Fisheries Management Zone 15

Background Information

February 1, 2019

Ministry of Natural Resources
and Forestry

Ontario

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1 Introduction

Since 2008, the Province of Ontario has undertaken a broader, landscape level, approach to fisheries management (OMNR 2005a) focused on: creating 20 new Fisheries Management Zones (FMZs) based on biological, climatic, and social factors; developing science-based regulatory “tool kits” for different sport fish species; monitoring and reporting on fisheries at a broader landscape level; and enhancing public input and involvement through creation of fisheries advisory councils in each FMZ. This approach allows the Ministry of Natural Resources and Forestry (MNRF) to manage and monitor fisheries resources and assess fisheries sustainability at a scale most appropriate, given current fisheries objectives, public expectations and government resources.

Ontario’s Provincial Fish Strategy: Fish for the Future was developed in 2015 as a guiding document for managing fisheries resources in Ontario and identifies goals, objectives and tactics at a provincial level (OMNRF 2015b). MNRF’s long-term strategic direction was updated in 2020. Horizons 2020 (OMNRF 2015c) was replaced with the Ministry of Natural Resources and Forestry Strategic Plan 2020-2025: Naturally Resourceful (OMNRF 2020a). These documents give 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.

FMZs are the geographic unit at which recreational fisheries management is implemented 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 used for each zone. This is accomplished by setting ecological and socioeconomic 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 method allows fisheries managers to adapt to a changing environment or circumstances, such as climate change or knowledge, to make continual improvements through time at a scale that is most practical and workable.

This background document presents specific physical, biological, and socioeconomic background data and information related to fisheries management in FMZ 15. Consolidating the background information is the first step towards the development of a Fisheries Management Plan specific to this zone. It is intended to document 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. In particular, it includes:

- Physical, geographic and anthropogenic descriptions of the zone,
- Biological descriptions including an overview of the fish communities present and an estimation of their current status, population trends and changes in composition,

- Reviews of the stresses on aquatic habitats in the zone,
- Outlines of the socioeconomic importance of the fishery, and
- Summary of historical and current management actions.

Public input and involvement are key components of fisheries management planning. The primary method of public engagement in fisheries management is through the establishment of a fishery advisory council in each FMZ. In FMZ 15, an advisory council was established in 2017. Currently the FMZ 15 advisory council includes members of the public, First Nation and Métis representatives, and various stakeholders, led by MNRF. The advisory council will use this background information to help frame discussions on developing realistic expectations of the fisheries resource, biological thresholds and objective setting as the FMZ 15 Fisheries Management Plan is written. As more current fisheries data from the Broad-scale Monitoring (BsM) becomes available, this information will be incorporated into the decision-making process. The MNRF is responsible for the preparation of the FMZ 15 Fisheries Management Plan and will draw on the recommendations of the advisory council. The advisory council will also review the MNRF strategies developed to achieve the objectives.

The ongoing Algonquin Treaty negotiations Agreement-In-Principle of 2016 contains fisheries management commitments for FMZ15 that will be included in this planning process and other fisheries management initiatives.

The plan will apply to all waterbodies across FMZ 15, excluding Algonquin Provincial Park. A separate Fisheries Management Plan will be developed for Algonquin Provincial Park. Algonquin Provincial Park staff will take part in the planning process at the project team and steering committee levels. The FMZ 15 background report and the draft objectives and management actions developed for the zone will inform the Algonquin Provincial Park Fisheries Management Plan.

The data presented here is reflective of data collected until February 2019 unless noted as otherwise.

Fish are of central importance to Aboriginal peoples in Ontario. Throughout the province, Aboriginal peoples have constitutionally-protected Aboriginal and treaty rights to fish for food, and for social and ceremonial purposes. There are also several Aboriginal commercial fisheries across Ontario, most of which stem from historical practice. Aboriginal commercial fisheries are found primarily on the Great Lakes, Lake Nipissing, Lake Nipigon, and lakes of northwestern Ontario. The history of Aboriginal fisheries pre-dates the existence of the province. Harvest traditionally occurred year round, including during spawning times. Harvesting tools included weirs, nets, traps, spears and baited hooks. Although tools have evolved over time, fishing continues to play a significant role in the lives of Aboriginal peoples, contributing to the dietary, social, cultural and economic needs of communities in Ontario today.

2 Physical Description

2.1 Overview

FMZ 15 spans an area of about 3.8 million hectares (37,832 km^2) in central Ontario and includes almost 50,000 waterbodies covering an area of almost 300,000 ha (3,000 km^2), including those within Algonquin Provincial Park. The zone extends from Georgian Bay in the west to the Ottawa River in the east. Its northern boundary follows the Pickerel River, Highway 522 and the northern edge of Algonquin Provincial Park (Figure 2.1). A legal description and map of the boundaries of FMZ 15 can be found at the FMZ 15 webpage. Major communities include Parry Sound, Gravenhurst, Bracebridge, Huntsville, Minden, Haliburton, Whitney, Bancroft, Deep River, Petawawa, Pembroke and Renfrew.

FMZ 15 is located entirely within the Ontario Shield Ecozone and Georgian Bay Ecoregion in south-central Ontario. This region is primarily Precambrian bedrock, which is often exposed, creating a rugged landscape typified by a large number of lakes and wetlands. Lakes and rivers cover over 10% of the surface area while wetlands are 2.5% of the total land cover.

The land cover in this ecoregion is primarily forest. The vegetation is representative of the Great Lakes – St. Lawrence Region, characterized by a mix of northern and southern species. Mixed forest (32.0%), deciduous forest (22.2%), coniferous forest (12.1%), and sparse forest (11.3%) form the majority of the land cover. Agricultural land comprises only 3.0% of the area (Crins et. al. 2009).

The forests, lakes and wetlands support a moderate diversity of fish, wildlife and plant species as a result of the combination of northern and southern habitat elements. As such, warm, cool and cold waterbodies can be found throughout FMZ 15, supporting species such as Smallmouth and Largemouth Bass, Northern Pike, Walleye, Brook Trout and Lake Trout.

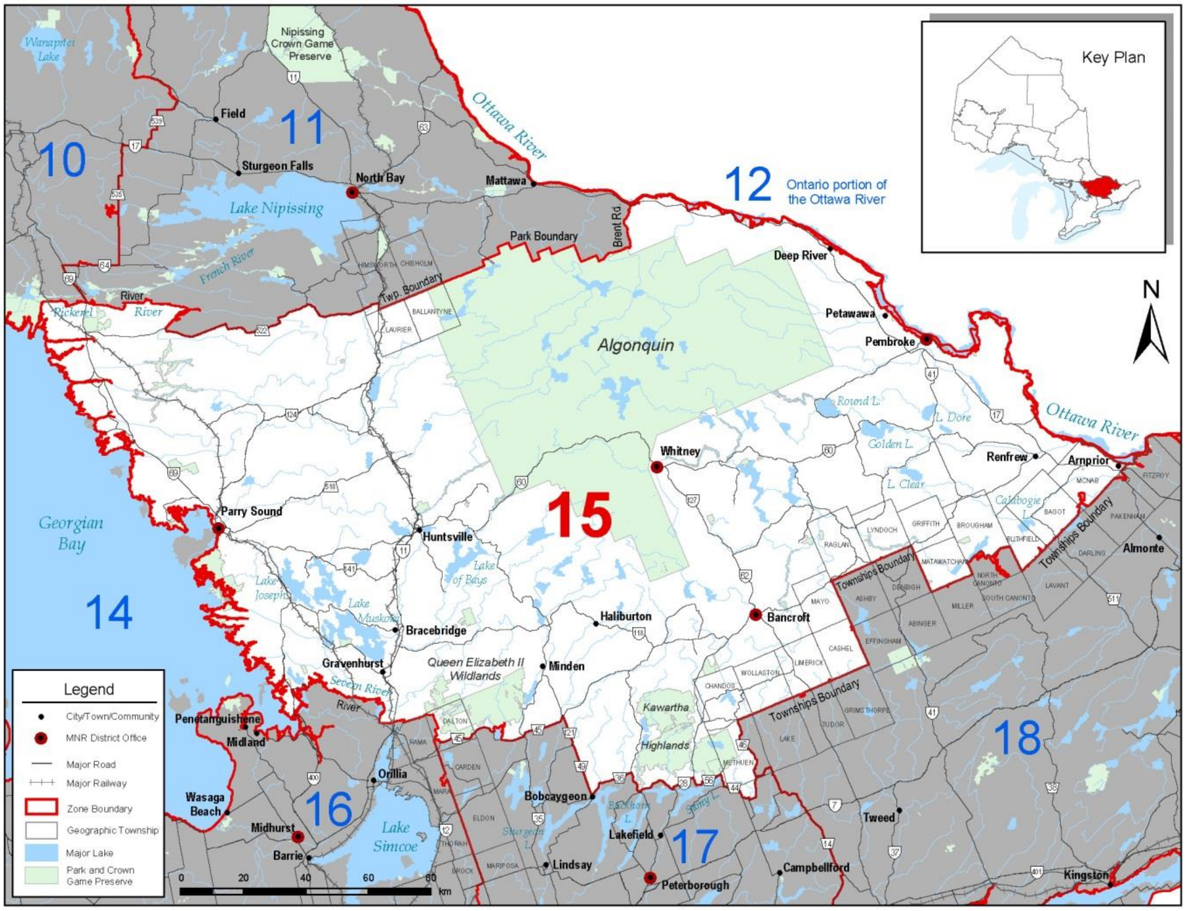


Figure 2.1 Map of FMZ 15, showing boundary, major water bodies, communities and roads.

The zone is located in the southern region administrative area of MNRF and is primarily in Parry Sound, Bancroft and Pembroke districts. Small portions of the zone are within North Bay, Sudbury and Peterborough districts.

Many provincial parks are located within FMZ 15, with the largest being Algonquin Provincial Park, followed by Kawartha Highlands Provincial Park, Queen Elizabeth II Wildlands Provincial Park, The Massasauga Provincial Park as well as many smaller parks and protected areas. Further discussion on Ontario Parks can be found in Section 2.6. In addition to regulated provincial parks, FMZ 15 has many areas of natural and scientific interest (ANSI), enhanced management areas (EMA) and conservation reserves. Maps and permitted land use for these areas can be found on the Crown Land Use Policy Atlas.

About 23% of the total land and water area of FMZ 15 is contained within regulated provincial parks, 39% is privately owned, 37% is Crown Land, and 1% is federally owned and First Nations Reserves.

2.2 Geology and Soils

All of FMZ 15 is contained within one ecozone, the Ontario Shield (Table 2.1). The Ontario Shield ecozone is characterized by shallow soils (e.g., coarse loam), impermeable bedrock, and rolling terrain which create ideal conditions for surface water features (e.g., lakes, rivers, wetlands and streams). Within FMZ 15, granite bedrock is the dominant geologic feature, covering about 70% of the landscape. Most of the remainder is formed of glacial fluvial (deposited by moving water) and moraine deposits. A small part in the Ottawa Valley has limestone bedrock and marine deposits.

Table 2.1 Surficial geology of FMZ 15.

Landform	Area (ha)	%
Granite Bedrock	2,124,160	70.5
Glaciofluvial	327,200	10.9
Moraine	285,058	9.5
Glaciolacustrine	121,025	4.0
Glaciomarine	88,379	2.9
Organic	54,176	1.8
Limestone Bedrock	12,989	0.4
Total	3,012,988	

2.3 Water Resources

Watersheds

FMZ 15 is located entirely in the Great Lakes – St. Lawrence primary watershed. The highest elevations in the zone are in the central Algonquin dome resulting in flow out of the zone in all directions via five secondary watersheds: Eastern Georgian Bay, Lake Ontario-Niagara Peninsula, Lower Ottawa, Central Ottawa and Wanapitei-French. Most of the water from the zone flows westward via the tertiary watersheds of the Magnetawan, Muskoka and Black Rivers or eastward via the Petawawa, Bonnechere and Madawaska Rivers and other direct tributaries of the central Ottawa River (Table 2.2, Figure 2.2). Smaller areas drain southward via the headwaters of the Gull, Kawartha Lakes and Trent-Crowe systems. Flowing northward are tributaries of the French and Central Ottawa-Kipawa watersheds of which only small portions are in the zone.

Table 2.2 Tertiary watersheds in FMZ 15.

Tertiary Watershed	Total Area (ha)	Area within FMZ 15	Percent of Watershed in FMZ15	Percent of FMZ15 by Watershed
02EA - Magnetawan	602,682	579,398	96%	19%
02EB - Muskoka	562,648	492,644	88%	16%
02KD - Upper Madawaska	621,838	410,809	66%	14%
02KC - Central Ottawa - Bonnechere	421,054	367,906	87%	12%
02HF - Gull	324,840	260,286	80%	9%
02EC - Black River - Lake Simcoe	618,851	172,920	28%	6%
02KE - Lower Madawaska	226,879	155,158	68%	5%
02DD - French	885,232	151,747	17%	5%
02HH - Kawartha Lakes	307,239	144,580	47%	5%
02KA - Central Ottawa - Dumoine	168,526	112,337	67%	4%
02HK - Trent - Crowe	361,839	106,340	29%	4%
02KB - Petawawa	417,732	40,948	10%	1%
02JE - Upper Ottawa - Kipawa	635,008	8,517	1%	0.3%
02HL - Moira	284,986	5,518	2%	0.2%
02KF - Central Ottawa - Mississippi	445,384	3,878	1%	0.1%

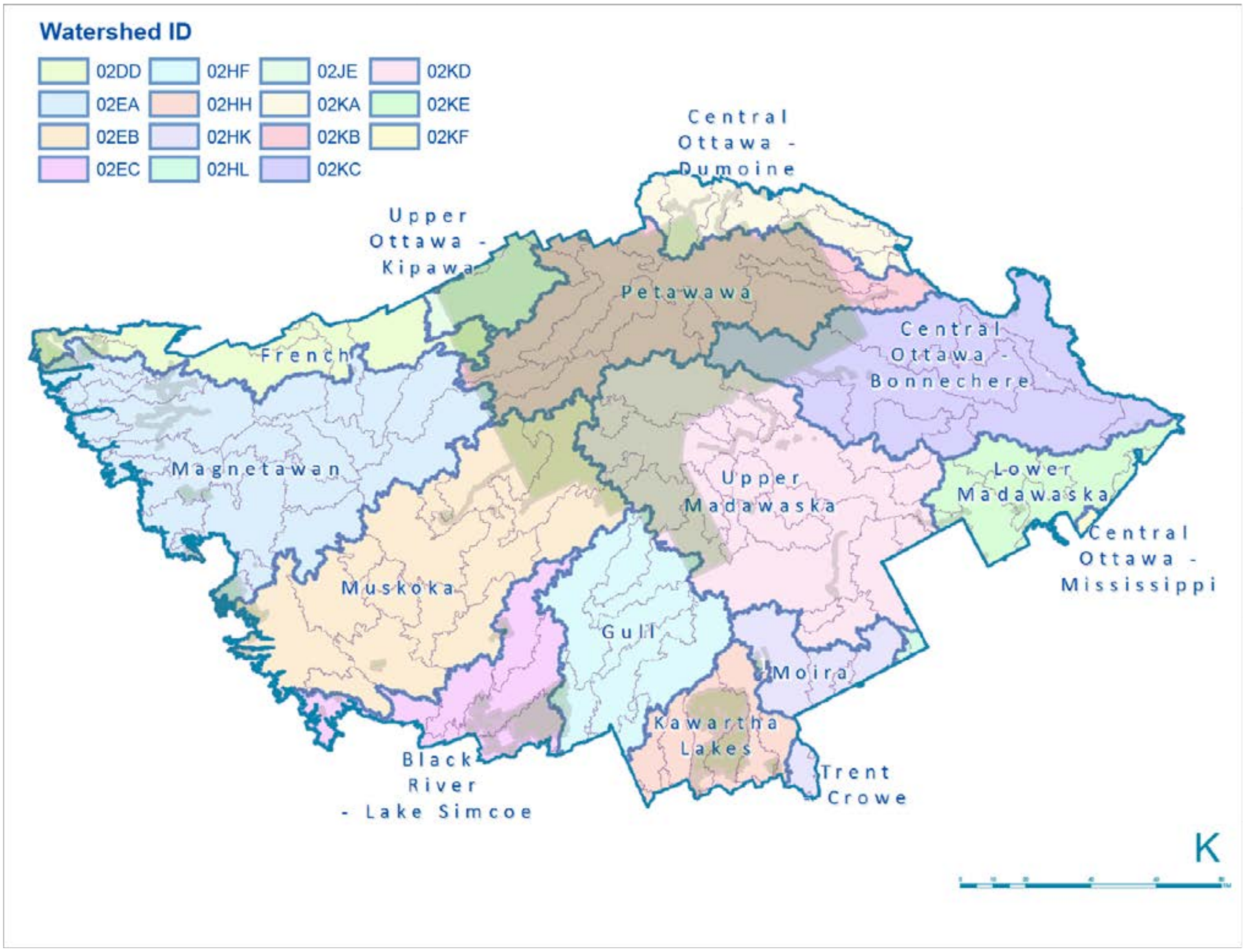


Figure 2.2 Tertiary watersheds in FMZ 15.

Lakes

FMZ 15 is typical of zones located on the Canadian Shield and has a large number of water bodies (Table 2.3). Small lakes and ponds (<50 ha) are most common numerically, but they make up only a small proportion of the total surface area and, unless managed for Brook Trout, are generally not actively managed or monitored. More than 600 lakes over 50 ha comprise almost 200,000 ha of surface area. In general, the mean and maximum depth, and water clarity increase with increasing lake size; but productivity as measured by the morpho-edaphic index generally decreases with lake size (Table 2.4). Of the water bodies greater than 50 ha, lakes between 50 and 500 ha are most common and form the greatest proportion of surface area. They are distributed throughout the zone, with the greatest number in the western part of the zone. Medium sizes lakes between 500 and 1500 ha occur primarily in the western and central parts of the zone. The 15 large lakes (1500-5000 ha) occur throughout the zone with no particular concentrations. Finally, all four extra-large lakes (>5000 ha) are clustered close to each other in the central Muskoka area. FMZ 15 lacks a Provincially Significant Inland Fishery (PSIF) such as those that occur in some surrounding zones (e.g., Lake Simcoe and Lake Nipissing).

Compared to surrounding zones, FMZ 15 is most like FMZ 10 and 11 and to a lesser degree FMZ 18. FMZ 16 and 17 have far fewer lakes, and they tend to be larger, shallower, have lower clarity and higher primary productivity.

Virtually all lakes greater than 500 ha have been surveyed (Figure 2.3). A lower proportion of medium-sized lakes have been surveyed and only a small proportion of lakes smaller than 50 ha have been surveyed, with a bias toward coldwater lakes in the central part of the zone.

Table 2.3 Number and surface area of lakes, by size class, FMZ 15.

Lake Size Class (ha)	Number	Percent of Number	Surface Area (ha)	Percent of Surface Area
<5	41,913	88	40,596	14
5-50	4,963	10	65,049	22
50-500	590	1	76,140	26
500-1,500	59	0.10	47,513	16
1,500-5,000	15	0.03	34,347	12
>5,000	4	0.01	30,264	10
Total	**47,544**	**100**	**293,909**	**100**

Table 2.4 Depth, water clarity and productivity of lakes, by size class, FMZ 15.

Lake Size Class (ha)	Average Mean Depth (m)	Average Maximum Depth (m)	Average Secchi Depth (m)	Average Morpho-edaphic Index	Percent of Lakes Measured
<5	3.4	10.6	3.1	24.1	0.40
5-50	4.4	11.9	3.5	14.0	21
50-500	7.2	21.0	4.2	9.1	83
500-1,500	11.7	39.0	4.4	6.0	99
1,500-5,000	14.5	47.1	5.6	5.5	98
>5,000	22.0	79.4	5.7	1.6	100
Total	**5.4**	**14.8**	**3.7**	**13.3**	**3.70**

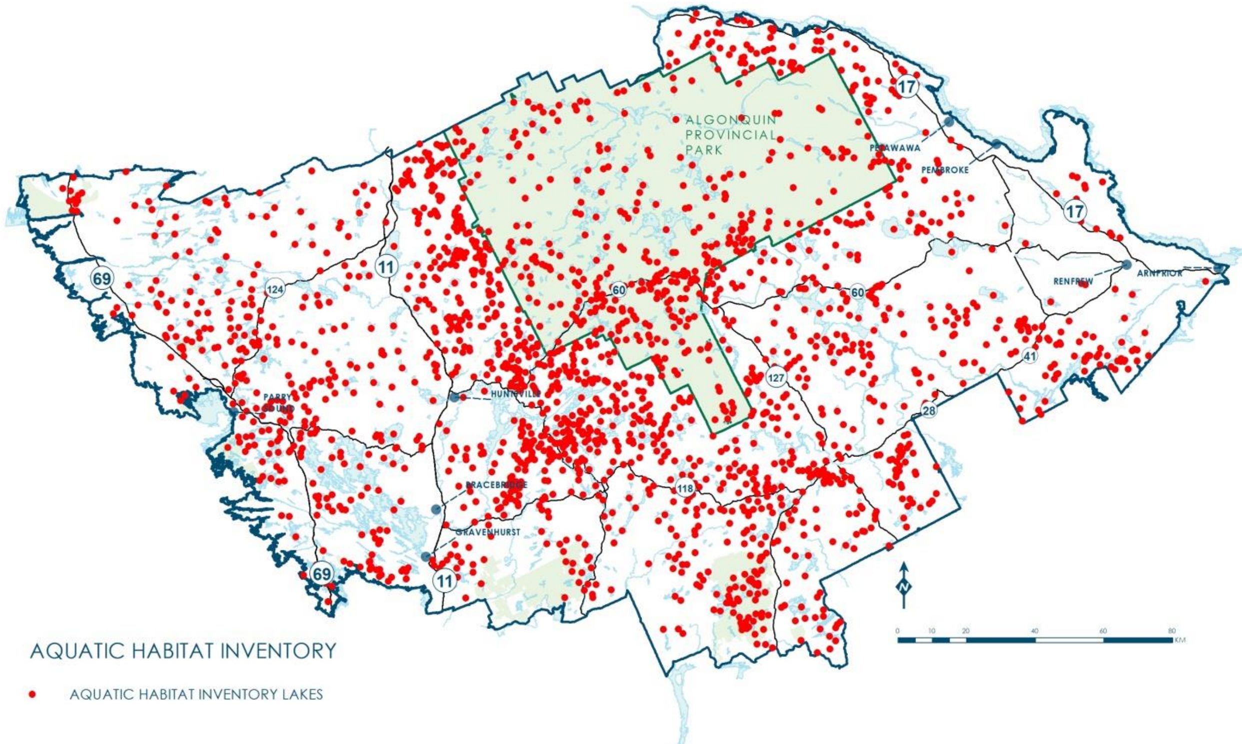


Figure 2.3 Lakes surveyed by the Aquatic Habitat Inventory program, FMZ 15.

Rivers and Streams

The rivers and streams of the zone follow irregular drainage patterns dictated by the exposure of bedrock and occurrence of surface deposits. Rather than being an orderly system of connected, entrenched channels, the streams are often interrupted by lakes, wetlands, beaver ponds and abrupt elevation changes that have a large influence on the thermal regime, channel characteristics, connectivity and fish community.

There is currently not a comprehensive classification system or monitoring program in place for streams in Ontario. The inventory of streams in the zones is sparse, some of the existing data has not been digitized and data that has been digitized is classified and interpreted differently across the three MNRF Districts within the zone. As a result, it is not possible currently to provide a rigorous description of the characteristics or distribution of streams in the zone.

Thermal regime can be used as a basic classification system for streams. It describes the typical summer water temperature of a waterbody, resulting in a classification of cold, cool or warm. Thermal regime is found using measures of water temperature and/or inferred from knowledge of the existing fish or invertebrate community.

Excluding Algonquin Provincial Park, coldwater streams, which directly support or contribute to waters which support Brook Trout, occur locally throughout large areas of the zone with the highest concentrations occurring around the periphery of Algonquin Provincial Park and through the Madawaska Highlands area. These tend to be small, low order, headwater streams. Porous surficial geological features such as glacial till sand and gravel deposits are sporadic across the zone, are often associated with groundwater upwelling's and are closely linked to the presence of coldwater species, including brook trout.

Cool and warm streams are intermixed throughout these areas as well, due to the factors mentioned above. The extreme west side of the zone, inland from Georgian Bay is devoid of coldwater streams due to the low relief and extremely thin soils. Therefore, unlike most areas of Ontario, there is a minimal occurrence of migratory Salmonids in great lakes tributaries in FMZ 15.

The rivers of the zone typically support cool/warmwater fish communities though Brook Trout occur regularly or incidentally in many due to connections with coldwater tributaries. Many rivers and streams have critical habitat for lake dwelling populations of Brook Trout in the form of spawning or nursery habitat.

Stream inventory data, particularly fish species occurrences, are captured in the Aquatic Resource Area (ARA) Survey Point data layer. Survey effort has been concentrated on Crown land and in areas of the zone where coldwater streams are more prevalent. Little is known about streams on private land and in areas where coldwater streams are less likely to occur.

Wetlands

Cool and warmwater fish species inhabit many wetland features for at least part of their life cycle, as these areas can often be associated with spawning and nursery habitat for species such as Northern Pike, Muskellunge and many baitfish species. Wetlands also have a critical ecological role for aquatic ecosystems in the form of water quality and water balance maintenance. These roles mitigate the negative impacts of pollution and nutrient loading and flooding/drought conditions which can stabilize habitat availability for many fish species (Chu 2015).

There are 254,600 ha of mapped wetlands within FMZ 15, of which 37,357 ha (15%) are located within Algonquin Provincial Park. Outside of the park, 109 individual wetlands have been evaluated as provincially significant, covering an area of 29,883 ha (14% of all wetland area outside of the park), 3051 ha (1% of wetland area outside of the park) were evaluated but not deemed to be provincially significant and 184,308 ha (85% of wetland area outside of the park) have not been evaluated. Of the evaluated wetlands, all major forms of wetlands have been identified including fens, bogs, marshes and swamps.

2.4 Climate

FMZ 15 is part of Ecoregion 5E (Georgian Bay Ecoregion). The climate of the Georgian Bay Ecoregion is cool-temperate and humid. Mean annual precipitation ranges between 771 and 1,134 mm, and the mean summer rainfall is between 204 and 304 mm (Mackey et al 1996). The mean annual temperature range is 2.8 to 6.2°C.

McKenney et al. 2010 predicted climatic conditions in each Ontario ecoregion for the next century with climate-related movement of flora and fauna and management strategies for these changes over time.

