivers.

4.5.4 Loss of Riparian and Littoral Vegetation

Cutting vegetation at stream edge (riparian) or lake edge (littoral) zones can affect lake and river ecosystems. Clear cutting lake habitats to shore can result in increased wind speeds, warmer water temperature in the littoral zone and increased sedimentation due to the loss of vegetation found at shoreline edges (Steedman et al. 2001). Increased wind velocities, particularly on small lakes (surface area >20 ha) may deepen lake thermocines, resulting in a larger warmer water layer, or prevent stratification of shallow waterbodies due to increased water column mixing (Brown 2007). Warmer water temperatures may increase primary productivity and create habitat that favours survival of warm water species such as smallmouth bass and walleye.

Cutting riparian habitat reduces shading and increases water temperatures of streams and rivers. High water temperatures, when water clarity is not impacted by sedimentation, may increase productivity resulting in increased fish survival and growth (Kiffney et al. 2003). However, higher water temperatures may also impact spawning or nursery habitat of species that prefer cooler temperatures.

Impacts associated with the loss of riparian or littoral vegetation are similar for both logging events and natural disturbances such as blowdown and forest fires. Forest management practices in Ontario require buffers around portions of lake and all stream and river habitat where forest management activities are to occur in order to reduce the impacts of terrestrial vegetation loss to aquatic communities. New directions in the Stand and Site Guide (OMNR 2009) recommend cutting littoral vegetation on some waterbodies in order to better emulate natural disturbance events on the landscape such as fire and blowdown which occur to the edge of riparian and littoral zones. Retaining shoreline forest in the Stand and Site Guide (OMNR 2009) includes maintaining 50% residual on ponds and small lakes (>8 and <100 ha), 75% residual on medium lakes (>100 and <1000 ha) and 90% on large lakes (>1000 ha) (OMNR 2009).

4.5.5 Logging Roads

Forestry operations create an extensive network of roads the impacts of which can exist on the landscape long after logging operations have ended. Adverse effects from roads on aquatic ecosystems can result from poorly designed water crossings, erosion of road surfaces and increased access by humans to formerly remote lakes and rivers. A detailed description of the impacts that roads and water crossings can have on aquatic ecosystems can be found in section 4.5 of the background report.

4.5.6 Forest Harvesting in FMZ 4

A wide variety of techniques have been developed to reduce the impacts of forest harvest activities on aquatic ecosystems. Use of riparian buffer strips which range in widths from 30 to 90 metres and increase in width in accordance to catchment slope is common in Ontario forest management planning and is effective at reducing sedimentation, erosion and temperature impacts of clear cut logging on aquatic communities (Rashin et al. 2006, OMNR 2009). When buffer zones are used in association with careful planning of road construction, appropriate timing of harvesting activities and well constructed water crossings, impacts such as sediment loading can be greatly reduced or even eliminated (Rashin et al. 2006).

Efforts have also been made to reduce the effects of logging on aquatic environments by limiting the proportion of the watershed area disturbed by forestry. Effects on water quality and quantity require the disturbance of at least 25% of the watershed, though impacts are highly dependent on watershed characteristics (Brown 2007), however impacts to fish species due to contamination, nutrient loading or habitat alteration can occur at percentages less than 25%. In general, limiting the proportion of the watershed area that is disturbed through forest management activities will minimize impacts, however the thresholds of those impacts on aquatic communities have yet to be determined (Brown 2007).

In Fisheries Management Zone 4, the entire proportion of the Crown Land area of the zone, aside from provincial parks or conservation reserves are active in forest management planning. In total, 9 active Forest Management Units exist either fully or in part within the Zone; the English River Forest, Caribou Forest, Lac Seul Forest, Trout Lake Forest, Wabigoon Forest, Dryden Forest, Whiskey Jack Forest, Kenora Forest and the Red Lake Forest (Table 10). Forest management activities within Zone 4 have the potential to contribute significantly to the cumulative impacts to aquatic ecosystems at a watershed scale.

Table 10. Forest Management Plans and Renewal Dates within Fisheries Management Zone 4

District	Forest Management Unit	Renewal Date
Ignace/Dryden	English River Forest	2014
Sioux Lookout	Caribou Forest	2013
Sioux Lookout	Lac Seul Forest	2011
Red Lake / Sioux Lookout	Trout Lake Forest	2014
Dryden/Fort Francis	Wabigoon Forest	2013
Dryden	Dryden Forest	2011
Kenora / Red Lake	Whiskey Jack Forest	2012
Kenora	Kenora Forest	2012
Red Lake	Red Lake Forest	2013

Concern about the impacts of forestry on waterbodies in Ontario has led to the development of forest management planning operations that approximate natural disturbance events (i.e. fire) which have been reduced on the landscape as a result of human intervention. These silvicultural systems approximate the disturbance patterns caused by natural disturbance events, however they do not approximate all of the stand level dynamics or chemistry associated with events such as wild fire (McRae et al. 2001). Implementing best practices, such as using buffer strips to reduce sedimentation and selecting road placement and effective water crossing construction, used in association with forest harvesting techniques modeled after natural disturbance regimes collectively may help in reducing impacts to aquatic communities. Continued research of forestry activities on waterbodies as well as monitoring impacts through silviculture effectiveness monitoring is required in order to better understand the cumulative impacts of forest management to fisheries resources.

4.5 Roads and Water Crossings

The majority of roads in FMZ 4 have been constructed by the forest industry in support of forest management activities. However, roads associated with mineral exploration activities appear to be increasing in number and length in response to high mineral values. The road network developed by the forest industry is comprised of active and inactive or abandoned roads. Some of these roads are the responsibility of MNR and while others are the responsibility of the forest management companies. Road responsibility is determined as part of the forest management planning process. Currently there are 18,451 kilometres of forestry roads on Crown land (Table 11).

Table 11. Total kilometres of roads and estimated numbers of water crossings within Fisheries Management Zone 4.

District	Km of Active Roads	Estimated Water Crossings on Active Roads
Dryden	5986 km	1236
Red Lake	4705 km	1006
Sioux Lookout	4357 km	1208
Kenora	3403 km	857
Total for FMZ	18451 km	4307

Adverse effects of roads on aquatic ecosystems may arise from poorly constructed water crossings, erosion of material from road surfaces, and increased human access to formerly remote lakes and rivers (Browne 2007). Roads also alter the lateral movement of surface runoff and may cause the movement of sediment from ditches and approach slopes into water courses (Toman 2004, Luce 2002, Wemple et al. 2001). Effects on lateral movement of surface runoff can also affect ground water recharge and impact spawning and incubation habitats (Curry and Devito 1996) and water quality (Curry et al. 1993). Since roads tend to persist on the landscape, their effects on the aquatic ecosystem and human access tend to be present for considerable periods of time (Browne 2007).

When roads intersect a river or stream water crossings are established to facilitate extension of the road system. There are estimated to be 4307 water crossings on Crown land within FMZ 4 (Figure 28).

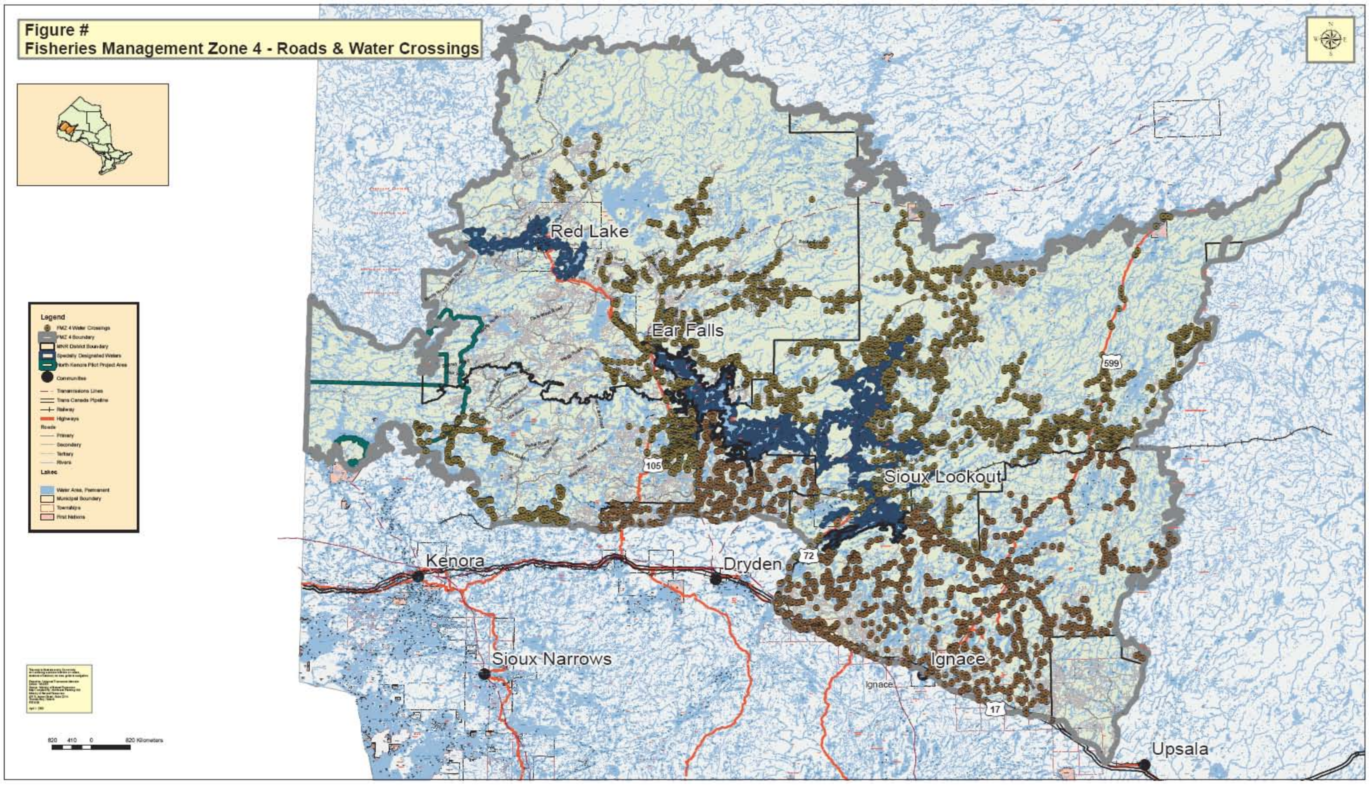

Figure 28. Estimated number of active roads and water crossings within Fisheries Management Zone 4.

The structures most commonly used in water crossings are corrugated metal culverts. Culverts are sized to pass flows that occur once every 15 years. MNR is currently embracing the assumption that if a culvert is properly sized that fish will be able to pass through the culvert. This assumption could certainly be questioned but has not yet been tested.

On smaller watercourses culvert diameter may span the active channel but rarely are culverts sized to provide for bankful flows that occur every 1.5 years. On larger watercourses culverts commonly do not span the active channel so fill slopes encroach on the active channel. Harper and Quigley (2000) demonstrated that stream crossings can produce direct losses in fish habitat (channel loss, riparian loss and benthic loss) due to encroachment. Water crossings that utilize culverts as the crossing structure are known to significantly fragment habitat and fish populations (Gibson et al. 2005). Upstream and downstream passage and migration of fish can be impaired or prevented by culverts that are perched (Langill and Zamora 2002). High water velocities through improperly sized culverts can also act as barriers to upstream movement (Gibson et al. 2005).

Erosion of material from unstablized or poorly stabilized fill slopes can be a significant source of suspended sediment at water crossings (Harper and Quigley 2000). Additional input of sediment can have significant detrimental effects on downstream primary productivity (Lloyd et al. 1987). Stream crossings can alter ecological processes by changing the hydrology of the water course. Changes in hydrological processes alter natural suspended and bedload sediment movement especially in the case of perched or undersized culverts. Similarly, the movement of organic material and woody debris can be altered or interrupted causing changes in downstream habitat for fish and wildlife.

Cumulative impacts of a large number of water crossings on individual watercourses have not been quantified. However, the scientific literature suggests that cumulative impacts are certainly possible. In the short to medium term there is a need to examine the number of water crossings on individual river systems and remove the ones that are no longer required. In the longer term consideration needs to be given to reducing the number of crossings on a given watercourse and the cumulative impacts of multiple water crossings needs to be formally investigated.

4.6 Waterpower and Water Control Structures

In 2008 the Green Energy Act was proclaimed. The main goals of the Green Energy Act are 1/ to make it easier to bring new renewable energy projects on line and 2/ to foster a culture of conservation by assisting homeowners, government, schools and industry to transition to lower and more efficient energy use. Political expectations of the Green Energy Act include building a stronger, greener economy with new investment, supporting well paying green jobs and more economic growth for Ontario including 50,000 jobs over the next 3 years; and protecting our environment, combating climate change and creating a healthier future for generations to come.

There are three primary drivers for the Green Energy Act. The first is climate change and a desire to reduce greenhouse gas emissions especially from coal fired electricity generation facilities by 2014. The second is a stronger, greener economy and in particular the creation of 50,000 new jobs over the next 3 years and encourage major investment to help address the current economic downturn. The last driver is the need to upgrade Ontario’s aging electricity infrastructure.

The implementation of this act fundamentally changed MNR’s role in the management and authorization of renewable energy activities on Crown land. MNR’s mandate and role still include management of fisheries, wildlife, petroleum and mineral aggregate resources and Ontario’s provincial parks and Crown lands and waters. MNR is still expected to administer its mandate through the various statutes that are the responsibility of MNR. However, not all statues can be tied directly to renewable energy and some statues have provisions to exempt renewable energy projects (e.g. *Endangered Species Act*).

There is now an integrated approach to approvals that has MNR decision making occurring simultaneously with other provincial ministries. MNR’s decision making is supported by up-front requirements established in the MNR Approval and Permitting Requirements Document and the Renewable Energy Approval regulation. For everything except large scale hydro generation proposals there is now a single set of provincial requirements. A water power class environmental assessment process remains in place for large scale hydro development but is a proponent driven process. There is a continuing role for MNR in providing input on waterpower development through an environmental assessment and for subsequent Lakes and Rivers Improvement Act approvals.

MNR's primary role the new process is to provide access to Crown land for renewable energy projects and contribute to achievement of renewable energy projects. MNR has a role in permitting but is no longer the decision maker on whether or not projects will move forward. Other changes that are significant from a fisheries management perspective include changes to how natural values and risk to those values is considered in decision making. Natural values cannot be used to reject renewable energy projects.

The Green Energy Act and renewable energy planning process have the potential to greatly affect fish habitat and productivity within FMZ 4. Since there has been no work undertaken to asses the aquatic values in rivers within FMZ 4 there is no way for resource managers to know what aquatic resource values are present. Thus, there is no way of knowing what risks are posed by extensive waterpower development on aquatic values and what the environmental cost could be of such developments.

Currently, three large hydroelectric generating stations, all on the English River System exist within FMZ 4. There is dam at Ear Falls at the outflow of Lac Seul, one at Manitou Falls near Barnston Lake, and one at Caribou Falls at the outflow of Umfreville Lake. All are owned and operated by Ontario Power Generation. In addition, there are 20 water control structures within FMZ 4, 5 of which are owned and operated by MNR and 15 that are owned and operated by Ontario Power Generation. In terms of potential water power sites within FMZ 4, there are a total of 32 sites within parks and protected areas, 103 direct release sites and 7 sites in the Northern Rivers Planning area for a total of 142 sites (source:www.lio.ontario.ca/imf-ows/imf.jsp?site=waterpower_en) (Figure 29). Currently, there are 9 sites that have submitted Feed In Tariff applications within FMZ 4.

Water power and water control structures can have significant effects on aquatic ecosystem integrity by altering the hydrological, thermal, sediment and water quality regimes. There is a significant body of scientific literature describing the adverse effects of dams. Clarke et al. (2008) provide a detailed discussion of the effects of water control structures on fish and fish habitat with extensive references. The following summary of the effects of dams on fish and fish habitat was based on the paper by Clarke et al. (2008).

Dams and related facilities can cause a direct loss of fish habitat because they are often placed at falls, rapids or riffle areas in watercourses where there is a marked drop in elevation. Dams physically impede upstream and downstream movement and migration of fish and other aquatic organisms. The effect of a physical barrier to upstream and downstream movement is the fragmentation of riverine habitat.

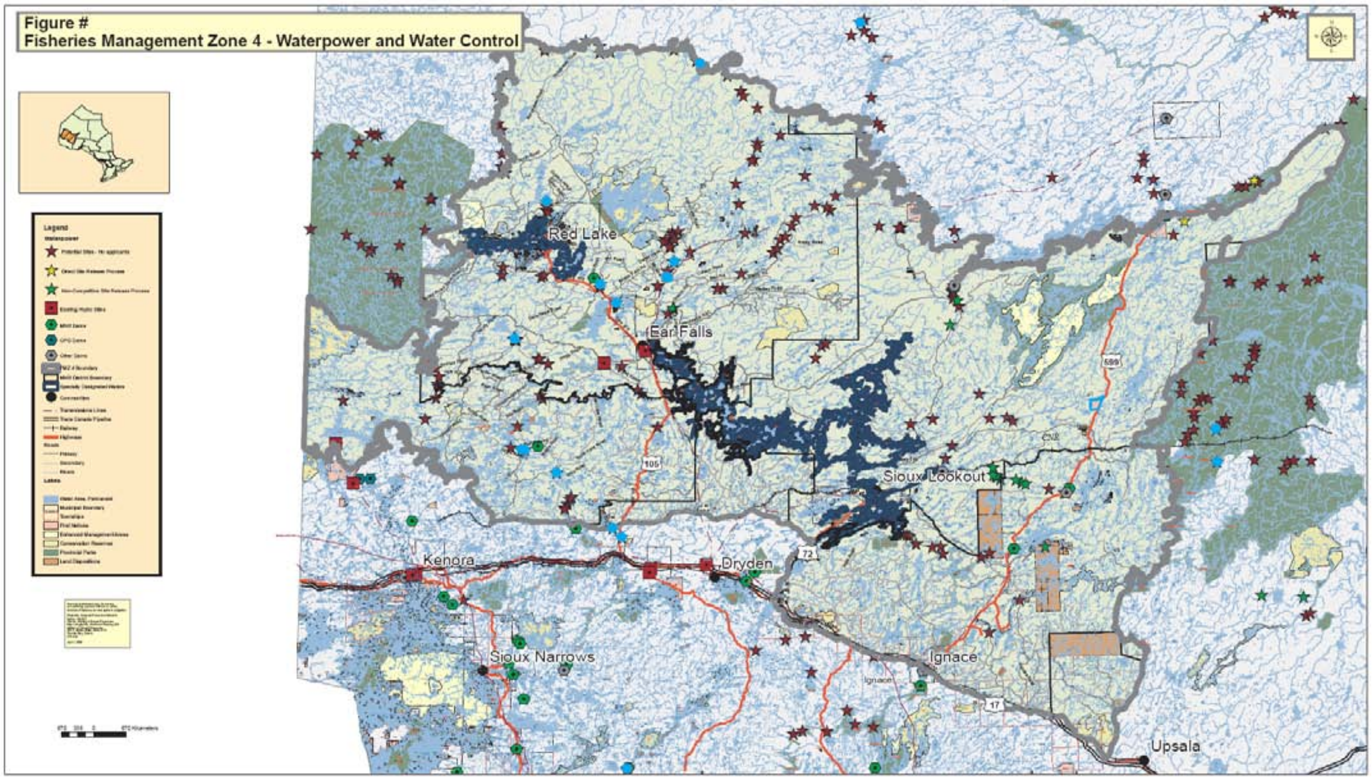

Figure 29. Fisheries Management Zone 4 waterpower facility and dam distribution

The greatest effect of dams is on the hydrological regime of the watercourse. Flow management alters the natural flow regime by changing the magnitude of discharge, duration, frequency, timing and rate of change of flows which in tern affects physical and ecological processes in an riverine ecosystem. Regular inundation of the flood plain may no longer occur or occur too frequently. Inundation of the floodplain connects the river with riparian vegetation which is important for nutrient cycling and creation of habitats. Flow management can prevent fish from using spawning and feeding habitats in inundated areas thus reducing fish community diversity and productivity.