Growing Degree Days

The climate in FMZ 15 is currently conducive to a mix of cold, cool and warmwater fish communities. Between 2004 and 2014, average Growing Degree Days (GDD) above 5˚C ranged between 1650 and 2100 annually (Figure 2.4; Cross et al. 2012). Figure 2.5 (Cross et al. 2012) shows the average annual GDD between 2004 and 2014 for Ontario. The area weighted average GDD for FMZ 15 is 1797, with a provincial average of 1591 (range: low of 1306 in Zone 7 to high of 2051 in Zone 18). Within southern region, FMZ 15 is the “coolest” of zones as the southern region average was 1951 (range: low of 1797 in Zone 15 to high of 2051 in Zone 18). The range of GDD in FMZ 15 is approximately 1650 to 2000 (Figure 2.6; Cross et al. 2012). As the GDD increases, the proportion of warmwater fish species in lakes increases. Once the GDD value is above 1800, more than 25% of the fish community is dominated by warmwater species. FMZ 15 is most similar in climate to FMZ 10 and 11. The southern inland zones (FMZ 16, 17 and 18) have a considerably longer duration of warm weather annually.

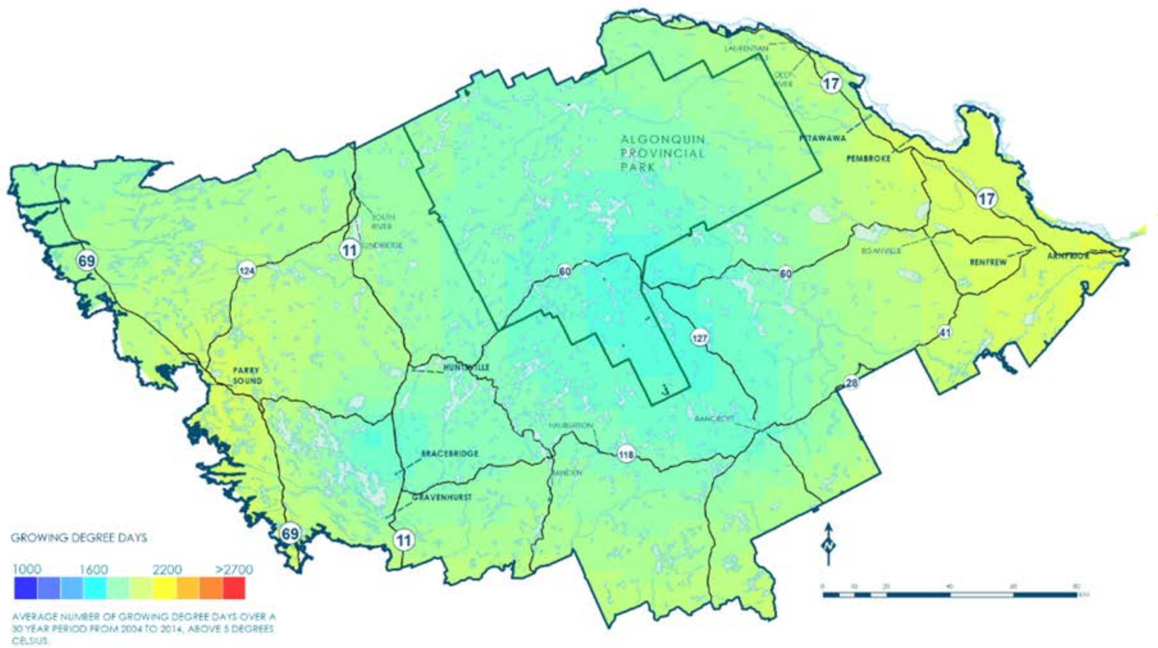


Figure 2.4 Average annual growing degree days above 5°C between 2004 and 2014, FMZ 15, derived from the Historical Climate Assessment Tool (Cross et al. 2012).

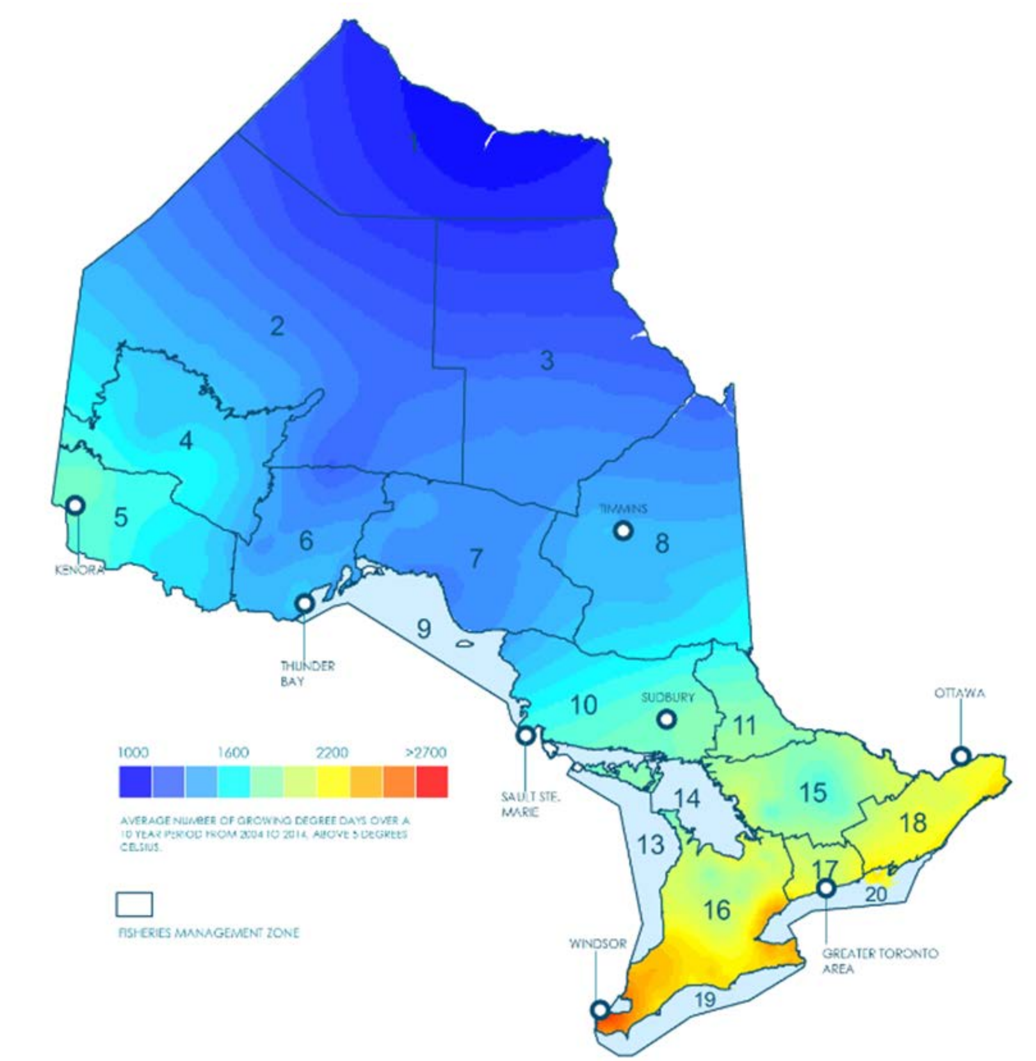


Figure 2.5 Average annual growing degree days above 5°C between 2004 and 2014 across Ontario, derived from the Historical Climate Assessment Tool (Cross et al. 2012).

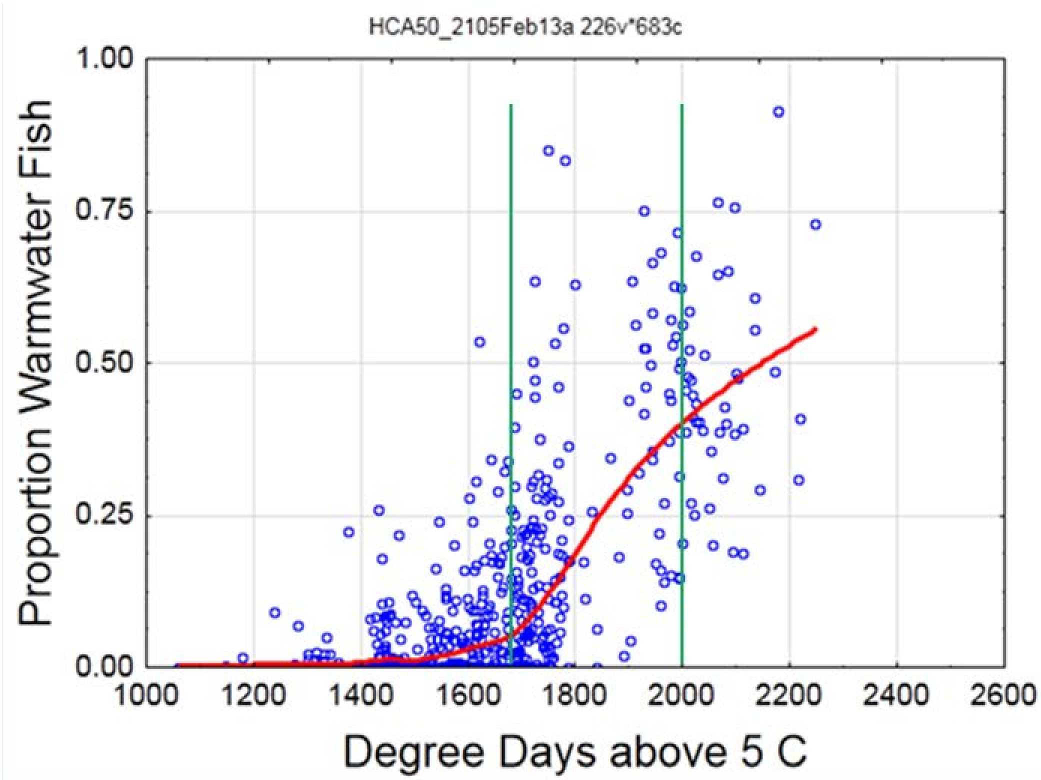


Figure 2.6 Proportion of warmwater fish community versus growing degree days above 5°C for lakes across FMZs in Ontario. Green vertical bars show range of GDD's for lakes in FMZ 15 based on 1981-2010 data (Cross et al. 2012).

2.4.1 Climate Change

Climate plays a key role in determining the structure and function of aquatic ecosystems. Therefore, as climate changes, the aquatic ecosystems in the zone will change as well. Anglers will have to adapt to these changes.

Recent climate history within FMZ 15 shows climate change has been underway for some time. For example, the annual mean GDD above 5˚C has shown a positive trend over the past 65 years (Figure 2.7).

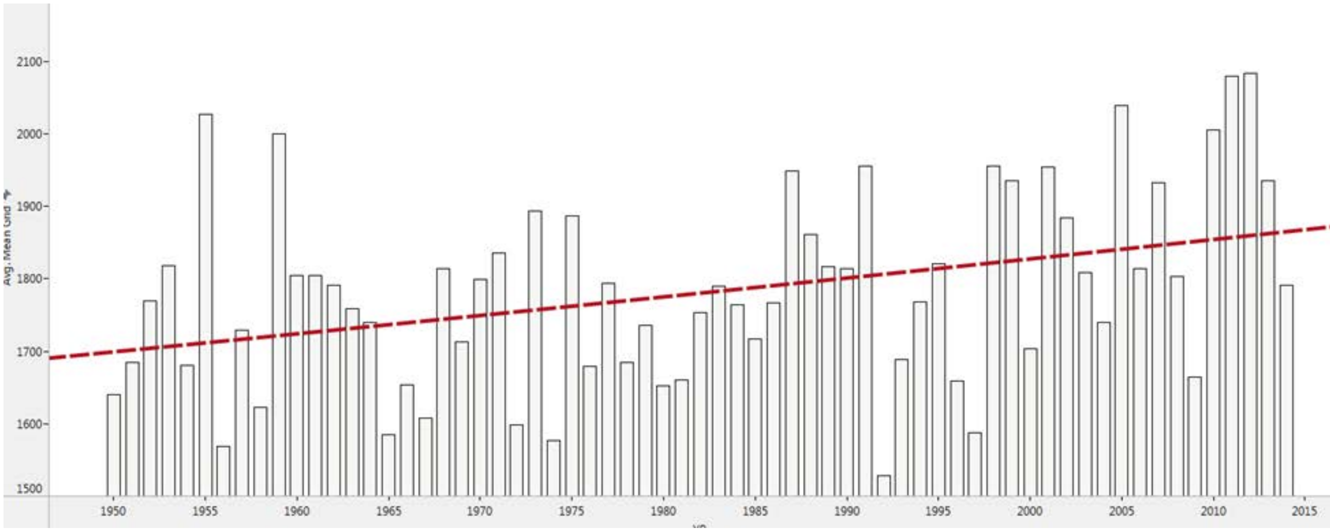


Figure 2.7 Mean Growing Degree Days (GDD) above 5˚C for FMZ 15, 1950-2015. (Cross et al. 2012)

Climate change is not just increased temperature but changing precipitation and evapotranspiration patterns and the greater likelihood for extreme weather events. These climatic changes have had direct effects upon the aquatic ecosystems across the zone. For example, climate change has resulted in a shorter duration of ice cover on lakes in FMZ 15. Since 1975, the duration of ice cover on lakes monitored by the Dorset Environmental Science Centre has declined by 0.6 days/year (Figure 2.8). Reduced duration of ice coverage has implications for the amount and distribution of fishing effort and potentially for onset of spawning and early life stage development and survivorship for many fish species (Chu 2015).

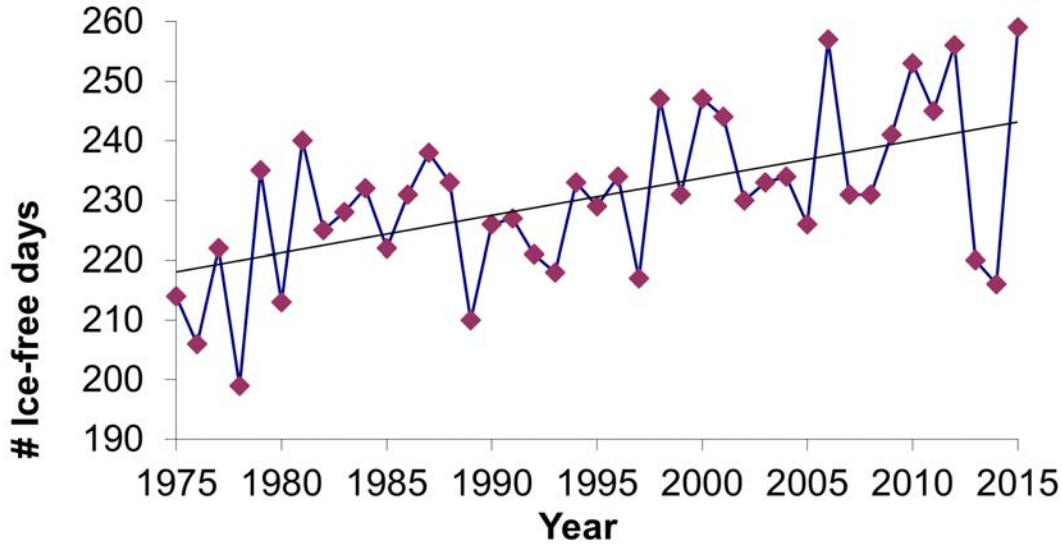


Figure 2.8 Number of ice-free days recorded for lakes monitored by the Dorset Environmental Science Centre, 1975-2015.

If this trend continues, one expects that in 40 years within FMZ 15 a lake will have 2 months of ice. The length of the recreational ice fishing will be shortened, but whether this reduction will equate to a reduction in effort is uncertain. Fisheries managers should be aware that the relationship between season length, effort and harvest will not necessarily be linear. Amtstaetter (2006) found that a 68% reduction in winter season length from a three month to a 1-month season (February 15-March 15) on Greenwater Lake in northwestern Ontario resulted in an effort reduction of 26%.

It is predicted that the mean annual air temperature will continue to increase with variation across the zone being driven by many variables including elevation and proximity to major waterbodies including the Great Lakes. Chu (2015) ran two different models, based upon different emissions scenarios, to predict lake surface (<2 m) water temperatures across the Great Lakes Basin for the year 2080. Both models predict significant increases in surface temperatures for lakes across southern Ontario, including FMZ 15 (Figure 2.9). Climate change will also lead to changes in the timing and frequency of high flow and low flow conditions in rivers and streams (Jones et al. 2015).

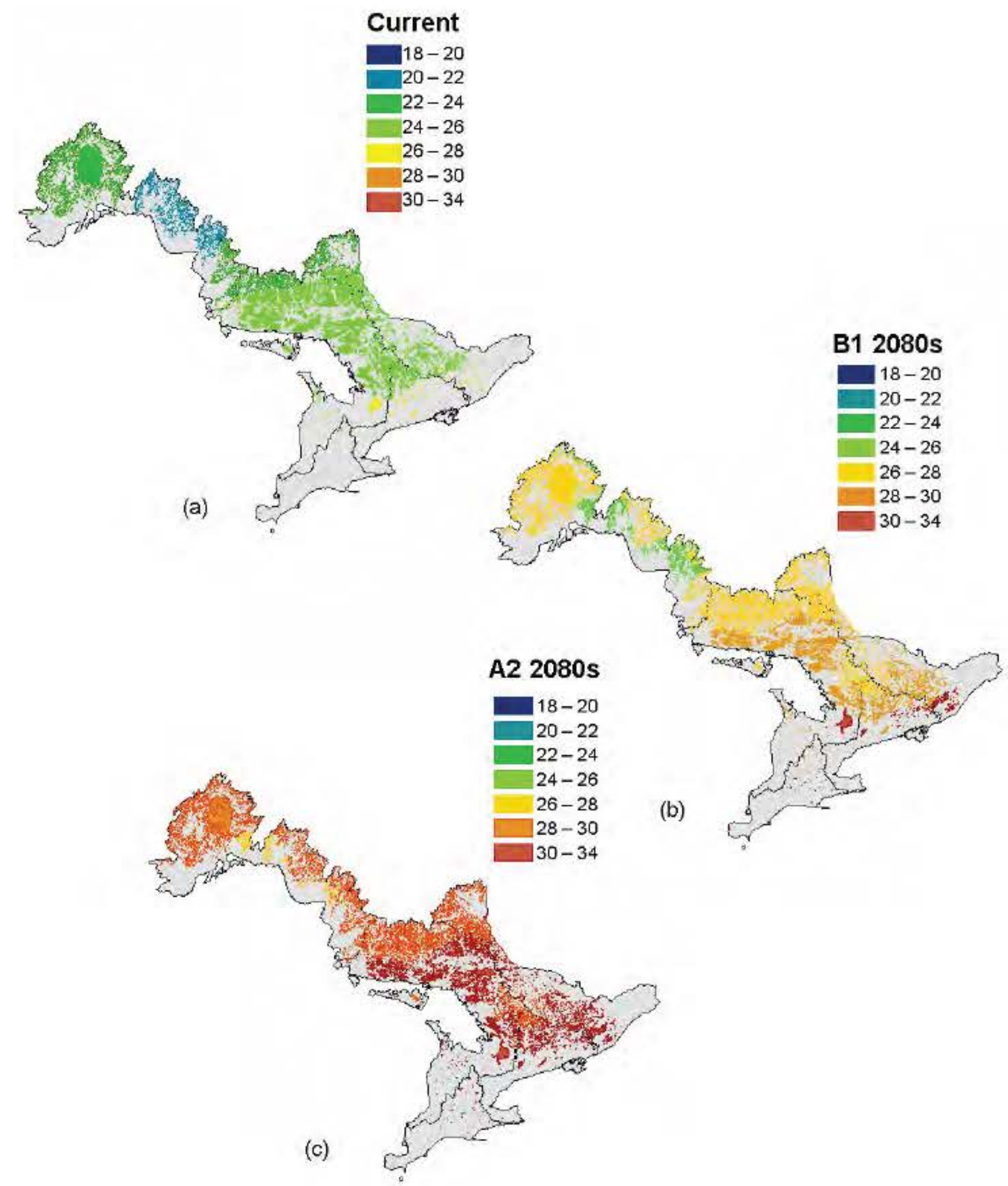


Figure 2.9 Maximum surface (<2 m) water temperatures (˚C) of lakes in the Great Lakes Basin, Ontario, under the (a) current, and 2080s air temperature projections of an ensemble of climate change models and the (b) B1 and (c) A2 emissions scenarios (Chu 2015).

2.4.1.1 Why is climate change an important factor to fish and fisheries?

The future impact of climate change on fish, their habitats and the associated fisheries in FMZ 15 is uncertain. Each species has thermal tolerances and preferences that dictate their distribution on the landscape, habitat suitability and preference and interactions with other species. They are commonly grouped into thermal guilds based on these tolerances as follows: coldwater (<19˚C), coolwater (19-25˚C) and warmwater (>25˚C). It is expected that responses to climate change in freshwater species will be directly associated with temperature requirements of individual species as the availability of these thermal requirements changes (Magnuson et al. 1990; Casselman 2002).

This pattern can be seen in the BsM data for Cycle 1 lakes across Ontario which shows a strong shift in proportional representation of species by thermal association above 1600 annual GDD. There is a considerable decline in coldwater species and an increase in warmwater species, and a more gradual decline of coolwater species across the gradient of GDD in Ontario (Figure 2.10). Habitat suitability will change with potential negative impacts to coldwater and coolwater species (Brook Trout and Walleye) and positive impacts to warmwater species (Smallmouth Bass and Panfish).

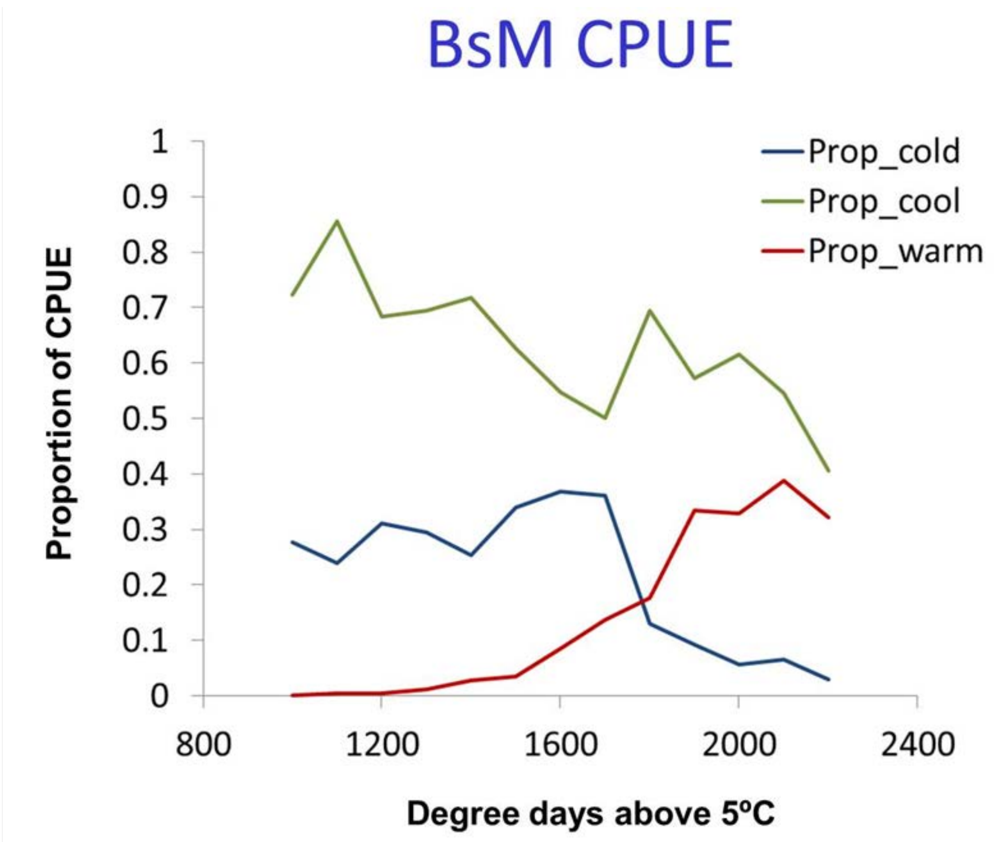


Figure 2.10 Proportional catch per unit effort by GDD above 5˚C and species thermal guild (coldwater (<19˚C), coolwater (19-25˚C) and warmwater (>25˚C), all FMZs, BsM Cycle 1.

North to south climate and fish diversity gradients are naturally present but as climate warms, fish habitat, fish diversity, fish communities and fisheries available to anglers will change. There will be changes to water temperatures, amounts of flowing water, ice-cover duration and the timing of the seasons (i.e., spring, summer, fall and winter). The impacts to aquatic communities will vary greatly depending on waterbody characteristics and community assemblages. As the structure of existing fish communities change, the productive capacity for warmwater fish species (e.g., Bass, Panfish) could increase, while coldwater fish species (e.g., Lake Trout, Brook Trout) could decline in abundance (Schindler 2001). For example, Minns et al. (2009) predicted that in central Ontario the amount of coldwater Lake Trout habitat will decline by 15-30% by the 2020s (2011-2040) and 30-50% by the 2080s (2071-2100).

Climate change can affect the physiology of fish (Whitney et al. 2016). Recent research suggests coldwater species such as Lake Trout may have a limited response to becoming acclimatized to warmer temperatures (Kelly et al. 2014). Life functions that depend on aspects of climate, such as the timing or success of reproduction could be affected.

Aquatic ecosystems may become more vulnerable to invasive species (Schindler 2001) and disease. Cumulatively, aquatic ecosystems across FMZ 15 and the species within them are likely to be influenced by several of these processes, with the impact dependent upon their vulnerability and adaptive capacity to change. The inherent uncertainty associated with climate change presents more challenges (identified below) that need to be discussed through adaptive management.

2.4.1.2 How do we adapt to mitigate effects of climate change on habitat?

One way to mitigate effects of climate change is to reduce levels of other stressors such as angling exploitation for cold and coolwater species. Another mitigation measure could be to encourage anglers to target more plentiful species. Angler accessibility to warm, cool and coldwater fisheries will change across FMZ 15 in the future as these fish communities shift in response to climate trends and as the associated community dynamics within these ecosystems change. A driver-response model developed by Hunt et al. (2016) which showed potential climate change impacts to anglers associated with the northward expansion of Smallmouth Bass in Ontario waterbodies (Figure 2.11). Responses to this expansion may include decreased revenues from nature-based tourism and increased angling effort towards Smallmouth Bass which, in turn, further drives confounding factors within those fish communities. Future angler well-being (i.e., satisfaction) stays unknown due to the complex and varied social connections to the natural world and how these relationships will play out in the context of climate change.

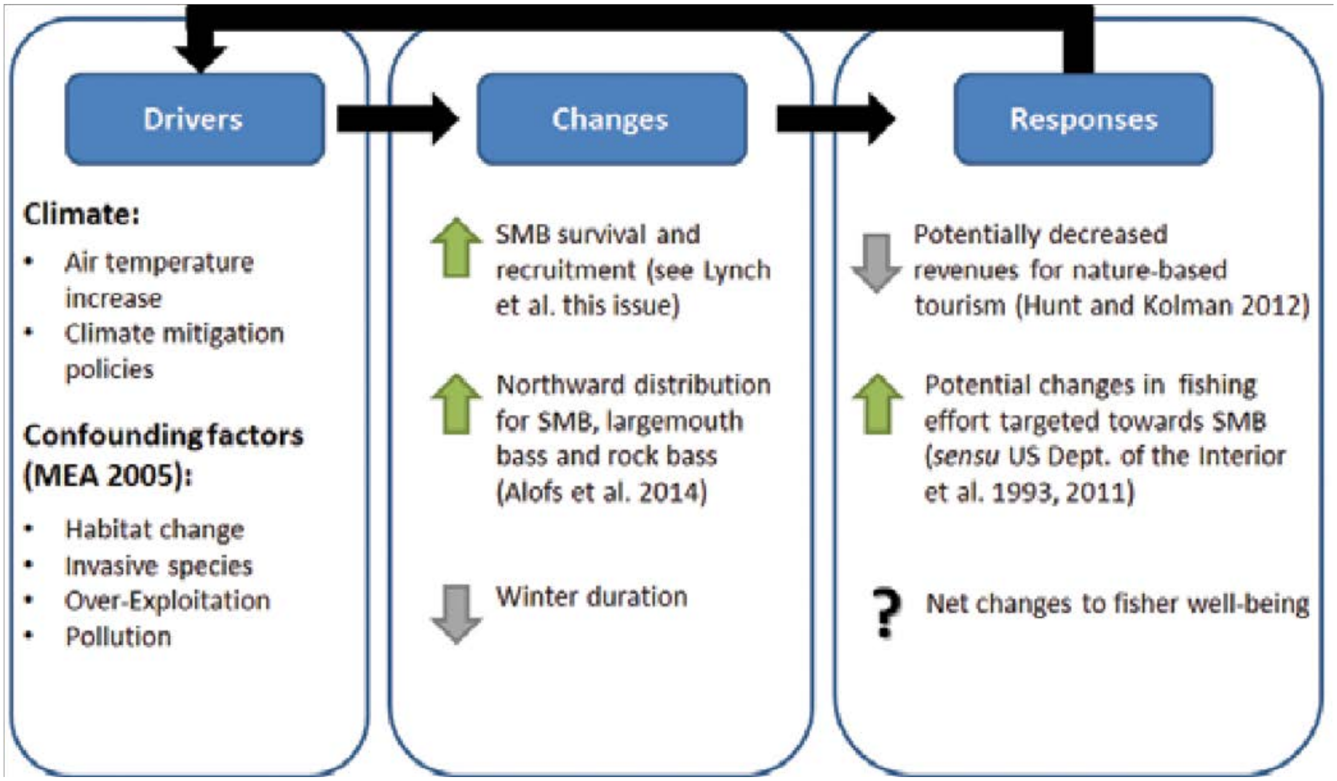


Figure 2.11 Possible impacts to anglers from northward range expansion of Smallmouth Bass (SMB) in Ontario's lakes by climate change (Hunt et al. 2016).

Fisheries management within FMZ 15 will consider the desired versus realistic future state of fish communities and human interaction with those communities. Incorporating uncertainty into fisheries management can take many forms and has been commonly practiced (i.e., setting targets below a maximum sustainable yield) historically due to the inherent uncertainty with fish populations and our influence on the stock-recruitment relationship through harvest (Allen and Hightower 2010). Controlling other factors that may confound and interact with climate change impacts (e.g., introduction of invasive and spread of non-native species) will become even more important in the future. Science and monitoring have, and will, play a key role in informing the development of realistic expectations for fisheries across FMZ 15 in the future.

2.5 Population

2.5.1 Indigenous Communities

Many First Nation and Métis communities have members living on their reserve or within their environs but also off their reserve or outside of their communities. Indigenous community population numbers are gathered by the periodic federal census however only gathered for those communities recognized by the Indian Act. Some of the Indigenous communities within FMZ 15 are not recognized under this act. As such, it is difficult to attain an accurate number reflecting First Nation and Métis community populations across FMZ 15.

The lands and waters of FMZ 15 have an extended history of use both before and after settlement. The history of use is varied and includes settlement, industry, agriculture, logging mineral exploration, mining, as well as recreational fishing and hunting. They continue to be treaty and traditional lands to First Nation and Métis communities.

Aboriginal rights and interests help guide fisheries management planning and activities in Ontario. MNRF acknowledges the importance of Indigenous traditional knowledge and continues to explore opportunities to increase Indigenous involvement in fisheries management through collaborative partnerships.

FMZ 15 is within treaty areas and traditional territories of First Nation and Métis communities and 29 communities situated in or adjacent to Fisheries Management Zone 15.

- The Anishinabek peoples who made the Robinson-Huron Treaty of 1850, include Dokis First Nation, Henvey Inlet First Nation, Magnetawan First Nation, Shawanaga First Nation, and Wasauksing First Nation.
- The Williams Treaties First Nations requested the inclusion of additional information about the Williams Treaties Settlement Agreement and other information that can be found below.
- Kawartha Nishnawbe reside in FMZ 15, and rights and assertions include Treaty 20 and the surrounding area.
- The Algonquins of Ontario are engaged with Ontario and Canada in negotiation of a treaty in the eastern part of FMZ 15. The Agreement-in-Principle (AIP) was signed in October 2016 and includes provisions related to fisheries management planning. The AOO Consultation Office coordinates consultation among the following member communities:
    1. Antoine
    2. Algonquins of Pikwàkanagàn
    3. Bonnechere
    4. Greater Golden Lake
    5. Kijicho Manito Madaouskarini (Bancroft)
    6. Mattawa/North Bay
    7. Ottawa
    8. Shabot Obaadjiwan (Sharbot Lake)
    9. Snimikobi
    10. Whitney and Area

- The Métis Nation of Ontario asserted Georgian Bay and Mattawa Nipissing Harvest Areas intersect FMZ 15. The communities of Moon River and Georgian Bay Métis are situated within FMZ 15, and the community of Mattawa Métis lies to the north.
- There are two communities found in Quebec that have asserted traditional territory within the eastern part of FMZ 15. These include Kebaowek First Nation and Wolf Lake First Nation.
- Wahta Mohawks, who are part of the Haudenosaunee Confederacy, and Moose Deer Point First Nation, who are Pottawatomi have communities that are situated in FMZ 15.

The Williams Treaties First Nations include the Chippewas of Beausoleil, Georgina Island and Rama and the Mississaugas of Alderville, Curve Lake, Hiawatha, and Scugog Island. These seven First Nations are signatories to various 18th and 19th century treaties that covered lands in different parts of south-central Ontario.

In 1923, the Williams Treaties were signed between these seven First Nations and the Crown. The Williams Treaties First Nations have expressed that they entered into the Williams Treaties with the spirit and intent to share the lands and resources of Southern Ontario with European settlers. The Crown entered into these treaties after decades of requests by First Nation leaders and community members to address the matter of settlers encroaching on Williams Treaties First Nations traditional lands. The Williams Treaties of 1923 were intended to resolve the Williams Treaties First Nations longstanding claims. Instead, the conclusion of these treaties created continuing injustices — insufficient compensation, inadequate reserve lands, and the inability to freely exercise harvesting rights. More information is available in the federal Crown's 2018 Statement of Apology for the Impacts of the 1923 Williams Treaties (rcaanc-cirnac.gc.ca).

In its interpretation of the 1923 Williams Treaties, the Crown failed to recognize the rights to hunt, fish, trap and gather on the William Treaties First Nations' pre-confederation treaty lands and the connection with the land, which is vitally important for cultural and spiritual sustenance, was severed.

In June 2018, the Williams Treaties First Nations ratified the Williams Treaties Settlement Agreement with Canada and Ontario. As it relates to harvesting, the Williams Treaties Settlement Agreement recognizes the Williams Treaties First Nations' continuing pre-confederation treaty harvesting rights to harvest fish, wildlife, trapping and gathering in Treaties 5, 16, 18, 20, 27, 27 ¼, the Gunshot Treaty and the Crawford Purchase. Aboriginal and treaty harvesting rights are protected under the Constitution 1982. The Williams Treaties Settlement Agreement affirms that harvesting rights are recognized and continue for food, social and ceremonial purposes. The Williams Treaties First Nations Harvesting Guide identifies that harvesting of fish, wildlife, trapping and gathering will be carried out in accordance with these values – the Seven Ancestors' Teachings: Truth, Love, Wisdom,

Bravery, Humility, Respect, and Honesty.
The territories of the Williams Treaties First Nations are located primarily in the Georgian Bay and Lake Ontario watersheds and includes certain principal tributaries and streams. The Williams Treaties First Nations have a special relationship with the lands, including the water and resources — not only on their treaty territories but also throughout gichi mikinaak (Big Turtle). Protection, conservation, and sustainable collaborative management are a priority for the Williams Treaties First Nations. Please see the link to the Williams Treaties First Nations website (https://williamstreatiesfirstnations.ca).

2.5.2 Communities

FMZ 15 is characterized by many small communities dispersed widely throughout the zone. This contrasts with the more southern zones which have many large urban centers and a dispersed rural population, and northern zones which tend to have most of the population concentrated in fewer communities and large areas of the zones are dominated by Crown land and largely uninhabited. FMZ 15 also has a large seasonal population, primarily associated with shoreline cottages dispersed widely throughout the zone and is easily accessible from a large population outside of the zone.

The population of the zone could not be readily determined because census divisions do not align with the boundary of the zone. A crude estimate is that the permanent population of the zone likely to be around 250,000 (Table 2.5). The largest proportion of the permanent population is in the towns on the Highway 11 corridor (Gravenhurst, Bracebridge, Huntsville) and the Highway 17 corridor (Arnprior, Renfrew, Pembroke, Petawawa) (Figure 2.12)..

Table 2.5 Major communities in FMZ 15 (2011 Census).

Community	Population	OMNRF District
Huntsville	19,056	Parry Sound
Pembroke	17,837	Pembroke
Haliburton County	17,026	Bancroft
Petawawa	15,988	Pembroke
Bracebridge	15,414	Parry Sound
Gravenhurst	12,055	Parry Sound
Renfrew	8,218	Pembroke
Arnprior	8,114	Pembroke
Parry Sound	5,800	Parry Sound
Minden	5,655	Bancroft
Deep River	4,193	Pembroke
Bancroft	3,880	Bancroft

The size of the seasonal population is less defined and documented by the national census. The west and central portions of FMZ 15 have a high concentration of cottages and are popular vacation areas as well; with seasonal residents coming primarily from southern Ontario and the Greater Toronto Area (GTA). The eastern part of the zone has fewer seasonal residents, who originate from eastern Ontario, especially the Ottawa area. As an example, the estimated seasonal population of the District of Muskoka was 81,907 in 2016, which is larger than the permanent population of 60,599 (District of Muskoka 2016).

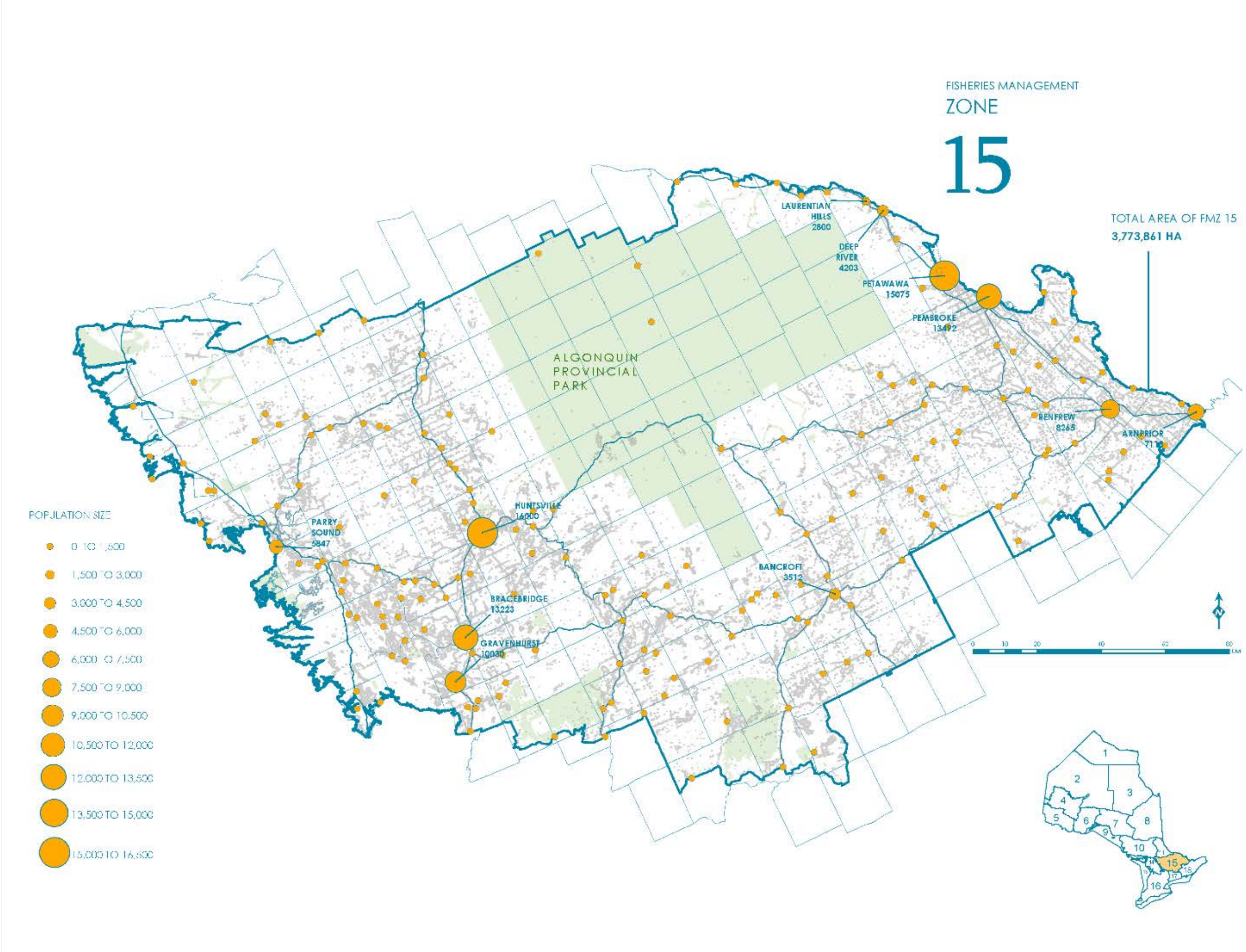


Figure 2.12 Population centers in FMZ 15.

Ontario's population is projected to grow by 30.1% over the next 26 years, from an estimated 13.8 million in 2015 to more than 17.9 million by 2041 (Ontario Ministry of Finance 2016). The GTA is projected to be the fastest growing region of the province, with its population increasing by over 2.8 million, or 42.9%, to reach 9.5 million by 2041 (Figure 2.13). Net migration (the difference between immigration into and emigration out of an area in a certain time) is projected to account for 73% of all population growth in the province. The number of seniors aged 65 and over is projected to more than double from 2.2 million, or 16.0% of population, in 2015 to over 4.5 million, or 25.3%, by 2041.

For Census Divisions that include part of FMZ 15, the greatest growth is expected in Haliburton and Muskoka, lesser amounts in Peterborough and the Kawartha Lakes and minimal growth in Hastings, Nipissing, Parry Sound and Renfrew (Table 2.6).

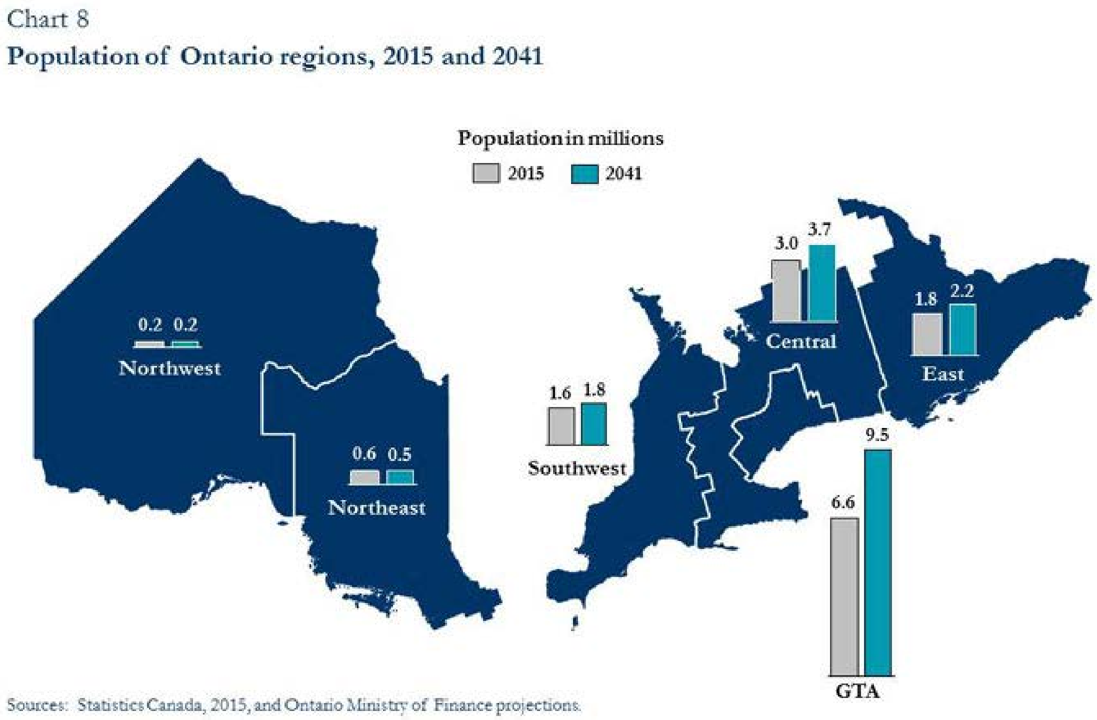


Figure 2.13 Population projections, by census region of Ontario, 2015 (grey) and 2041 (blue) (Ontario Ministry of Finance 2016).

Table 2.6 Population projections for census divisions that include part of FMZ 15, 2015-2041 (Ontario Ministry of Finance 2016).

Census Division	2015	2041	% Change
Haliburton	18,029	22,156	23
Muskoka	62,737	73,508	17
Parry Sound	42,519	43,473	2
Nipissing	87,555	90,182	3
Renfrew	104,382	110,166	6
Hastings	138,308	138,541	0
Peterborough	139,886	157,640	13
Kawartha Lakes	75,845	85,499	13
Total	669,261	721,165	8

2.6 Land Use

FMZ 15 is characterized as a forested landscape, with many dispersed, small communities. Small areas of low intensity agriculture occur in discrete pockets and the shorelines of many lakes are highly developed with seasonal residences.

2.6.1 Land Cover

The land cover within FMZ 15 (outside of Algonquin Provincial Park), based on Provincial Land Class data (Spectranalysis Inc. 2004), is primarily forested (>75%), followed by water and wetlands (about 15%), and agricultural and rural areas making up 6% (Table 2.7).

Table 2.7 Land cover in FMZ 15 (Spectranalysis Inc. 2004).

Description	Area (ha)	Percent Cover (%)
Mixed Treed	875,568	29%
Deciduous Treed	726,529	24%
Coniferous Treed	362,460	12%
Clear Open Water	317,794	11%
Sparse Treed	317,737	11%
Agriculture and Rural Land Use	184,218	6%
Bog	58,894	2%
Bedrock	50,790	2%
Swamp	33,771	1%
Community/Infrastructure	32,034	1%
Other	52,885	2%

2.6.2 Land Ownership

The zone has a mosaic of private and Crown land. About 39% of the land area is privately owned, 37% Crown land, 23% regulated provincial parks, and 1.2% federally owned and First Nations Reserves land. With Algonquin Provincial Park excluded (over 763,000 ha), the majority (53%) of the land area in FMZ 15 is privately owned (almost 1.5 million ha), with 39% being Crown land (just under 1.1 million ha), and the remainder falls within other regulated provincial parks (4.4%), federally owned land (1.4%) and First Nations Reserves (1%).

2.6.3 Land Use Planning

Crown land planning and management are conducted under the authority of the Public Lands Act (PLA). It allows for the designation of specific areas as parks, conservation reserves, forest reserves, EMAs, general use area, etc. The PLA also enables MNRF to establish permitted land uses such as recreational use (camping, hunting, fishing, etc.) and commercial use (forestry, baitfish, trapping, power generation, etc.). The planning control of private land in municipalities is exercised by those municipalities under the authority of the Planning Act.

Private land use includes residential and rural developments, small agricultural areas as well as industrial/commercial and recreational uses like those on Crown land. The province gives recommendations to municipalities on the protection of natural heritage features, including fish habitat, through the Provincial Policy Statement (PPS, MMAH 2014).

Information on land use intent and management direction for Crown land in FMZ 15 is documented in the Crown Land Use Policy Atlas (CLUPA) (2003). CLUPA outlines land use direction for public lands in the Province of Ontario and is managed by MNRF. The primary sources for the content of the CLUPA are the Ontario's Living Legacy (OLL) Land Use Strategy (1999) and the District Land Use Guidelines (1983). Crown land within the management unit boundary has been divided into land use areas and EMAs. Based on the intent documented in CLUPA, a variety of activities may or may not be permitted in each land use area (e.g., bait harvesting, timber harvesting, boat caches, cottaging, recreation). Most of the Crown land in FMZ 15 is designated as General Use. This designation is typically the most permissive with respect to activities and development. Detailed land use direction for each area within FMZ 15 can be found online through the Crown Land Use Policy Atlas (CLUPA).

Commercial activities on Crown land within FMZ 15 include energy production (wind, solar and waterpower), forestry, mineral and aggregate production and exploration, and baitfish and furbearing harvesting. Currently, forest resource harvesting is the main resource extraction activity within the zone, and three Forest Management Units are located within FMZ 15. These are the Bancroft-Minden Forest, Ottawa Valley Forest and French Severn Forest. A Forest Management Plan is in place for each of these units. Recreational activities on Crown land are wide ranging and include hunting, fishing, camping, All-Terrain Vehicle (ATV) use, snowmobiling, hiking, wildlife viewing, cottaging, and other general use activities.

The lands and waters of FMZ 15 have a varied history of use, including settlement, industry, agriculture, logging, mineral exploration and mining, as well as recreational fishing and hunting. At one time, most shorelines of lakes and rivers were undisturbed; but shoreline lots were sold off to promote cottage and residential development as well as tourism. Many of these land uses do or have the potential to impact aquatic ecosystems and fish through increased sedimentation in waterways, changes in water flow, habitat fragmentation, release of pollutants, and increased access for recreational fishing. Impacts of each of these land use activities will be discussed further in later sections.

2.6.4 Provincial Parks and Conservation Reserves

Many provincial parks are located within FMZ 15, with the largest being Algonquin Provincial Park, followed by Kawartha Highlands Signature Site, Queen Elizabeth II Wildlands Provincial Park and The Massasauga Provincial Park (Table 2.8). Fisheries management and fishing regulations in FMZ 15 generally apply to waterbodies within provincial parks. There are instances where regulations differ within a provincial park to maintain consistency with park management plans and objectives. In Algonquin Provincial Park it is the use of possession of live baitfish that is prohibited (dead baitfish is still allowed) and some motorboats are permitted. Algonquin Provincial Park also has different open seasons and will be preparing a fisheries management plan specific to the park. Ontario Parks, including Algonquin Zone staff representing Algonquin Provincial Park, will take part in planning team and advisory council meetings and both the FMZ 15 Fisheries Management Plan and the Fisheries and Aquatic Ecosystem Management Plan for Algonquin Provincial Park will be aligned and linked where possible.

Table 2.8 List of regulated provincial parks, sorted by class, in FMZ 15, as of 2016.

Name	Class	Area (ha)
Petroglyphs	Cultural Heritage	1,643
Quackenbush (partial)	Cultural Heritage	40
Algonquin	Natural Environment	763,459
Arrowhead	Natural Environment	1,237
Bell Bay	Natural Environment	558
Bigwind Lake	Natural Environment	1,967
Grundy Lake	Natural Environment	3,614
Hardy Lake	Natural Environment	808
J. Albert Bauer	Natural Environment	164
Kawartha Highlands	Natural Environment	37,587
Killbear	Natural Environment	1,760
Queen Elizabeth II Wildlands	Natural Environment	33,505
Silent Lake	Natural Environment	1,610
The Massasauga (partial)	Natural Environment	13,105
Westmeath (partial)	Natural Environment	610
Alexander Stewart	Nature Reserve	30
Centennial Lake	Nature Reserve	530
Dividing Lake	Nature Reserve	469
Egan Chutes	Nature Reserve	322
Gibson River	Nature Reserve	333
Matawatchan	Nature Reserve	65
O'Donnell Point	Nature Reserve	875
Petawawa Terrace	Nature Reserve	200
Round Lake	Nature Reserve	2,585
Bonnechere	Recreational	162
Carson Lake	Recreational	12
Driftwood	Recreational	422
Foy Property	Recreational	147
Lake St. Peter	Recreational	478
Mikisew	Recreational	131
Oastler Lake	Recreational	32

Name	Class	Area (ha)
Six Mile Lake	Recreational	212
Sturgeon Bay	Recreational	14
Barron River	Waterway	539
Big East River	Waterway	1,050
Bissett Creek	Waterway	1,676
Bonnechere River	Waterway	1,198
Bonnechere River Addition	Waterway	20
Egan Chutes Additions	Waterway	778
French River (partial)	Waterway	73,530
Grant's Creek	Waterway	1,444
Lower Madawaska River	Waterway	1,200
Magnetawan River	Waterway	3,424
Noganosh Lake	Waterway	3,082
Opeongo River	Waterway	955
Ottawa River (partial)	Waterway	125
Oxtongue River-Ragged Falls	Waterway	507
Upper Madawaska	Waterway	1,085

Fifty-six (56) regulated conservation reserves occur within FMZ 15, comprising a total area of 64,306 ha. Most are in the western part of the zone. The largest conservation reserve is Island Lake Forest and Barrens (15,473 ha) followed by Ahmic Forest and Rock Barrens (6081 ha) which are north and northeast of Parry Sound, respectively. Most conservation reserves have a Statement of Conservation Interest (SCI) which details the activities that can occur in the reserve.

Provincial parks and conservation reserves are regulated and managed under the Provincial Parks and Conservation Reserves Act (PPCRA), under the authority of Ministry of the Environment, Conservation and Parks (MECP). Objectives relate to permanently protecting representative ecosystems, conserving biodiversity, preserving natural and cultural heritage; providing opportunities for ecologically sustainable uses and associated economic benefits, and facilitating research in protected areas for monitoring ecological change on the broader landscape. Another objective for provincial parks is to give opportunities to increase knowledge and awareness of natural and cultural heritage. Furthermore, the PPCRA includes a principle that "maintenance of ecological integrity shall be the first priority", guiding all aspects of the planning and management of provincial parks and conservation reserves. Conservation reserves differ from most provincial parks in that they are to provide opportunities for ecologically sustainable land uses including traditional outdoor heritage activities (e.g., hunting, trapping, etc.).