Rapid changes in flow at peaking facilities can result in alteration of the quantity and quality of habitat available to fish. Effects can be direct such as stranding, mortality and habitat abandonment or indirect such as downstream displacement, depleted food supply volitional movement, reduced food production and increased physiological stress. Total gas pressure, which is the concentration of oxygen, argon and nitrogen in water can be increased when water and air are mixed in spill ways then allowed to plunge into deep water. This can lead to gas bubble trauma in fish and mortality. Increased drift of food organisms can occur with positive and negative effects on feeding efficiency. High flows can increase energetic costs with negative effect on foraging ability and decreased growth of fish.

The movement of resident fish can also be impeded. While movement is known to be important for resident fish the effects of changes to movement patterns are not well understood. Changes in movement patterns may cause changes in fish community composition, reduce genetic diversity and, reduce species persistence.

Temperature is considered one of the most significant variables affecting the life history traits of aquatic organisms such as the timing of migration and spawning. In addition, water temperature affects metabolism, growth, susceptibility to disease. Dams that cause the creation of reservoirs can significantly later the thermal regime of a river. The establishment of reservoirs essentially changes a portion of the river from a flowing water system to a lake system. Just like in lakes heat from the sun can cause the water column of the reservoir to stratify with warmer water in the top layer and cooler water in the bottom layer. The location in the water column where water is drawn from a reservoir can have significant effects on downstream water temperatures. Colder or warmer water temperatures downstream may result. Higher flows can extend the extent of the temperature effect downstream. In some cases elevated water temperatures can extend preferred feeding periods which may offset the effects of greater energetic costs. Overall, changes in temperature have been observed to change fish community composition, year class strength and predation. Such changes may also facilitate the establishment of invasive species.

Dams, since they alter flows, reduce the amount of suspended sediment and bedload sediment that is carried by a watercourse. Essentially, dams act as sediment traps. Water released from a dam is sediment poor thus the water has excess energy. The river expends this energy by eroding the banks and channel. Increased water flows or redirected water flows from penstocks can scour river beds and increase bank erosion rates. Positive and negative effects of scouring on food chains have been observed. Changes in sediment movement and deposition patterns downstream can affect habitat establishment or maintenance which ultimately affects biomass and productivity of fishes. The loss of species diversity and species richness has commonly been observed.

Altered flow regimes have a significant effect on nutrient dynamics and nutrient availability. Dams interrupt upstream and downstream transport of nutrients and disconnect the river channel, river edge, riparian zone and floodplain. The establishment of reservoirs has been known to increase mercury concentrations in water due to the re-solublization of mercury that was once bound in sediments. This means that it is more available to aquatic organisms and bio-magnification can result in the food chain. Altered nutrient dynamics affects primary productivity and ultimately the productivity of fish populations.

The geographic area or zone of influence upstream and downstream of a dam that is affected by changes to the hydrological, thermal, sediment and water quality regimes upstream can vary spatially and temporally. The point downstream from a dam where changes in the natural flow pattern are no longer detectable may be a considerable distance from the dam. However, changes to the biological characteristics of the river that result from alterations in the hydrologic regime may extend even further downstream (Vinson 2001). Changes to flows can elicit changes in erosion and sedimentation that can been measured hundreds of kilometres downstream (OMNR 1977; Poehlman 1996). The distance downstream of a dam that the thermal regime is affected varies depending on the position of the dam in the watershed, how the dam is operated, the depth from which water is released, and the environmental and geomorphic setting (Olden and Naiman 2009). Thermal effects have been observed to extend great distances downstream before recovery occurs (Edwards 1978; Lessard and Hayes 2003; Olden and Naiman 2009). Predicting the zone of influence upstream and downstream of a proposed facility can be difficult and may be largely subjective at the planning stage.

5.0 Socio-economic Description

Due to the overall high quality of fisheries, good access and abundance of fishing opportunities in FMZ 4, many waterbodies within the Zone are popular destinations for Ontario resident, Canadian resident and non-Canadian resident anglers. Angling by these residency groups remains primarily a consumptive use of the fisheries resources. The maintenance of fishing quality and diversity of fishing opportunities is heavily reliant on sustainable, naturally reproducing fish populations.

5.1 Recreational Sportfishing

In general, participation in fishing has been declining. Hofmann (2008) indicated that the national recreational fishing survey results showed a decline in the number of days fished from 48.8 million in 1995 to 37.7 million days fished in 2005. The days fished per angler appear to have remained the same so participation must have declined. Hofmann suggested that this decline appeared to be due to the aging population.

The results of the national recreational fishing survey conducted in 2005 were used to identify recreational angler characteristics and expenditures for FMZ 4. The survey conducted in 2005 is unique in that the data can now be geo-referenced to allow analysis by specific geographic areas. The analysis referenced in the following sections was provided by S. Hogg of Fisheries Section of the Ontario Ministry of Natural Resources.

A total of 125,379 anglers were estimated to have fished in FMZ 4 in 2005. Eighty-seven percent (87%) of anglers were male and 13% were female. The average age of male and female anglers across all residency categories was 53 years and 46 years respectively. The average ages of male and female anglers is probably underestimated because anglers aged 65 and older are not required to purchase a licence and licence records were used to sample anglers. Thus, anglers 65 years of age an older are under-represented in the sampling design. An examination of angler participation by age class indicates that the participation of anglers in the younger age classes (18 to 34 years) is relatively low representing only 14% of male anglers and 19% of female anglers. Anderson et al. (2004) suggests that fewer women participate in angling because of the perception that this is a male dominated activity, commitments to family, lack of time, skill and cultural influences.

It is estimated that 6,301,776 angler hours of fishing effort were exerted on the fisheries resources in FMZ 4 in 2005. Majority of fishing effort, (84% of total fishing effort or 5,301,867 angler hours) resulted from angling by non-Canadian residents. Ontario residents contributed 14% (860,768 angler hours) of total angling effort followed by Canadian resident anglers who exerted the least amount of angling effort at 2% of total angling effort (139,141 angler hours). Ice fishing was undertaken by 8.1% or 10,113 anglers who exerted an estimated 172,737 angler hours of fishing effort on the fisheries resources of FMZ 4.

In terms recreation, angler use of the fisheries resources of FMZ 4 were estimated to provide 881,221 angler days of recreation. Ice fishing was estimated to provide 31,658 angler days of recreation.

Fishing effort by Ontario and non-Canadian residents was distributed across 39 and 265 lakes respectively. It was clear that the majority of fishing effort was focused on larger lakes in the fisheries management zone. These results also demonstrate the social and economic importance of the large lakes. It would appear that fishing effort by Ontario residents is focused in the Red Lake and Sioux Lookout areas. Fishing effort appears to increase as you move northward in the zone and decreases as you move from west to east in the zone.

When anglers across all angler residency categories were asked what their most preferred species were they indicated that walleye were most preferred followed by northern pike and lake trout. The results of the 2005 survey for "*fish caught*" indicate that walleye, northern pike, smallmouth bass, yellow perch and lake trout in that order were the most popular fish species. For "*fish kept*" by number, walleye, northern pike, yellow perch, lake trout and smallmouth bass were the most popular species. An examination of the proportion of fish caught that were kept demonstrated a preference for yellow perch (28%) followed by lake trout (27%), walleye (11%), northern pike (7%) and smallmouth bass (5%). These results also demonstrate that the catch and release philosophy is clearly a part of angling activities in FMZ 4. Depending upon the species from 72% to 95% of individual fish that were caught were subsequently released. The extensive use of a catch and release philosophy needs to be considered in future management actions designed to maintain fish populations and fishing quality.

It was estimated that anglers fishing in FMZ 4 in 2005 spent a total of $133,322,411.00 on fishing activities. The majority of these expenditures ($112,693,711.00) were on consumable goods such as accommodation, meals, travel, boat rentals, fishing supplies, licence fees, access fees and package deals. Expenditures on investment goods such as fishing, boating and camping equipment, special vehicles, land and, buildings were estimated to be $28,628,700.00. The economic impact of non-Canadian resident angler participation in the fisheries is clear as this group of anglers were responsible for 84% of all expenditures in FMZ 4.

5.1.1 Ontario Resident Anglers

Of the total of 125,379 anglers estimated to have fished in FMZ 4 in 2005 approximately 14% were Ontario residents. Of Ontario resident anglers 65% were male and 35% were female. Female participation in angling for Ontario residents was the greatest for all angler residency categories.

Of the Ontario residents that fished in FMZ 4, 51% originated from FMZ 4 which is not surprising given the quality and diversity of the fishing opportunities in the zone. An additional 21% and 4% of Ontario residents fishing in FMZ 4 originated in adjacent fisheries management zones 5 and 6 respectively. What is surprising is that 20% of anglers originated from FMZ 16 which is located in the heart of southern Ontario.

Of the total fishing effort (6,301,776 angler hours) estimated to have been exerted on the fisheries resources in FMZ 4 in 2005 14% (860,768 angler hours) was due to Ontario residents. Of the total estimated ice fishing effort of 172,737 angler hours 75% (129,032 angler hours) was due to Ontario resident anglers.

In terms recreation, angler use of the fisheries resources of FMZ 4 were estimated to provide 881,221 angler days of recreation. Ice fishing was estimated to provide 31,658 angler days of recreation. On average Ontario residents fished an average of 22 days and contributed 20% (172,037 angler days) of total angler days in FMZ 4 in 2005. The majority of angler days of recreation (79%) associated with ice fishing activities were attributable to Ontario residents.

Fishing effort by Ontario residents was distributed across 39 lakes. The majority of Ontario resident fishing effort (71%) was focused on Trout Lake, Lac Seul, Red Lake, Pumphouse Lake, Longlegged Lake and Little Vermilion Lake. The majority of Ontario resident ice fishing effort (80%) was focused on Trout Lake, Joyce Lake, Hartman Lake and Red Lake.

The fisheries in FMZ 4 are extremely important to local communities. Open water fishing and ice fishing are important are important recreational activities. In addition, these fisheries are vital to the economic well being of local communities. It has been shown that the attraction of recreational fishing opportunities has helped local communities to withstand economic downturns in such resource industries as mining and forestry.

5.1.1 Canadian Resident Anglers

Of the total of 125,379 anglers estimated to have fished in FMZ 4 in 2005 3% were Canadian residents. Female participation in angling for Canadian residents was also quite high at 23%.

Of the Canadian residents fishing in FMZ 4 the majority (84%) originated from Manitoba. Overall, 93% of Canadian residents fishing in FMZ 4 originated from the western provinces of Alberta, Saskatchewan and Manitoba. The remaining 7% of anglers originated from Quebec.

Canadian residents contributed only 2% (139,141 angler hours) off the total fishing effort (6,301,776 angler hours) estimated to have been exerted on the fisheries resources in FMZ 4 in 2005. Canadian residents appeared to be focused primarily on open water fishing with only 4% of total ice fishing effort due to this residency group.

Only 3% (28148 angler days) of the total estimated 881,221 angler days of recreation exerted on the fisheries resources in FMZ 4 in 2005 was due to angling by Canadian residents. On average Canadian residents fished 10 days in FMZ 4. When ice fishing is considered the contribution of angler days by Canadian residents was 5% (1735 angler days) of total angler days (31658 angler days) attributable to ice fishing activities.

5.1.3 Non-resident Anglers and the Tourism Industry

The majority of non-Canadian residents fishing in FMZ 4 utilized the services of the resource based tourist outfitters. The resource based tourism industry is well developed within FMZ 4 with approximately 104 main base lodges and 211 outpost camps. These facilities include drive-to facilities and remote fly-in or boat-in facilities. The majority of outpost camps are fly-in and these are clustered in 4 areas predominantly; 1/ in the western portion of the zone south of Woodland Caribou Provincial Park, 2/ northeast of Ear Falls, 3/ north and northeast of Sioux Lookout and 4/ east of Sturgeon Lake which is northeast of Ignace (Figure 30). Drive to lodges are clustered primarily in the central portion of the zone and along highway 599 that runs north from Ignace.

A total of 125,379 anglers were estimated to have fished in FMZ 4 in 2005. Of these anglers surveyed 84% were non-Canadian residents. Armstrong et al. (1999) identified that 85% of anglers were non-Canadian residents in 1998 so it would appear that the proportion of non-Canadian residents participating in angling, at least in FMZ 4, does not appear to have changed.

Of the non-Canadian residents fishing in FMZ 4 91% were males. Female participation in angling was the lowest for non-Canadian residents at 9%.

Non-Canadian residents fishing in FMZ 4 originated from 36 states in the United States of America (USA). Fifty-one percent (51%) of non-Canadian resident anglers originated from Minnesota (27%) and Wisconsin (24%). Iowa and Illinois accounted for an additional 14% and 13% of non-Canadian resident anglers who fished in FMZ 4. Together these four states accounted 77% of all non-Canadian residents fishing in FMZ 4.

Eighty four percent (84%) of the total estimated 6,301,776 angler hours of fishing effort exerted on the fisheries resources in FMZ 4 in 2005 was due to angling by non-Canadian residents. Ice fishing was undertaken by 8.1% or 10,113 anglers who exerted an estimated 172,737 angler hours of fishing effort on the fisheries resources. Surprisingly, 21% (36,275 angler hours) of the ice fishing effort was due to non-Canadian residents who obviously had to travel through FMZ 5 and possibly FMZ 6 to participate in ice fishing in FMZ 4.

In terms recreation, angler use of the fisheries resources of FMZ 4 were estimated to provide 881,221 angler days of recreation. On average non-Canadian residents fished the fewest days (average 7 days) of all residency categories but contributed (77%) of total angler days. Ice fishing was estimated to provide 31,658 angler days of recreation.

Fishing effort by non-Canadian residents was distributed across 265 lakes. The majority of non-Canadian resident fishing effort (52%) was focused on Lac Seul, Minitaki Lake, English River, the Red Lake/Gullrock Lake system, Pakwash Lake, Savant Lake Cedar Lake and Wabaskang Lake.

The economic importance of non-Canadian resident anglers and the tourism industry to local communities and the general economy of FMZ 4 is very clear from the results of the national recreational fishing survey. This is consistent with the findings of an economic analysis on the impact of resource based tourism conducted in 1996 by the Ontario Ministry of Tourism. This study found that total tourism spending in the northwest region was $249.4 million with resource based tourism spending in Sunset Country, which encompasses all of FMZ 4, accounting for 57.9% ($144.0 million) of this amount (MTR 1998). An economic impact analysis of tourism in Sunset Country in 2003 indicated that 9,898 jobs were created by the tourism industry with $302 million in expenditures retained in the area (Forster, 2003).

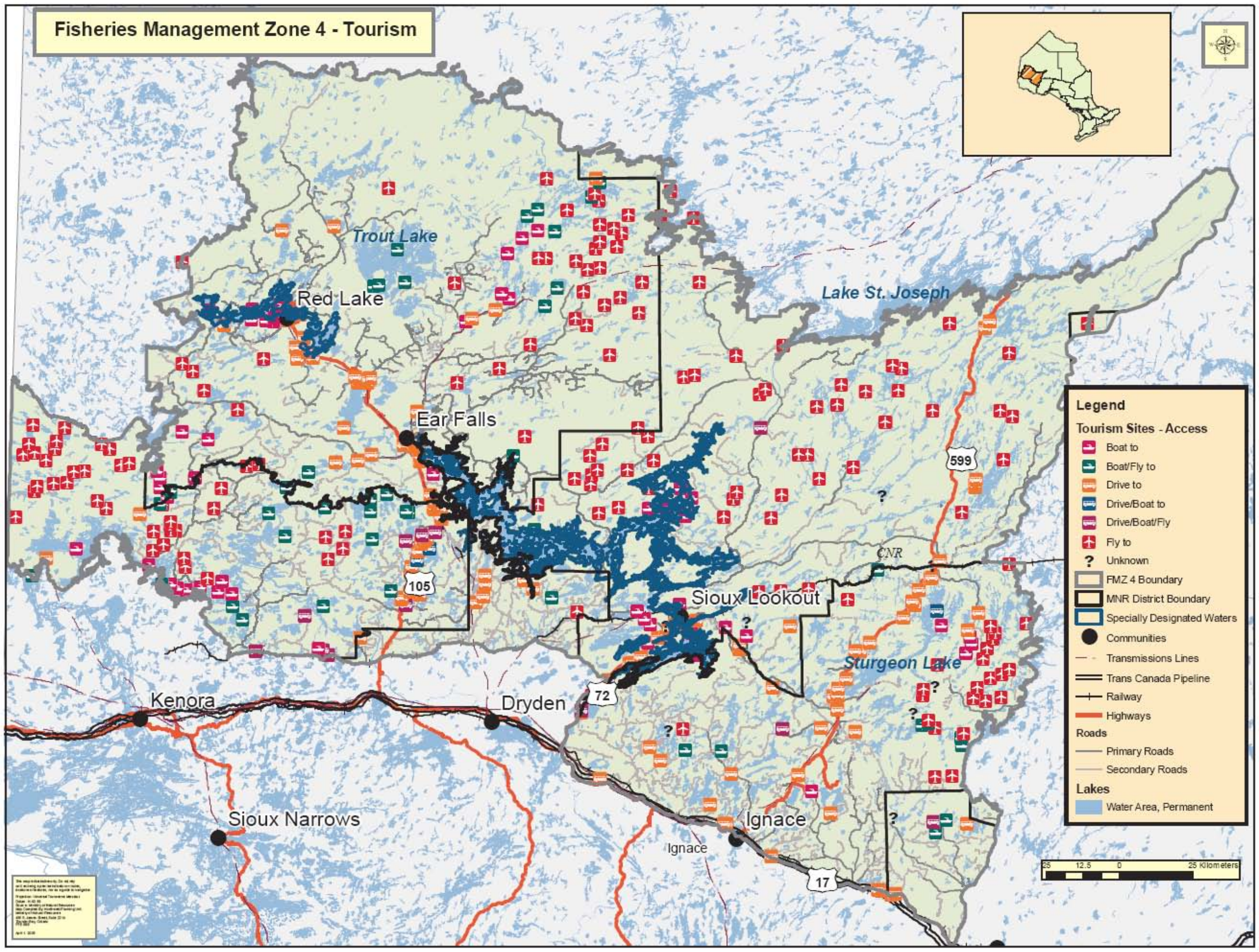

Figure 30. Fisheries Management Zone 4 Road Access and Tourism

5.2 First Nations

Resources including the waterbodies and fisheries of FMZ 4 have significant socio-economic importance to First Nations Communities within and around Zone 4. The abundance of waterbodies and diversity of fish species found within Zone 4 and the surrounding area provide First Nations communities with resources for subsistence living, an important component of traditional land use in addition to social and spiritual significance which are unique to each Community.

There are nine First Nations Communities within Fisheries Management Zone 4. These communities include Whitedog First Nations (Wabaseemoong Independent Nations), Ochiichangwe 'Babigo'ining (Dalles), Grassy Narrows First Nation (Asubpeeschoseewagong Netum Anishinabek), Wabauskang First Nation, Pikangikum First Nation, Lac Seul First Nation, Saugeen First Nation, and Mishkeegugamang First Nation (Figure 31). Other First Nation Communities outside of Zone 4 may have traditional use areas within the Zone, however these areas are not well defined (Figure 31). Zone 4 incorporates three Treaty areas including Treaty 3, Treaty 5 and Treaty 9.

First Nations communities with a history of traditional use within Zone 4 are encouraged to participate on the Advisory Council and contribute information to the development of a Fisheries Management Plan for the zone.

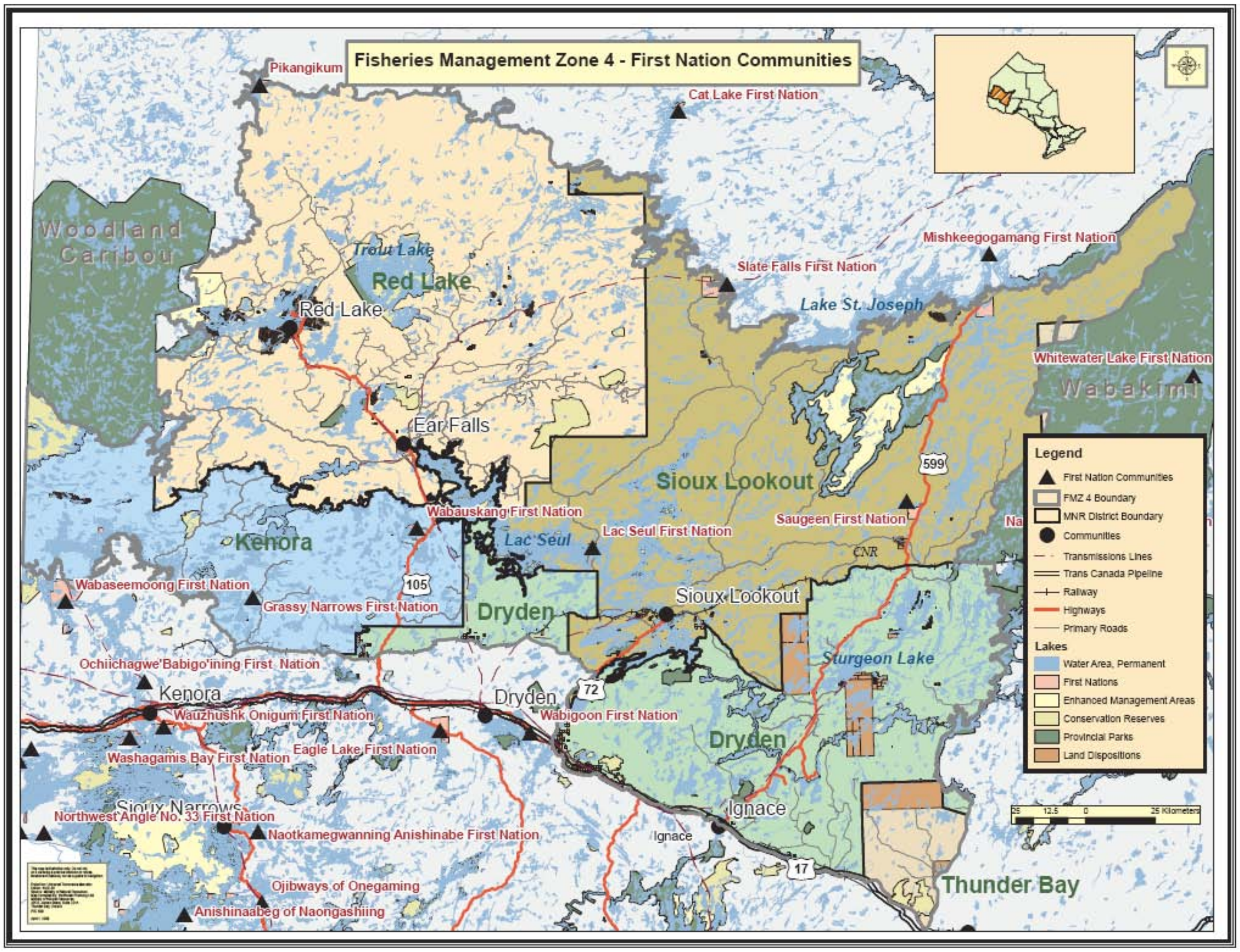

Figure 31. First Nation Communities and Fisheries Management Zone 4.

5.3 Commercial Fishing

Commercial fishing in zone 4 exists for lake whitefish, northern pike, walleye, perch and to a lesser extent lake trout on a small number of lakes within the zone.

There is a declining trend in active commercial fisheries within Northwestern Ontario. To date there are a total of thirty-six licences in FMZ 4, sixteen of which are active and twenty of which are inactive (Figure 32).

Commercial fishing licences are regulated under the Fish and Wildlife Conservation Act 1997 under section 31.1. Licensed commercial harvesters are required under the act to prepare daily returns of fish taken each day and submit the return to a conservation officer. The commercial fish harvester is also required to make a record of every sale of fish and compile those records for submission to the Ministry of Natural Resources on a monthly basis.

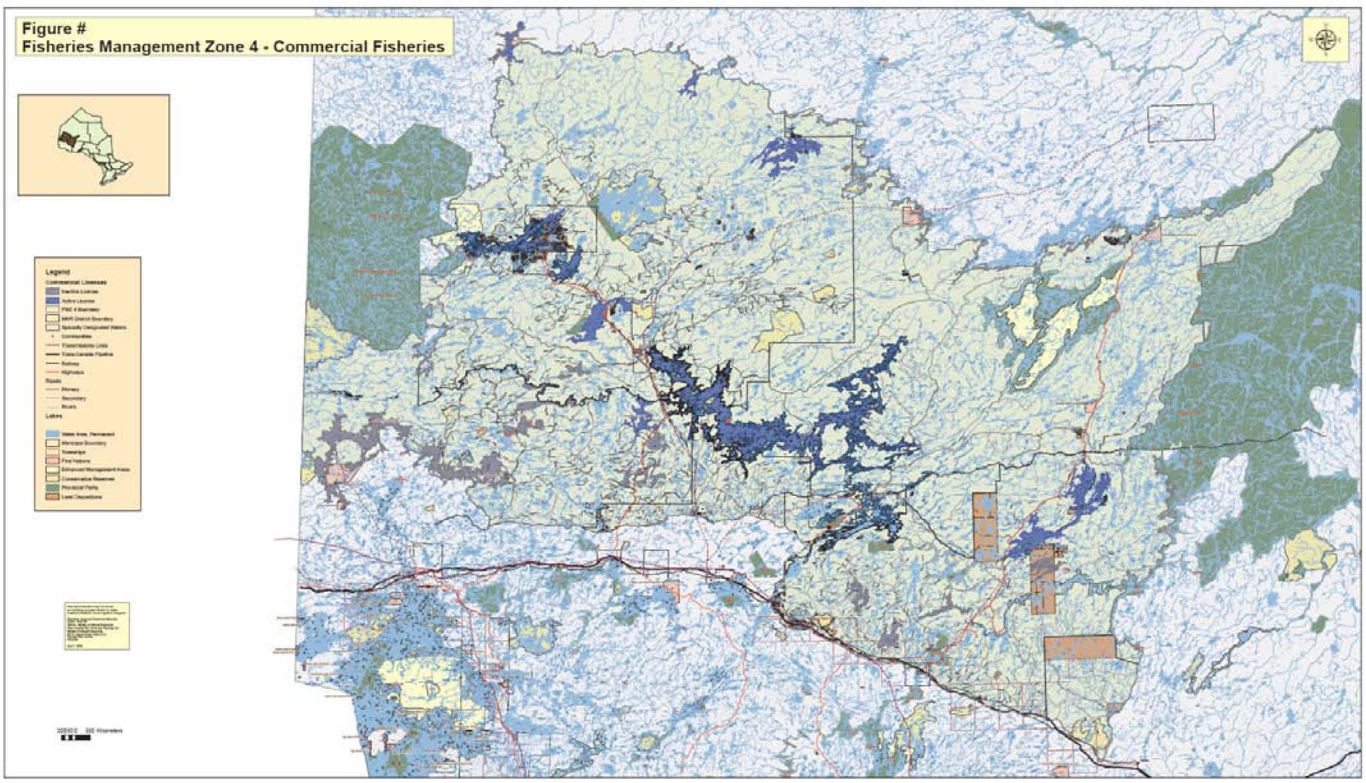

Figure 32. Fisheries Management Zone 4 lakes with commercial fishing activities (active and inactive)

Out of the thirty-six licences, twenty-five licences are First Nation and eleven licences are non-native. Fifteen of the licences are within the District of Dryden, eleven are in the District of Kenora, nine are in the district of Red Lake and only one commercial licence exists for the District of Sioux Lookout. The total number of lb/year harvested from the zone for each species is summarized in Table 12.

Table 12. Commercial fishing quotas by species for Fisheries Management Zone 4

Species Harvested	Harvest (lb/year)
Walleye	15904
Northern Pike	12529
Lake Trout	579
Lake Whitefish	218237
Lake Sturgeon	0
Yellow Perch	454 (or unlimited)

5.4 Baitfish

Baitfish may be collected for personal use by individuals possessing a recreational fishing licence with some restrictions (Table 13), or they may be collected and sold for commercial use by a licensed commercial baitfish harvester. Commercial baitfish licences are regulated under the *Fish and Wildlife Conservation Act* 1997 under section 31.3. Licence holders are required by the Act to keep a log book with information regarding the harvest (i.e. date, location), species, selling and purchasing events and quantities. In addition to the log, licence holders are also required to submit an annual return to the Ministry of Natural Resources.

New regulations have also been developed surrounding the baitfishing industry to prevent the transfer and introduction of invasive and introduced species. In addition to submitting an account of harvest and species harvested, commercial baitfish dealers are also required to develop a Hazard Analysis and Critical Control Point (HACCP) plan to minimize risk of invasive species transfer. Issuance of a baitfish licence for commercial use is now conditional on the development of a suitable HACCP plan. The HACCP plan allows for a critical analysis of methods, equipment, timing and species involved in harvesting, and allows both baitfish harvesters and the OMNR to identify invasive species hazards, establish controls and monitor controls to prevent the spread of invasive species and diseases such as VHS.

Concern regarding the labour and time involved with training and development of a HACCP plan has been identified by many baitfish harvesters in Zone 4. Though there are drawbacks in terms of the length of the reports, time required for training and the level of detail involved in report development, it is a very important step in ensuring appropriate protocols are followed and that risk is minimized when collecting, transporting and selling baitfish species across the province. Adoption of precautionary approaches and increased education and awareness are the best available tools for the prevention of the introduction and spread of invasive species.

Table 13. Restrictions placed on the harvest of bait for personal use with a recreational fishing licence (OMNR 2009).

Bait	Limit	Notes
Baitfish	120 Includes those caught and or purchased. See list of permitted baitfish species.	Only resident anglers may capture baitfish, using the methods outlined below. One baitfish trap no more than 51 cm (20 in.) long and 31 cm (12.2 in.) wide can be used day or night. Bait-fish traps must be clearly marked with the licence holder's name and address. One dip-net no more than 183 cm (6 ft.) on each side if square, or 183 cm (6 ft.) across if circular, during daylight hours only (after sunrise and before sunset). Dip-nets and baitfish traps may not be used in Algonquin Park.
Leeches	120 Includes those caught and or purchased.	Only one leech trap no more than 45 cm (17.7 in.) in any dimension can be used day or night to capture leeches. Leech traps must be clearly marked with the licence holder's name and address.
Crayfish	36	Must be used in same water body where caught. May not be transported overland. May be captured by hand or using the methods outlined for Baitfish, above.
Frogs	12	Only northern leopard frogs may be captured or used as bait.

Estimating baitfish species requires more effort in Northwestern Ontario. Baitfish harvesting has come a long way with the advent of the Bait Association of Ontario (BAO) as well as a more standardized reporting system (*Fish and Wildlife Conservation Act 1997*), however knowledge of baitfish populations is very limited.

In total, there are 306 baitfish harvest blocks located within FMZ 4 all of which are being utilized within the zone (Table 14). Utilization is divided between regular dealers, tourist dealers, regular harvesters and tourist harvesters. Bait fish harvesting is a viable business within FMZ 4, however increasing fuel prices continue to drive the price of bait higher, resulting in an increased demand for harvest blocks closer to residential areas.

Table 14. Total number of bait harvest blocks in FMZ 4 by district and total number of blocks utilized as of 2010.

District	Bait Harvest Blocks	Number of blocks utilized
Kenora	38	38
Sioux Lookout	89	89
Dryden/Ignace	68	68
Thunder Bay	8	8
Total	306	306

6.0 Current Fisheries Management Actions

Current fisheries management actions within zone 4 must be consistent with the OMNR's strategic direction outlined within *Our Sustainable Future* (OMNR 2005) and the *Ontario Biodiversity Strategy* (OMNR 2005). The Ministry of Natural Resources is the steward of Ontario's natural resources on behalf of the people of Ontario. *Our Sustainable Future* (OMNR 2005) indicates that one of MNR's mandated activities is the management of fish and wildlife. Specifically, MNR is to provide leadership and oversight in the management of Ontario's fish and wildlife resources, including species at risk, Great Lakes management, fish culture and stocking, resource monitoring, assessment and allocation, research, food safety and disease control, and enhancing fishing and hunting opportunities. *Our Sustainable Future* (OMNR 2005) states that the Ministry's vision is sustainable development. To achieve the primary goal of sustainability, the MNR has developed an operating philosophy of resource stewardship. This philosophy has been defined by eleven resource stewardship principles which include requirements such as the need for sound information and understanding, applied research, participation of interest groups in resource management, adaptive management, environmental protection and environmental impact assessment, and an ecosystem approach to resource management planning. These stewardship principles guide MNR's decision making process in the management of the provinces fisheries resources.

One of the strategies under the goal of ensuring a healthy environment for Ontarians in *Our Sustainable Future* (OMNR 2005) is the conservation of Ontario's biodiversity. Associated with this strategy was the action to develop an umbrella biodiversity strategy for Ontario. As a result of this direction, *Ontario's Biodiversity Strategy* (OMNR 2005b) was developed. *Ontario's Biodiversity Strategy* is about protecting what sustains us. Biological diversity or biodiversity refers to the variety of life, as expressed through genes, species and ecosystems, that is shaped by ecological and evolutionary processes (MNR 2005b).

Our Sustainable Future (OMNR 2005) coupled with the *Ontario Biodiversity Strategy* (OMNR 2005) recommends that the overall long term goal for the use, management and desired end state of Ontario's natural resources is to maintain ecological sustainability for future generations.

In addition to the MNR's guiding documents, there exists some direction to the Management of Ontario's Fisheries at the provincial level. This direction is contained in a document entitled *Strategic Plan For Ontario's Fisheries* (SPOF II) (OMNR 1992). This document was intended to serve as a blueprint for a province wide course of action for management the of the fisheries resources. SPOF II consists of four main parts; a goal for Ontario fisheries; objectives to meet the goal; guiding principles to form the foundation of fisheries management; and strategic management actions to resolve important fisheries management issue. The goal of SPOF II is to ensure healthy aquatic ecosystems that provide sustainable benefits, contributing to society's present and future requirements for a high quality environment, wholesome food, employment and income, recreational activity, and cultural heritage.

A significant amount of strategic direction needs to be considered when managing Ontario's fisheries resources. Since this direction tends to be very broad, the challenge is to take this direction and interpret it so that it is more functional for fisheries managers in the field.

Fortunately, Fisheries Section of the Ministry of Natural Resources has been attempting to implement the direction from all of the strategic documents mentioned above by developing a series of operational fisheries management objectives. These are in draft form at the present time and are in the process of being reviewed internally. Fisheries managers and advisory councils will need to consider these objectives when developing goals, objectives and management actions for their fisheries management zones.

In August 2005 MNR published "A New Ecological Framework for Recreational Fisheries Management in Ontario (MNR 2005c). The intent of this framework is to ensure resource sustainability and to optimize angling opportunities. The new framework focuses on creating new fisheries management zones, developing regulatory tool kits for different sport fish species, monitoring fisheries in a standardized manner and enhancing public input and involvement in fisheries management. The approach outlined in the framework is consistent with the strategic direction indicated in SPOF II as well as *Our Sustainable Future* and the *Biodiversity Strategy*. This framework brings forth a number of new ways of managing the fisheries resources in Ontario, including new ecological fisheries management zones, the management of fisheries on a broad geographic or landscape basis, and enhanced stewardship.

FMZ 4 was one of 20 new zones created as new units for fisheries management planning across the province. FMZ's are defined by similar ecological, physical, social and economic attributes and are intended to delineate areas that are expected to react similarly to external changes, pressures and management actions. An adaptive management planning cycle of 5 years is employed for each zone, through the setting of ecological and socio-economic objectives, application of suitable management actions, allocations and regular monitoring that focuses on fisheries quality and achievement of planning objectives across the entire zone rather than on individual lakes.

Monitoring at the landscape level will be completed through the broad scale monitoring program, a standardized methodology which will permit state of the resource reporting on a wide variety of lakes within a zone. This means that MNR will be managing a greater number of lakes on the landscape rather than focusing on a few individual lakes where issues have been identified. Some large significant lakes within each region will continue to be managed on an individual basis as specially designated waters (SDW's). Implementation of a standardized monitoring methodology on a province wide basis will allow for comparison of monitoring results from individual fisheries management zones to gain insight into changes that might be occurring to fisheries resources across the province.

A new model for fisheries stewardship is also being proposed as part of the new ecological framework for fisheries management. This new model is based on the establishment of fisheries advisory councils for each fisheries management zone. The public, through fisheries management zone councils, will have increased involvement in determining fisheries management goals, objectives and actions for the fisheries management zone. These councils will also play a key role in communicating fisheries monitoring results within the fisheries management zone. Each zone advisory council will have specific terms of reference and will be guided by fourteen principles. These principles are summarized as follows:

1) Ecological approach: An ecological approach to fisheries management will be followed to ensure conservation and use of the resource in a sustainable manner.

2) Landscape level management: Fisheries will be managed on a landscape scale-the FMZ scale. Individual lake management is discouraged other than in the context of water bodies specially designated by MNR (Specially Designated Waters) e.g. Red Lake/Gullrock Lake, Lac Seul, Pelican Lake, Big Vermillion Lake, Botsford Lake, Minnitaki Lake and Abram Lake.

3) Balanced resource management: Strategies and actions will consider the ecological, economic, social and cultural benefits and costs to society, both present and future.

4) Sustainable development: The finite capacity of the resource is recognized in planning strategies and actions within a FMZ. Only natural resources over and above those essential for long-term sustainability requirements are available for use, enjoyment and development.

5) Biodiversity: Fisheries management will ensure the conservation of biodiversity by committing to healthy ecosystems, protecting our native species, and sustaining genetic diversity of fisheries in the FMZ. All species in the FMZ including non-sport fish and Species at Risk must be considered.

6) Natural reproduction: Priority will be placed on native, naturally reproducing fish populations that provide predictable and sustainable benefits with minimal long-term cost to society. Hatchery-dependent fisheries will also play a role in providing fishing opportunities.

7) Habitat protection: The natural productive capacity of habitats for Canada’s fisheries resources will be protected and habitat will be enhanced where possible.

8) Valuing the resource: Stakeholders and other users will be invited to understand and appreciate the value of fisheries resources and to participate in decisions to be made by MNR that may directly or indirectly affect aquatic ecosystem health.

9) Responsibility: Local, regional, provincial and federal cooperation and sharing of knowledge, costs and benefits will be sought to manage fisheries at an FMZ level.

10) Multi-party involvement: A wide range of stakeholders, Aboriginal peoples, and interested parties will provide fisheries management advice to ensure an open and transparent process that acknowledges their valuable role in the process.

11) Aboriginal interests: Ontario is committed to building better relationships with Aboriginal peoples and in involving them in decisions that affect them.

12) Direct action: All possible options must be considered and evolve to implementation actions that are feasible.