Ecological integrity refers to a condition in which biotic and abiotic parts of ecosystems and the composition and abundance of native species and biological communities are characteristic of their natural regions and rates of change and ecosystem processes are unimpeded. Ecological integrity includes healthy and viable populations of native species, including species at risk, and maintenance of the habitat on which the species depend, and levels of air and water quality consistent with protection of biodiversity.

2.7 Habitat Stressors

2.7.1 Shoreline Development

Shorelines are one of the most important areas contributing to the health of natural systems and water quality. A natural shoreline (one not disturbed by human activity) offers habitat for many species, water quality filtering and shoreline erosion protection. Development along shorelines, whether residential or commercial, can have impacts on water quality, fish habitat and fish populations.

Shoreline development can result in increased nutrient loading which can negatively affect water quality, especially for coldwater species such as Lake Trout. High levels of phosphorous promote eutrophication which results in excessive plant and algae growth, reduced water clarity, depletion of dissolved oxygen and loss of habitat for coldwater species. The main source of phosphorous is from septic systems associated with development, as well as shoreline clearing, use of fertilizer, erosion and overland run off from agricultural sources.

In some lakes, a moderate amount of nutrient enrichment is beneficial to fish production, but uncontrolled eutrophication can bring about a loss in the recreational value of a body of water and degrade the structure of the biological community. Excessive growth of rooted aquatic plants can blanket the shallow regions of the lake and interfere with swimming and boating, while increased concentrations of algae in the water can result in decreased water clarity and light penetration.

Shoreline development can also physically alter, disrupt or destroy fish habitat. This usually occurs when shoreline developments such as docks, boathouses, beaches, etc. are built on or next to critical fish habitat such as spawning habitat or physical features such as woody debris and vegetation are removed to facilitate associated uses such as swimming.

Shoreline development can also indirectly impact fish populations, specifically fishing quality, due to increased angling effort and harvest exerted by cottagers and year-round residents. As lakes become more highly developed, the increased recreational use can also contribute to reduced water quality through erosion and sedimentation due to boat traffic and wake and the potential for increased gas and oil leakage (MOE 2011).

Increased demand for waterfront property and the proximity of lakes in southern Ontario to major urban centers has resulted in considerable residential and commercial development on many of the lakes within FMZ 15. Lakes have a finite capacity to accommodate most types of development.

The PPS outlines matters of provincial interest in land use planning. The PPS requires that development occur only if there will be no negative impact on natural heritage features such as fish habitat and water quality. MECP has prepared the Lakeshore Capacity Assessment Handbook (MOE 2010) to guide municipalities in planning and controlling residential shoreline development on the Precambrian Shield, which covers FMZ 15, to meet the requirements of the PPS. The MNRF identifies lakes managed for Lake Trout. The MNRF and MECP jointly monitor nutrient levels in Lake Trout lakes and determine their development status and communicate this information to municipalities to ensure Lake Trout habitat is protected from development impacts.

Based on research conducted by MNRF, a volume-weighted mean hypolimnetic dissolved oxygen (MVWHDO) concentration of 7 mg/L is required to meet the needs of juvenile Lake Trout and to make sure that natural recruitment in a lake continues (Evans 2007). This level of dissolved oxygen in the hypolimnion has been adopted as the criterion used for protection of Lake Trout habitat and is measured during late August or early September before the beginning of fall turn-over. This coincides with the critical period of lowest dissolved oxygen concentrations in the hypolimnion.

In 2008, the MNRF also updated the Crown land disposition policy to protect Lake Trout lakes on Crown Land from the negative impacts of shoreline development. The policy states MNRF will not dispose of vacant undeveloped Crown land where the disposition could lead to impacts to habitat or lakeshore carrying capacity for Lake Trout, using the same dissolved oxygen criteria of 7 mg/L.

Shoreline development occurs on private land and as a result, is not monitored by MNRF. Data merged on the amount of shoreline development is not readily available from municipalities.

2.7.2 Roads and Access

Roads are an important part of the landscape, both from a recreational as well as socio-economic perspective. Roads give access to resources for many purposes including forestry, mining and mineral exploration, wind and waterpower, fishing, hunting and cottaging, but roads can have detrimental effects on the landscape as well. New road construction can lead to increased human access to remote lakes and rivers. This access is often long-term as even decommissioned roads can be used by the public through ATVs. Access to these lakes can result in increased angling pressure, as well as the potential transfer of invasive or non-native species.

The amount of private land in combination with Crown land forest management has resulted in a landscape with a high density of roads within FMZ 15. The impacts of these roads can be long lasting. As many forest access roads are no longer supported, over time the deterioration of water crossings and erosion of road surfaces can have a significant impact on fish habitat and populations. Lachance et al. 2008 showed that even properly installed culverts of forestry roads can have fine sediment effects greater than 1 km downstream for 3 years in Brook Trout habitat.

Road-based access to the fisheries of FMZ 15 is evenly distributed across the zone. Major road corridors include Highways 400, 69, 62, 60, 41, 17, and 11. County and municipal roads along with forest access roads offer more access to the fishery across the zone.

There are few limitations to access for most users interested in reaching the majority of lakes and rivers across FMZ 15. These limitations include private land, EMAs, Madawaska Highlands Land Use Area (MHLUP) and some Ontario Parks. The MHLUP (OMNR 1996), was prepared to guide use of Crown land within the Madawaska Highlands area and includes restrictions on new roads and access within the planning area.

While some areas may be considered remote, with ATV's and snowmobiles, few would be considered inaccessible due to terrain.

As of 2016, there were 484 identified fishing access points in the zone (Table 2.9). Undoubtedly, there are many more that are not documented. Also, many lakes, particularly small lakes located on Crown land, are accessible without a formal access point (e.g., trails and portages).

Table 2.9 Summary of fishing access points in FMZ 15, 2016.

Access Type	Federal	Municipal	Private	Provincial	Unknown	Total
Boat Launch	2	169	25	28	186	**410**
Enhanced Shoreline Access		22		1		**23**
Shoreline Access		29	1	20	1	**51**
Total	**2**	**220**	**26**	**49**	**187**	**484**

Construction and maintenance of roads and water crossings for the forest industry on Crown land is governed by the Crown Forest Sustainability Act (CFSA), the requirements of the Forest Management Planning Manual (FMPM), Stand and Site Guide (SSG) and fish habitat risk assessments are completed to meet the requirements of the Fisheries Act. Aside from direct impacts to fish habitat and water quality from road construction itself, the proper construction and maintenance of water crossings is critical to support healthy aquatic ecosystems. Improper installations can result in road surface erosion into waterways, perched culverts and increased water velocity that act as barriers to fish passage, and waterway channel realignment resulting in habitat loss and conversion. Lack of maintenance most often leads to continuing erosion of materials into the waterway and road washouts due to accumulation of debris or beaver material.

2.7.3 Water Control and Hydro Power

Waterpower and water control structures can have significant effects on the aquatic environment by altering water levels and flows, temperatures, sediment and water quality. A great amount of scientific literature describes the effects of dams. Clarke et al. (2008) offers a detailed discussion of the effects of water control structures on fish and fish habitat.

The Ontario Dam Inventory lists 254 dams in FMZ 15, of which 227 are outside of Algonquin Provincial Park (Table 2.10, Figure 2.14). A large proportion of the dams are a legacy of the pioneer logging era when many dams were built to store water for log drives. Over time the purposes of the dams have transitioned into other uses including hydro-electric power generation, supporting summer lake levels for recreation, and servicing the Trent-Severn Waterway.

Table 2.10 Number of water control structures, by quaternary watershed and ownership, FMZ 15, as of 2016.

Watershed	**Conservation Authority**	**Federal**	**Municipal**	**Ontario Power Generation**	**Private**	**Provincial**	**Total**
French				3	1	12	16
Magnetawan			2		10	30	42
Muskoka			1	5	9	32	47
Black River-Lake Simcoe				1	6	7	14
Gull		27			8	5	40
Kawartha Lakes		5			2	4	11
Trent-Crowe	1				3	6	10
Moira							
Upper Ottawa-Kipawa							
Central Ottawa-Dumoine							
Petawawa		1	1				2
Central Ottawa-Bonnechere			2		11	1	14
Upper Madawaska				3	3	12	18
Lower Madawaska				7	5	1	13
Central Ottawa-Mississippi							
Total	**1**	**33**	**6**	**19**	**58**	**110**	**227**

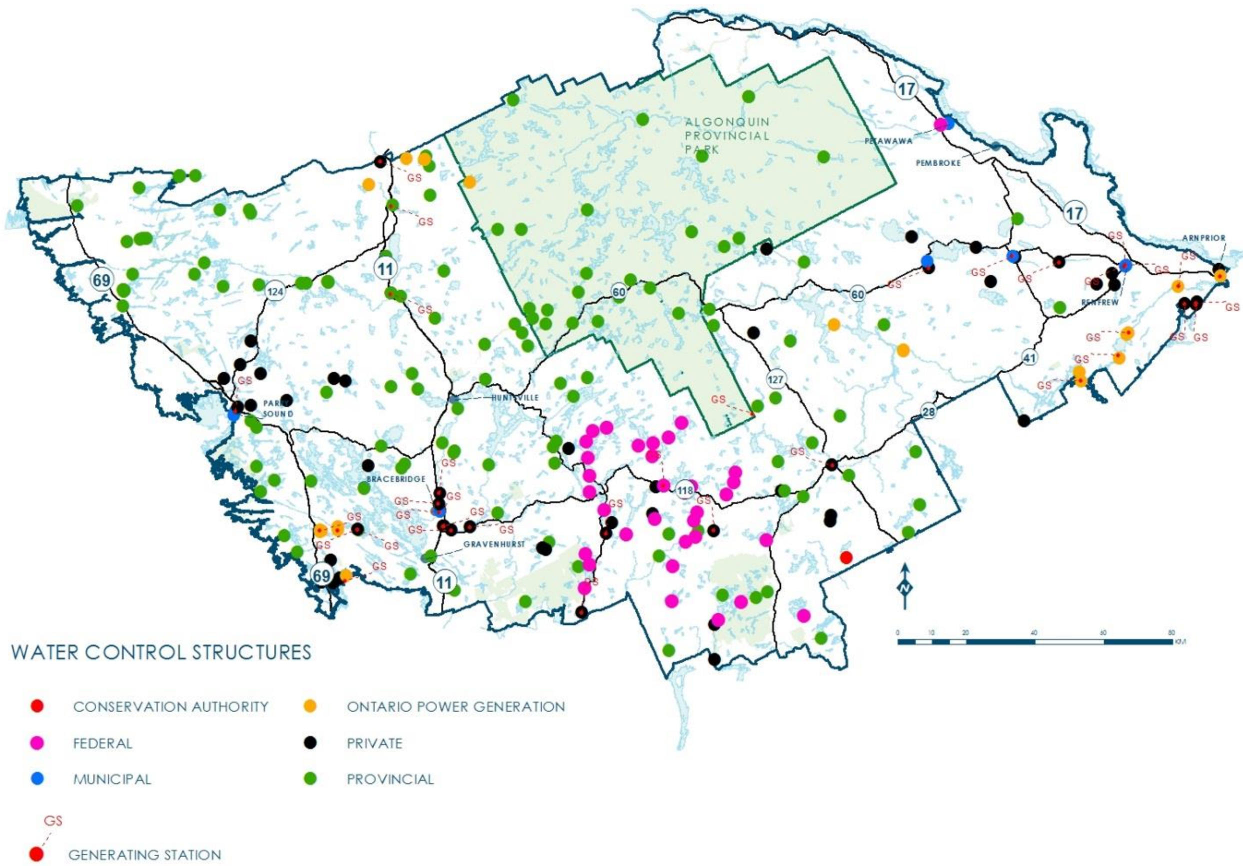


Figure 2.14 Water control structures in FMZ 15.

A large proportion of dams in the zone are located at the outlets of natural lakes or waterfalls. The dams control water levels to varying degrees but the water bodies are not reservoirs in the sense of being primarily artificial water bodies that have large fluctuations in water levels and lake volume. Exceptions include several reservoirs on the Madawaska River system and the Matthias Reservoir on the South Muskoka River.

The provincial government owns the largest number of dams in the zone (110). Most are owned and operated by the MNRF. They operate based on Water Management Plans (WMP) (for watersheds that have waterpower facilities) or dam operating plans. These plans typically try to balance a variety of objectives including ecological, commercial (power generation) and recreational. The highest concentrations of MNRF dams are in the Magnetawan and Muskoka watersheds.

There are 58 private dams in the zone. Most are waterpower generation facilities or are managed to provide water for that purpose (Table 2.11). Private dams occur throughout the zone with concentrations in the Seguin River, Muskoka River, Gull River and Central Ottawa-Bonnechere River watersheds. Refer to Appendix 2 for a complete list of hydro-electric generating facilities in FMZ 15.

Table 2.11 Hydro-electric generating facilities in FMZ 15, 2016.

Watershed	Run of River	Base Load	Peak Load	Total	Owner(s)	Capacity (mW)
South River	1	1		2	OPG	1.4
Magnetawan River		1		1	Bracebridge Generation	1.1
Seguin River	1			1	Bracebridge Generation	1.2
Muskoka River	5	5		10	Bracebridge Generation (3), OPG (5), Orillia Power (1), Algonquin Power (1)	33.9
Gull River	1	3		4	Private (4)	5.1
Bonnechere River	6			6	Multistream Power (1), Town of Eganville (1), Renfrew Power Generation (3), Vornweg Waterpower (1)	8.2
York River	1	1		2	Private (2)	0.6
Madawaska River	3	1	4	8	OPG (5), Private (3)	619.4

Ontario Power Generation (OPG), a Crown Corporation, owns 19 dams in the zone. Like other private dams, they either have a generation facility directly associated with them or occur in a watershed with facilities.

There are 33 federal dams in the zone. All except 1 are located in the Gull and Kawartha Lakes watersheds and are part of the Trent-Severn Waterway. Although they are not directly on the navigable part of the waterway, the dams are managed to supply water to the downstream canal system.

Six (6) dams are classified as municipally owned. The classification of municipal and private dams may not be entirely consistent in the inventory as some municipal dams appear to be classified as private, and vice versa. Two of the municipal dams are on the Seguin River watershed and managed cooperatively with the other private dams in the watershed. Similarly, the Bracebridge Falls dam is operated by Bracebridge Generation, which owns several other dams in the area.

The sole Conservation Authority dam is located on Wollaston Lake in the Trent-Crowe watershed.

Following the Lakes and River Improvement Act (LRIA), all owners of waterpower facilities and water control dams on Ontario's rivers with waterpower facilities are now required to prepare a WMP. The future of WMPs is uncertain at this time. Existing plans have had their expiry periods extended by five years.

Within the zone, the major issues related to fisheries management include winter drawdowns on lakes that support natural Lake Trout populations and the provision of flows for Walleye and Lake Sturgeon in river spawning locations.

2.7.4 Forestry

Forestry results in two major changes to the landscape that may affect aquatic ecosystems. The removal of vegetation through forestry activities may alter 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. A specific potential impact of the alteration of groundwater flow is the impact to Brook Trout by changing the flow of water to spawning areas and thermal refugia which are critical habitat for the species.

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.

Forestry in FMZ 15 occurs both on private and Crown land. Private land forestry is largely undocumented and unregulated, whereas Crown land forestry is highly regulated through the CFSA and documented in Forest Management Plans (FMP). FMPs contain Conditions on Regular Operations (CRO) and prescriptions for Areas of Concern (AOC) that protect fish and fish habitat from the potential impacts described above.

In FMZ 15, the entire Crown land area of the zone, aside from provincial parks or conservation reserves, is subject to forest management planning. Excluding Algonquin Provincial Park Forest, three active Forest Management Units exist either fully or in part within the zone: the French Severn Forest, Bancroft-Minden Forest and Ottawa Valley Forest (https://www.ontario.ca/page/forest-management-planning).

2.7.5 Agriculture

Agriculture makes up about 6% of the land use within FMZ 15 (OMNRF 2014b). Despite the low percentage, it is an important economic sector locally, especially in the eastern portion of the zone. Ecological impacts on aquatic habitat and biota from agriculture can include declining water quality and quantity, surface water pollution and nutrient input, sedimentation and shoreline degradation.

While there are several large-scale farming operations within the zone, they are of a smaller scope and scale than those that occur further south in Ontario. These farming operations are located primarily on the downstream reaches of the Bonnechere River watershed. Few of these operations have irrigation systems, with the majority using the rivers and streams for watering livestock. (OMNRF 2014a). Long-term use of riparian areas by livestock results in shoreline and bank destabilization, erosion and sedimentation into the watercourse, as well as the input of nitrogen and phosphorus into the ecosystem (Osborne and Kovacic 1993). Wetland infilling and conversion to agricultural fields further reduces a watershed's capacity to filter sediments and absorb pollutants before they enter a watercourse.

Impacts to fish and fish habitat can be direct, through declining water quality as well as water quantity. Fertilizer and animal manure are the primary sources of excess nutrients that enter water systems directly, or through runoff. Nitrogen (N) and phosphorus (P) are naturally occurring elements in the environment and aquatic ecosystems, and they support the growth of aquatic plants and algae (Horne and Goldman 1994; Environmental Protection Agency (EPA) 2015); however, an excess of N and P can cause algal blooms which significantly decreases the oxygen available to fish and other aquatic life, block sunlight from reaching aquatic plants, and may release harmful toxins (EPA 2015).

Sedimentation can have direct and indirect effect on fish health and populations. Indirect effects include changes to the characteristics of the watercourse, changes in size and composition of the sediments (i.e., changing from sand or gravel to silt or finer particles), decreasing water clarity, and increasing water temperatures (Castro and Reckendorf 1995). Direct effects include degradation and loss of spawning habitat, mortality of eggs and larvae, changes to or loss of prey species, difficulty foraging due to decreased water clarity, decreased growth rates and mortality (Birtwell 1999).

2.7.6 Mining

Mining is the process of extracting valuable minerals or other geological materials from the earth. Mining encompasses a series of stages known as the mining sequence. The mining sequence covers all aspects of mining, including prospecting for ore bodies, analysis of the profit potential of a proposed mine, extraction of the desired materials and, once a mine is closed, the restoration of all lands used for mining. The Mining Act is the provincial legislation that governs and regulates prospecting, mineral exploration, mine development and rehabilitation in Ontario. The purposes of the Mining Act are to encourage prospecting, staking and exploration for the development of mineral resources and to decrease the impact of these activities on public health and safety and the environment. Individual activities within the mining sequence may need regulatory approval from other agencies. Specific to activities that may impact fish or fish habitat they may include MNRF, MECP and Fisheries and Oceans Canada (DFO).

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. Compared to other human caused impacts to fish habitat such as forestry, mining has the potential for more severe and long-term environmental impacts. This is 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.

Surface and ground water discharge is one of the main impacts of mines on aquatic ecosystems. 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 releasing metals, acids, salts, fine particles and/or synthetic chemicals into the mine discharge. The second is through the contamination of surface water when precipitation falls on or runs through waste rock and mine tailings stored on the surface. Effluent enters the watershed through surface water runoff or ground water discharge which has been contaminated by either or both processes. Contaminants are either diluted or concentrated in receiving bodies of water or aquifers within the watershed. Mining can also result in the impact of large area of watersheds or even loss of lakes and streams through creation of open pit mines and tailing, or waste rock disposal areas.

Current policy with respect to mine development and environmental assessments for new mining projects requires consideration of the effectiveness of mitigation measures to compensate for lost fish habitat and prevent impacts to aquatic communities through pollution events such as acid mine drainage. Regulations for mine closure plans within Ontario through the Mining Act require mine operators to develop a detailed remediation plan. Mine closure and reclamation measures try to contain, rather than remove, potential sources of water pollution such as tailings and waste rock.

Mining activity within the boundaries of FMZ 15 is limited. There are no active mines in the Parry Sound district. A graphite mine near Kearney was operational in the 1980's. The Closure Plan was being updated circa 2012 and some approvals were issued, but operations have not resumed to date. The site has been subject to MECP compliance action due to ongoing issues with drainage from the Mill Yard to Graphite Lake and on treatment of effluent from the tailings area. Graphite Lake is regulated as a year-round fish sanctuary, to decrease stress to the Lake Trout population that have been subjected to impaired water quality in combination with naturally marginal habitat.

The Northern Graphite open pit mine, located in the Pembroke district, has been in existence since 1980. Since that time, some approvals have been issued and several Closure Plans have been initiated and exist at various stages of completion. The current Closure Plan has been approved and other approvals are pending. Drainage from this mine site may influence multiple watersheds of Grants Creek.

There are many abandoned mines within Pembroke district due to a history of mining corundum, molybdenum, uranium, and marble.

Bancroft and the surrounding areas have a rich mining history, though few mines are still in production today. The Town of Bancroft is known as the "Mineral Capital of Canada". Over 1600 different mineral species have been identified in this part of the province. Uranium mining was active in the 1950's and 1960's. Four uranium mines; Bicroft, Greyhawk, Dyno and Faraday ran between 1953 and 1964. Faraday, the last to close, re-opened as the

Madawaska Mines and operated until the early 1980s. It produced about 9.5 million pounds of uranium during its operating periods and is decommissioned. Many other mines operated for iron, copper, corundum, marble, sodalite, granite, mica and feldspars.

2.7.7 Aggregates and Peat

Aggregates are usually sand, gravel, clay, earth and bedrock. They are used to make roads, subway tunnels, homes and other structures. Loose material, such as sand and gravel, is removed from a pit. Solid bedrock, such as limestone and granite, is removed from a quarry. Peat is partially decayed organic matter that accumulates in some types of wetlands, primarily fens and bogs, and is used primarily for agriculture and in some areas of the world, fuel. Peat is an important carbon sink.

The MNRF:

- Oversees the rules governing aggregate management,
- Issues licences, permits and changes to existing approvals,
- Inspects aggregate operations and responds to complaints,
- Enforces compliance, and
- Ensures rehabilitation is carried out on sites.

Most of Ontario's pits and quarries are regulated under the Aggregate Resources Act (ARA). Operations may also need approvals under the Planning Act, Water Resources Act, and/or Environmental Protection Act.

The extraction of aggregates has the potential to impact fish and fish habitat primarily through direct alteration of water bodies or indirect changes to water quality and quantity. Small, coldwater streams are probably the type of fish resource that is the most vulnerable to impacts from aggregate extraction. FMZ 15 is within the part of Ontario that is designated under the ARA, so extraction is regulated and landscape scale impacts to fish are not expected. Localized impacts from individual operations may occur, particularly operations that were in existence before the designation under the Act. They are addressed through the processes in place for managing licenced operations.

There are over 1,100 pits and quarries in the zone of which almost 900 are active (Table 2.12). These numbers do not include pits used by the forest industry on Crown land.

Table 2.12 Summary of licenced aggregate sites in FMZ 15, excluding forestry industry pits on Crown land, as of 2016.

Type	Quarry	Pit	Both	Total
Active	73	662	160	895
In-Active	6	101	113	220
Total	**79**	**763**	**273**	**1115**

At present, no policy exists regulating the extraction of peat within Ontario. There are no Peat Production Areas in FMZ 15, though some small-scale local extraction probably occurs. The main fisheries impact from peat extraction are related to impacts on water flow due to drainage of extraction areas.

2.7.8 Loss of Wetlands

Wetlands are among the most productive and biologically diverse habitats on earth and are an essential part of Ontario's biodiversity. In terms of supporting healthy fisheries and aquatic ecosystems, wetlands offer nursery, spawning, cover and feeding habitat for many commercially and recreationally harvested fish species (OMNR 2015e). In addition to providing food, shelter and habitat to hundreds of species, wetlands play an important role in supporting water quality by filtering sediments and attenuating nutrients and some chemicals. Nearly 70% of southern Ontario's original wetlands have been lost, primarily due to conversion (draining and infilling), as well as through changes to hydrology, pollution, and invasive species (OMNRF 2015e).

Impacts from draining and infilling wetlands are far-reaching. Direct impacts to aquatic life include the immediate loss of fish, reptiles, amphibians, insects and aquatic plants. Spawning and nursery areas for certain fish species can be eliminated. Degraded wetlands ecosystems become susceptible to invasions from non-native species, leading to further degradation. Wetland loss also leads to increased sedimentation into streams and rivers, as the natural filtration process of water flowing through a wetland is no longer available. Downstream riverine or lacustrine spawning areas may be changed through the sedimentation.

Wetland loss across FMZ 15 has been largely less than what has occurred in southern Ontario. Data from Agriculture and Agri-Food Canada (2016) for the 20-year period from 1990-2010 calculates a wetland loss of about 560 hectares across the zone, or less than 1% of the wetland cover, with 89% due to urban development and the remainder to roads (Table 2.13).

Data from Agriculture and Agri-Food Canada illustrates the loss of wetlands by tertiary watershed. Over the 20-year period, the Muskoka tertiary watershed has experienced the greatest percent loss at 30% or 165 hectares.

Table 2.13 Wetland loss within FMZ 15, by tertiary watershed, 1990-2010 (Agriculture and Agri-Food Canada 2016).

Tertiary Watershed	Wetland Loss Since 1990 (ha)	Percent of Total 20 Year Loss
Muskoka	165	30%
Magnetawan	67	12%
Central Ottawa - Dumoine	67	12%
Gull	46	8%
Black River - Lake Simcoe	44	8%
Upper Madawaska	39	7%
Kawartha Lakes	33	6%
Central Ottawa - Bonnechere	26	5%
Petawawa	23	4%
Trent - Crowe	20	4%
Lower Madawaska	16	3%
French	14	2%
Central Ottawa - Mississippi	1	0.1%
Total Loss 1990-2010	**560**	

3 Biological Description

3.1 Data Sources and Assessment Methods

Data for this section has been derived from coordinated provincial and national monitoring programs, local data collections from district offices, external agency monitoring programs as well as volunteer and incidental observations. The temporal and spatial scale and level of standardization of the data dictate their applicability for describing the status of the resource at the FMZ scale.

The primary data source is the BsM program, described below. A limitation of the BsM program at this time is that it was started recently, in 2008. Before 2008, most monitoring was done at a local level using a variety of protocols. Generally, results from those earlier surveys cannot be easily compared to the BsM data.

In addition to the BsM program, data have been collected and stored using a suite of standard netting protocols and databases (Table 3.1).

Table 3.1 List of selected data sources and netting protocols, FMZ 15.