13) Knowledge: The best available information will be used for FMZ based objective setting and strategy development and implementation.

14) Adaptive management: FMZs will be managed using an adaptive management approach. Objectives will be set, monitoring will occur, results will be compared.

In 2003 the *Northwest Region Fisheries Action Plan* was prepared (MNR, 2003). This action plan built on direction described in the *Fisheries Action Plan 1997 – 2000*, Northwest Region (MNR 1997). The *Northwest Region Fisheries Action Plan* is intended to provide direction for fisheries management in the Northwest Region. This direction is to be used in the development of a strategic approach to fisheries management activities at the regional and district levels. It provides the basis for establishing priorities, thus helping to focus limited resources (funding and staff) on the highest priority fisheries management needs. Overall, the action plan functions to integrate field actions, science, policy and planning efforts. The direction in the action plan needs to be considered when developing fisheries management goals, objectives and actions for any fisheries management zone in the Northwest Region.

6.1 Catch and Possession Limits, and Seasons

Seasons and catch and possession limits are in place in FMZ 4 for the following species: walleye, sauger, largemouth bass, smallmouth bass, northern pike, muskellunge, yellow perch, crappie, sunfish, brook trout, rainbow trout, lake trout, splake, lake whitefish and lake sturgeon (closed all year). In addition, aggregate limits apply to brook trout, lake trout and splake. Seasons and limits for all of these species are described further in Table 15. In general, season objectives for most sport fish species are to protect while they are moving to and from spawning areas or while they are spawning. Slot size objectives are to protect individuals within the population that may be at risk to over exploitation, such as large mature, sexually reproductive individuals that contribute to maintaining naturally occurring populations. In cases where possession of a single fish greater than a specified size limit was permitted, the objective was to allow anglers to retain a trophy fish if they so desired. Limits associated with regulations protect populations from overharvesting by limiting the number of fish of a particular species that can be harvested or possessed by anglers. In addition, possession limits provide the opportunity for the fisheries resources to be shared amongst a greater number of anglers.

Table 15. Fisheries Management Zone 4 Current (2010) Seasons and Limits

Species	Season	Limits and Size Restrictions
Walleye & Sauger or any combination	Jan. 1 to Apr. 14 & 3rd Sat. in May to Dec 31.	S – 4; not more than 1 greater than 46 cm (18.1 in)
Smallmouth Bass	Open all Year	S – 2; must be less than 35 cm (13.8 in) from Jan. 1 – June 30 & Dec. 1 – Dec. 31. S – 4; no size limit from July 1 – Nov 30 C – 1; must be less than 35 cm (13.8 in) from Jan. 1 – June 30 & Dec. 1 – Dec 31 C – 2; no size limit from July 1 – Nov. 30
Northern Pike	Open all Year	S – 4; none between 70-90 cm (27.6-35.4 in.), not more than 1 greater than 90 cm (35.4 in) C – 2; none between 70-90 cm (27.6-35.4 in), not more than 1 greater than 90 cm (35.4 in).
Muskellunge	3rd Sat in June to Dec. 15	S – 1; must be greater than 102 cm (40 in) C – 0
Yellow Perch	Open all Year	S – 50 C – 25
Crappie	Open all Year	S – 15 C – 10
Sunfish	Open all Year	S – 50 C – 25
Brook Trout	Open all Year	S – 5 C – 2
Lake Trout	Jan. 1 – Sept. 30	S – 2; not more than 1 greater than 56 cm (22 in.) from Sept. 1 to Sept. 30 C – 1; no size limit
Splake	Open all Year	S – 5 C – 2
Lake Whitefish	Open all Year	S – 12 C – 6
Lake Sturgeon	Closed all Year	

There are two types of possession limits. A sport possession limit is for anglers who have purchased a sport fishing licence and represents the full allowable limit for each sport fish species. The second limit, which is normally half of the limit associated with a sport fishing licence, is for anglers who have purchased a conservation licence. The sport fishing possession limits for walleye, northern pike and bass (possession of 6) were reduced to lower harvest and maintain fishing quality. Present day possession limits are presented in Table 15. Muskellunge, considered a trophy species and not a species for consumption has a possession limit of 1 fish allowing anglers to keep a trophy fish. The possession limit on lake sturgeon, a threatened species, is 0 as these populations have been over harvested in the past and are very slow to recover. Yellow perch and crappie limits were reduced from being limitless for perch and a limit of 30 fish for crappie to a limit of 50 and 15 respectively. This action was taken in response to the commercialization of these species by anglers.

Toolkits to guide decisions regarding regulatory options for sport fish species have been developed for the province of Ontario (Table 16). Toolkits are an important component of the

Ecological Framework for Recreational Fisheries Management in Ontario (OMNR 2005a) that are aimed at influencing management actions. The toolkits are aimed towards:

- providing effective science based management strategies that ensure sustainability of the resources while providing for optimum angling opportunities;
- providing a standard suite of regulations for use as new regulations;
- facilitating the review of existing regulations; and
- simplifying and streamlining the regulations.

The regulatory options in these tool kits are meant to be applied on a zone wide basis. Some exceptions for stressed or quality fisheries may be considered but they must be consistent with the direction in the tool kits and will be subject to a more rigorous review and approval process. Table 16 describes the regulations toolkits that exist for the province.

Table 16. Provincial Regulation toolkits for sportfish species, status and implementation.

Title	Status	Implementation
Muskellunge	Completed	August 2005
Splake	Completed	Implemented 2004
Yellow Perch	Completed Ban on sale of angler caught perch	Implementation in 2007 Implemented in 2005
Crappie	Completed	Implementation in 2007
Sunfish	Completed	Implementation in 2007
Brown Trout	Completed	Implementation in 2007
Lake Whitefish	Completed	August 2005
Non-angling methods	Completed	Implementation in 2007
Lake Sturgeon	Currently in preparation	Implementation in 2007
Channel Catfish	Completed	Implementation in 2007
Ice Hut registration	Awaiting approval	Pending
Rainbow trout/pacific salmon	Completed	Implementation in 2007/2008
Atlantic salmon	Completed	Implementation in 2007/2008
Bass	Completed	November 2006
Walleye	Draft Completed	Draft June 2008
Northern pike	Completed	September 2006
Lake trout	Completed	January 2007
Brook trout	Completed	January 2007

6.2 Exceptions

Historically, the Ontario Ministry of Natural Resources has implemented lake-specific regulations to address issues such as overexploitation and conservation of fisheries resources. The accumulation of many individual lake exceptions province-wide has resulted in a complex fishing regulation summary. Many of these exceptions have been questioned by both the public and the OMNR due to lack of information on regulation origin and supporting rationale as well as concerns regarding resources required enforcement and monitoring. Implementing separate regulations and monitoring efforts on individual "problem" lakes meant that resources were not available to monitor a broad distribution of lakes to assess sustainability (Lester et. al 2003). Not only was this individual-lake approach costly and ineffective, it also failed to recognize the mobility of anglers. When new regulations are put into place on individual lakes, for example, fishing pressure tends to simply shift to other waterbodies, resulting in uneven distribution of angling effort (Lester et. al 2003).

One of the objectives in The Ecological Framework for Fisheries Management (OMNR 2005a) was to reduce the number of individual lake exceptions and standardize fishing regulations across the FMZ's. The Ecological Framework for Recreational Fisheries Management in Ontario (OMNR 2005a) recommends simplification of the fishing regulations summary which includes streamlining exceptions to angling in each Fisheries Management Zone. Streamlining regulation exceptions would contribute to public transparency of the fisheries management planning process and eliminate regulations that may be considered redundant as fisheries management planning moves away from a lake specific management approach to landscape or "broad scale" management.

Currently in Zone 4 there are a total of 59 exceptions to Zone 4 regulations (Figure 33, Table 17). Of these exceptions 29 are related to fish sanctuaries, 9 are related to management of walleye, 8 are related to the management of lake trout, 9 are related to the management of muskellunge and the remaining exceptions relate to closures or exceptions for all species.

Over the past 5 years OMNR has examined many zone-wide exceptions and reduced the total number of exceptions Province-wide. However in some zones areas of special interest still exist. These areas include exceptions surrounding specially designated waters, fish sanctuaries as well as some areas of special and/or conservation interest.

6.2.1 Specially Designated Waters

All lakes in the northwest region that were being managed on an individual lake basis were reviewed using a systematic process that involved the use of biological, social and economic criteria. Based on the results of this review, specific lakes that ranked high under these three criteria within each fisheries management zone were chosen as specially designated waters (SDW's). This means that these lakes will continue to be managed on an individual lake basis. These lakes will eventually have lake specific management plans prepared to manage the fisheries resources. Within FMZ 4 Red Lake/Gullrock Lake, Lac Seul, Big Vermillion Lake, Pelican Lake, Botsford Lake, Abram Lake and Minnitaki Lake were selected for management as specially designated waters. Exceptions to the SDW's are included in Table 17 as highlighted rows, these exceptions will be reviewed upon the development of each individual SDW management plan and are not within the scope of this background report.

6.2.2 Fish Sanctuaries

Some bodies of water, or parts of them, are declared as fish sanctuaries for all or part of the year. Fish sanctuary locations within FMZ 4 are found in Table 17, and are also available in the Ontario Fishing Regulations Summary. Within FMZ 4, there are a total of 29 fish sanctuaries that protect sensitive fish habitat (i.e. spawning locations).

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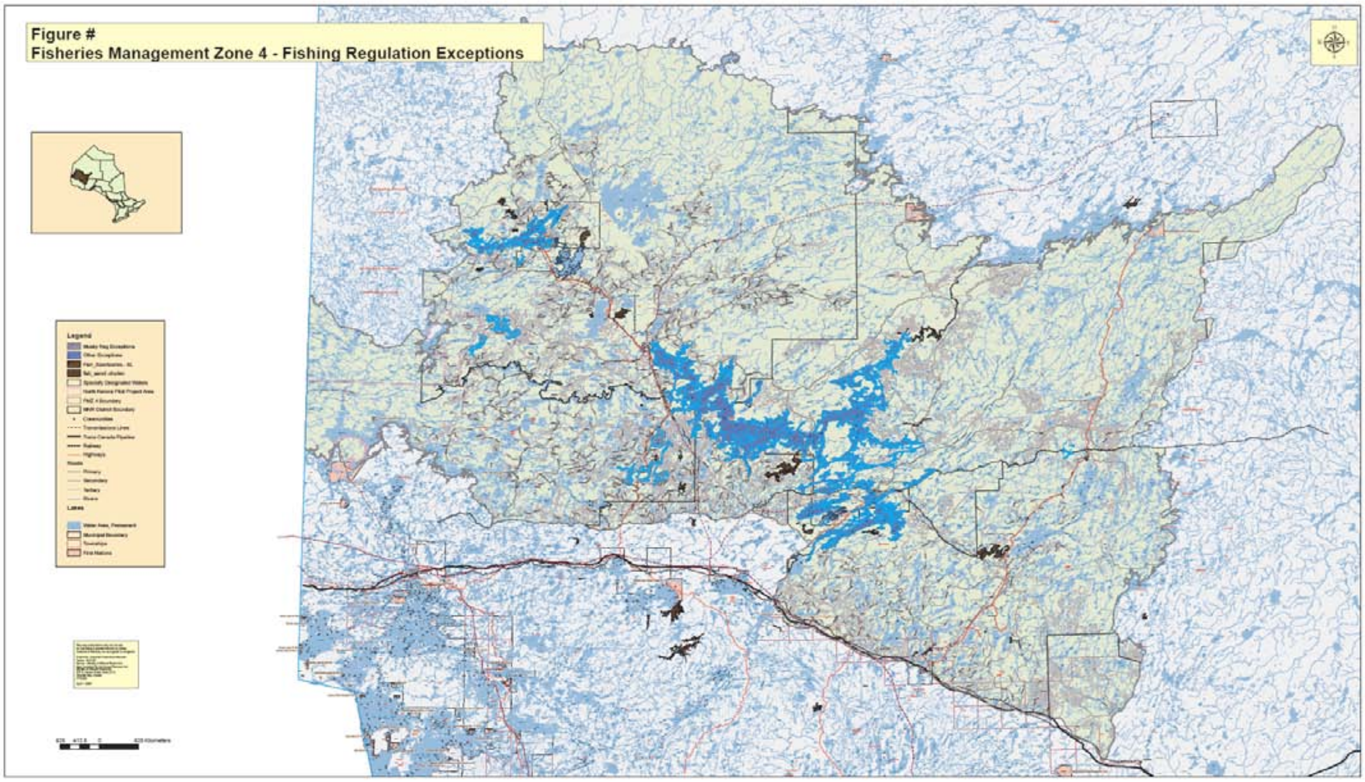

Figure 33. Fisheries Management Zone 4 lakes with regulation exceptions (sanctuaries, muskellunge size limits, and other)

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6.2.3 Sub-zones of Special Interest

Within FMZ 4 there are two sub-zones that have been created by concerns over exploitation of the fisheries resources. These two zones include the North Kenora Pilot Project Area (NKPPA) within the Kenora District and the Watcomb Lake Chain within the Ignace Area. These zones have adopted regulations that are different from the remainder of the Zone.

The North Kenora Pilot Project Area was created during the 1996-2016 Forest Management Plan for the Kenora Management Unit when it became evident that no consensus on forest operations could be made within the Sydney Lake area. Disagreements over access for timber harvesting while protecting remote tourism values led to the deferral of proposed blocks and to the development of a pilot Alternative Dispute Resolution process. Through this process an agreement was reached (North Kenora Pilot Project Agreement or NKPPA) which included revised forest stand allocations for harvest, non-resident Crown Land camping restrictions, road corridor realignments, road access restrictions and controls, designated tourism lakes and changes in fishing (adoption of conservation limits for resident and non-resident anglers) and hunting regulations. Of particular concern was the proposed construction of an access road and bridge in the Sydney Lake area.

The effective term of the agreement was for a 5 year period commencing with the initiation of forest operations in the Sydney Lake area. For a number of forestry-related reasons the Sydney Lake Road and bridge crossing did not proceed and the 2006-2026 Kenora Forest FMP dropped the proposed road and bridge. Pressure from stakeholder groups to rescind changes made to accommodate the NKPPA caused the MNR to revisit the NKPPA in 2006/2007. The proposal to remove conservation limits for resident anglers within the NKPPA was approved in 2007. This was consistent with objectives identified in the Ecological Framework for Fisheries Management to streamline sport fishing regulations within FMZ's. Conservation limits for non-resident anglers within the NKPPA was maintained (Table 17). This regulation is consistent with regulations specially designated waterbodies that experience a high degree of non-resident use (i.e. Rainy Lake, Lake of the Woods, Winnipeg River). The underlying rationale and objectives of the North Kenora Pilot Project Area will be revisited as a "fisheries management action" during the FMZ 4 Fisheries Management Planning. This review by the FMZ 4 Advisory Council was mandated by the Minister of Natural Resources in 2007.

The Watcomb Chain includes Watcomb Lake, Whiterock Lake, Young Lake and Elva Lake northeast of the town of Ignace. In 1998 new fishing regulations were implemented in the Watcomb Chain to address concerns of overexploitation of the walleye populations. Creel surveys conducted in 1991 and 1994 suggested that fishing pressure was high relative to the estimated productive capacity for the lakes. Index netting conducted in 1996 and 1998 did not indicate that walleye populations were displaying major signs of stress. Public concern regarding the fishing quality of the lakes resulted in consultation on the issue and the implementation of new regulations on the chain of lakes in 1998 which included:

- Conservation limit of 2 walleye in Watcomb Lake (Table 17)
- Catch and Release only for walleye in Whiterock, Young and Elva Lakes (Table 17)

Fall Walleye Index Netting on the lakes in 2002 and 2003 were conducted to reassess the status of walleye within the chain of lakes, results from monitoring suggested that walleye populations were in good shape. Due to the strength of the walleye populations within the Watcomb Chain Lakes, the decision to implement regulation changes to the Watcomb Lake Chain was re-visited in 2009. Two options were presented to the public through consultation:

- Option 1: Implementing the current standard sportfish limit of 4 walleye on all lakes
- Option 2: Implementing a conservation limit of 2 walleye on all lakes

Due to inconclusive public consultation results on a preferred option, it was determined that the Watcomb Lake Chain regulations will be revisited as a “fisheries management action” during the FMZ 4 Fisheries Management Planning Process.

Table 17. List of current (2010) regulation exceptions on waterbodies within FMZ 4.

Waterbody	Exception Details	Rationale
Agimak River and Little Indian Lake downstream from Sandbar Lake to the mouth of the Agimak River where it enters Indian Lake – Gour Twp.	Fish sanctuary – no fishing from Apr. 1 – June 14.	Fish Sanctuary
Barnard Creek between Fourbay Lake and Eady Lake	Fish Sanctuary – no fishing from Apr. 1 – June 14.	Fish Sanctuary
Big Vermillion Lake	Only artificial lures may be used. Only one line may be used when angling through the ice. Lake trout – none between 45-60 cm (17.7 – 23.6 in.), not more than 1 greater than 60 cm (23.6 in.).	Specially Designated Water
Bruce Lake – from Bruce Creek at Hwy. 105 north to, and including, the south half of Bruce Lake.	Fish sanctuary – no fishing from Apr. 1 – June 14.	Fish Sanctuary
Camp Creek and part of Indian Lake – Gour Twp.	Fish sanctuary – no fishing from Apr. 1 – June 14.	Fish Sanctuary
Cedar lake	Muskellunge must be greater than 137 cm (54 in.).	Minimum size limit set through a provincial muskellunge management strategy
Cedar Lake (Louise Rapids, Nelson Lake)	Fish sanctuary – no fishing from Apr. 1 – June 14.	Fish Sanctuary
Cedarbough Lake and all connecting streams to Little Vermillion Lake – Jordan, Drayton, Vermillion and Pickerel Twps.	Lake trout closed all year.	Sustainability Issues
Cliff Lake – at Hwy 105.	Muskellunge must be greater than 137 cm (54 in.).	Minimum size limit set through a provincial muskellunge management strategy
Cloudlet Lake and connecting streams	Fish sanctuary – no fishing from the 3rd Sat. in June & Dec. 1 – Dec. 31. Only artificial lures may be used. Only one barbless hook may be used. Smallmouth bass S – 0 and C – 0 Northern pike S – 0 and C – 0 Muskellunge S – 0 and C - 0	Fish Sanctuary
Confusion Lake	Muskellunge must be greater than 91 cm (36 in.).	Minimum size limit set through a provincial muskellunge management strategy
Elva Lake	Walleye S – 0 and C – 0	Area of Special Interest
English River – from an unnamed island at Talking Falls to latitude 49°33’45”N drawn across Franks Lake	Fish sanctuary – no fishing from Apr. 1 – June 14.	Fish Sanctuary
Flat Lake	Muskellunge must be greater than 91 cm (36 in.).	Minimum size limit set through a provincial muskellunge