Data Source	Target	Description
Aquatic Resource Area (ARA) Databases	All Species	MNRF database of species occurrence, origin, management status
Broad-scale Monitoring (BsM)	Fish Community, habitat, angling effort, etc.	Comprehensive landscape-based monitoring program (2008-)
Fall Walleye Index Netting (FWIN)	Walleye	Large random sample of lakes in southern region surveyed in 2001. Aspects can be directly compared with BsM program
Nearshore Community Index Netting (NSCIN), End of Spring Index Netting (ESTN)	Walleye, other Cool/Warm species (bass, crappie, pike, panfish)	Trap net methodology used for local monitoring. Limited landscape or trend value but provides supplemental fish attribute information for local lakes
Summer Profundal Index Netting (SPIN)	Lake Trout	Large set of non-random local surveys. Survey design and size of data set allows some comparisons to BsM (~2000-)
Spring Littoral Index Netting (SLIN)	Lake Trout	Large set of non-random, local surveys (most surveys 1990-2005) limited current applicability

Data Source	Target	Description
Brook trout Index Netting (BTIN); other Brook trout surveys	Brook trout	Large number of local presence/absence surveys, stocking assessments and population assessments targeting brook trout; not directly comparable to BsM but provides information on brook trout occurrence; many are small lakes not sampled by BsM
National Survey of Recreational Fishing	Angling effort, catch, harvest, demographics	Conducted every 5 years by Fisheries and Oceans Canada
Sport Fish Contaminant Monitoring program	Contaminant levels in sport fish	Administered by MECP
Lake Partner Program	Water Quality	Administered by MECP
Fish Stocking Information System	Stocked Fish	MNRF database of fish stocking (2001-)

References: BsM: Sandstrom et al. 2013, NSCIN: Stirling 1999, ESTN: Skinner and Ball 2004, FWIN: Morgan 2002, SPIN: Sandstrom and Lester 2009, SLIN: Hicks 1999, BTIN: Monroe 2005

3.1.1 Broad-scale Monitoring (BsM) Program

The BsM program was created by MNRF to evaluate Ontario's fisheries at a landscape level. On a 5-year cycle, information is collected from a representative sample of lakes in each FMZ in a standardized way. The number of lakes included in the program is enough for managing and reporting on fisheries in each zone, but a relatively small percentage of the total number of lakes in Ontario. BsM includes the collection of detailed information about fish species and fish communities, physical and chemical water characteristics, aquatic invasive species, and fishing effort for each lake surveyed. The first sampling cycle of the BsM program occurred from 2008 to 2012.

The BsM program is designed to:

- Describe the distribution, amount, and diversity of fishes in Ontario and at the FMZ level,
- Estimate the current state and changes over time of Ontario's and FMZ level fisheries,
- Find natural and human-caused stresses affecting fisheries of Ontario and at the FMZ level,
- Provide reports on the state of fisheries and aquatic environments in Ontario and at the FMZ level.

The program offers MNRF with more benefits and opportunities to gather information on the biodiversity and health of aquatic environments. It includes monitoring the spread of aquatic invasive species, collecting genetic samples for researchers, gathering climate change data, sampling fish for contaminants for the MOE's Guide to Eating Ontario Sport Fish, and collecting samples for the monitoring of water quality in surveyed lakes.

Lakes are randomly selected for the program and identified as either a trend lake or a state lake. A trend lake is sampled once in each monitoring cycle. Trend lakes must contain Brook Trout, Lake Trout, or Walleye. These species are top predators and indicators of the status of coldwater and coolwater aquatic ecosystems. The BsM program originally aimed to survey 10% of all known Brook Trout, Lake Trout, and Walleye lakes in Ontario. A review of the statistical power of the sampling program, conducted after the completion of cycle 2 resulted in a change to the sampling strategy. From cycle 3 onwards, 25 trend lakes will be chosen for each target species, and they will be sampled once every 10 years (every second cycle).

State lakes originally were sampled once in a 5-year cycle but following the program review, were changed to a 10-year sampling interval, alternating cycles with trend lakes. State lakes are any lakes greater than 50 ha regardless of the fish species present. The primary objective of sampling state lakes is to evaluate the status of fishery resources in the province with the secondary objectives of measuring biodiversity and tracking the distribution of invasive species and Species at Risk. State lakes are randomly selected each cycle and are not necessarily re-sampled. The BsM program aims to survey an equal number of trend and state lakes across the province within each zone.

Monitoring trend lakes is designed for detecting changes in fish populations and aquatic ecosystems over time, while monitoring state lakes describes the overall status of fish populations at a given point in time. Including both trend and state lakes within the monitoring program is important for providing a balance between detecting changes quickly and describing the state of fishes and aquatic resources.

Within each FMZ, 10% of all known Brook Trout, Lake Trout, or Walleye lakes between 50 and 250,000 ha were selected as trend lakes, with at least 10 lakes selected for Brook Trout and Lake Trout, and 20 lakes for Walleye. Fifty-two (52) lakes were sampled by the BsM program in FMZ 15 in Cycle 1(OMNRF 2016b). Fifty-one (51) lakes were sampled during Cycle 2 (Figure 3.1). Refer to Appendix 3 for a complete list of lakes sampled during Cycle 1 and 2.

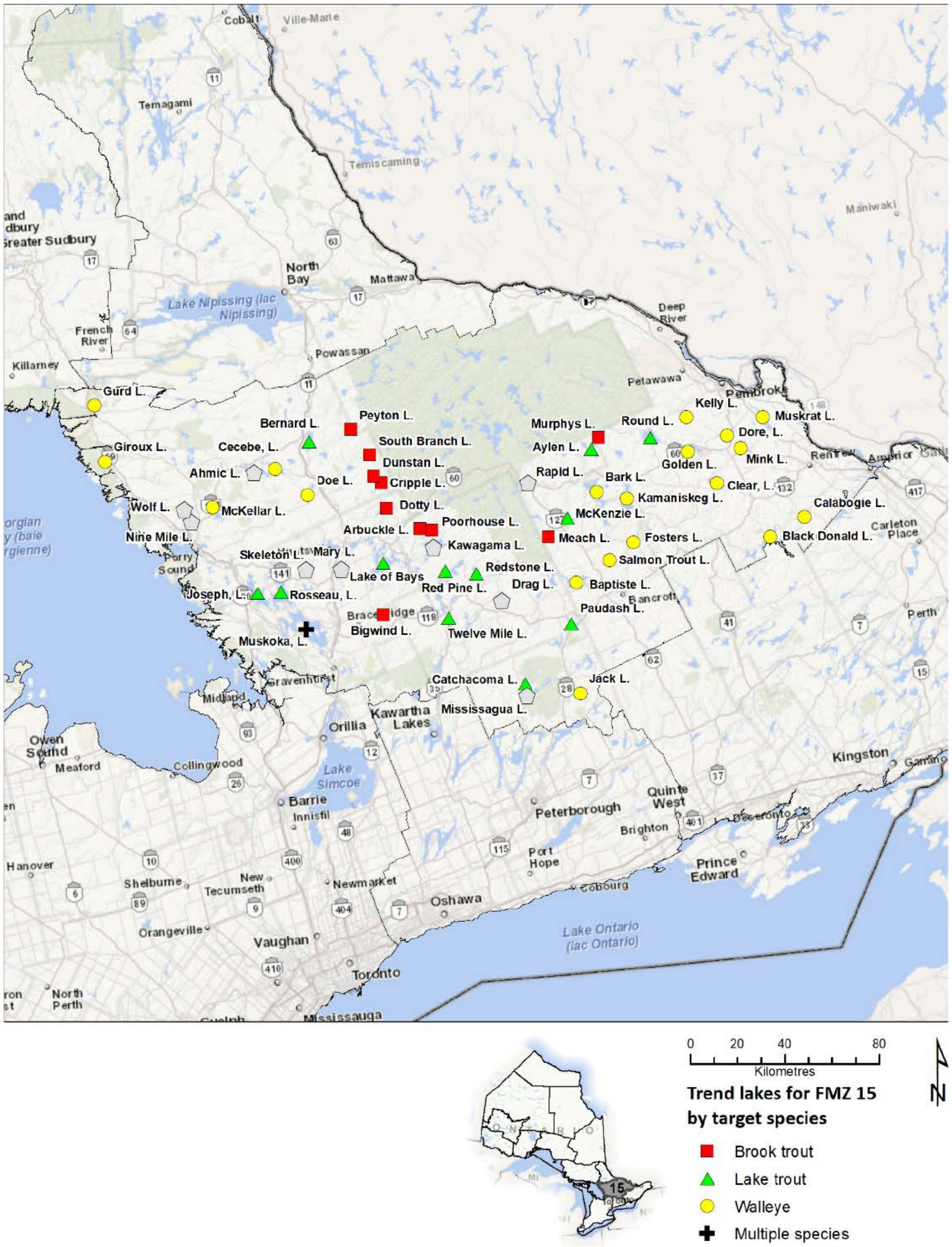


Figure 3.1 Trend lakes sampled by the BsM program, FMZ 15, Cycle 2.

Fish Netting

Fish netting is conducted to study and monitor the abundance and health of all fish species in a lake. BsM uses a combination of two types of gill nets:

- "Large mesh" gill nets that target fish larger than 20 cm in length, the size range of interest to anglers
- "Small mesh" gill nets that target smaller fish utilized as prey by larger fish

Large mesh nets are used to target sport fish like Brook Trout, Lake Trout, Smallmouth Bass and Walleye and provide population size estimates. A variety of information is collected from the fish caught in each lake survey including length, weight, sex, maturity, ageing structure (scales and/or ear bone), contaminant sample from muscle and stomach contents.

Small mesh nets are useful for providing information on fish communities (how many species exist). For small mesh nets, fish species, numbers caught, and length are recorded for each species. Information collected from both large and small mesh nets is used to describe the fish community structure including growth rates, survival estimates, feeding relationships, contaminant levels, fish health, and habitat use.

Details of the netting protocol are provided in Table 3.2.

Table 3.2 Basic details of the North American / Large Mesh (NA1) and small mesh (ON2) methodology, BsM (Sandstrom et al. 2013).

Parameter	Description
Sampling Season	Surface water greater than 18°C
Set Duration	Large Mesh: min. 18 hours; max. 22 hours Small Mesh: min. 12 hours; max. 22 hours
Gear Length	Large Mesh: 49.6m (8 mesh sizes per gang x 3.1m panels x 2 gangs) Small Mesh: 25.0m (5 mesh sizes per gang x 2.5m panels x 2 gangs)
Gear Height	Large Mesh: 1.8m (option of 0.9m for 1-3m stratum) Small Mesh: 1.8m (option of 0.9m for 1-3m stratum)
Mesh Series	Large Mesh: 38, 51, 64, 76, 89, 102, 114, 127 (stretch mm) Small Mesh: 13, 19, 25, 32, 38 (stretch mm)
Mesh Order	Non-sequential single series
Set Orientation	Perpendicular of oblique to contours
Depth Stratification	1-3, 3-6, 6-12, 12-20, 20-35, 35-50, 50-75, >75 m
Spatial Stratification	Effort equally distributed over entire lake
Samples per Lake	Varies with lake size and maximum depth
Sets per Day	Large Mesh: 4 or 6 double gang sets Small Mesh: 2 or 4 double gang sets

Bathymetry

The BsM program requires bathymetric (depth) data to:

- Estimate lake depths;
- Determine where to set fish nets; and
- Analyzing fish netting data.

Bathymetric data is available for nearly 10,000 lakes in Ontario. For lakes without bathymetric information, a new depth survey is conducted.

Water Clarity

Water clarity is measured by collecting a reading using a black and white metal disc known as a secchi disc. The deeper the secchi disc can be seen, the clearer the water.

Lakes with high amounts of suspended materials have lower water clarity and lower secchi depth readings. Suspended materials such as nutrients and algae may indicate that the lake is productive. Typically, high productivity means lots of plant growth, low dissolved oxygen. When used in conjunction with other measurements, secchi depth readings can help to evaluate the nutrient status of a lake. As a general guideline, typical secchi depth readings for low productivity lakes are greater than 5 m, between 2- and 5-m depth ranges for medium-productivity lakes, and less than 2 m in depth for highly productive lakes.

Temperature and Dissolved Oxygen

Dissolved oxygen and temperature profiles are recorded using a digital oxygen/temperature meter at the deepest location of the lake. Measurements are observed and recorded at the surface, and then at every metre until 16 m depth, then at every 2 m to the lake bottom. The temperature and dissolved oxygen measurements gives information on fish habitat and the types of fish that can live in the lake. For example, Lake Trout need high oxygen levels in the cold deeper portions of the lake to survive.

Water Chemistry

Lake water chemistry is evaluated for information on the nutrients in each lake surveyed. Fish distribution and production are linked to water chemistry and nutrient concentrations. Elements, minerals and nutrients contribute to the production of algae, which is food for many aquatic animals and fish.

Water samples are analyzed for true colour, pH, conductivity, alkalinity, calcium, magnesium, sodium, potassium, chloride, sulphate, silicate, iron, dissolved inorganic carbon, dissolved organic carbon, ammonia/ammonium, nitrate/nitrite, total Kjeldahl nitrogen, and total phosphorous.

Zooplankton

Zooplankton are collected and examined for Spiny Waterflea (*Bythotrephes longimanus*) and larval stages of zebra mussels (*Dreissena polymorpha*), which are aquatic invasive species. This zooplankton information is used to document the distribution of aquatic invasive species and to help prevent further spread of aquatic invasive species into lakes and rivers through education of the public. Any occurrence of an aquatic invasive species new to Ontario or new to a waterbody is reported to the Invading Species Hotline.

Angling Activity

Aerial activity counts are completed each year during summer and winter to determine how fishing is taking place in a zone. Angling surveys are done by airplane where the number of anglers, boats, and ice huts are recorded. As many lakes as possible are surveyed within the flight path.

Contaminant Sampling

Contaminant sampling is conducted on fish caught during netting. A sample of tissue is taken from sport fish species spanning the range of sizes caught. The tissue sample is frozen and shipped to the MECP's Sport Fish Contaminant Monitoring Program. The information collected contributes to the Guide to Eating Ontario Sport Fish.

Reporting on the Broad-scale Monitoring Program

Data collected through the BsM program is presented in different types of reports to help display and understand the information. BsM bulletins have been created to briefly summarize the information collected on each lake in the program.

Lake bulletins can be found on MNRF's Fish ON-Line website.

State of the Resources Reports will also be produced for the BsM program at some point in the future and will summarize information for each FMZ and show the status of Ontario's fisheries.

3.2 Description of Metrics

The BsM Guide to the Lake Synopsis (OMNRF 2016a) provides detail on the calculations of metrics provided by the BsM program. Metrics are based on fish caught in the North American standard large mesh nets, unless otherwise stated.

Results are often displayed using box plots which present the median, mean, quartiles, non-outlier range and outliers (Figure 3.2). For plots that show the metrics within the zone, the number of lakes sampled in each lake size class is shown below each box plot (n). The lake size classes are Extra Small (5 – 50 ha), Small (50 - 500 ha), Medium (500 -1,500 ha), Large (1,500 – 5,000 ha), and Extra Large (+5,000 ha). The number of lakes (n) is not constant for all displays within a zone/species as not all metrics could be calculated for every lake in every zone. That was because of small sample sizes or missing data.

The scale on any figure is not fixed for the province and therefore the reader should be cautious when comparing boxplots between FMZs.

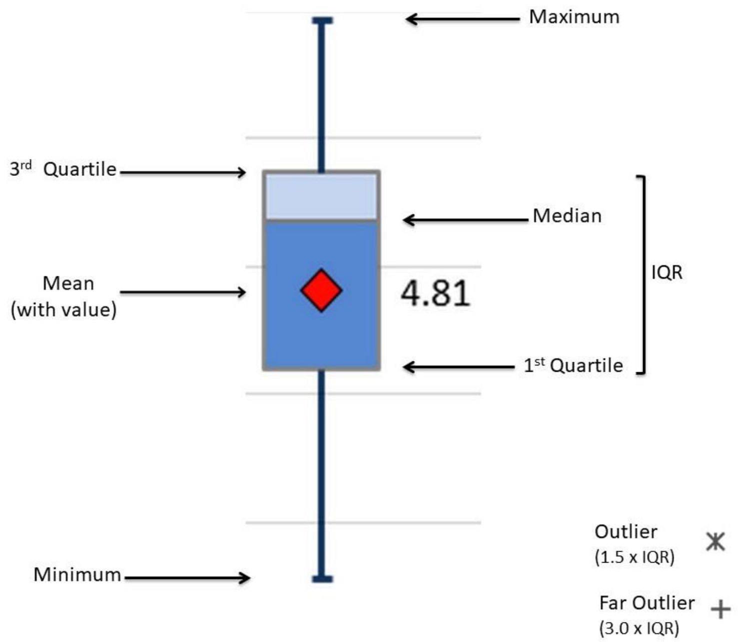


Figure 3.2 Box plot example.

Where results are available for two BsM cycles, scatter plots may be used to display the differences in the metric between cycles. Only lakes that were sampled in both cycles are included. The example below shows the catch rate of Walleye in Cycle 1 and 2. A 1:1 reference line (red) is included; if the value for a particular lake was higher in Cycle 2 than Cycle 1, the point is above the line, and vice versa, the further a point is from the line, the greater the difference between cycles. In this example, there are similar numbers of points above and below the line and of similar distance from the line, indicating that, on average, there was little difference in catch rate between cycles, but the catches from individual lakes varied considerably (Figure 3.3).

Many metrics are expressed as a measure of recruit-sized fish. That means that small fish that are not fully vulnerable to the nets and are not vulnerable to angling are not included. This approach eliminates some variability and expresses the metric in terms more relevant to anglers. The minimum recruit sizes used are:

- Brook Trout 250 mm
- Lake Trout 350 mm
- Lake Whitefish 400 mm

- Northern Pike 500 mm
- Muskellunge 500 mm
- Rock Bass 150 mm
- Smallmouth Bass 200 mm
- Largemouth Bass 250 mm
- Black Crappie 200 mm
- Yellow Perch 150 mm
- Walleye 350 mm

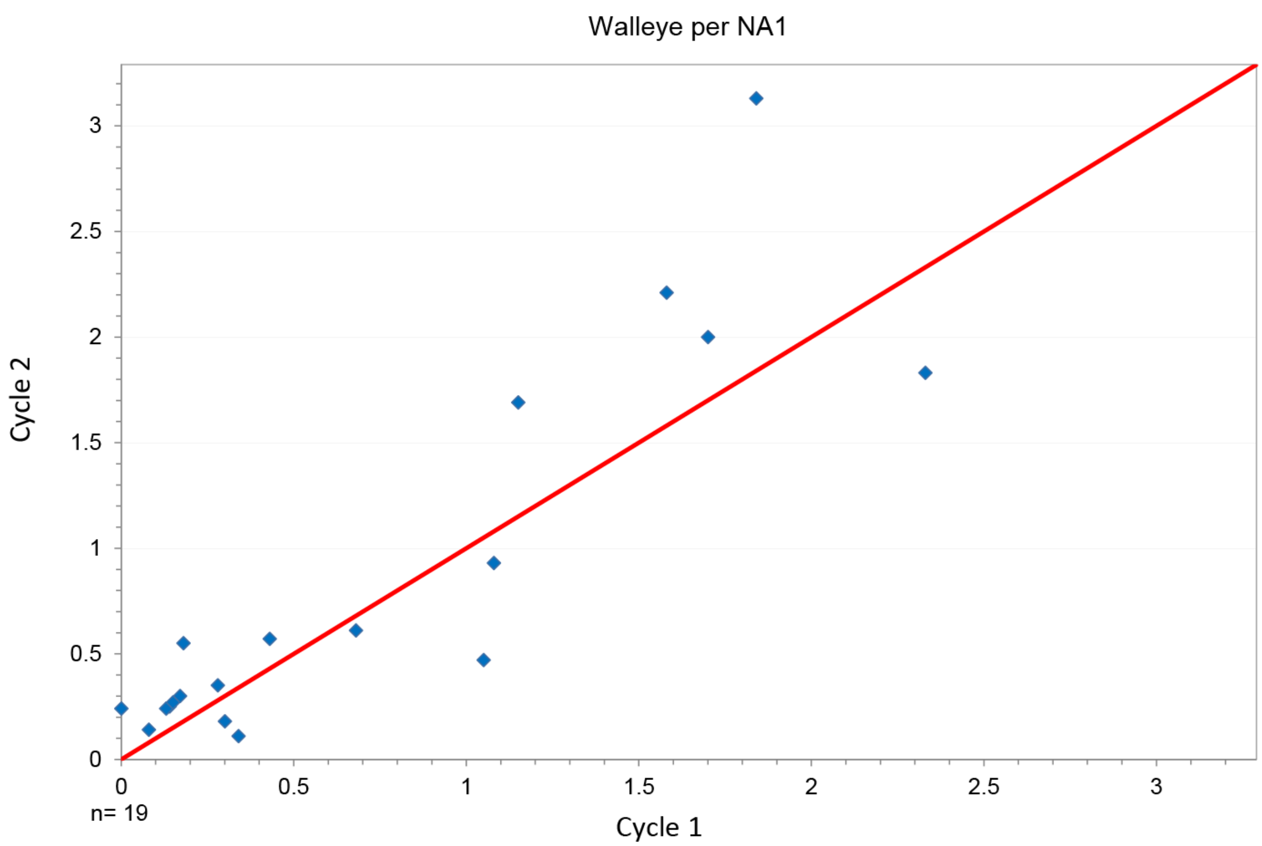


Figure 3.3 Example scatter plot comparing a metric between BsM Cycle 1 and Cycle 2.

3.2.1 Abundance

Abundance is a measure of the prevalence of a species, often for a specified size range. This metric is an important measure of the status of a fish population. It can be expressed by the number or biomass of fish and in absolute terms (total for a waterbody) or relative terms (number or weight/unit area). The latter is most commonly used to allow comparison of abundance across lakes.

Index netting, such as is done in the BsM program, produces a measure of relative abundance e.g., catch-per-unit-effort by number (CUE) or catch-per-unit-effort by weight (CUEW) rather than actual abundance. The relationship between actual fish abundance and CUE is determined by the catchability and selectivity of the sampling gear of each species and size of fish. Accounting for this catchability can produce abundance or density estimates (number or weight/unit area) for each lake.

3.2.2 Size, Age, Growth, Maturity

Measures of the size, age, growth rate and size or age of maturity of fish in a population are supporting indicators of population status. They are highly inter-related and influenced by multiple factors many of which are independent on the fishery. As such, interpreting them is difficult. Their usefulness is improved when long time series are available.

The size composition of a fish population can be expressed as the Proportional Size Distribution (PSD) (Gabelhouse 1984). Changes in the size composition of a population can be tracked and management goals developed by categorizing the length distribution into length classes that are meaningful to fishers. For the purposes of zone planning, the size categories chosen to determine the PSD are based on the Ontario Angling Record for each species (Table 3.3).

Table 3.3 Total length (mm) ranges used for calculation of proportional size density for selected species, FMZ 15.

Size Class	% of Ontario Record Length	Brook trout	Lake Trout	Northern Pike	Smallmouth Bass	Walleye
Source	<26	<210	<340	<320	<160	<240
Stock	26-41	210-329	340-539	320-499	160-249	240-379
Quality	41-55	330-439	540-719	500-679	250-339	380-509
Preferred	55-64	440-509	720-839	680-789	340-389	510-589
Memorable	64-80	510-639	840-1049	790-979	390-489	590-739
Trophy	>80	>640	>1050	>980	>490	>740

In developing the PSD, the 'Stock' category is the minimum size at which a fish has a recreational value to an angler. 'Quality' length is characterized as the inflection point, where fish growth rate increases rapidly and is the minimum size anglers like to harvest. Gabelhouse (1984) suggested that although anglers may enjoy catching a fish of "Quality" length, they would prefer a larger-sized 'Preferred' fish. 'Memorable' is defined as a size of fish most anglers remember catching, and 'Trophy' was considered worthy of acknowledgement.

The size structure of fish populations is regulated by some important processes. For instance, recruitment controls the numbers of young fish entering the smaller length categories. Growth rates of individual fish, on the other hand, controls fish advancing into larger size categories. Fishing mortality, in contrast, controls fish removal, mostly from larger size categories. Finally, natural mortality controls fish removal from both larger and smaller length categories. Thus, size structure analysis offers insight on many aspects of population dynamics.

3.2.3 Mortality

Mortality is the rate at which fish in a population die. It is the one of most important measures of a fish population status or health resulting in structuring the age distribution. It is the rate at which fish die in proportion to the number alive at any point in time, typically measured on an annual basis. It is expressed as the instantaneous total mortality rate (Z) and is comprised of two components; natural (M) and fishing (F) mortality.

As fishing mortality increases, population abundance declines, and yield increases to a point known as maximum sustainable yield (MSY; the largest harvest that can be sustained over time, all other conditions staying constant e.g., environment, Figure 3.4). The primary goal of fisheries management is to keep population biomass above the MSY threshold and fishing mortality below it. This reduces the risk of overfishing and sustains fishing quality over the long term.

The fishing mortality rate at MSY is denoted $F_{MSY,}$ a benchmark against which observed fishing mortality can be compared if F exceeds F_{MSY}, yield and fish abundance decline, decreasing the benefits derived from the fishery and puts the stock at risk.

F_{MSY} and M can be estimated from long-term monitoring or predictive models. Z is measured from monitoring data.

The goal of fisheries management is to keep population abundance above the level that produces the MSY. This reduces the risk of overfishing and increases fishing quality over the long term (OMNRF 2015b).

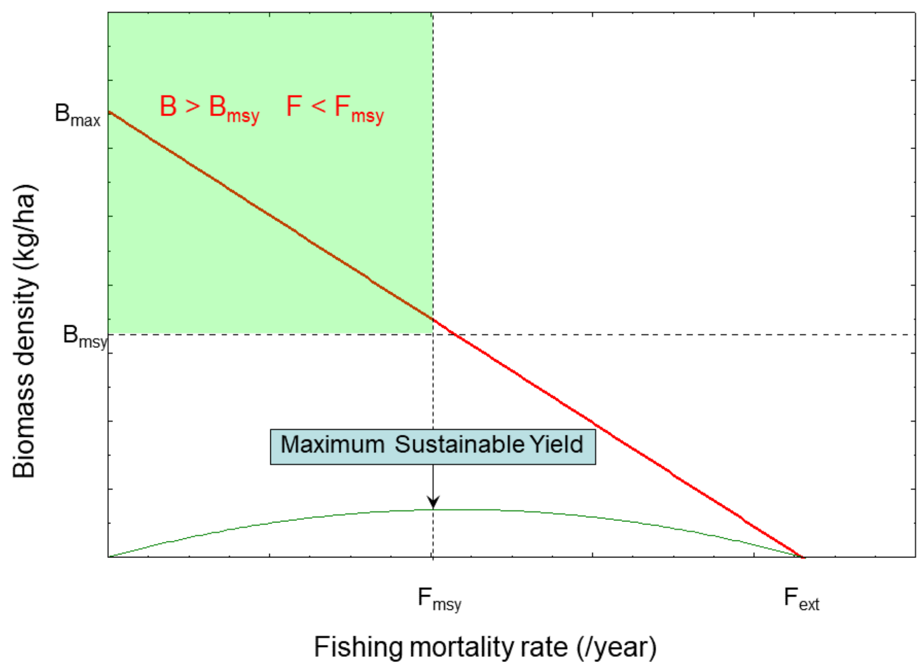


Figure 3.4 Relationship between fishing mortality, population biomass (red line) and yield (green line). Shaded area is area where sustainable harvest occurs.

Biological Reference Points

Biological reference points are a way to compare observations from netting data (BsM) to what would be expected based on the characteristics of a waterbody. The two reference points that are contrasted are mortality reference point (Z/M) and a biomass reference point (B_{OBS}/B_{MSY}). Observed values are then compared to the expected values.