		management strategy
Graystone Lake – from Hwy. 599 to a line drawn across Graystone Lake at 91°03'13"W.	Walleye open from Jan. 1 – Mar. 31 & June 15 – Dec. 31.	Sustainability Issues
Gullrock Lake	Lake Trout S – 0 and C – 0	Specially Designated Water
Hooch Lake and connecting waters – Echo, Lomond, Pickerel and Vermillion Twps.	Fish sanctuary – no fishing from the 3rd Sat. in June & Dec. 1 – Dec. 31. Only artificial lures may be used. Only one barbless hook may be used. Smallmouth bass S – 0 and C – 0 Northern pike S – 0 and C – 0 Muskellunge S – 0 and C - 0	Fish Sanctuary
Jackfish Creek – from the outflow of Jackfish Lake to the inflow of Perrault Lake.	Fish sanctuary – no fishing from Apr. 1 – June 14.	Fish Sanctuary
Keg Lake	Lake Trout S – 0 and C – 0	Sustainability Issues
Lac Seul, including Broad, Sunlight, Root River, Vaughan (Whitefish Lake) and Lost Lakes, and Wenasaga River from the first rapids upstream from Lac Seul approx. 3 km downstream to the last group of islands.	Walleye and sauger – non between 46 – 53 cm (18.1 – 20.9 in.) not more than 1 greater than 53 cm (20.9 in.). Muskellunge S – 0 and C – 0 No person may possess any live fish taken by angling other than bait-fish.	Specially Designated Water
Little Vermillion Lake and all connecting waters to Cedarbough Lake in Jordan, Drayton, Vermillion and Pickerel Twps.	Lake trout closed all year.	Sustainability Issues
Longlegged Lake	Muskellunge must be greater than 137 cm (54 in.).	Minimum size limit set through a provincial muskellunge management strategy
Maskinonge Lake and connecting waters – Echo, Lomond, Pickerel and Vermillion Twps.	Fish sanctuary – no fishing from the 3rd Sat. in June & Dec. 1 – Dec. 31. Only artificial lures may be used. Only one barbless hook may be used. Smallmouth bass S – 0 and C – 0 Northern pike S – 0 and C – 0 Muskellunge S – 0 and C - 0	Fish Sanctuary
Megikons River and Sowden Lake – that part downstream from confluence of Megikons River and Reba River to longitude 91°10'W drawn through Sowden Lake.	Fish sanctuary – no fishing from Apr. 1 – June 14.	Fish Sanctuary
Minnitaki Lake, including Abram, Duck, Hidden, Pelican, Botsford lakes and the English River, Red Pine Bay and Rice River.	Walleye and Sauger – none 46-53 cm (18.1 – 20.9 in.), not more than 1 greater than 53 cm (20.9 in.). Northern pike open from Jan. 1 – Apr. 14 & the 3rd Sat. in May – Dec. 31. No person may possess any live fish taken by angling other than bait	Specially Designated Water

	fish.	
Minnitaki Lake, Grassy Bay and English River – between English Falls downstream to include all of Grassy Bay of Minnitaki Lake.	Fish sanctuary – no fishing from Apr. 1 – June 14.	Specially Designated Water
Minnitaki Lake, Red Pine Bay	All species S – 0 and C – 0 from 3rd Sat. in May – June 14.	Specially Designated Water
Minnitaki Lake, Twin Bay and the Rice River, including Twill Lake, Flower Lake, Twinflower Lake, Purity Lake, Parnes Lake and connecting streams, Twin-flower Creek and Twin Bay of Minnitaki Lake (collectively known as the Rice River) and waters extending approximately 300 m (980 ft.) North, to the parallel of latitude 49°58'34"N., drawn across Minnitaki Lake.	Fish sanctuary – no fishing from Apr. 1 – June 14.	Specially Designated Water
Mud Lake – all waters in the unsurveyed portion of the territorial District of Kenora starting from where its mouth enters Wabaskang Lake – Kenora District.	Fish sanctuary – no fishing from Apr. 1 – May 31.	Fish Sanctuary
Nelson Lake – from a line between the western shoreline at approximately 50°13'05" N, 93°09'44"W and the eastern shoreline ag 50°13'05"N, 93°09'26"W upstream including the north part of Nelson Lake and the creek and Richmond Lake – Kenora District.	Fish sanctuary – no fishing from Apr. 1 – May 31.	Fish Sanctuary
Ord River – from 50°15'22"N, 93°01'40"W upstream to the top of the first set of rapids at 50°12"55N, 93°01'08"W – Kenora District.	Fish sanctuary – no fishing from Apr. 1 – May 31.	Fish Sanctuary
Pakwash Lake – Fisherman's Bay	Fish sanctuary – no fishing from Apr. 1 – June 14.	Fish Sanctuary
Perrault Falls and Wabaskang Lake – Town of Perrault Falls, between Hwy. 105 bridge and a point 500 m (1640 ft.) northeast of the bridge.	Fish sanctuary – no fishing from Apr. 1 – May 31.	Fish Sanctuary
Perrault Lake	Muskellunge must be greater than 137 cm (54 in.).	Minimum size limit set through a provincial muskellunge management strategy
Post Creek – from the base of the waterfall in Post bay to latitude 49°55'36"N on Sturgeon Lake.	Walleye open from Jan. 1 – Mar. 31 & June 15 – Dec. 31.	Fish Sanctuary
Puzzle Bay of Ord Lake south of the narrows at latitude	Fish sanctuary – no fishing from Apr. 1 – May 31.	Fish Sanctuary

50°08'18"N.		
Ranger Lake	Lake Trout S – 0 and C - 0	Sustainability Issues
Red Lake – all the waters upstream of the Chukuni River at Hwy. 125.	Only artificial lures may be used while angling for lake trout. Only one barbless hook may be used while angling for lake trout. Lake Trout S – 0 and C - 0	Specially Designated Waters
Red Lake – Chukuni River – McDonough and Bateman Twps., from Little Vermilion Lake south to Red Lake, including part of Hoyles Bay – Golden Creek – Bateman Twp., from the Pine Ridge Road, south to Red Lake, including part of East Bay. - Parker Creek – Fairlie Twp., from Parker Lake to Red Lake, including an unnamed bay. - Ranger Lake, Ranger Creek and Part of North Bay of Gullrock Lake.	Fish sanctuary – no fishing from April. 1 – June 14.	Specially Designated Waters
Red Lake/Gullrock Lake System – those waters upstream of Snowshoe Dam on the Chukuni River, which includes Red Lake, Keg Lake, Gullrock Lake, Ranger Lake, Two Island Lake and all portions of the Chukuni River in-beteween these lakes and any waters flowing into the Red Lake/ Gullrock System.	Lake Trout S – 0 and C - 0	Specially Designated Waters
Minnitaki Lake, Red Pine Bay	All Species S – 0 and C – 0 from 3rd Sat. in May – June 14	Specially Designated Waters
Richmond Lake – Kenora District	Fish Sanctuary – no fishing from April 1 – May 31.	Fish Sanctuary
Root River	Fish Sanctuary – no fishing from Jan. 1 – June 14 & Dec. 1 – Dec. 31.	Fish Sanctuary
Russett Lake	Muskellunge must be greater than 91 cm (36 in.)	Minimum size limit set through a provincial muskellunge management strategy
Savant Lake (North Arm) – Savant Twp.	Fish Sanctuary – no fishing from Apr. 1 – June 14.	Fish Sanctuary
Sturgeon lake described as Trappers Point Bay to the intersection of Trout Creek and Second Creek with Hwy. 599.	Walleye open from Jan. 1 – Mar. 31 & June 15 – Dec. 31.	Fish Sanctuary
Sydney Lake Area – North Kenora Pilot Project Area. Waters within boundaries of Manitoba/Ontario border to south shore of the English River System including Goshawk and Tourist Lakes to Separation Rapids Bridge and South	Non-resident walleye and sauger S – 2 and C – 2, not more than 1 greater than 46 cm (18.1 in). Non-resident largemouth and smallmouth bass S-1 and C-1 must be less than 35 cm (13.8 in). from Jan. 1 – June 30 and Dec. 1 – Dec. 31.	Area of Special Interest

Pakwash Road to Leano Lake, south boundary of Woodland Caribou Provincial Park to Manitoba/Ontario border.	Non-resident northern pike S – 2 and C – 2, none between 70-90 cm (27.6-35.4 in.), not more than 1 greater than 90 cm (35.4 in.) Non-resident muskellunge S – 0 and C – 0 Non-resident yellow perch S – 25 and C – 25 Non-resident lake trout S – 1 and C – 1 Non-resident lake whitefish S – 6 and C – 6	
Troutlake River – from the top of Whitefish Falls to a point 2 km (1.2 mi.) downstream	Fish sanctuary – no fishing from Apr. 1 – June 14	Fish Sanctuary
Two Island Lake	Lake Trout S – 0 and C – 0	Sustainability Issues
Unnamed Lake – Paul-Orr	Muskellunge must be greater than 91 cm (36 in.)	Minimum size limit set through a provincial muskellunge management strategy
Unnamed Lake - Spires	Muskellunge must be greater than 91 cm (36 in)	Minimum size limit set through a provincial muskellunge management strategy
Vaughan Lake (Whitefish Lake)	Fish Sanctuary – no fishing from Jan. 1 – June 14 & Dec. 1 – Dec. 31.	Fish Sanctuary
Vermilion River and tributaries between Elbow Lake and Expanse Lake	Fish Sanctuary – no fishing from Apr. 1 to June 14.	Fish Sanctuary
Watcomb Lake	Walleye S – 2 and C – 2, not more than 1 greater than 46 cm (18.1 in.)	Area of Special Interest
Wenasaga River – from the first rapids upstream from Lac Seul approx. 3 km (1.86 mi.) downstream to the last group of islands.	Fish Sanctuary – no fishing from Apr. 1 – June 14.	Fish Sanctuary
Whiterock Lake	Walleye S – 0 and C – 0	Area of Special Interest
Young Lake	Walleye S – 0 and C – 0	Area of Special Interest
Zeemel Lake – including the Paseminon River upstream to 300 m (984 ft) above the Musslewhite Mine Road.	Fish Sanctuary – closed all year.	Fish Sanctuary

6.3 Stocking

Fish stocking is a management tool that is used in response to a fisheries management problem such as loss of fish stocks from habitat degradation or overexploitation. Stocking can also provide additional angling opportunities in areas that receive high angling pressure to disperse activity over a wide area. There are two broad objectives of fish stocking within the province:

1) To establish or re-establish natural reproducing populations
2) To provide hatchery dependent fisheries

Greater than 95% of the fish caught in Ontario are from naturally reproducing populations across the province (OMNR 1991), as a result, priority in the province is placed on sustaining these naturally reproducing fish communities. Intensive stocking of hatchery reared fish can dilute native stocks which are often locally adapted to specific lake conditions, which leads to decreased fitness and potential loss of native populations (Evans and Willox 1991). Due to this threat, the OMNR identified in SPOF II that supplemental stocking of native fish species in areas of overexploitation of natural populations should not be encouraged and that emphasis should be placed on setting appropriate management actions and regulations to maintain those populations instead of encouraging Put Grow Take fisheries.

Put Grow Take (PGT) fisheries and the rehabilitation of degraded fisheries through stocking programs are still practiced within Ontario, and fish hatcheries continue to play a role in the provision of additional fishing opportunities and rehabilitation efforts. However, it is important to note that any use of hatchery-dependent (PGT, rehabilitation) fisheries is based on the analysis of long-term ecological, social and economic benefits and costs associated with the introduction.

Prior to the development of a stocking program, an environmental assessment under the Class Environmental Assessment for MNR Resource Stewardship and Facility Development Projects is required to weigh potential impacts of introducing stocked species. Fish stocking falls under two potential categories in the Class EA; the first is for ongoing fish stocking events in inland lakes which falls under Category A: projects with the potential for low negative environmental effects and/or public or agency concern. The second citatory is for the introduction of native or non-native fish species which falls under Category C: projects with the potential for medium to high negative environmental effects and/or public or agency concern. This precautionary approach to stocking introduced fish species aims to reduce the risks associated with stocking which include dilution of native stocks and decreased fitness of naturally reproducing populations (Brown 2007).

Fish species that have been historically stocked within the waters of FMZ 4 include muskellunge, rainbow trout, lake trout, brook trout, walleye and smallmouth bass. Current stocking efforts within the zone no longer focus on supplemental stocking of naturally reproducing populations of sportfish species such as walleye and muskellunge. However PGT opportunities continue to be provided through stocking of brook trout, splake and rainbow trout throughout the zone (Figure 34) in order to provide additional fishing opportunities and distribute angling pressure. A complete stocking list of species and lakes can be found in Appendix 8.

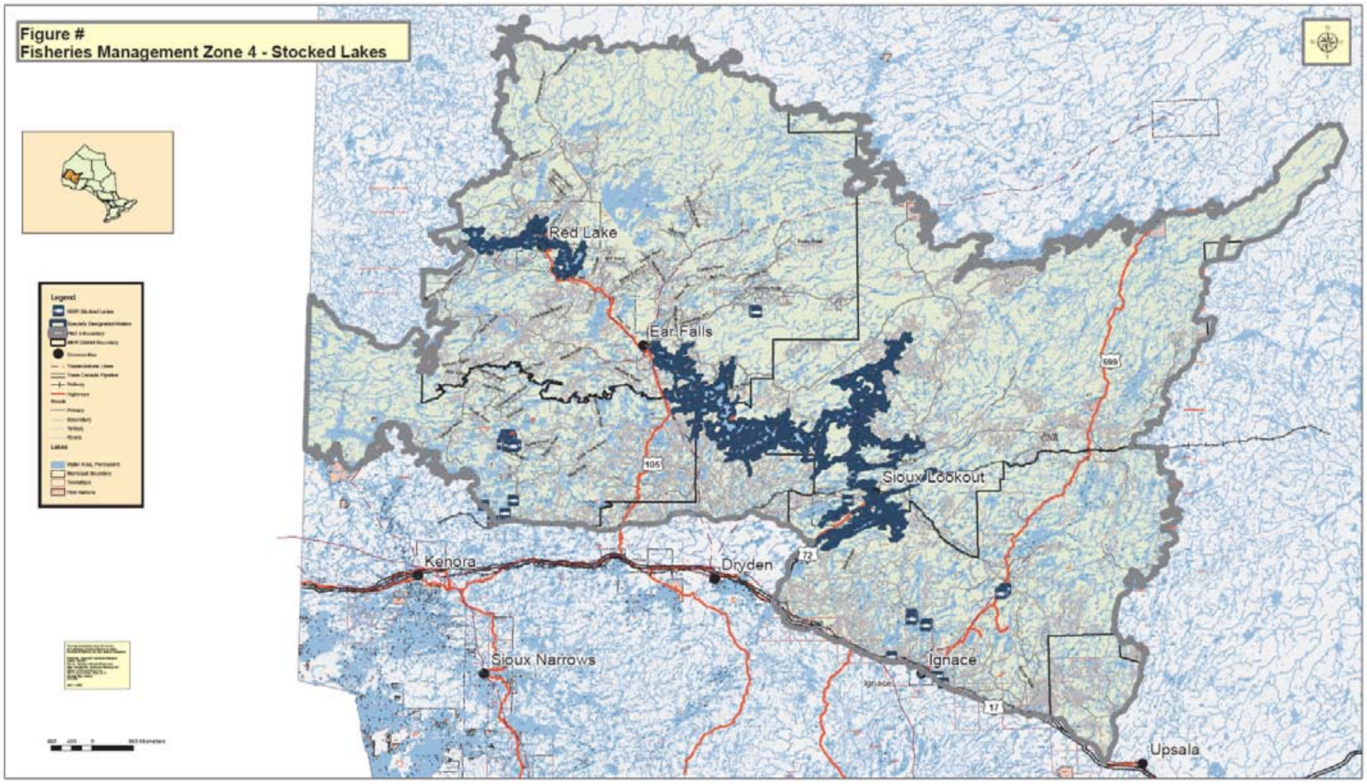

Figure 34. Fisheries Management Zone 4 stocked lakes

6.4 Indirect Methods

6.4.1 Boat Caches

A few indirect methods have been employed in Fisheries Management Zone 4 to provide additional protection to fisheries at a regional or local level. These include the application of Boat Cache Licences and regulatory restrictions that are put in place through land use planning exercises (i.e. Forest Management Planning).

Boat caches are permitted in portions of the Northwest Region, north of the old North-Central Region line near Ignace, for commercial, resource harvester and recreational purposes. Applications must be submitted to the MNR for licence approval, however there is no cost associated with the issue of a boat cache licence. Approvals for licences are supported through the Public Lands Act, and a class EA under Category A is required for all boat cache licences. The approval process is an important component of fisheries resource management, as it is valuable to resource managers to know how many boat caches exist on a waterbody and across the landscape. Records of boat cache locations and numbers is also of importance to tourism outfitters, resource harvesters and recreational anglers as licences are considered values during land use planning activities.

Some difficulties do exist with the current boat cache system. The approvals process requires administration, monitoring and enforcement and generates no revenue, in addition little to no information exists on how often boat caches on individual lakes are accessed or how many angler hours are associated with each boat cache. Data on fisheries resources for each lake where a boat cache exists is also limited. Therefore, from a management perspective it is difficult to associate fishing effort with boat cache distribution, though it is likely that lakes with greater numbers of boat caches receive greater amounts of angling pressure. Enforcement of licences is also difficult due to remote locations and access issues, and many caches are non-compliant with the licensing system.

6.5 Enforcement and Compliance

Compliance and enforcement activities within FMZ 4 are guided by an annual compliance operating plan (ACOP). The ACOP is a risk based plan that incorporates provincial, regional and local priorities.
Provincial enforcement priorities:

- Sport fishing where sustainability is an issue
- Unregulated or illegal commercial harvest and sale of fisheries resources
- Controlling the spread of disease and invasive species
- Food safety

Regional enforcement priorities:

- Heavily exploited walleye lakes
- Protection of sensitive fish or fisheries
- Protection of fisheries that support remote tourism opportunities
- Commercialization of fish from a sustainability and food safety perspective

Local enforcement priorities:

- Focusing enforcement effort on the fisheries of the specially designated waters (Red Lake/Gullrock Lake, Lac Seul, Pelican Lake, Big Vermillion Lake, Abraham Lake, Botsford Lake, Minnitaki Lake).
- Lakes receiving moderate fishing pressure
- Sensitive fisheries
- Protection of spawning runs
- Compliance with sanctuaries
- Preventing the introduction of invasive species and the movement of VHS
- Promotion of public understanding of the regulations in place for FMZ 4

7.0 User Expectations of Fisheries Resources

In 1996 a “fisheries needs analysis” was conducted in the Northwest Region to support development of a Fisheries Action Plan (OMNR 1997). At that time the needs analysis identified that the primary users of the fisheries resources were:

- present and future generations
- recreational anglers
- commercial food fishing industry

- commercial bait fishing industry
- resource based tourism (commercialized recreational angling)
- First Nations
- Metis

The 1996 “fisheries needs analysis” identified that the broad expectations of these users. These are summarized as follows:

- Continuing opportunities for recreation, a healthy environment and jobs;
- The supply of fish and the quantity and quality of opportunities (for recreation, jobs and healthy environment) are maintained or improved;
- That decisions, impact assessment and measuring resource status would be knowledge based and;
- People want to be involved in planning and decision making but want an understandable process.

In 2000 a review of the Fisheries Action Plan for the Northwest Region was undertaken. This review reconfirmed these expectations.

The 1996 needs analysis provided sufficient information to permit the broad user expectations to be examined in greater detail by specific user group. The expectation of the specific user groups is summarized and discussed in the following paragraphs.

7.1 Present and Future Generations

- Healthy environment and continued opportunities for recreation
- Species at risk are protected and rehabilitated
- Prevent the introduction or expansion of invasive species
- Want to be involved in decision making

In general this group was more interested in the general health of the aquatic environment. They were interested in having opportunities for recreation whether or not they actually accessed those opportunities. It would appear in many cases that this group just wanted to know that these opportunities were there. This group was concerned about the protection of species at risk and the introduction and/or expansion of invasive species. These concerns are consistent with this group’s general concern about the health of the environment.

7.2 Recreational anglers (residents and non-resident anglers)

- Healthy environment and in particular protection of fish populations and habitat. (concerns about contaminants, introduced species, invasive species
- Fish populations are managed sustainably
- Maintain and/or increase the diversity of angling opportunities
- High quality fishing opportunities (focus is on walleye, lake trout and bass primarily).

- Access to fishing opportunities (the concern here is primarily related to physical access e.g. via roads, but access to resources restrictions imposed by regulation is also a concern)
- Muskellunge anglers want to maintain muskellunge in lakes that currently support muskellunge populations, want lakes with muskellunge managed so that the growth potential of muskellunge is reached and that muskellunge are managed as a “trophy’ species.
- Want to be involved in decision making

Recreational anglers were also concerned about maintaining a healthy environment but their focus was on the protection of fish habitat and fish populations. Recreational anglers in the Northwest Region expect that high quality fishing opportunities for walleye, northern pike, lake trout and bass are maintained but want all fish populations to be managed sustainably. The results of the 2005 Survey of Recreational Fishing in Canada for FMZ 4 (DFO, 2007) indicated that over fishing, habitat loss, fish contaminant levels and invasive species were of most concern to recreational anglers.

This group also expects that access to fishing opportunities will continue. In the case of this “expectation” the concern is related to physical access to the fisheries resources via the road system but access restriction imposed by regulatory controls is also a concern. The 2005 Survey of Recreational Fishing in Canada for FMZ 4 (DFO, 2007) indicated that access was 9th overall of recreational angler concerns.

This group expected to be involved in making decisions on management of the fisheries resources and supported joint decision making with all user groups. This group also expected that future management planning exercise would address topics that were placed in a “parking lot” as part of the process in 1998 to institute region wide fishing regulations. One of these topics was the management of lake trout (M. Sobchuk pers. Comm. 2010).

A survey of FMZ 4 Advisory Council members conducted in December 2009 confirmed that members highly rank the variety of fishing opportunities associated with remote, semi-remote and accessible lakes. The wilderness aspect of FMZ 4 was also considered very important to council members.

Recreational angler expectations appear to change over time and may be influenced by geographic location where they are fishing or intend to fish. Armstrong et al. (1999) reported that recreational anglers in different areas have different motivations and behaviors. They also indicated that non-catch motivations (to enjoy a pristine environment; to have a stimulating and exciting experience; to be with friends and family; and to get away from the usual demands of life) appear to be more important to anglers than catch related motivations.

7.3 Commercial food fishing industry

- Continued opportunities for jobs and being able to make a living
- Healthy products so that access to markets is maintained
- Fish populations are managed sustainably

- Want to be involved in decision making

Commercial fishers also indicated that they wanted fish populations managed sustainably. If fish populations could support commercial use, this group expected that they would continue to have access to commercial fishing opportunities. Native commercial fishers expectations were slightly different in that they were interested in additional commercial fishing opportunities within their traditional use areas.

In general, this group expected that the government would continue to manage contaminant levels so the commercial fishing industry continued to have healthy products to sell. This would help to ensure that access to markets is maintained.

Once again, this group expected to be involved in making decisions on management of the fisheries resources.

7.4 Commercial bait fishing industry

- Continued opportunities for jobs and being able to make a living
- Access to markets
- Want to be involved in decision making

This group expected that they would continue to have access to commercial bait fishing opportunities that would support jobs. They also expected that they would continue to have access to markets in the region. Related to this expectation of access to markets was the concern that regulations could be imposed that restricted the use of bait fish.

Once again, this group expected to be involved in making decisions on management of the fisheries resources.

7.5 Resource based tourism (commercialized recreational angling)

- Business flexibility to deal with changing business environment
- Consistency in the application of policies and processes
- Certainty of continued access to land and the fisheries resources
- Protection of remoteness for semi remote and fly-in businesses
- Fish populations are managed sustainably
- High quality fishing opportunities (focus is on walleye, lake trout and bass primarily).
- Want to be involved in decision making

The expectations of the resource based tourism industry that were identified in the 1996 “needs analysis’ received further clarification in 2005 as a result of an issue that arose of the use of bed capacities by MNR as the way resource use is linked to resource capacity (M. Sobchuk pers. Comm. 2010).

The resource based tourism industry in the Northwest Region expects that fish populations will be managed sustainably with a focus on maintaining high quality fishing opportunities for walleye, northern pike, lake trout and bass.

The resource-based tourism industry indicated that they needed “certainty” in terms of their ability to use the fisheries resources that their lodges and outpost camps are based on. The concern related to “certainty” focused on security of land tenure and on continued use of the fisheries resources at a level that sustained the business. Security of land tenure is important to the industry because most outpost camp and lodge facilities are located on Crown land. The resource-based tourism industry would like increased business flexibility to meet changing market conditions.

The resource-based tourism industry would like to see consistency in all aspects of the land and fisheries management process. The industry would like to see a consistent process no matter where you are in the province. Of particular concern is what happens when an operator wants to sell or transfer an outpost camp.

The protection of the remote and semi remote nature of outpost camps and lodges remains an expectation of the resource based tourism industry.

Once again, this group expected to be involved in making decisions on management of the fisheries resources. There is the general expectation that decisions on fisheries management will recognize the importance of the resource-based tourism industry to Ontario's tourism sector and the overall well-being of Ontario. This expectation is consistent with the Resource Based Tourism Policy (OMNR 1998).

7.6 First Nations

- Recognition of treaty and aboriginal rights
- Government must meet consultation responsibilities and obligations
- Want to be involved in decision making

First Nations expect to be involved in decisions related to fisheries management within their traditional use areas. Associated with this involvement is the expectation that treaty and aboriginal rights will be respected and upheld in fisheries management decisions. First Nations expect that the government will meet all their consultation responsibilities and obligations.

Although it was not discussed specifically as part of the 1996 “needs analysis” it is also clear from other planning processes that First Nations expect that fish populations will be managed sustainably (M. Sobchuk pers. Comm. 2010).

7.7 Metis

- Recognition of aboriginal rights
- Government must meet consultation responsibilities and obligations
- Want to be involved in decision making

The Metis community also expects to be involved in decisions related to fisheries management within their traditional use areas. Associated with this involvement is the expectation that Metis rights will be respected and upheld in fisheries management decisions and that the government will meet all their consultation responsibilities and obligations.

Although it was not discussed specifically as part of the 1996 "needs analysis" it is also clear from other planning processes that Metis expect that fish populations will be managed sustainably (M. Sobchuk pers. Comm. 2010).

7.8 General Discussion

A common "expectation" among all user groups is the desire to see the fisheries resource managed sustainably. Within the Northwest Region the decision was made 1980's when the first district fisheries management plans were being developed that MNR would manage for high quality fishing opportunities based on self sustaining, naturally reproducing fish populations. This management philosophy was carried forward into the fisheries action plans that were developed in 1997 (OMNR 1997) and 2000 (OMNR 2003) and the fisheries management plan that was developed for FMZ 6 (OMNR 2009).

It should be made clear that it may not be possible to achieve all expectations within small geographic areas within FMZ 4. However, since MNR is managing fisheries on a landscape basis it may be possible to achieve all expectations across the fisheries management zone.

8.0 Fisheries Management Issues or Challenges

The FMZ 4 advisory council used a systematic process, which included the use of a facilitator, to identify and prioritize the fisheries management issues and challenges in FMZ 4. The first step in the process involved the opportunity for all members of the advisory council to identify and discuss situations or concerns that they felt would affect the management of the fisheries resources in FMZ 4. This resulted in sixty (60) potential management issues and challenges being identified.

The second step in the process involved a group discussion of each of the potential fisheries management issues and challenges to determine if a/ it was the actual underlying management issue or b/ it was the symptom of a management issue. In the cases where a potential management issue or challenge was considered a symptom of a management issue the council defined the underlying issue. As a result the 60 potential management issues were placed in six (6) broad categories:

- Education
- Information for management
- Exploitation
- Habitat
- Invasive/introduced species
- Species at risk

The third step in the process involved prioritization of potential fisheries management issues and challenges. Each council member was given 36 sticky dots (6 dots per category) and asked to apply the dots by the potential issues and management challenges that they thought were most important within each of the six categories indicated above. Once this was done the potential issues and management challenges were sorted in order of priority. Appendix 12 describes the results of the initial issue and management challenge prioritization exercise.

The final step in the prioritization process was to discuss the initial prioritization of the list of potential issues and management challenges with the advisory council. The advisory council was asked to consolidate potential issues and management challenges where appropriate because there were clear overlaps and similarities between some issues. The council was then asked to select the suit of issues and management challenges that they wanted to deal with in the current management plan. The council identified 13 management issues and challenges in 4 categories to deal with in a management plan for FMZ 4. Table 18 summarizes the management issues and challenges that the council wants to deal with in the management plan for FMZ 4.

Table 18. Fisheries Management Issues and Challenges, in order of priority, that will be dealt with in the fisheries management plan for FMZ4.

Priority	Category	Management Issue or Challenge?	Considerations
1	Education	- Poor public awareness of management objectives and actions - Elevated levels of mortality of released fish	- The council feels that increased public awareness of the rationale for the fisheries management objectives in FMZ 4 will increase support and compliance with regulatory actions - The council feels that because fishing quality remains good in FMZ 4 that high levels of catch and release fishing may be a source of increased mortality on fish if proper handling techniques are not being practiced.
2	Habitat	- Loss or degradation of fish habitat.	- The council has specific concerns related to the identification and protection of spawning areas. - In addition, there are concerns that the stand and site guide used in forest management planning may not be adequately protecting fish habitat in all situations.
3a	Exploitation of the Fisheries Resources	- Protection of fish during spawning period	- The council is concerned that the timing of the opening of the season for walleye may not always protect pre and post spawning fish.
3b	Exploitation of the Fisheries Resources	- Ensuring that fish harvests are within allowable yield - Decline in fishing opportunities if over-	- The council feels that there is a need to ensure that the sustainability of fish populations in FMZ 4 must be the first consideration with make

		exploitation is allowed to occur - There is a need to provide a diversity of accessible fishing opportunities. - There is a need to ensure that the regulations are enforced throughout the FMZ.	decisions on developments to enhance social and economic benefits. There is the feeling that we can maximize the social and economic benefits from use of the fisheries resources but within the context of ensuring sustainability of those resources. - There is the concern that there may be a concentration of fishing effort on certain accessible lakes due to declining road access within the zone. - The council would like to see the diversity of accessible fishing opportunities in FMZ 4 maintained. In particular they would like to examine the current stocking program to ensure that it continues to contribute to the diversity of fishing opportunities currently enjoyed by anglers in the zone. - The council feels that a significant enforcement challenge in the zone is the ability of conservation officers to get to all the lakes in the zone to ensure that the regulations are being adhered to. - The council would like to ensure that any discussion of new regulations considers their effect on the distribution of fishing effort and the impact on other species.
3c	Exploitation of the Fisheries Resources	- Slot size is preventing the use of pike of acceptable size for shore lunches.	- There is the need to look at the rationale for the size limit on pike currently in place in FMZ 4. The rationale for current protected slot regulation is not defensible.
3d	Exploitation of the Fisheries Resources	- Maintenance of fishing quality.	- The council considers fishing quality within the zone to generally be good. However the council feels that there may be the need for specific areas for higher quality opportunities e.g. North Kenora Pilot project /Watcomb lake area. - In addition, the council would like to see different types of fishing quality incorporated into the development of fisheries management objectives for the zone.
3e	Exploitation of the Fisheries	- Need to tailor the management of lake trout	- The management of lake trout was of concern to the council

	Resources	to the type of lake? - Small lake trout lakes are susceptible of over-exploitation	especially the sustainability of lake trout in lakes with marginal habitat. This concern is related to the potential for development pressures to affect these lakes and the potential effects of climate change. - The exploitation of lake trout in small lakes because they can be easily over fished was also a concern and they council felt that the harvests from these small lakes must be monitored.
4	Invasive/Introduced Species	- Movement of invasive and introduced species	- Of particular concern to the council from the perspective of the establishment or movement of invasive and introduced species was the potential effect of live bait used by anglers. - The council was also concerned about the potential effects of climate change on the expansion of invasive and introduced species

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Appendices

Appendix 1. Methodology for classification of low, medium and high road density areas within FMZ 4.

a) Creating rasterized road layer

The first step was to convert a vector (line) road layer to a rasterized (grid) road layer to enable the use of arc info's grid functionality to perform the road density survey. The output raster cell size was 250m x 250m and each cell was differentiated into the following fmp road classes (0 – no road, 1 – primary, 2 – secondary, 3 – tertiary).

b) Weighting the rasterized road layer

For the purposes of road density analysis the roads classes were weighted as follows (primary 15, secondary 10, tertiary – 5) given the fact that primary roads are most traveled, then secondary, followed by tertiary. This would give us a more realistic view of road pressures on lakes.

c) Road Density Analysis

Arc Info' neighbourhood analysis was used on the weighted rasterized layer with a search radius of 1km to total up all of the weighted values within the search radius. A new rasterized layer was created based on these totals and categorized into three classes (low, medium, high). Values ranged from 0 – 10350 (mean 322) and broken into classes based on the most realistic representation.

** Note that the roads used for this analysis were based from the NRVIS data distribution data set. The four districts were at very stages of updating their road layers at the time this analysis was completed. Some districts were only starting the process of removing historic roads so they were included in this analysis in some the districts which may not reflect a true road density in these areas. **

Appendix 2. List of fish species present in Fisheries Management Zone 4

OMNR Code	Common Name	ScientificName
ACIPENSERIDAE - sturgeons		
031	lake sturgeon	*Acipenser fulvescens*
SALMONINAE - salmon and trout subfamily		
080	brook trout	*Salvelinus fontinalis*
081	lake trout	*Salvelinus namaycush*
COREGONINAE - whitefish subfamily		
091	lake whitefish	*Coregonus clupeaformis*
093	lake herring	*Coregonus artedi*
100	shortjaw cisco	*Coregonus zenithicus*
OSMERIDAE - smelts		
121	rainbow smelt	*Osmerus mordax*
ESOCIDAE - pikes		
131	northern pike	*Esox lucius*
132	muskellunge	*Esox masquinongy*
UMBRIDAE - mudminnows		
141	central mudminnow	*Umbra limi*
HIODONTIDAE - mooneyes		
152	mooneye	*Hiodon tergisus*
CATOSTOMIDAE – suckers		
162	longnose sucker	*Catostomus catostomus*
163	white sucker	*Catostomus commersonii*
168	silver redhorse	*Moxostoma anisurum*
171	shorthead redhorse	*Moxostoma macrolepidotum*
CYPRINIDAE - carps and minnows		
182	northern redbelly dace	*Phoxinus eos*
183	finescale dace	*Phoxinus neogaeus*
185	lake chub	*Couesius plumbeus*
194	golden shiner	*Notemigonus crysoleucas*
196	emerald shiner	*Notropis atherinoides*

OMNR Code	Common Name	ScientificName
198	common shiner	*Luxilus cornutus*
199	blackchin shiner	*Notropis heterodon*
200	blacknose shiner	*Notropis heterolepis*
201	spottail shiner	*Notropis hudsonius*
206	mimic shiner	*Notropis volucellus*
208	bluntnose minnow	*Pimephales notatus*
209	fathead minnow	*Pimephales promelas*
210	eastern blacknose dace	*Rhinichthys atratulus*
211	longnose dace	*Rhinichthys cataractae*
214	pearl dace	*Margariscus margarita*
GADIDAE - cods		
271	burbot	*Lota lota*
PERCOPSIDAE - trout-perches		
291	trout-perch	*Percopsis omiscomaycus*
CENTRARCHIDAE - sunfishes		
311	rock bass	*Ambloplites rupestris*
313	pumpkinseed	*Lepomis gibbosus*
315	longear sunfish	*Lepomis megalotis*
316	smallmouth bass	*Micropterus dolomieu*
PERCIDAE - perches		
331	yellow perch	*Perca flavescens*
332	sauger	*Sander canadensis*
334	walleye	*Sander vitreus*
338	Iowa darter	*Etheostoma exile*
341	johnny darter	*Etheostoma nigrum*
342	logperch	*Percina caprodes*
345	river darter	*Percina shumardi*
COTTIDAE - sculpins		
381	mottled sculpin	*Cottus bairdii*
382	slimy sculpin	*Cottus cognatus*
383	spoonhead sculpin	*Cottus ricei*

Appendix 3. FWIN projects completed in FMZ 4 on waterbodies without special regulations.

Included in Cano and Parker 2005 Assessment	Waterbody Name	Project Type	Year	Project Number
No	Amik	FWIN	2005	IA05_AMI
No	Barrel	1 day FWIN	1999	NA
No	Dollar	1 day FWIN	1999	NA
No	Ellipse	1 day FWIN	1999	NA
No	Eva	1 day FWIN	1999	NA
No	Flatrock	1 day FWIN	1999	NA
No	Frank	1 day FWIN	1999	NA
No	Friday	1 day FWIN	1999	NA
No	Goshen	1 day FWIN	1999	NA
No	Heathwalt	1 day FWIN	1999	NA
No	Indian	1 day FWIN	1999	NA
No	Islandia	1 day FWIN	1999	NA
No	Kekwanzik	1 day FWIN	1999	NA
No	Mattawa	1 day FWIN	1999	NA
No	Mit	1 day FWIN	1999	NA
No	Press	1 day FWIN	1999	NA
No	Sandbar	1 day FWIN	1999	NA
No	Selwyn	1 day FWIN	1999	NA
No	Sowden	1 day FWIN	1999	NA
No	Squaw	1 day FWIN	1999	NA
No	Teddy	1 day FWIN	1999	NA
No	Thursday	1 day FWIN	1999	NA
No	Wabazikaskiwi	1 day FWIN	1999	NA
No	Wintering	1 day FWIN	1999	NA
No	Wyatt	1 day FWIN	1999	NA
No	Trout, Little Trout & Otter	FWIN	1998	IA98_TLO
No	Rowe Lake	FWIN	1999	IA99_ROW
No	Setting Net Lake	FWIN	2003	IA03_SNL
No	Delesseps Lake	FWIN	2004	IA04_DEL
Yes	Abram Lake	FWIN	2001	16D_IA01_ABR
Yes	Ball Lake	FWIN	1997	14D_IA97_BAL
Yes	Ball Lake	FWIN	1998	14D_IA98_BAL
Yes	Botsford Lake	FWIN	2001	16D_IA01_BOT
Yes	Broad Lake	FWIN	1998	16D_IA98_BRO
Yes	Cedar Lake	FWIN	2003	14D_IA03_CED
Yes	Churchill Lake	FWIN	1998	16D_IA98_CHU
Yes	Elva Lake	FWIN	1998	11D_IA98_ELV

Yes	Elva Lake	FWIN	2002	11D_IA02_ELV
Yes	Expanse Lake	FWIN	1998	16D_IA98_EXP
Yes	Harris Lake	FWIN	2001	16D_IA01_HAR
Yes	Jutten Lake	FWIN	2001	16D_IA01_JUT
Yes	Keikewabik Lake	FWIN	1997	11D_IA97_KEI
Yes	Kukukus Lake	FWIN	2000	11D_IA00_KUK
Yes	Little Trout Lake	FWIN	1998	15D_IA98_LIT
Yes	Longlegged Lake	FWIN	1997	15D_IA97_LON
Yes	Lount Lake	FWIN	1997	14D_IA97_LOU
Yes	Lount Lake	FWIN	1998	14D_IA98_LOU
Yes	Melgund Lake	FWIN	1997	11D_IA97_MEL
Yes	Neston Lake	FWIN	2001	16D_IA01_NES
Yes	Ord Lake	FWIN	2003	14D_IA03_ORD
Yes	Otter Lake	FWIN	1998	15D_IA98_OTT
Yes	Perrault Lake	FWIN	2003	14D_IA03_PER
Yes	Red Lake	FWIN	2000	15D_IA00_RED
Yes	Separation Lake	FWIN	1996	14D_IA96_SEP
Yes	Separation Lake	FWIN	1997	14D_IA97_SEP
Yes	Sturgeon Lake	FWIN	1995	11D_IA95_STU
Yes	Sydney Lake	FWIN	2000	15D_IA00_SYD
Yes	Trout Lake	FWIN	1998	15D_IA98_TRO
Yes	Wabaskang Lake	FWIN	2003	14D_IA03_WAB
Yes	Walsh Lake	FWIN	2002	15D_IA02_WAL
Yes	Wapesi Lake	FWIN	1998	16D_IA98_WAP
Yes	Watcomb Lake	FWIN	1996	11D_IA96_WAT
Yes	Watcomb Lake	FWIN	2003	11D_IA03_WAT
Yes	Wawang Lake	FWIN	1998	18D_IA98_WAW
Yes	Whiterock Lake	FWIN	1998	11D_IA98_WHI
Yes	Whiterock Lake	FWIN	2002	11D_IA02_WHI
Yes	Young Lake	FWIN	1998	11D_IA98_YOU
Yes	Young Lake	FWIN	2002	11D_IA02_YOU
Yes	Zizania Lake	FWIN	1999	15D_IA99_ZIZ

Appendix 4. SLIN and SPIN projects completed in FMZ 4 on waterbodies without special regulations.