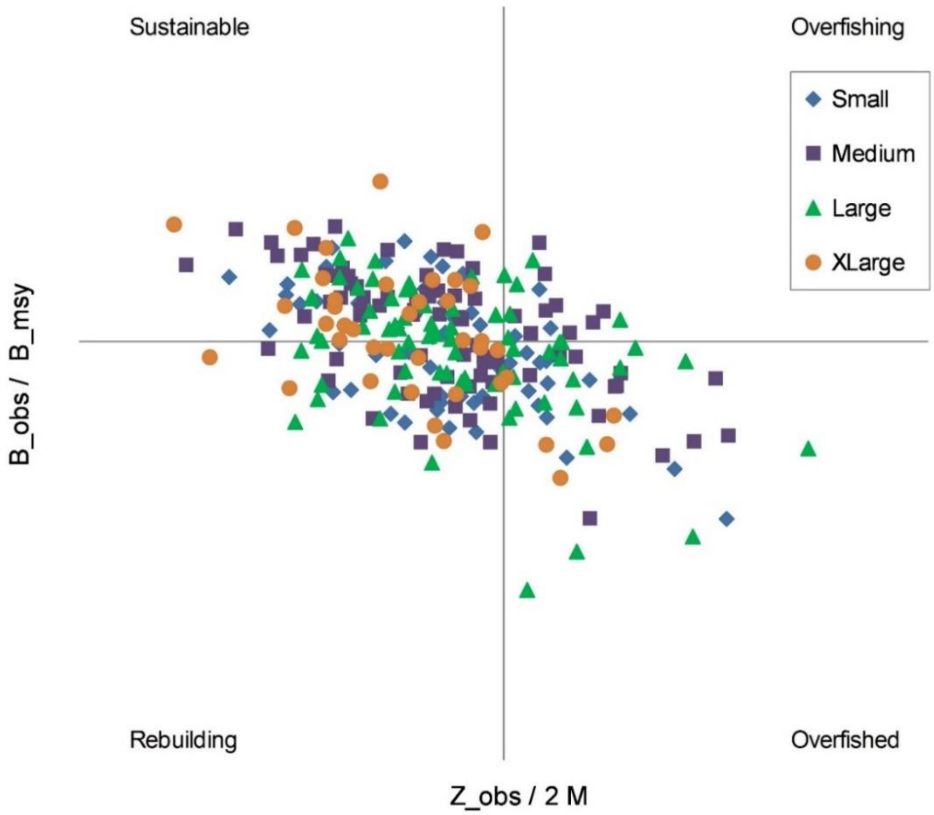
The quadrant plot classifies a fish population into one of four status stages based on the relationship between biomass and mortality (Figure 3.5) (Lester et al. 2003):

1) Sustainable – lakes in this quadrant have a higher biomass and lower mortality than predicted at Maximum Sustainable Yield.
2) Overfishing – lakes in this quadrant have a higher biomass and higher mortality than predicted at Maximum Sustainable Yield. This is a temporary state and if not corrected by lowering mortality, a population will advance to the lower right quadrant.
3) Overfished – lakes in this quadrant have a lower biomass and higher mortality than predicted at Maximum Sustainable Yield

4) Rebuilding – lakes in this quadrant a have lower biomass and lower mortality than predicted at Maximum Sustainable Yield. Biomass and fishing mortality are low, as anglers have generally abandoned fishing these lakes due to the poor quality of fishing. This stage should be temporary as well but residual mortality and ecosystem changes such as predator/prey dynamics may make it difficult to impossible for a population to return to its' original level of abundance.

The quadrant approach works best when applied to a large group of lakes on a landscape scale to account for natural variability in lakes and statistical uncertainty is associated with estimating biomass and fishing effort. Thus, using a large number of lakes offers a more robust approximation of the state of the resource and dampens the uncertainty around individual lakes.

At the end of each target species section, the quadrant plot will be displayed by selected target species. Lakes are differentiated based on lake size (colour and symbol of the points). Each plot consists of the Mortality reference line (Total Mortality observed/two times the Natural Mortality) (x-axis) and the Biomass reference line (Biomass observed/Biomass at Maximum Sustainable Yield) (y-axis). Each reference point is made of comparing what was observed to what is expected. Currently (2018), the expected values are only available for Walleye. Lake Trout and Brook Trout will be available in the future.



	XSmall	Small	Medium	Large	XLarge	Total	
Sustainable		40%	44%	41%	55%	44%	
Overfishing		5%	11%	8%	0%	7%	
Overfished		23%	15%	26%	13%	20%	
Rebuilding		32%	30%	25%	33%	29%	
n=		57	84	73	40	254	
no. n/a	0	51	28	27	10	116	31%

n/a are lakes with insufficient data

Figure 3.5 Quadrant plot of Walleye trend lakes, all FMZs, BsM Cycle 2.

3.3 Productive Capacity

Fish production is a manifestation of the productive capacity of a waterbody with fish populations at equilibrium, when the annual recruitment (number) of young new fish to the population is equal to the annual loss of same age and older fish due to mortality (natural + fishing).

A principal objective of fisheries management is to balance F against M (Schaefer 1968). Understanding how fish production varies among lakes and rivers and determining the major factors that contribute to this variation is critical in setting user expectations associated with allocation and harvest in support of sustainable fisheries management in Ontario.

The productive capacity of a waterbody, or the largest amount of fish a waterbody can produce and be harvested on a sustainable basis varies by waterbody and is influenced by many factors, including water temperature, nutrients, water clarity and lake morphometry. Other than climate, these factors are largely controlled by the geology, soils, topography and vegetative cover of the surrounding watershed, as described in preceding sections. Also, both natural and human disturbances of the waterbody or the surrounding landscape can impact fish productivity. Human influences may include climate change, introduction of invasive species and degradation and loss of fish habitat as a result of forestry, water management, urbanization and agricultural practices. Factors may act to limit or decrease fish production, while others may enhance production or cause shifts to occur in fish community structure.

Lake productivity is related to climate with warmer conditions resulting in a longer growing season, faster growth and earlier maturity of fish which leads to a higher biomass of warm water species (Venturelli et al. 2010). The amount of heat energy a lake receives can be expressed by GDD (refer to Section 0, for more details of the climate in FMZ 15). Temperature also controls the relative productivity of the three major thermal guilds of fish (cold, cool and warm). Increasing temperature may increase overall fish production but, depending on specific lake characteristics may decrease production of cold or coolwater species and increase production of warmwater species (Hansen et al. 2017)

Fish and other aquatic biota depend on nutrients for development, growth and survival. The nutrient levels of lakes and rivers are strongly dependent on the watershed within which they occur. Nutrient levels in lakes are typically measured as total phosphorus (TP), normally the limiting element in freshwater, or total dissolved solid (TDS). Nutrient levels depend on the glacial history, amount of rainfall, topography and soil and vegetation types characteristic of its watershed. Organic carbon inputs from the surrounding terrestrial environment are particularly important in riverine habitats. Also, nutrient loading from human activities, including forestry practices, agriculture and urbanization can result in increased productivity of changed aquatic ecosystems.

In FMZ 15, the average total phosphorus level across all lakes sampled in Cycle 1 BsM was 8.6 µg/l (Figure 3.6). Provincially, for Cycle 1, only FMZ 5, 10 and 11 had lower average phosphorus levels, while the zones with the most productive waters (FMZ 8, 12, 16 and 17) had phosphorus levels that were about two times as high. Similar trends were seen in Cycle 2; the average total phosphorus level in all lakes was 8.3 µg/l. For Cycle 2, FMZ 10 and 11 were the only other zones that had lower average phosphorus levels compared to FMZ 15, while FMZ 8, 12 and 16 had phosphorus levels that were about two times as high as FMZ 15.

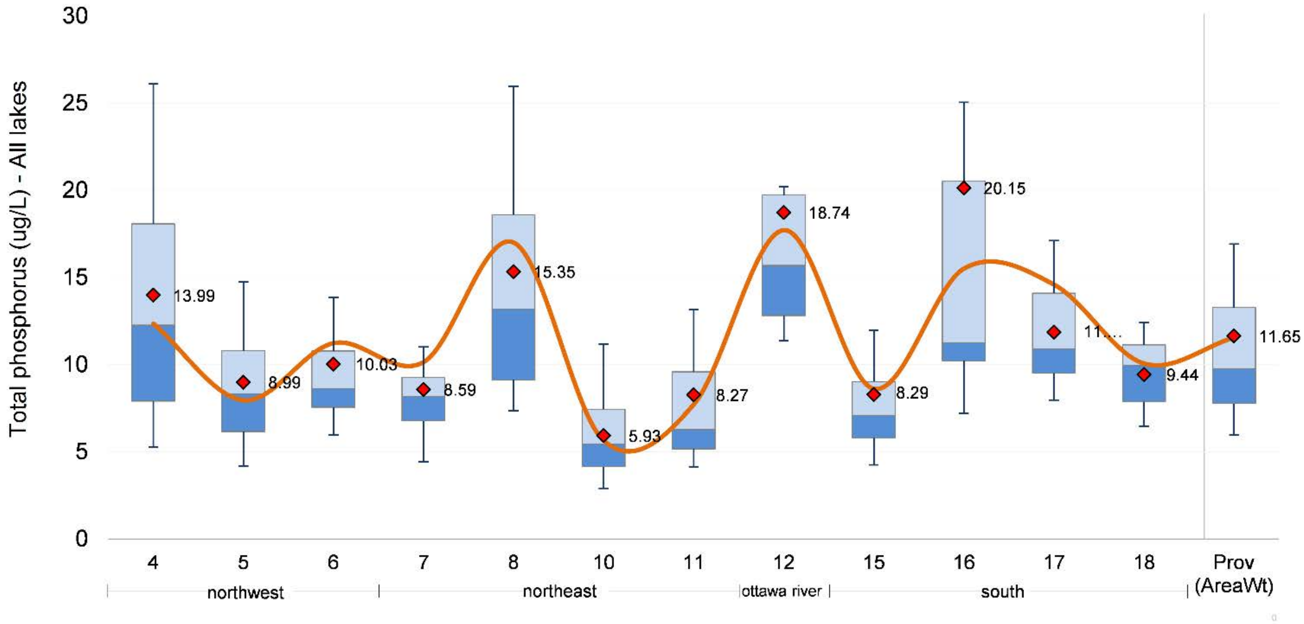


Figure 3.6 Area-weighted average total phosphorus concentration in all lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

Phosphorus levels, and therefore overall lake productivity, has been declining. Long-term monitoring of lakes by MECP in the Dorset since the 1970's, Ontario area (within FMZ 15) documented an average decline of about 30% (Yan et al. 2008). The cause of the decline isn't clear but may be related to acid rain recovery and forest succession.

Water clarity is also an important determinant of productive capacity in influencing the habitat suitability of species. Specifically, Walleye production tends to be higher in lower clarity waters and conversely, Lake Trout production is higher in high clarity waters. Similarly, lake morphometry, the size and shape of lake basins, has a strong influence on habitat suitability for different species.

Finally, the productivity capacity of different species is influenced by the fish community within which they reside. In general, as community complexity increases, the fish production is partitioned amongst those species as well, with the proportion's dependent on the trophic position and habitat suitability for each species. For example, if a lake supports only Lake Trout as a top predator, a large proportion of the lakes' annual production will go into Lake Trout biomass. If Smallmouth Bass are introduced to the lake, a proportion of the annual production will go into bass and the production of Lake Trout will decline. Refer to the individual species sections for more information on fish community and species productivity.

Several models have been used to estimate the productive capacity of Ontario lakes. Models that have been used by MNRF include the Morphoedaphic Index (MEI) (Ryder 1965); the Lake Trout Life History Model (Shuter et al. 1998) and the Thermal Optical Habitat Area Model (TOHA) (Lester et al. 2004) developed for Walleye. Ryder's (1965) early MEI model uses the mean depth of a water body and the amount of nutrients as measured by total dissolved solids (TDS) to determine productive capacity of the entire fish community (MEI = TDS/mean depth). The MEI model is the simplest of the models used to estimate production.

Shuter et al. (1998) developed a Lake Trout Life History Model that uses lake morphology (area) and TDS as inputs into a growth model to estimate yield and exploitation rates for Lake Trout. This model is more complex than Ryder's (1965) model, but the information needed to run the model is easily collected during field surveys.

More recently, Lester et al. (2004) developed a model (Thermal-Optical Habitat Area – TOHA model) to determine Walleye habitat and yield for Ontario lakes using chemical, physical properties (lake size, depth, nutrient levels (TDS), water clarity (Secchi) and temperature (GDD's). This model describes a method for calculating the theoretical maximum sustainable yield (MSY) for Walleye in Ontario lakes.

The Lake Trout Life History Model (Shuter et al. 1998) and TOHA model (Lester et al. 2004) are used to calculate the benchmarks for Lake Trout and Walleye abundance and mortality, which are described in Section 0.

3.4 Fish Species and Community Diversity

Biological diversity, or biodiversity, is the variety of life, a measure of all the earth's living organisms and ecological processes, and how they function and interact. Biodiversity can be described on three broad levels: ecological diversity, species diversity and genetic diversity (Ontario Biodiversity Council (OBC) 2011). Conserving biodiversity is important for overall ecosystem health and resiliency, and because humans derive ecosystem services, in the form of food, shelter, materials and employment. Biodiversity is threatened through habitat loss, invasive species, pollution, population growth, over-exploitation and climate change to name a few (OBC 2011).

Spanning central Ontario, FMZ 15 is rich in biodiversity. The zone is the northern extent of range for many species, and the southern extent for others; changes in species and populations are often first noticed at the outer limits of their ranges. The underlying geology of Precambrian shield and limestone result in waterbodies with different water chemistry and the ability to support a variety of fish and other aquatic species.

Individual fish species as well as fish communities are indicators of the overall health of aquatic ecosystems. Changes in fish species, fish community composition, growth rates, mortality, and overall fish health offer a sign of the health and condition of the waterbody and may be indicative of trends across the landscape. The following sections discuss species at risk and invasive species, both of which have implications for ecosystem health and biodiversity.

The current aquatic biodiversity of FMZ 15 is a result of colonization following the retreat of the Laurentide glacial ice sheet followed by human perturbations. As the glaciers retreated the melt water flowed into different watersheds at different time periods. This phenomenon gives an opportunity for differential colonization of different parts of the zone by various species. The high elevation areas of the zone were naturally devoid of most cool and warmwater fish species resulting in high concentrations of coldwater lakes dominated by Lake Trout and Brook Trout. The introduction of cool and warmwater fish species into many of these lakes, either accidentally or intentionally has resulted in the loss of native biodiversity in exchange for increased total biodiversity.

A total of 101 species of fish have been documented in FMZ 15. Of those, 68 species are thought to be native, 19 species have been introduced and the status of 14 species is uncertain (unverified identification or origin). Refer to Appendix 4 for a complete list of all species recorded.

The compilation of a definitive list of native species occurrences is complicated by factors such as stocking history, incomplete inventory and difficult identification. This accounting does not describe the extensive change of distribution within the zone that has occurred for many species (see individual species sections for more details) nor does it account for local-scale distributions of species which may be native to a portion of the zone, but also are not necessarily native to the entire zone and all its associated drainages.

The BsM program has captured about half of the species recorded in the zone. No previously undocumented species have been detected to date. Out of the most common species occurring in FMZ 15, Rainbow Trout is the only sportfish not captured in the BsM program. This species is commonly stocked for put-grow-take (PGT) purposes across the zone. BsM does not target PGT lakes, but some are sampled as trend lakes for other species or as state lakes.

Almost half of the recorded species have 10 or few occurrences in the ARA or BsM databases.

Fish diversity is spread across 18 different families. The most diverse groups in FMZ 15 are the 19 species of minnows (*Cyprindae*). Other diverse groups within the zone include Perches (*Percidae*), Suckers (*Catostomidae*), Sunfishes (*Centrarchidae*), and Whitefishes (*Coregoninae*).

3.5 Status of Featured Sport Fish Species

3.5.1 Brook Trout

3.5.1.1 Description

Brook Trout are endemic to eastern North America. In Ontario, they occur throughout most of the province where suitable habitat exists, except for areas of Northwestern Ontario. They occur in lakes and streams, where suitable habitat and compatible fish communities occur.

Brook Trout are adapted to cold water. They spawn in the fall and eggs incubate and hatch during the winter and fry emerge in the spring when the water temperature begins to increase, and food becomes available. Brook Trout spawning areas are closely associated with upwellings or seepages of groundwater and if such areas are not available reproducing Brook Trout populations will not be present. Fry emerge in the spring and seek out nursery areas which may include shallow areas of lakes or small tributary streams. They generally need water temperatures of 20˚C or less. Therefore, they occur in lakes that thermally stratify and have adequate dissolved oxygen in the metalimnion throughout the warm months. Similarly, they occur in streams where groundwater inputs keep the water temperature within the tolerable limits or at least offer refugia such as springs and seeps where trout can persist despite the mainstream temperature being too warm.

Brook Trout populations are sensitive to depredation by and competition with other species of fish. Populations are most abundant in waters with simple fish communities. In particular, spiny-rayed fish species such as Yellow Perch (Fraser 1978) and Smallmouth Bass have major impacts on the abundance and even persistence of Brook Trout populations.

3.5.1.2 Distribution

In FMZ 15, Brook Trout waters occur generally in the areas of the zone with higher elevations and deeper soils where groundwater inputs and oligotrophic lakes absent of competing species occur. Brook Trout occur throughout Algonquin Provincial Park; however; the focus here is outside of Algonquin Provincial Park in the rest of zone 15. Brook Trout are absent from the far western part of the zone, adjacent to Georgian Bay, where thin soils and conflicting fish communities prevail. In the far south-eastern part of the zone, in the lower Ottawa Valley, Brook Trout occur only in streams as suitable lakes do not occur.

The description of the historical and current distribution of reproducing Brook Trout water in the zone is seriously confounded by several factors including the extensive historical and ongoing stocking, the impacts of ongoing non-native species introductions and the difficulty of monitoring large numbers of small, dispersed, often remote, water bodies. Distinguishing and classifying waters based on the occurrence of or amount of reproduction is also a problem.

Brook Trout have been and continue to be stocked extensively in the zone. The stocking program is described in more detail in Section 5.13.

Lakes

The first compilation of Brook Trout lakes in the area was completed in 1980 (OMNR 1980). Results were organized by the District boundaries of the time which have since changed. The lakes were re-sorted by current FMZ and District boundaries (Table 3.4). In 1980, lakes were classified by relative strength of natural reproduction. Class 1 lakes were supported entirely by natural reproduction, with no stocking occurring. Class 2 lakes show natural reproduction, but stocking was done to enhance the fishery (supplemental stocking). Class 3 lakes were sustained entirely by stocking (PGT lakes). The status of Class 4 lakes was unknown. Supplemental stocking generally no longer occurs, making the classification system somewhat obsolete. Also, the occurrence of introduced species, an important descriptor of the status of Brook Trout lakes was not described in the 1980 atlas.

Only 18 of 312 lakes listed were classified as Type 1 lakes, with 12 occurring in Parry Sound and 6 in Bancroft district. A further 68 were known to have some reproduction (Class 2). Together, Class 1 and 2 lakes comprised just over 27% of lakes. About 50% of lakes were classified as PGT lakes, where no natural reproduction had been documented. The status of 25% (78/312) of lakes was not known.

Overall, Bancroft had the greatest total number of lakes, of which a higher proportion was PGT and unknown status lakes. Parry Sound had a greater proportion of Class 1 and 2 lakes. Pembroke had the fewest lakes overall and most were PGT.

Table 3.4 Brook Trout lakes in FMZ 15, 1980, classified by reproductive status.

Status	1	2	3	4	Total	Not Surveyed	Surveyed	% Surveyed
Bancroft	6	13	67	44	130	19	111	85
Parry Sound	12	50	22	23	107	4	103	96
Pembroke		5	59	11	75	0	75	100
Total	18	68	148	78	312	23	289	

1: Self-reproducing population with spawning facilities enough to produce an angling fishery by natural reproduction alone. Stocking not required.

2: Spawning facilities sparse and the limited reproduction that occurs is inadequate to keep a sport fishery. Stocking required.

3: Artificial. No spawning facilities and no reproduction. Population kept entirely by stocking.

4: Status of reproduction unknown.

Knowledge of the occurrence and status of Brook Trout populations and management approach has changed significantly since 1980. Following a pilot project done in zone 15 (Forward et al. 2014), in 2018 a comprehensive review and classification of Brook Trout lakes was completed as part of a province-wide exercise. A key was used to objectively classify records of Brook Trout observations contained in district files. Results were entered into a database that can be updated and queried. Each record of a Brook Trout observation was classified by:

- Origin of the record (e.g., Sampling record or Verbal report),
- Date of each record,
- Fish origin (natural, stocked, undetermined), and,
- Fish community.

Based on the records review, each lake was classified as to the origin of the Brook Trout population:

- Observed natural Brook Trout lake,
- Verbal natural Brook Trout lake,
- Observed Brook Trout lake – source undetermined,
- Verbal Brook Trout lake – source undetermined, and,
- Stocked Brook Trout lake.

For each lake class, other variables such as the age of records and fish community information can be combined to provide a comprehensive picture of the distribution, status and our state of knowledge of Brook Trout in lakes in the zone.

The records review revealed that natural Brook Trout have been observed in 195 lakes in the zone (Figure 3.7, Table 3.5). There were verbal records of natural Brook Trout in another 111 lakes. A further of 213 lakes had records of Brook Trout being observed or reported but their origin (natural or stocked) could not be determined with certainty; it is likely that a significant number were natural.

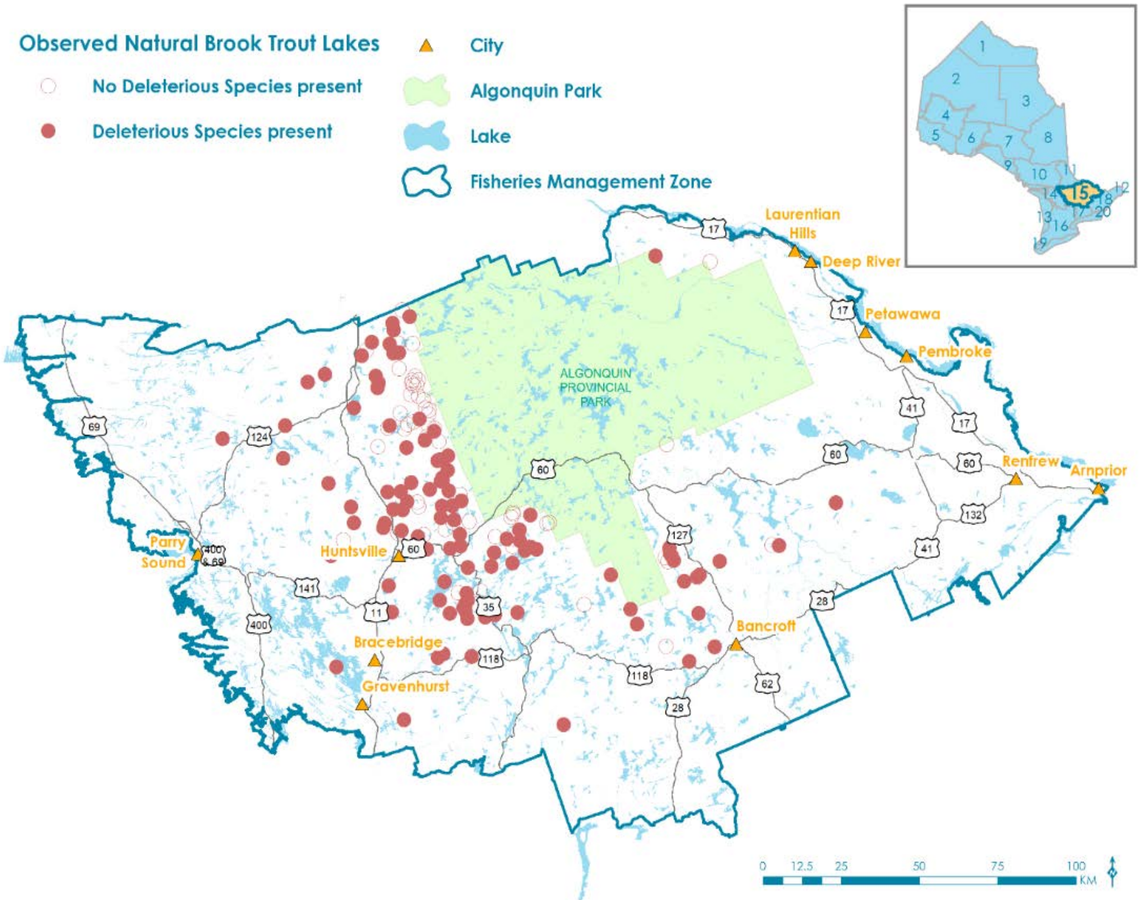


Figure 3.7 Observed natural Brook Trout lakes, classified by whether deleterious species are present, FMZ 15, excluding Algonquin Provincial Park.

Table 3.5 Number of lakes with observations or verbal reports of natural Brook Trout, and records or reports where the origin could not be determined, by year of most recent observation, FMZ 15.

Year of Most Recent Record	Observed	Verbal	Undetermined (observed and verbal)
1900-1909		1	
1910-1919			
1920-1929	3	5	1
1930-1939	3	3	1
1940-1949		6	2
1950-1959	6	14	18
1960-1969	15	8	33
1970-1979	53	29	93

Year of Most Recent Record	Observed	Verbal	Undetermined (observed and verbal)
1980-1989	40	14	28
1990-1999	18	9	12
2000-2009	28	17	9
2010-2019	29	5	
Total	195	111	213

The year of the most recent observation or verbal report of a natural Brook Trout for an individual lake varied greatly, from 1902 to 2017; for about half of the lakes, a natural Brook Trout has not been recorded in over 40 years old. The age of the records is a function of the years in which sampling took place and whether natural Brook Trout were detected. Table 3.6 shows a summary of the detection of natural Brook Trout in relation to sampling history and the presence of introduced species. After a lake has been invaded, the probability of Brook Trout being detected in subsequent sampling declines greatly. Of the 195 lakes where natural Brook Trout have been sampled, harmful species have been detected in 127. Of those, natural Brook Trout were caught in almost half (59/127) the most recent time it was sampled. By contrast, of 68 lakes where harmful species had not yet been detected Brook Trout were caught in almost all of them the last time they were sampled. These figures may be biased as the selection of lakes for monitoring has been mostly non-random.

Table 3.6 Number of natural Brook Trout lakes, classified by presence of harmful species and whether natural Brook Trout were caught in the most recent sampling event, FMZ 15.