Included in Cano and Parker 2005 Assessment	Waterbody Name	Project Type	Date	Project Number
No	Cecil	SPIN	2000	NA
No	Flatrock	SLIN	1997	NA
No	Indian	SLIN	1997	NA
No	Upper Medicine Stone	SPIN	2004	NA
No	Upper Medicine Stone	SLIN	2005	NA
No	Little Vermillion	SLIN	1994	NA
No	Little Vermillion	SLIN	1996	NA
No	Little Vermillion	SLIN	2003	NA
No	Little Vermillion	SLIN	2005	NA
No	Little Vermillion	SLIN	2007	NA
No	Little Vermillion	SPIN	2008	NA
Yes	Cedarborough	SLIN	1997	16D_IA97_CED
Yes	Little Vermillion Lake	SLIN	1999	16D_IA99_LVL
Yes	Emarton	SLIN	2000	15D_IA00_EMA
Yes	Longlegged	SLIN	2000	15D_IA00_LLL
Yes	Confusion Lake	SLIN	2003	15D_IA03_CON

Appendix 5. List of lakes containing Species At Risk in Fisheries Management Zone 4

Lake Name	Species	Status
Big Sandy	Shortjaw Cisco	Unknown
English River	Lake Sturgeon	Unknown
Pikangikum Lake	Lake Sturgeon	Unknown
Berens River	Lake Sturgeon	Unknown
Birch Lake	Lake Sturgeon	Unknown
Shabumeni Lake	Lake Sturgeon	Unknown
Shab River	Lake Sturgeon	Unknown
Springpole Lake	Lake Sturgeon	Unknown

Appendix 6. List of lakes containing invasive species in Fisheries Management Zone 4

Lake Name	Species	Date Observed
Sandybeach Lake	Rainbow Smelt	1987
Big Grassy River	Rainbow Smelt	
Bill	Rainbow Smelt	
Crystal	Rainbow Smelt	
Eva Lake	Rainbow Smelt	1972
French Lake	Rainbow Smelt	
Lac La Croix	Rainbow Smelt	1989
Little Eva	Rainbow Smelt	
Little Eva	Rainbow Smelt	
Little Grassy River	Rainbow Smelt	
Little Vermillion	Rainbow Smelt	1990
Loon	Rainbow Smelt	1990
Marion	Rainbow Smelt	
McGinnis Creek	Rainbow Smelt	
Namakan Lake	Rainbow Smelt	1990
Namakan River	Rainbow Smelt	
Pickerel Lake	Rainbow Smelt	
Rainy - North Arm	Rainbow Smelt	1991
Rainy - South Arm	Rainbow Smelt	1990
Rainy - Redgut Bay	Rainbow Smelt	1999
Rainy River	Rainbow Smelt	
Sand Point Lake	Rainbow Smelt	1990
Three Mile	Rainbow Smelt	
Wilson Creek	Rainbow Smelt	
Ball	Rainbow Smelt	1989
Favel Lake	Rainbow Smelt	1989
Indian Lake	Rainbow Smelt	1989
Lake of the Woods	Rainbow Smelt	1991
Whitefish Bay - LOW	Rainbow Smelt	1999
Shoal Lake - LOW	Rainbow Smelt	1999
Maynard Lake	Rainbow Smelt	1989
Oak Lake	Rainbow Smelt	1989
Tide Lake	Rainbow Smelt	1989
Winnipeg River	Rainbow Smelt	1993
Gunn L. (Winnipeg R.)	Rainbow Smelt	1996
Sand L (Winnipeg R.)	Rainbow Smelt	
Boomerang Lake	Rainbow Smelt	

Cedar Lake	Rainbow Smelt	
Helen Lake	Rainbow Smelt	1974
Jackfish Lake	Rainbow Smelt	
Klotz	Rainbow Smelt	
Nipigon	Rainbow Smelt	1976
Long	Rainbow Smelt	1999
Lukinto	Rainbow Smelt	
Margo	Rainbow Smelt	
Otter Lake	Rainbow Smelt	1981
Polly Lake	Rainbow Smelt	1974
Jesse Lake	Rainbow Smelt	1974
Nipigon R.	Rainbow Smelt	1974
Selim Lake	Rainbow Smelt	
Smelt Lake (NL)	Rainbow Smelt	1967
Walker Lake	Rainbow Smelt	
Gullrock Lake	Rainbow Smelt	1989
Keg Lake	Rainbow Smelt	1989
Pakwash Lake	Rainbow Smelt	1989
Red Lake	Rainbow Smelt	1986
Ranger	Rainbow Smelt	
Two Island	Rainbow Smelt	
Bruce	Rainbow Smelt	
Camping	Rainbow Smelt	1988
English R.	Rainbow Smelt	1993
Wegg	Rainbow Smelt	1994
Abram Lake	Rainbow Smelt	1989
Botsford Lake	Rainbow Smelt	
Lac Seul	Rainbow Smelt	1990
Minnitaki Lake	Rainbow Smelt	1990
Pelican Lake	Rainbow Smelt	1990
Arrow Lake	Rainbow Smelt	1987
Cloud Lake	Rainbow Smelt	1988
Dog Lake	Rainbow Smelt	1977
Gneiss	Rainbow Smelt	1979
Gunflint Lake	Rainbow Smelt	1983
Hawkeye	Rainbow Smelt	1977
Huronian Lake	Rainbow Smelt	1971
Little Dog Lake	Rainbow Smelt	1980
Northern Light	Rainbow Smelt	1990
Pass Lake	Rainbow Smelt	1990
Paul Lake (NL)	Rainbow Smelt	1980

Rose	Rainbow Smelt	
Rudge Lake	Rainbow Smelt	1971
Saganaga Lake	Rainbow Smelt	1989
Sandstone Lake	Rainbow Smelt	1994
Silver	Rainbow Smelt	1979
Surprise Lake	Rainbow Smelt	1990
Two Island Lake	Rainbow Smelt	1980
Unnamed Lake	Rainbow Smelt	1978

Appendix 7. List of lakes surveyed by Creel in Fisheries Management Zone 4

Lake Name	Date	District
Pending Data – Will be updated as Data becomes available		

Appendix 8. List of stocked lakes in Fisheries Management Zone 4

Year	District	Species Stocked	Lake Name	Life Stage
2000	Dryden	SPLAKE	Trott L.	YLG
2000	Dryden	BROOK TROUT	Anteater L.	YLG
2001	Dryden	BROOK TROUT	Snowfall L.	YLG
2001	Dryden	SPLAKE	Little Clobber L.	YLG
2002	Dryden	SPLAKE	Trott L.	YLG
2002	Dryden	BROOK TROUT	Anteater L.	YLG
2002	Dryden	SPLAKE	George L.	YLG
2003	Dryden	SPLAKE	Trott L.	YLG
2003	Dryden	BROOK TROUT	Anteater L.	YLG
2006	Dryden	SPLAKE	George L.	YLG
2006	Dryden	BROOK TROUT	Anteater L.	YLG
2006	Dryden	SPLAKE	Trott L.	YLG
2007	Dryden	BROOK TROUT	Snowfall L.	YLG
2007	Dryden	SPLAKE	Little Clobber L.	YLG
2008	Dryden	SPLAKE	George L.	YLG
2008	Dryden	BROOK TROUT	Anteater L.	YLG
2008	Dryden	SPLAKE	Trott L.	YLG
2009	Dryden	SPLAKE	Little Clobber L.	YLG
2009	Dryden	BROOK TROUT	Anteater L.	YLG
2009	Dryden	RAINBOW TROUT	Snowfall L.	YLG
2005	Dryden	SPLAKE	Little Clobber L.	YLG
2005	Dryden	BROOK TROUT	Snowfall L.	YLG
2000	Ignace	SPLAKE	Little Notman L.	YLG
2000	Ignace	SPLAKE	Hakli L.	YLG
2000	Ignace	BROOK TROUT	McLaurin L.	YLG
2000	Ignace	BROOK TROUT	Krisco L.	YLG
2000	Ignace	BROOK TROUT	O'Dell L.	YLG
2000	Ignace	BROOK TROUT	Little Snowstorm L.	YLG
2000	Ignace	BROOK TROUT	Reguly L.	YLG
2000	Ignace	BROOK TROUT	Shrimp L.	YLG
2000	Ignace	BROOK TROUT	Little Butler L.	YLG
2000	Ignace	BROOK TROUT	Emerald L.	YLG
2000	Ignace	BROOK TROUT	Berglund L.	YLG
2001	Ignace	BROOK TROUT	Little Snowstorm L.	YLG
2001	Ignace	BROOK TROUT	Emerald L.	YLG
2001	Ignace	BROOK TROUT	Shrimp L.	YLG
2001	Ignace	BROOK TROUT	McLaurin L.	YLG

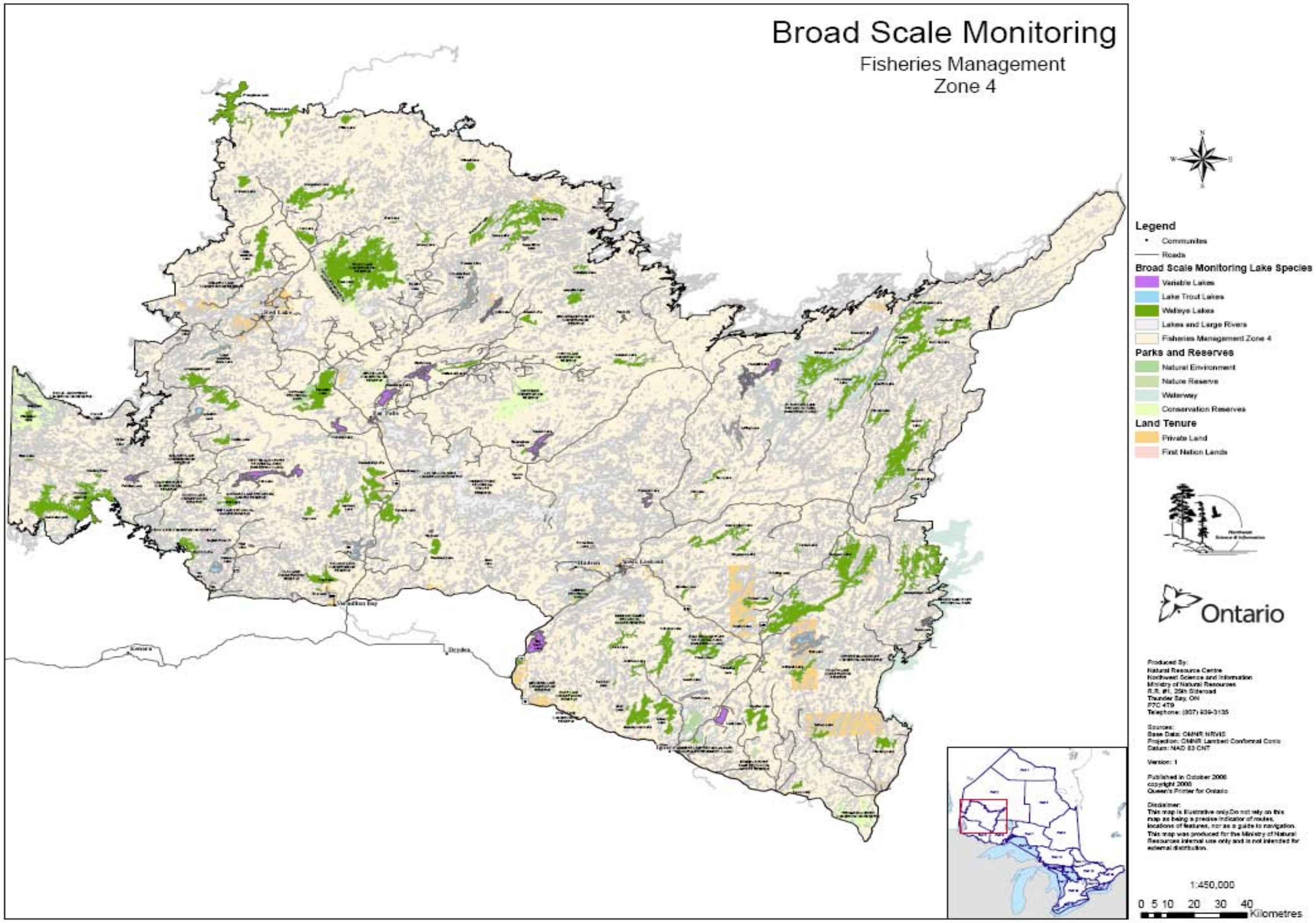
2001	Ignace	BROOK TROUT	Little Butler L.	YLG
2001	Ignace	BROOK TROUT	Reguly L.	YLG
2001	Ignace	BROOK TROUT	O'Dell L.	YLG
2001	Ignace	BROOK TROUT	Berglund L.	YLG
2001	Ignace	BROOK TROUT	Krisco L.	YLG
2002	Ignace	SPLAKE	Little Notman L.	YLG
2002	Ignace	BROOK TROUT	O'Dell L.	YLG
2002	Ignace	BROOK TROUT	Shrimp L.	YLG
2002	Ignace	BROOK TROUT	Reguly L.	YLG
2002	Ignace	BROOK TROUT	McLaurin L.	YLG
2002	Ignace	BROOK TROUT	Little Snowstorm L.	YLG
2002	Ignace	BROOK TROUT	Little Butler L.	YLG
2002	Ignace	BROOK TROUT	Krisco L.	YLG
2002	Ignace	BROOK TROUT	Emerald L.	YLG
2002	Ignace	BROOK TROUT	Berglund L.	YLG
2003	Ignace	BROOK TROUT	McLaurin L.	YLG
2003	Ignace	BROOK TROUT	Krisco L.	YLG
2003	Ignace	BROOK TROUT	Little Snowstorm L.	YLG
2003	Ignace	BROOK TROUT	O'Dell L.	YLG
2003	Ignace	SPLAKE	Hakli L.	YLG
2003	Ignace	BROOK TROUT	Shrimp L.	YLG
2003	Ignace	BROOK TROUT	Reguly L.	YLG
2003	Ignace	BROOK TROUT	Little Butler L.	YLG
2003	Ignace	BROOK TROUT	Emerald L.	YLG
2003	Ignace	BROOK TROUT	Berglund L.	YLG
2005	Ignace	BROOK TROUT	Reguly L.	YLG
2005	Ignace	SPLAKE	Hakli L.	YLG
2005	Ignace	BROOK TROUT	Shrimp L.	YLG
2005	Ignace	BROOK TROUT	Little Snowstorm L.	YLG
2005	Ignace	BROOK TROUT	Berglund L.	YLG
2006	Ignace	BROOK TROUT	McLaurin L.	YLG
2006	Ignace	SPLAKE	Little Notman L.	YLG
2006	Ignace	BROOK TROUT	Emerald L.	YLG
2006	Ignace	BROOK TROUT	Little Butler L.	YLG
2006	Ignace	BROOK TROUT	O'Dell L.	YLG
2006	Ignace	BROOK TROUT	Krisco L.	YLG
2007	Ignace	BROOK TROUT	Reguly L.	YLG
2007	Ignace	BROOK TROUT	Little Snowstorm L.	YLG
2007	Ignace	BROOK TROUT	Shrimp L.	YLG
2007	Ignace	BROOK TROUT	Berglund L.	YLG
2007	Ignace	SPLAKE	Hakli L.	YLG

2008	Ignace	BROOK TROUT	McLaurin L.	YLG
2008	Ignace	SPLAKE	Hakli L.	YLG
2008	Ignace	BROOK TROUT	Emerald L. (2)	YLG
2008	Ignace	BROOK TROUT	O'Dell L.	YLG
2008	Ignace	BROOK TROUT	Krisco L.	YLG
2009	Ignace	BROOK TROUT	Little Butler L.	YLG
2009	Ignace	BROOK TROUT	Shrimp L.	YLG
2009	Ignace	BROOK TROUT	Little Snowstorm L.	YLG
2009	Ignace	BROOK TROUT	Reguly L.	YLG
2009	Ignace	BROOK TROUT	Berglund L.	YLG
2009	Ignace	SPLAKE	Little Notman L.	YLG
2000	Kenora	BROOK TROUT	Bill L.	YLG
2000	Kenora	BROOK TROUT	Howard L.	YLG
2000	Kenora	BROOK TROUT	Tox L.	YLG
2000	Kenora	SPLAKE	Arpin L.	YLG
2000	Kenora	SPLAKE	Dogtooth L.	YLG
2001	Kenora	BROOK TROUT	132, L.	YLG
2001	Kenora	BROOK TROUT	East Emerson L.	YLG
2001	Kenora	BROOK TROUT	Emerson L.	YLG
2001	Kenora	SPLAKE	Arpin L.	YLG
2001	Kenora	SPLAKE	Dogtooth L.	YLG
2002	Kenora	SPLAKE	Dogtooth L.	YLG
2002	Kenora	BROOK TROUT	Bill L.	YLG
2002	Kenora	BROOK TROUT	Howard L.	YLG
2002	Kenora	BROOK TROUT	Tox L.	YLG
2003	Kenora	BROOK TROUT	132, L.	YLG
2003	Kenora	RAINBOW TROUT	Arpin L.	FLG
2003	Kenora	SPLAKE	Dogtooth L.	YLG
2003	Kenora	BROOK TROUT	East Emerson L.	YLG
2003	Kenora	BROOK TROUT	Emerson L.	YLG
2005	Kenora East	RAINBOW TROUT	Dog L.	FLG
2005	Kenora East	RAINBOW TROUT	Wreck L.	FLG
2005	Kenora East	RAINBOW TROUT	Arpin L.	FLG
2005	Kenora East	BROOK TROUT	East Emerson L.	YLG
2005	Kenora East	BROOK TROUT	Emerson L.	YLG
2006	Kenora East	RAINBOW TROUT	Percy L.	YLG
2006	Kenora East	RAINBOW TROUT	Dixie L.	YLG
2006	Kenora East	BROOK TROUT	Tox L.	YLG
2006	Kenora East	BROOK TROUT	Howard L.	YLG
2006	Kenora East	BROOK TROUT	Bill L.	YLG
2007	Kenora East	BROOK TROUT	Emerson L.	YLG