	Harmful Species Not Present		Harmful Species Present	
Year of Most Recent Sampling Event	Detected	Not Detected	Detected	Not Detected
1920-1929				3
1930-1939				3
1940-1940				
1950-1959	2		1	3
1960-1969	3	1	2	9
1970-1979	18	2	18	12
1980-1889	10	2	15	13
1990-1999	6	1	7	4
2000-2009	12		10	6
2010-2017	11		15	13
Total	62	6	68	59

Streams

Brook Trout occur widely in streams in the zone, in the same general geographic areas as lakes that support Brook Trout (Figure 3.8). Brook Trout in streams may occur as discrete stream-dwelling populations or in tributaries where they serve as nursery streams for lake-dwelling populations. Brook Trout also occur casually or seasonally in lakes and larger streams that do not offer year-round habitat. The occurrence of Brook Trout in streams is more poorly understood than for lakes. The interconnected nature of streams and environmental gradients that occur in them make it difficult to define population and habitat boundaries or interpret point-based sampling information.

Brook Trout occurrence in streams is mapped by two means: coldwater thermal regime applied to stream segments and by point sampling sites.

No formal monitoring program is in place for streams. Data is available from other programs such as values collection for Forest Management Planning, Licences to Collect Fish for Scientific Purposes and local inventories.

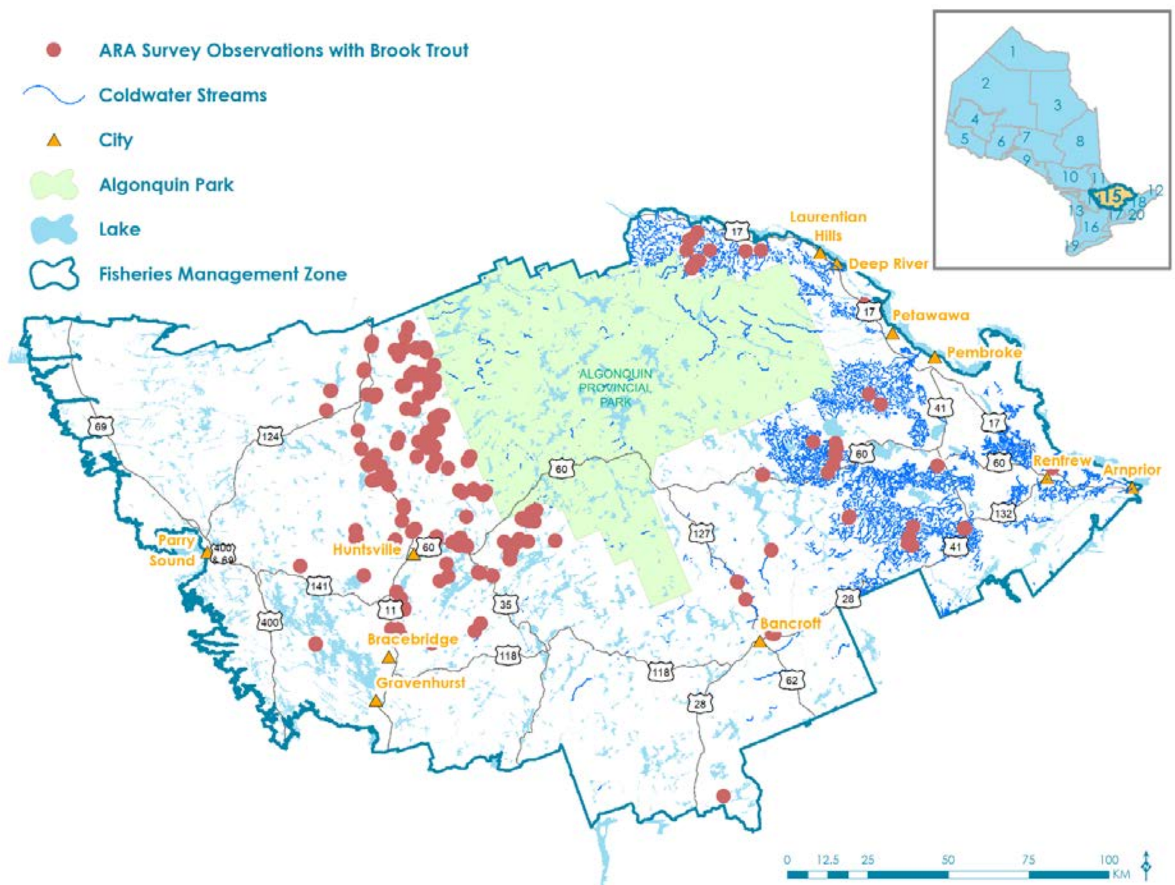


Figure 3.8 Map of coldwater streams, and stream survey points where Brook Trout have been captured in FMZ 15, excluding Brook Trout in coldwater streams in Algonquin Provincial Park.

3.5.1.3 Habitat and Fish Community

Brook Trout are highly susceptible to severe impacts from competing species such as Yellow Perch and Smallmouth Bass. A large number of natural Brook Trout lakes in the zone have been invaded by such species, resulting in the marginalization of many populations where they often persist at a low density and support poor fisheries. Of the 195 observed natural lakes, 127 have records of non-compatible species. Similarly, 70 of 111 lakes where natural Brook Trout have been verbally reported have been invaded. Based on surface area, the picture is even more stark as lakes that remain pristine are primarily very small lakes with limited access. The source of the invasions is varied, and often unknown, but mostly through intentional stocking; both authorized and illegal.

In Cycle 1 of the BsM program, 13 lakes were sampled for trend monitoring; however, Brook Trout were only caught in six of the chosen lakes. Six of the seven lakes where no Brook Trout were caught contained at least one species of incompatible competitors, such as perch or bass. Four of the six lakes where Brook Trout were caught contained competing incompatible species.

Locations of critical habitat features including spawning and nursery areas are collected as encountered. The primary source is values collection activities for the Forest Management Planning process. Others are identified during local targeted monitoring surveys or through incidental encounters. Monitoring is not generally conducted.

A large proportion of natural Brook Trout lakes are in areas dominated by Crown land and the most common activity near them is forest management. Identified critical habitat, spawning areas, nursery areas and groundwater re-charge areas are protected by Area of Concern prescriptions in Forest Management Plans but for most lakes these habitats have not been identified to date.

A small number of stream habitat enhancement projects have been done including erosion control and water crossing/barrier mitigation.

3.5.1.4 Abundance

Due to the small number of lakes sampled by the BsM program in which Brook Trout were caught, no useful zone-wide measures of Brook Trout abundance could be generated.

3.5.1.5 Population Characteristics and Biological Reference Points

Lakes were selected for monitoring by the BsM program from a complete list of all known natural Brook Trout lakes at the time. As a result, most lakes chosen were lakes with non-compatible species and few if any Brook Trout were caught. As result, very little information is available on the population characteristics of Brook Trout at the zone-scale.

3.5.2 Lake Trout

3.5.2.1 Description

The Lake Trout is North America's largest species of native trout (Scott and Crossman 1998). Lake Trout occur throughout Ontario and are highly sought after in both sport and commercial fisheries. They inhabit deep, clear, cold oligotrophic lakes, with healthy levels of oxygen. Optimal temperature for adult Lake Trout is 10˚C (Scott and Crossman 1998) with preferred temperature ranges between 8 and 12˚C (Christie and Regier 1988).

Spawning occurs in autumn, generally late October through early November in Ontario, when water temperatures decline towards 10˚C (Kerr and Grant 2000). Spawning habitat is generally rocky shoals off points or islands, or mid-lake, where wind and wave action keep the shoals free of sediments (Kerr and Grant 2000). The substrate generally consists of clean large rocks or boulders with deep spaces which hold and protect the eggs; average water depth over the shoal is generally less than 6 m in Ontario (Scott and Crossman 1998; Kerr and Grant 2000). The eggs incubate on the spawning shoal from 15-21 weeks, and the fry stay on the shoals for four more weeks after they emerge and begin to feed on plankton and invertebrates (Kerr and Grant 2000).

Size and growth vary greatly, depending on habitat and diet, but the average length of an adult Lake Trout is 15-20 inches, and weights up to 10 lbs (Scott and Crossman 1998), a long-lived species, with known ages exceeding 40 years (Kerr and Grant 2000).

Lake Trout move extensively throughout the waterbody as they seek out colder temperatures and hunt for food. They are opportunistic and omnivorous predators, feeding on a variety of aquatic plant, invertebrates, small mammals and fish, with fish becoming more important in their diet as they grow (Kerr and Grant 2000). The freshwater shrimp, *Mysis relicta*, is an important part of the diet of young Lake Trout (Scott and Crossman 1998). A wide variety of fish are consumed, including Lake Herring, Lake Whitefish, suckers, Yellow Perch, and a variety of minnow species. Populations of Lake Trout that stay planktivorous, feeding largely on Mysids; these fish are generally slower to grow, mature at smaller sizes and have shorter lifespans (Scott and Crossman 1998; Kerr and Grant 2000).

Habitat loss and degradation are limiting factors for Lake Trout. This commonly occurs when oxygen levels within the waterbody decline and/or when the spawning shoals become degraded. Lake Trout are a good indicator of the overall health of their aquatic ecosystem (Kerr and Grant 2000).

3.5.2.2 Distribution

The native distribution of Lake Trout in the zone is uncertain due to extensive historical stocking and absence of complete inventory data. The first relatively complete list available was compiled circa 1990 for the Lake Trout synthesis project (OMNR 1990a). An earlier summary was done in 1976 (Martin and Olver 1976) but the lake list was not available. In 1990, there were 325 listed Lake Trout lakes in the zone. They were classified primarily by origin (native or introduced) and stocking purpose (not stocked, supplemental, put-grow-take, stocked with other trout species) (Table 3.7).

Beginning in 2006, lakes managed for Lake Trout have been designated on a formal list maintained by Fish Policy Section (OMNR 2015d). A formal list was required to facilitate application of provincial policies specific to Lake Trout. The classification is simpler than the system used in 1990; lakes are classed as either natural or put-grow-take. Stocking only occurs in PGT lakes, with a few exceptions. A comparison of the 1990 and 2006 lists is shown in Table 3.7. The classification and management approach (stocking) of many lakes changed between 1990 and 2006, primarily due to the collection of data and the implementation of recommendations in the Lake Trout Synthesis. For example, a total of 86 lakes were classified as 'Introduced-stocked' in 1990. In 2006, 51 were still being stocked and classified as PGT, 25 were no longer stocked and managed as natural populations and 10 were no longer being managed for Lake Trout. Most notably, there were 9 lakes classified as having native populations that were no longer managed as lake trout lakes in 2006.

Table 3.7 Comparison of Lake Trout lake designation, 1990 (rows) and 2006 (columns), FMZ 15. See text for explanation of how to interpret the table.

	2006 Designation			
1990 Designation	**Natural**	**PGT**	**Not**	**Total**
Extinct			19	19
Introduced – self sustaining	2		1	3
Introduced - stocked	25	51	10	86
Lost			10	10
Native – not stocked	50			50
Native – supplemental stocking	81	8	3	92
Native – PGT stocking	9	9	2	20
Native – stocked with Splake			4	4
Other	8	2	22	32
Unknown History			9	9
Not Listed	2		2	4
Total	**177**	**70**	**82**	**329**

The 2006 list was amended in 2015 with several changes applying to lakes in FMZ 15; 2 natural and 2 PGT lakes were removed from the list, 2 earlier unlisted lakes were added as natural lakes and 3 lakes were changed from natural to PGT (Table 3.8). Excluding Algonquin Provincial Park, as of 2015, there were 245 designated Lake Trout lakes in the zone (174 natural, 71 PGT); 82 less than were listed in 1990.

Table 3.8 Summary of changes to the designated list of Lake Trout Lakes in FMZ 15, 2006-2015.

	Natural	PGT
Number of Lakes Designated in 2006	177	70
Number of Lakes Removed from list in 2015	2	2
Number of Lakes Added to list in 2015	2	
Number of Lakes where Designation was Changed from Natural to PGT in 2015	-3	3
Number of Lakes Designated in 2015	174	71

In addition to designated Lake Trout lakes, there are a number of lakes which were formerly managed for Lake Trout and are not currently designated but may have remnant populations. Also, several lakes where Lake Trout have been documented or reported are not designated for management because the status of the populations have not been verified to date.

Lake Trout are widely distributed in FMZ 15. They occur in greatest number in the central part of the zone in Bancroft District with most of the largest lakes comprising a large proportion of the surface area and habitat occurring in the Muskoka area (Figure 3.9). Few Lake Trout lakes occur in the lower elevation areas of the eastern and northwestern parts of the zone.

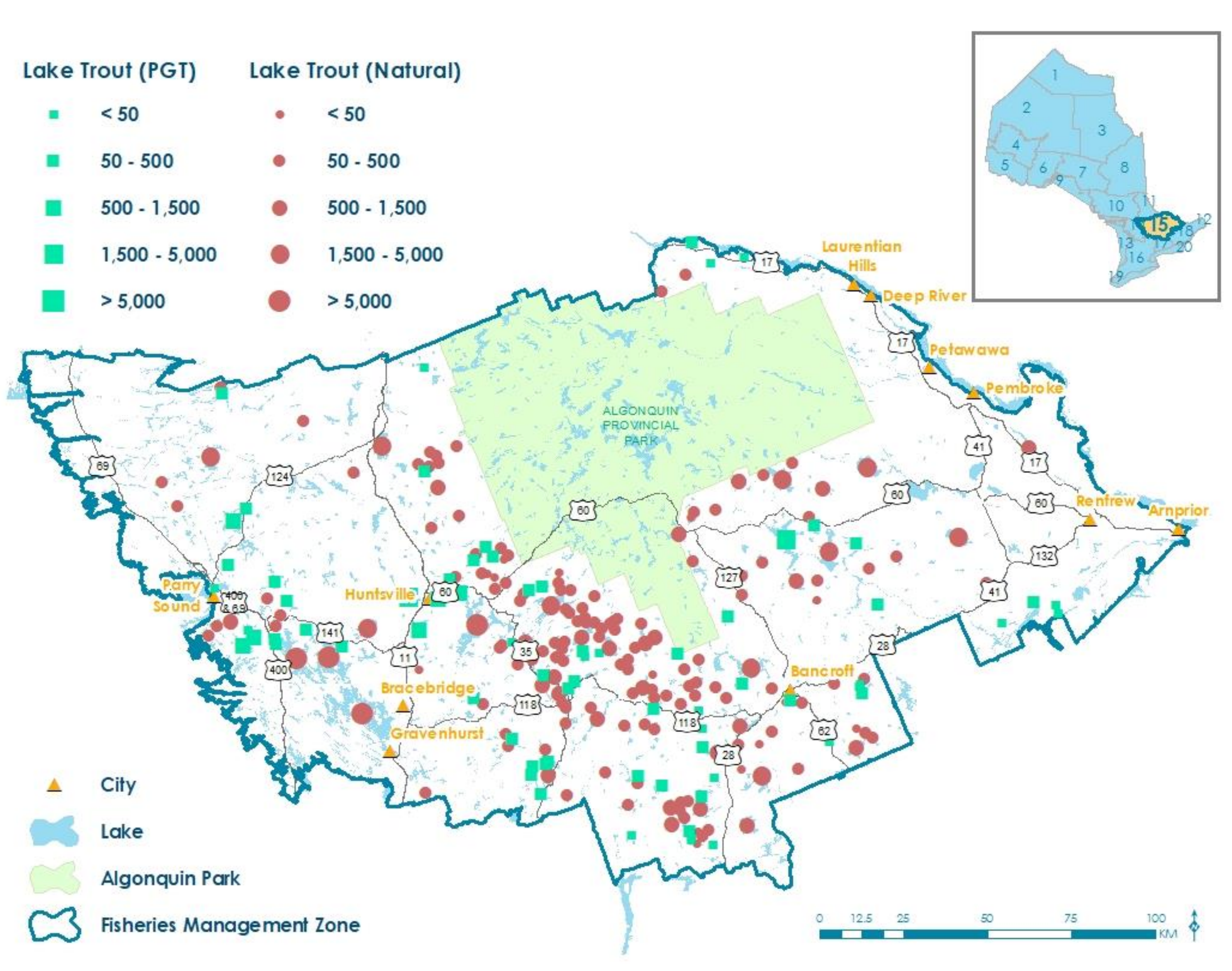


Figure 3.9 Designated Lake Trout lakes in FMZ 15, 2015, excluding Algonquin Provincial Park.

Lake Trout lakes in the zone tend to be small, with 116 of 174 (47%) natural lakes being between 50 and 500 ha and comprising 18% of the surface area (Table 3.9).

There are only 14 large natural lakes (>1500 ha) but together they comprise 47% of the surface area. The size distribution of lakes is similar for natural and PGT lakes, other than there are no large PGT lakes.

Table 3.9 Number and surface area (ha) of Lake Trout Lakes in FMZ 15, by BsM lake size class, 2015. Percentages are in brackets.

Number	5-50	50-500	500-1500	1500-5000	5000-250000	Total
Natural	19 (8)	116 (47)	25 (10)	10 (4)	4 (2)	174 (71)
PGT	21 (9)	42 (17)	6 (2)	2 (1)		71 (29)
Total	40 (16)	158 (64)	31 (13)	12 (5)	4 (2)	245 (100)
Area (ha)						
Natural	635 (1)	20,162 (18)	22,168 (20)	21,827 (19)	31,354 (28)	96,145 (85)
PGT	696 (1)	5,600 (5)	4,338 (4)	5,818 (5)		16,452 (15)
Total	1,330 (1)	25,762 (23)	26,506 (24)	27,646 (25)	31,354 (28)	112,598 (100)

Habitat and Fish Community

The BsM program collects data on several parameters that describe the amount and quality of Lake Trout habitat. The mean depth is a measure of the amount of deep-water habitat available. Provincially, the area-weighted mean depth of Lake Trout lakes monitored in Cycle 2 was 14m (Figure 3.10). The averages were very similar across most zones because Lake Trout only occur in lakes that are relatively deep, leaving only limited room for variation across zones. The average for FMZ 15 was 16m, indicating the lakes in FMZ 15 are comparable to other zones in the province in terms of their potential Lake Trout habitat.

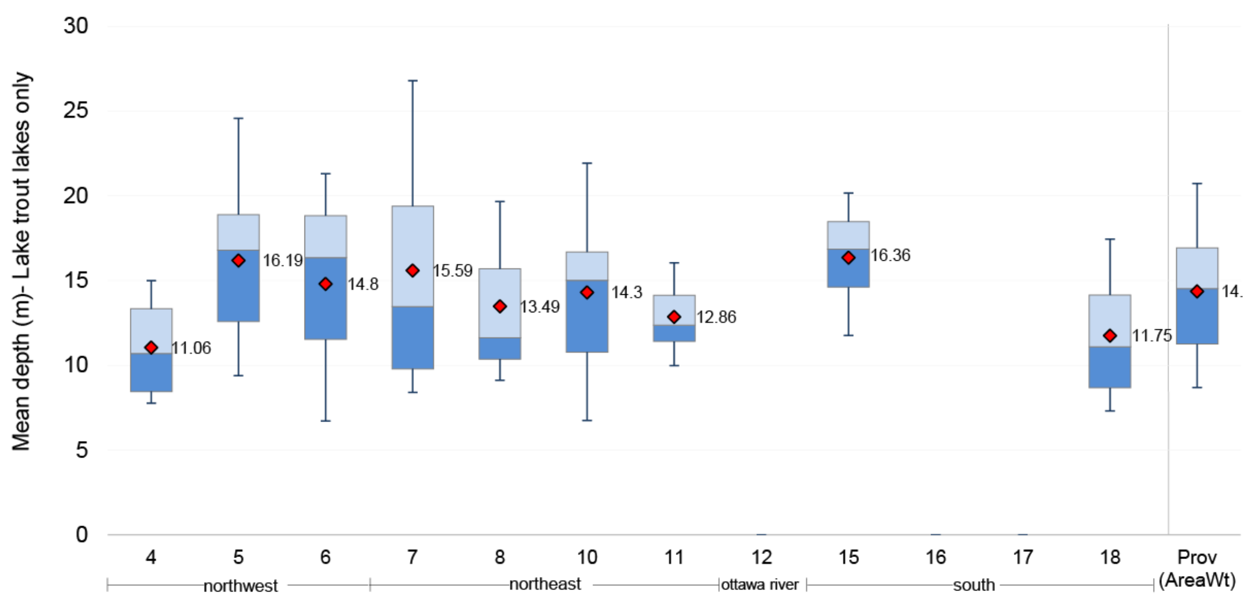


Figure 3.10 Area-weighted average mean depth (m) of Lake Trout trend lakes, by FMZ, BsM, Cycle 2.

The quality of deep-water habitat can be described by water quality parameters, including water clarity and total phosphorus concentration. Penetration of light into the deep-water habitat allows Lake Trout to feed, avoid predation and carry-on other life processes. The ability of lakes to support productive Lake Trout populations declines below a water clarity threshold of about 4m and they seldom occur in lakes with clarity of less than 3 m. Climate change is expected to reduce the water clarity in lakes due in increasing levels of dissolved organic carbon. Nutrient enrichment can also reduce clarity due to increased algal growth. The average secchi depth in Lake Trout trend lakes in FMZ 15 was 4.8 m in Cycle 2, which was about average for lakes monitored provincially (Figure 3.11). Neighbouring zones 10, 11 and 18 all had higher average water clarity than zone 15.

In Canadian shield lakes, phosphorus is usually the element that limits the amount of primary productivity, in the form of plant and algae growth. These in turn control the rate at which oxygen is depleted in deep water due to decomposition when the lakes are thermally stratified. Values less than 10µg/l indicate oligotrophic conditions. Higher phosphorus will result in a faster rate of oxygen depletion and less or poorer Lake Trout habitat. The average phosphorus concentration in Lake Trout trend lakes was 6µg/l in Cycle 2, which was similar to the provincial average and indicates that nutrients levels are low (Figure 3.12).

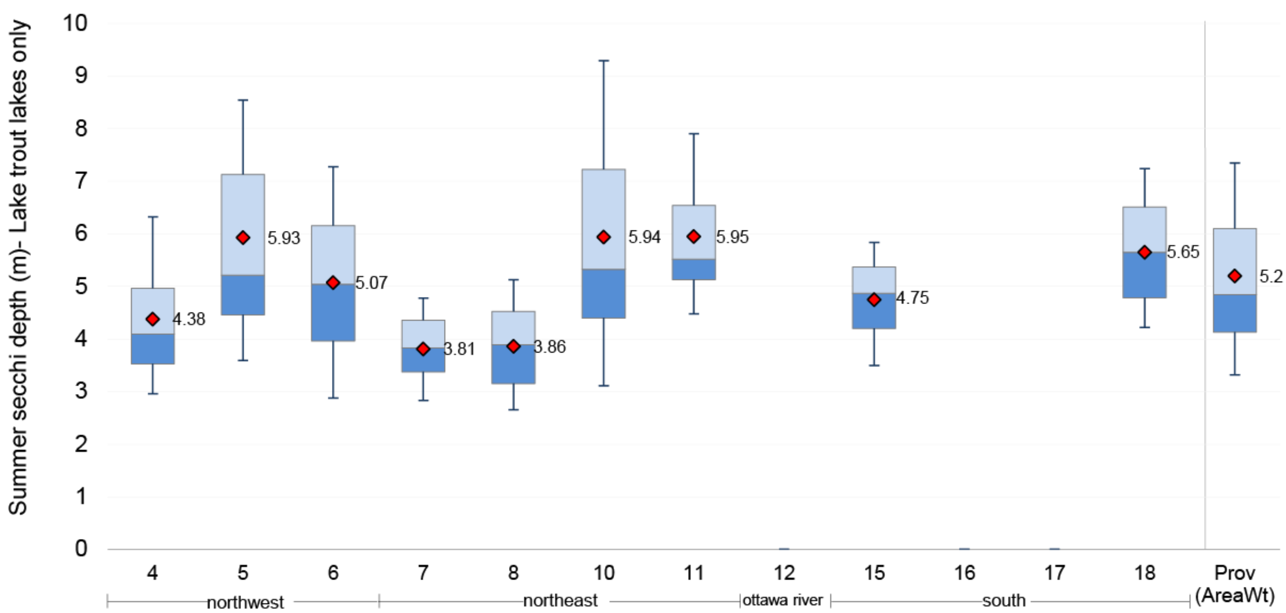


Figure 3.11 Area-weighted average secchi depth (m) of Lake Trout trend lakes, by FMZ, BsM Cycle 2.

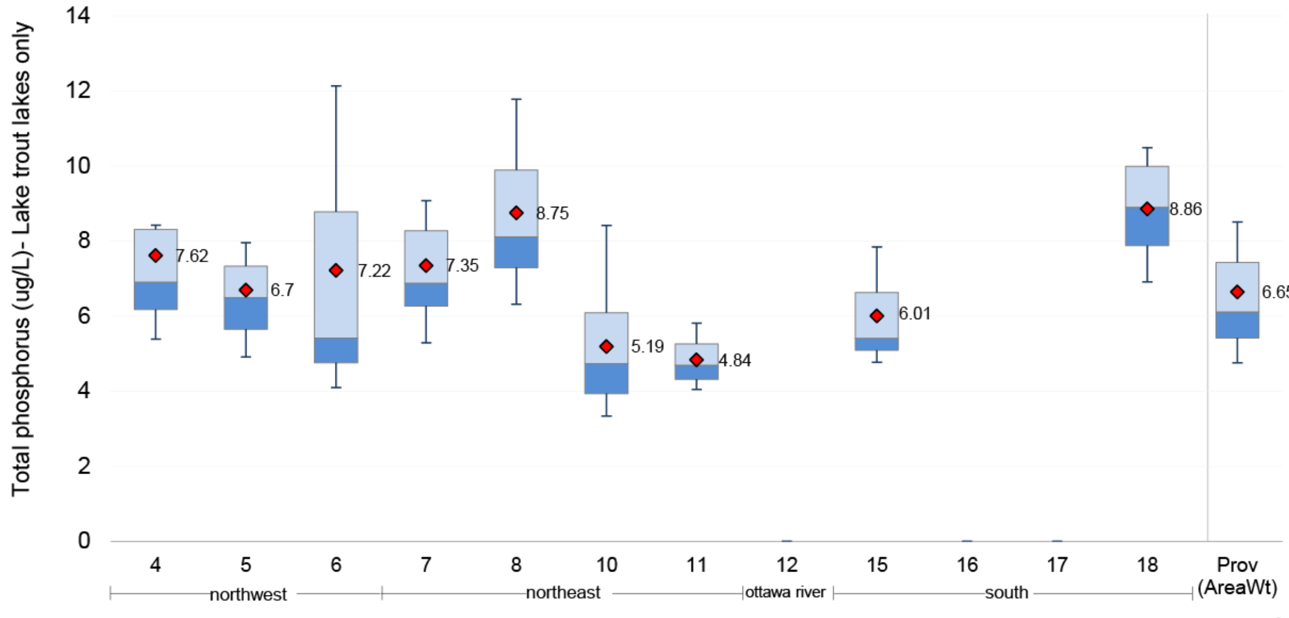


Figure 3.12 Area-weighted average total phosphorus concentration of Lake Trout trend lakes, by FMZ, BsM Cycle 2.