2007	Kenora East	BROOK TROUT	Dixie L.	YLG
2007	Kenora East	BROOK TROUT	Percy L.	YLG
2007	Kenora East	RAINBOW TROUT	Wreck L.	FLG
2007	Kenora East	RAINBOW TROUT	Dog L.	FLG
2008	Kenora East	RAINBOW TROUT	Percy L.	FLG
2008	Kenora East	BROOK TROUT	Tox L.	YLG
2008	Kenora East	BROOK TROUT	Howard L.	YLG
2008	Kenora East	BROOK TROUT	Bill L.	YLG
2008	Kenora East	RAINBOW TROUT	Dixie L.	FLG
2009	Kenora East	RAINBOW TROUT	Arpin L.	YLG
2009	Kenora East	RAINBOW TROUT	Wreck L.	YLG
2009	Kenora East	BROOK TROUT	Emerson L.	YLG
2009	Kenora East	RAINBOW TROUT	Dog L.	YLG
2009	Kenora East	BROOK TROUT	East Emerson L.	YLG
2005	Lac Seul	BROOK TROUT	Mile 40, L.(NL)	YLG
2005	Lac Seul	BROOK TROUT	Nyilas L.	YLG
2005	Lac Seul	BROOK TROUT	Snyder L.	YLG
2005	Lac Seul	BROOK TROUT	Whiz L.	YLG
2005	Lac Seul	BROOK TROUT	Highway L.	YLG
2005	Lac Seul	SPLAKE	Boot L.	YLG
2006	Lac Seul	BROOK TROUT	Whiz L.	YLG
2006	Lac Seul	BROOK TROUT	Snyder L.	YLG
2006	Lac Seul	BROOK TROUT	Highway L.	YLG
2006	Lac Seul	BROOK TROUT	Nyilas L.	YLG
2006	Lac Seul	SPLAKE	Boot L.	YLG
2006	Lac Seul	BROOK TROUT	Mile 40, L.	YLG
2007	Lac Seul	BROOK TROUT	Nyilas L.	YLG
2007	Lac Seul	BROOK TROUT	Snyder L.	YLG
2007	Lac Seul	SPLAKE	Boot L.	YLG
2007	Lac Seul	BROOK TROUT	Whiz L.	YLG
2007	Lac Seul	BROOK TROUT	Mile 40, L.	YLG
2007	Lac Seul	BROOK TROUT	Highway L.	YLG
2008	Lac Seul	BROOK TROUT	Snyder L.	YLG
2008	Lac Seul	BROOK TROUT	Nyilas L.	YLG
2008	Lac Seul	BROOK TROUT	Whiz L.	YLG
2008	Lac Seul	BROOK TROUT	Highway L.	YLG
2008	Lac Seul	BROOK TROUT	Mile 40, L.	YLG
2008	Lac Seul	SPLAKE	Boot L.	YLG
2009	Lac Seul	SPLAKE	Boot L.	YLG
2009	Lac Seul	BROOK TROUT	Whiz L.	YLG
2009	Lac Seul	RAINBOW TROUT	Mile 40 L.	YLG

2009	Lac Seul	BROOK TROUT	Highway L.	YLG
2009	Lac Seul	BROOK TROUT	Nyilas L.	YLG
2009	Lac Seul	BROOK TROUT	Snyder L.	YLG
2000	Red Lake	BROOK TROUT	Sunday L.	YLG
2002	Red Lake	BROOK TROUT	Sunday L.	YLG
2005	Red Lake	LAKE TROUT	Red L.	YLG
2006	Red Lake	LAKE TROUT	Red L.	YLG
2007	Red lake	LAKE TROUT	Red L.	YLG
2007	Red Lake	SPLAKE	Sunday L.	YLG
2008	Red Lake	LAKE TROUT	Red L.	YLG
2009	Red Lake	LAKE TROUT	Red L.	YLG
2009	Red Lake	SPLAKE	Sunday L.	YLG
2000	Sioux Lookout	SPLAKE	Boot L.	YLG
2000	Sioux Lookout	BROOK TROUT	Whiz L.	YLG
2000	Sioux Lookout	BROOK TROUT	Mile 40, L.(NL)	YLG
2000	Sioux Lookout	BROOK TROUT	Highway L.	YLG
2000	Sioux Lookout	BROOK TROUT	Snyder L.	YLG
2000	Sioux Lookout	BROOK TROUT	Nyilas L.	YLG
2001	Sioux Lookout	BROOK TROUT	Highway L.	YLG
2001	Sioux Lookout	SPLAKE	Boot L.	YLG
2001	Sioux Lookout	BROOK TROUT	Whiz L.	YLG
2001	Sioux Lookout	BROOK TROUT	Snyder L.	YLG
2001	Sioux Lookout	BROOK TROUT	Nyilas L.	YLG
2001	Sioux Lookout	BROOK TROUT	Mile 40, L.(NL)	YLG
2002	Sioux Lookout	BROOK TROUT	Nyilas L.	YLG
2002	Sioux Lookout	BROOK TROUT	Highway L.	YLG
2002	Sioux Lookout	BROOK TROUT	Mile 40, L.(NL)	YLG
2002	Sioux Lookout	SPLAKE	Boot L.	YLG
2002	Sioux Lookout	BROOK TROUT	Whiz L.	YLG
2002	Sioux Lookout	BROOK TROUT	Snyder L.	YLG
2003	Sioux Lookout	SPLAKE	Boot L.	YLG
2003	Sioux Lookout	BROOK TROUT	Whiz L.	YLG
2003	Sioux Lookout	BROOK TROUT	Snyder L.	YLG
2003	Sioux Lookout	BROOK TROUT	Nyilas L.	YLG
2003	Sioux Lookout	BROOK TROUT	Mile 40, L.(NL)	YLG
2003	Sioux Lookout	BROOK TROUT	Highway L.	YLG
2005	Sioux Lookout	BROOK TROUT	Whiz L.	YLG
2005	Sioux Lookout	SPLAKE	Boot L.	YLG
2005	Sioux Lookout	BROOK TROUT	Snyder L.	YLG
2005	Sioux Lookout	BROOK TROUT	Mile 40, L.(NL)	YLG
2005	Sioux Lookout	BROOK TROUT	Highway L.	YLG

2005	Sioux Lookout	BROOK TROUT	Nyilas L.	YLG



Appendix 9. Lakes surveyed by Broad Scale Monitoring (BSM) 2009 in Fisheries Management Zone 4

Appendix 10. List of lakes surveyed by Broad Scale Monitoring (BSM) 2009 in Fisheries Management Zone 4

Lake Name	Fixed	Variable	Year	District
Amik L.	1		2009	Dryden
Arc L.	1		2009	Sioux Lookout
Arethusa L.	1		2009	Dryden
Bain L.	1		2009	Kenora
Bawden L.	1		2009	Sioux Lookout
Bee L.	0	Variable	2009	Kenora
Bell L.	1		2009	Dryden
Berens L.	1		2009	Red Lake
Bertaud L.	1		2009	Sioux Lookout
Big Fox L.	1		2009	Kenora
Big Sandy L.	0	Variable	2009	Dryden
Birch L.	1		2009	Red Lake
Birmingham L.	1		2009	Sioux Lookout
Blair L.	1		2009	Red Lake
Bluffy L.	0	Variable	2009	Red Lake
Bury L.	1		2009	Sioux Lookout
Camping L.	0	Variable	2009	Red Lake
Carling L.	1		2009	Sioux Lookout
Cecil L.	0	Variable	2009	Dryden
Churchill L.	0	Variable	2009	Sioux Lookout
Clay L.	1		2009	Kenora
Cliff L.	1		2009	Kenora
Coli L.	1		2009	Red Lake
Confederation L.	1		2009	Red Lake
Confusion L.	1		2009	Red Lake
Conifer L.	1		2009	**Kenora**
Crystal L.	1		2009	Dryden
Davies Lake	1		2009	Dryden
De Lesseps Lake	1		2009	Sioux Lookout
Delaney Lake	1		2009	Kenora
Dowswell Lake	1		2009	Kenora
Expanse L.	0	Variable	2009	Sioux Lookout
Eye L.	1		2009	Kenora
Fitchie L.	1		2009	Sioux Lookout
Fletcher L.	0	Variable	2009	Kenora
FMZ4_01	1		2009	Dryden
FMZ4_02	0	Variable	2009	Red Lake

FMZ4_03	0	Variable	2009	Sioux Lookout
Gibraltar L.	1		2009	Dryden
Gooch L.	1		2009	Dryden
Grace L.	1		2009	Red Lake
Greenbush L.	1		2009	Sioux Lookout
Hailstone L.	1		2009	Red Lake
Hamilton L.	1		2009	Sioux Lookout
Hartman L.	1		2009	Dryden
Hik L.	1		2009	Sioux Lookout
Indian L.	1		2009	Dryden
Jeanette L.	1		2009	Red Lake
Jubilee L.	1		2009	Red Lake
ken-nl-5064 (Val L.)	1		2009	Kenora
Kirkness L.	1		2009	Red Lake
Kukukus L.	1		2009	Dryden
Little Sandbar L.	1		2009	Dryden
Little Vermilion L.	1		2009	Red Lake
Longlegged L.	1		2009	Red Lake
Mameigwess L.	1		2009	Dryden
Marchington L.	1		2009	Sioux Lookout
Mattawa L.	1		2009	Dryden
McCrea L.	1		2009	Sioux Lookout
Medcalf L.	0	Variable	2009	Sioux Lookout
Minchin L.	1		2009	Sioux Lookout
Minniss L.	1		2009	Sioux Lookout
Mold L.	1		2009	Dryden
Mud L.	1		2009	Dryden
Nungesser L.	1		2009	Red Lake
Oak L.	0	Variable	2009	Kenora
Onnie L.	1		2009	Red Lake
Otatakan L.	1		2009	Sioux Lookout
Pakwash L.	1		2009	Red Lake
Pashkokogan L.	1		2009	Sioux Lookout
Penassi L.	1		2009	Dryden
Perrault L.	1		2009	Kenora
Pikangikum L.	1		2009	Red Lake
Premier L.	1		2009	Red Lake
Press L.	1		2009	Dryden
Richardson L.	1		2009	Sioux Lookout
RL_083 L.	0	Variable	2009	Red Lake
Rude L.	0	Variable	2009	Dryden

Savant L.	1		2009	Sioux Lookout
Savoy L.	1		2009	Dryden
Selwyn L.	1		2009	Thunder Bay
Seseganaga L.	1		2009	Dryden
Shabu L.	1		2009	Red Lake
Shabumeni L.	1		2009	Red Lake
Silcox L.	1		2009	Red Lake
Silver L.	1		2009	Sioux Lookout
Singapore L.	1		2009	Sioux Lookout
Smye L.	1		2009	Sioux Lookout
Sowden Lake	1		2009	Dryden
Spruce L.	1		2009	Sioux Lookout
Square L.	0	Variable	2009	Dryden
Sturgeon L.	1		2009	Dryden
Sup L.	1		2009	Kenora
Superstition L.	0	Variable	2009	Red Lake
Thaddeus L.	1		2009	Dryden
Tide L.	1		2009	Kenora
Tom L.	1		2009	Kenora
Towers L.	1		2009	Dryden
Trout L.	1		2009	Red Lake
Uchi L.	0	Variable	2009	Red Lake
Umfreville L.	1		2009	Kenora
Upper Medicine Stone L.	1		2009	Red Lake
Victoria L.	1		2009	Dryden
Wabaskang L.	1		2009	Kenora
Wapesi L.	0	Variable	2009	Sioux Lookout
Wavell L.	1		2009	Red Lake
Wawang L.	1		2009	Thunder Bay
Wenasaga L.	0	Variable	2009	Red Lake
Whitemud L.	1		2009	Red Lake
Winding R.	1		2009	Kenora
Wingiskus L.	1		2009	Kenora
Wintering L.	1		2009	Dryden
Wolf L.	0	Variable	2009	Kenora
Wyder L.	1		2009	Kenora
Victoria L.	1		2009	Dryden
Wabaskang L.	1		2009	Kenora
Wapesi L.	0	Variable	2009	Sioux Lookout
Wavell L.	1		2009	Red Lake

Wawang L.	1		2009	Thunder Bay
Wenasaga L.	0	Variable	2009	Red Lake
Whitemud L.	1		2009	Red Lake
Winding R.	1		2009	Kenora
Wingiskus L.	1		2009	Kenora
Wintering L.	1		2009	Dryden
Wolf L.	0	Variable	2009	Kenora
Wyder L.	1		2009	Kenora

Appendix 11. List of Acronyms used in the FMZ 4 Background Report

Acronym	Full Title
ACOP	Annual Compliance Operating Plan
AHI	Aquatic Habitat Inventory
BAO	Baitfish Association of Ontario
CEQ	Council on Environmental Quality
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
COSSARO	Committee on the Status of Species at Risk in Ontario
CLUPA	Crown Land Use Policy Atlas
CUE	Catch per Unit Effort
DFO	Department of Fisheries and Oceans
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
EA	Environmental Assessment
FMP	Forest Management Plan
FMZ	Fisheries Management Zone
FWIN	Fall Walleye Index Netting
GDD	Growing Degree Days
HACCP	Hazard Analysis and Critical Control Point
MEI	Morphoedaphic Index
NKPPA	North Kenora Pilot Project Area
OMNR	Ontario Ministry of Natural Resources
PAPA	Provincial Park and Protected Areas
PGT	Put Grow Take
SAR	Species at Risk
SARO	Species at Risk Ontario
SDW	Specially Designated Waters
SLIN	Spring Littoral Index Netting
SPIN	Summer Profundal Index Netting
SPOFF II	Strategic Plan for Ontarios Fisheries
TDS	Total Dissolved Solids
TOHA	Thermal Optimal Habitat Area
VHS	Viral Hemorrhagic Septicemia

Appendix 12. Results of the Initial Issue and Management Challenge Prioritization Exercise

Rank	Category (Habitat, exploitation, invasive species, changing environment?)	Actual management issue?	Consideration
1	Information for Management	Public awareness of a variety of management issues objectives and actions	Education
2	Habitat	Loss or degradation of fish habitat.	Habitat
2	Habitat	Loss or degradation of fish habitat specifically spawning areas	Protection of spawning habitat - Identify special spawning areas
2	Exploitation	Protection of fish during spawning period	Timing of opening season for walleye
3	Habitat	Loss or degradation of fish habitat specifically spawning areas	Are spawning grounds areas in good shape?
4	Exploitation	Need to ensure harvests are within allowable yield	Creating fish sustainability in lakes while maximizing the social and economic benefits
5	Habitat	Loss or degradation of fish habitat.	Habitat concerns – stand and site guide.
5	Exploitation	Over exploitation and a decline in fishing opportunities	Concentration of fishing effort.
5	Exploitation	Maintenance of fishing quality	North Kenora Pilot project /Watcomb (for maintaining fish quality)
5	Exploitation	Slot size is preventing the use of pike of acceptable size for shore lunches. Rationale for protected slot is not defensible.	Pike regulation – slot size
5	Exploitation	Increased mortality of released fish.	Education – catch and release
6	Exploitation	Need to increase the diversity of fishing opportunities	Stocking – diversity of fish opportunities
6	Exploitation	Loss of fishing opportunities/ concentration of fishing effort	Access to new fishing opportunities - removal of access.
7	Exploitation	Inability to meet angler demands for accessible fishing opportunities, diversity of opportunities??? Changing demographics	Changing Angler Demands, declining angler numbers

7	Exploitation	Enforceability of regulations	Enforcement challenges getting to all the lakes and ensuring regulations are being adhered to
7	Exploitation	Need to tailor the management of lake trout to type of lake?	Lake Trout sustainability in lakes with marginal habitat vs lakes with good habitat.
7	Exploitation	Incorporating different types of fishing quality in management objectives?	Management of fish species - trophy vs quantity
7	Invasive Species	Movement of invasive species	Use of live bait
8	Exploitation	Maintenance of fishing quality	Fishing quality – can we maintain it?
8	Exploitation	Small lake trout lakes are susceptible of over-exploitation	Lake trout exploitation – specifically on small lakes
8	Exploitation	Redirection of fishing effort could occur to other species	When considering regs look at impact on other species.(species specific mgmt)
8	Exploitation	Increased mortality of released fish.- spawning information to facilitate the quick and locational release of spawning fish & its importance -proper netting and handling of fish to be released - equipment to aid in the release process ie: type of nets, hook removal devices and techniques ect. -use of circle, barbless, or one hook only	Angler information to help increase survival rates and decrease mortality on release: -spawning information to facilitate the quick and release of spawning fish & its importance -proper netting and handling of fish to be released -equipment to aid in the release process ie: type of nets, hook removal devices and techniques etc. -use of circle, barbless, or one hook only
8	Invasive Species	Effect of climate change on expansion of invasive species	Climate change
9	Exploitation	Fishing effort is not distributed evenly across the zone	Fishing diversity differs across the zone
9	Exploitation	Are the size regulations the right ones?	Muskellunge adjustment of regulations (size limits)
9	Exploitation	Effect of regulations on fishing opportunities and participation in fishing	Number and complexity of regulations
9	Exploitation	Increased mortality of released fish.	Use of live bait
10	Exploitation	Concentration of fishing effort resulting in over-exploitation	More Access = more fishing pressure.

10	Exploitation	Mortality of released fish due to sorting	Management for culling fish
10	Habitat	Loss or degradation of fish habitat.	Culverts passage for fish, wetland drainage, culvert maintenance
10	Habitat	Effect of climate change on fish populations, angling opportunities	Climate change
10	Invasive Species	Invasive species and their effects on fish communities	Invasive Species - such as smallmouth bass
10	Invasive Species	Movement of invasive species	Movement of baitfish, over harvest of forage base
10	Species at Risk	Protection of species at risk	Species at risk.
10	Species at Risk	Protection of species at risk	Recovery opportunities
10	Exploitation	Enforceability of regulations	Enforceability
10	Exploitation	Northern pike are being underutilized	Increase profile of pike fishery
10	Exploitation	Increased mortality of released fish.	Catch and release policy and sorting
11	Exploitation	Over exploitation and a decline in fishing opportunities	Access to new fishing opportunities - too much access.
11	Exploitation	Concentration of fishing effort resulting in over-exploitation	More access = more fishing pressure
11	Exploitation	Maintenance of fishing quality for walleye in small lakes	Fishing quality on small walleye lakes (exploitation)
11	Species at Risk	Loss or degradation of fish habitat.	Habitat
11	Species at Risk	Protection of species at risk	Distribution – where are they and can we keep them.
11	Information for Management	Lack of understanding or trust in science used to estimate productivity of fish populations	Methodology for classifying productivity and growth
11	Exploitation	Enforceability of the regulations	Identification – why so we need to keep a patch of skin
11	Exploitation	The balance harvest with size structure allowable yield.	Trophy management for Smallmouth Bass
0	Exploitation	Concentration of fishing effort resulting in over-exploitation	Linkage to access
0	Exploitation	Concentration of fishing effort resulting in over-exploitation	Lakes vary on type of access so therefore fishing pressure varies
0	Exploitation?	Need to understand what affects angle performance	Influences on anglers performance
0	Exploitation	Increase in exploitation efficiency	Technology

0	Exploitation	By-catch of walleye is too high so ability to catch primary quotas is impacted / alternate prey source/ climate change	To many walleyes- commercial fishing (eagle lake), trouble staying away from them.
0	Exploitation	Effect on food safety and marketability	Parasite load effects on recreational fishing/commercial fishing
0	Exploitation	Effect on the environment and food safety	Contaminants -Lead free tackle
0	Invasive Species	Movement of invasive species	More access = more fishing pressure
0	Invasive Species	Movement of invasive species	Access to Fishing Opportunities - too much access.
0	Information for Management	Protection of species at risk	Distribution – where are they and can we keep them.
0	Exploitation	Protection of fish during spawning period	Lack of regulations for small mouth bass during spawning
0	Exploitation	Is the size regulation for lake trout defensible?	Size regulation on lake trout
0	Exploitation	Design of regulations doesn’t reflect different species vulnerabilities	Difference in species vulnerabilities
0	Habitat	Loss or degradation of fish habitat.	Caribou conservation plan

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