Two additional habitat components specific to Lake Trout are collected/monitored locally; late summer deep water oxygen levels and spawning habitat. The ability of a lake to support a reproducing population and the size and quality of the fishery is largely determined by the volume of, and dissolved oxygen levels in, the hypolimnion during summer thermal stratification. The amount of dissolved oxygen can be reduced by nutrient enrichment resulting from shoreline and watershed development. The Dissolved Oxygen Criterion for the Protection of Lake Trout Habitat (MNR Policy FisPo.7.5.1) was developed to protect Lake Trout habitat from such impacts, necessitating the collection of data. The mean volume-weighted hypolimnetic dissolved oxygen concentration (MVWHDO) has been measured in most lakes and monitored regularly by MNRF or MECP (Figure 3.13). Most lakes with average values of 6 mg/l and higher are managed as natural lakes. Exceptions tend to have other limiting factors, such as low water clarity. Similar numbers of lakes with late summer oxygen levels between 3 and 6 mg/l are managed as either natural or PGT lakes. The benchmark frequency distribution of mean volume-weighted hypolimnetic dissolved oxygen concentration for designated Lake Trout lakes in FMZ 15 is shown in Table 3.10. The reasons for the difference in management approach is differences in other factors including lake bathymetry, the presence of a native population, historic stocking, fish community and accessibility. Many lakes with oxygen levels lower than 3 mg/l were managed as natural populations. This seemingly counter-intuitive observation may be because the lakes in the category are not actively managed due to the low quality of the habitat. Many lakes with low oxygen levels have been converted to fisheries for other species, especially Splake.

Spawning areas in many lakes have been identified through surveys or incidental encounters. Data collection is generally limited, but in a small number of lakes more detailed measurements have been made such as studies of egg deposition and fry emergence. These studies have generally been one-time occurrences for local management needs and long-term monitoring is not generally conducted.

Climate change is expected to have a major impact on Lake Trout habitat (Minns et al. 2009). Warmer temperatures and longer periods of thermal stratification will result in lower oxygen levels. Large deep lakes will be most resilient to change, and small, shallower lakes will be changed the greatest.

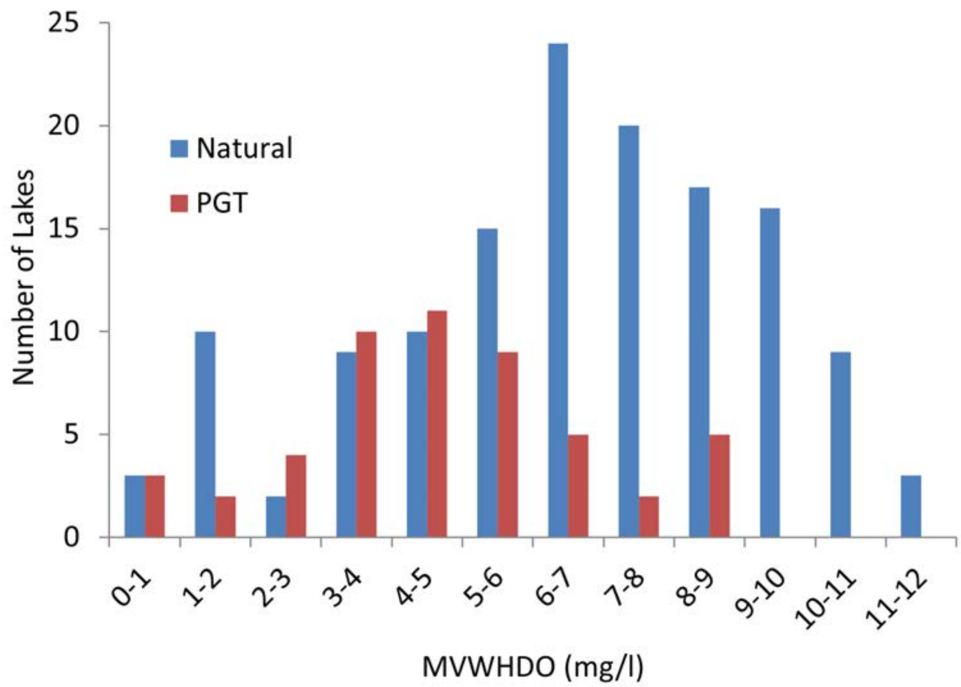


Figure 3.13 Frequency distribution of late summer mean volume-weighted hypolimnetic dissolved oxygen (MVWHDO) of designated Lake Trout lakes in FMZ 15.

Table 3.10 Benchmark frequency distribution of mean volume-weighted hypolimnetic dissolved oxygen concentration for designated Lake Trout lakes, FMZ 15.

MVWHDO (ppm)	Natural	PGT	Total
0.0-1.0	0.02	0.06	0.03
1.1-2.0	0.07	0.04	0.06
2.1-3.0	0.01	0.08	0.03
3.1-4.0	0.07	0.20	0.10
4.1-5.0	0.07	0.22	0.12
5.1-6.0	0.11	0.18	0.13
6.1-7.0	0.17	0.10	0.15
7.1-8.0	0.14	0.04	0.12
8.1-9.0	0.12	0.10	0.12
9.1-10.0	0.12	0.00	0.08
10.1-11.0	0.07	0.00	0.05
11.1-12.0	0.02	0.00	0.02

Fish community composition is a major stress on Lake Trout in FMZ 15. Smallmouth Bass have been introduced to almost every Lake Trout lake in the zone. Bass were caught in every Lake Trout trend lake in Cycle 2 and in those lakes, bass abundance was relatively high (Figure 3.14). Exotic Rainbow Smelt have also been widely introduced. They were caught in small-mesh nets in 8 of 12 trend lakes in Cycle 2, with a very high level of abundance (Figure 3.15). Walleye were caught in 5 of 12 trend lakes in Cycle 2 (Figure 3.16). Overall lake-wide abundance was relatively low.

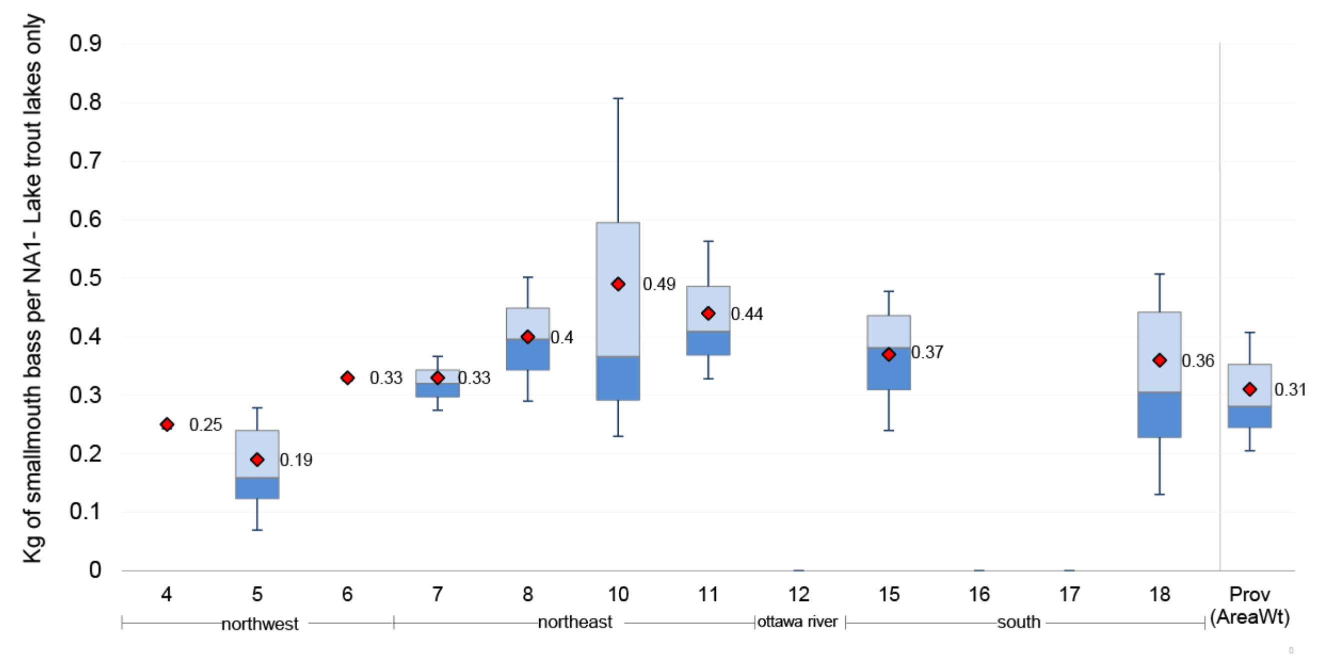


Figure 3.14 Area-weighted CUEW (kg/net) of Smallmouth Bass, for Lake Trout trend lakes, by FMZ, BsM Cycle 2.

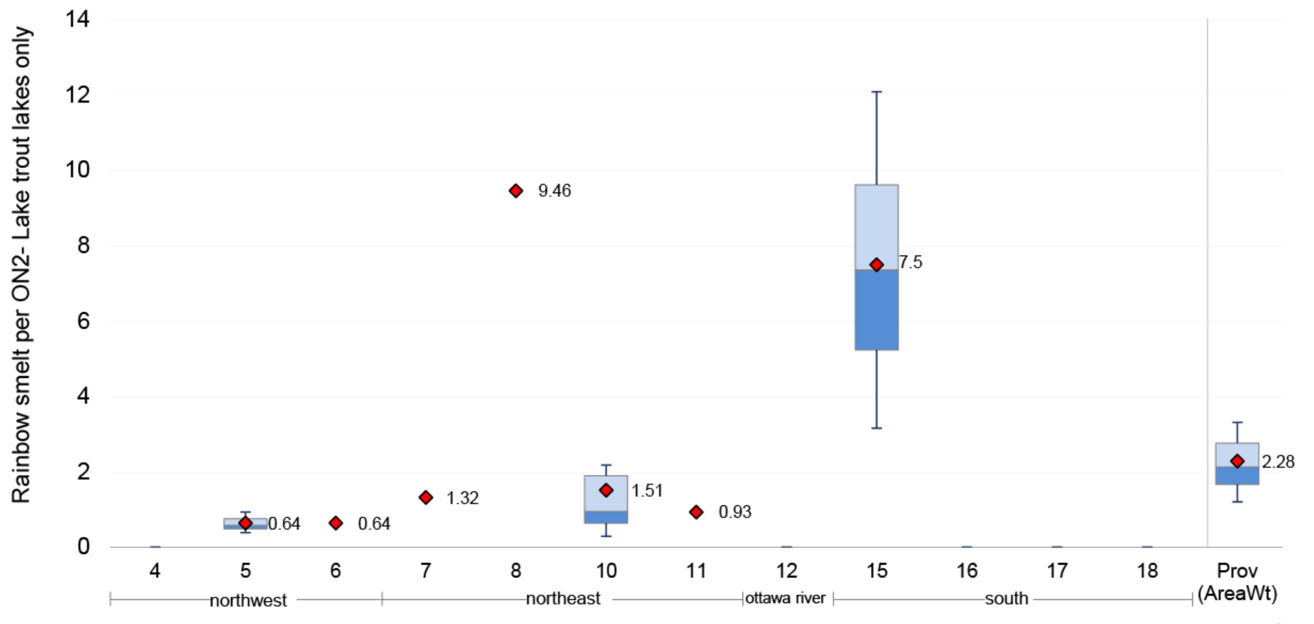


Figure 3.15 Area-weighted CUE (number of fish/net) of Rainbow Smelt from small mesh nets, for Lake Trout trend lakes, by FMZ, BsM Cycle 2. CUE was calculated using only lakes in which smelt were caught.

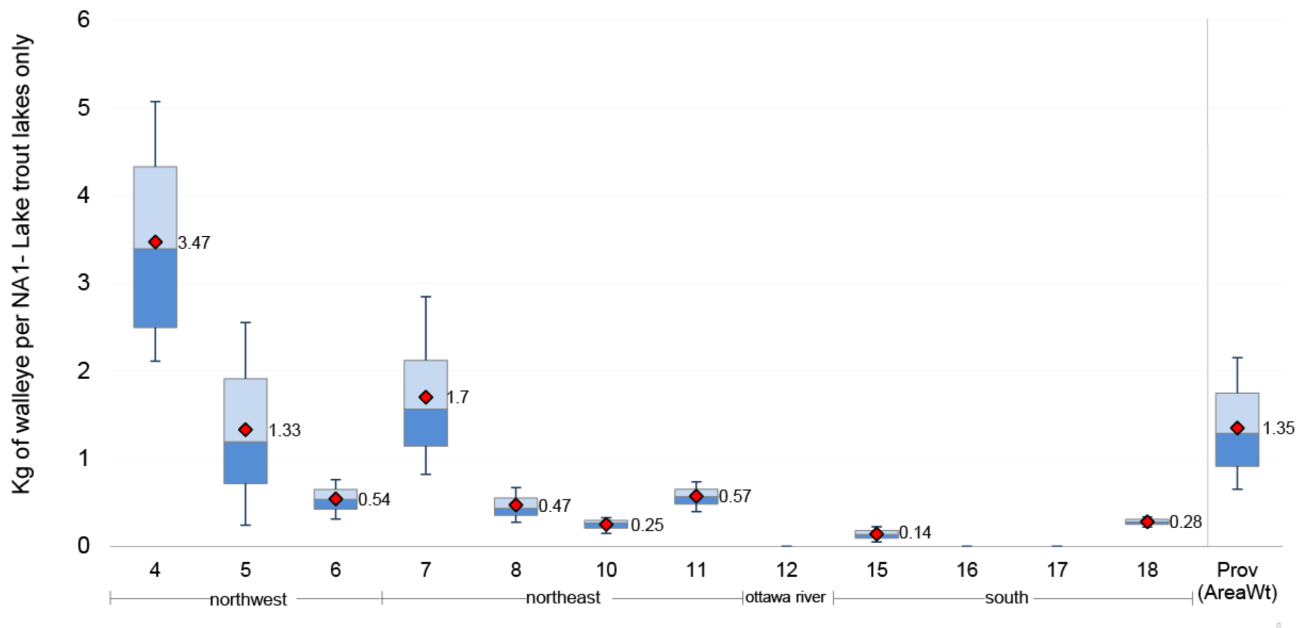


Figure 3.16 Area-weighted CUEW (kg/net) of Walleye for Lake Trout trend lakes, by FMZ, BsM Cycle 2. CUEW was calculated using only lakes in which Walleye were caught.

3.5.2.4 Abundance

The abundance of Lake Trout in FMZ 15 is monitored primarily through the BsM program. Those data have been supplemented through local monitoring, primarily using the Summer Profundal Index Netting (SPIN) protocol. Data from the local projects are used to inform decisions about individual lakes but because lake selection is not random is less useful for describing the overall status of the Lake Trout resource in the zone.

The average catch of Lake Trout of recruit size (>350 mm), by weight, in large mesh nets was 0.4kg in both Cycle 1 and 2 (Figure 3.17). The catch rate was lower than the provincial average of 0.7kg and similar to FMZ 18 which neighbours FMZ 15, to the south. The catch rates in zone 10 and 11, adjacent to the north, were higher. Differences in habitat, fish community and harvest probably explain the differences observed but it is not possible to discern which factors had the greatest influence.

Even though the overall zone average was the same between cycles, the catches from individual lakes varied greatly between BsM cycles (Figure 3.18). Overall, half of the lakes had higher catches in Cycle 2 and half lower catches. No zone-wide management actions were undertaken between cycles and the time period was probably too short for any landscape-wide stresses to cause long-term changes; therefore, the observed differences were probably due to individual lake variation and not any systematic changes to groups of lakes.

More detailed trend information was available for Lake Joseph and Lake Rosseau, which have been monitored most years since 2008 using the SPIN protocol. They are among the largest natural Lake Trout lakes and probably support the largest fisheries in the zone. The catch rates in these lakes have a large influence on the zone average due to the large surface area and high catch rates. Like the BsM data, there is a lot of year-to-year variation, but the greater number of sample points indicates that there has been an overall declining trend in abundance in both lakes since 2008 (Figure 3.19).

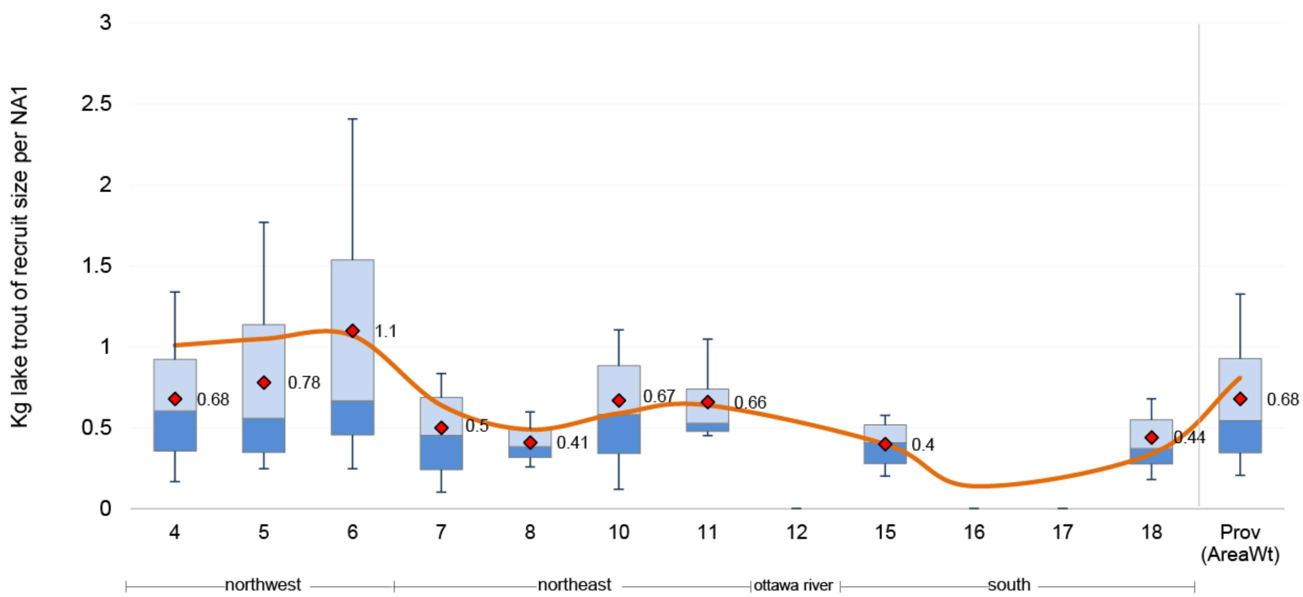


Figure 3.17 Area-weighted CUEW (kg/net) of Lake Trout recruits, for Lake Trout trend lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

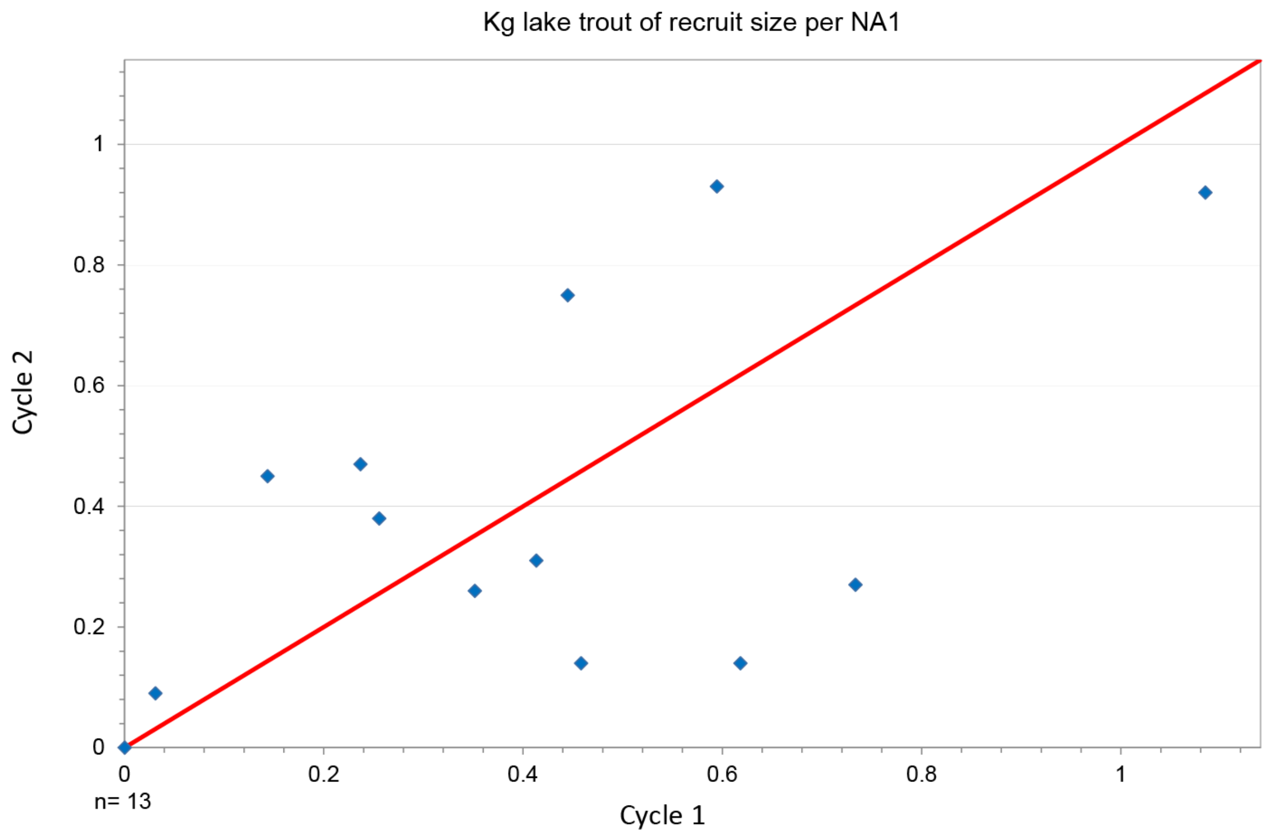


Figure 3.18 Comparison of CUEW (kg/net) of Lake Trout recruits, FMZ 15, BsM Cycle 1 and 2.

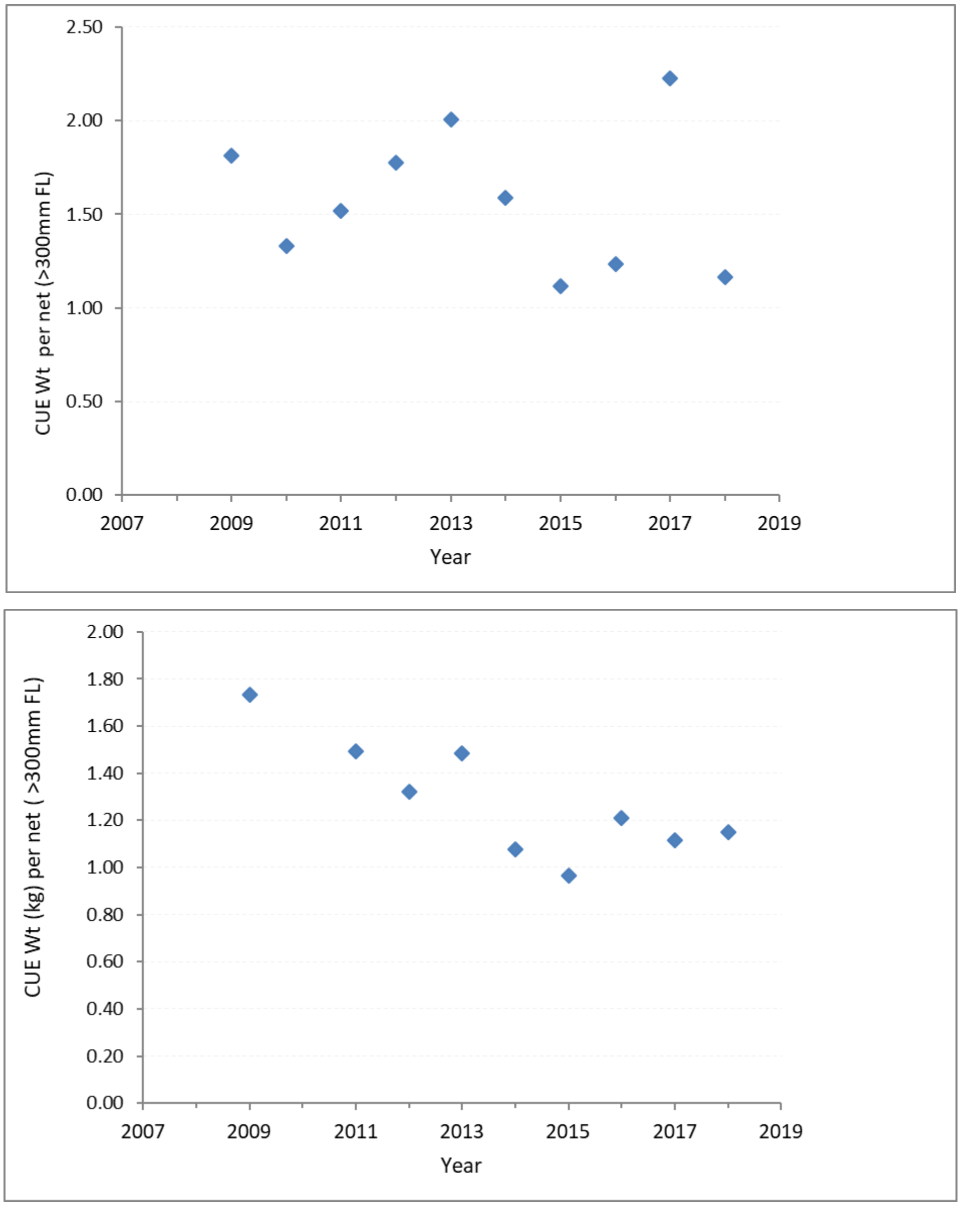


Figure 3.19 CUEW (kg/net) of Lake Trout recruits for Lake Joseph (top) and Lake Rosseau (bottom), SPIN, 2008-2018.

3.5.2.5 Population Characteristics

Size

The growth rate, size at maturity and potential maximum size of Lake Trout follow two general patterns, dictated largely by the type and size of food that is available. This variability has important implications for the management of Lake Trout. 'Small-bodied' populations occur in lakes where the primary prey are invertebrates and small fish; they mature at a small size, grow slowly as adults, and seldom attain large sizes. Typically, they become mature at about 35cm and adults grow to about 55cm. 'Large-bodied' populations occur in lakes where larger fish, especially cisco, comprise a large proportion of the diet; they mature at a larger size, grow more as adults, and attain large adult sizes. Typically, Lake Trout become mature at about 50 cm and grow to over 80cm. As always, there is considerable variation between populations, but most populations can be classified as one of the two types.

In FMZ 15, the body size of most populations has been determined through sampling (Table 3.11). There are roughly equal numbers of populations of each type. Small-bodied populations occur more frequently in smaller lakes, and vice versa, but there are exceptions, based on the prey that are available.

Total length distributions of Lake Trout captured by the BsM program for FMZ 15, separated by population body size classification are shown in Figure 3.20. Fish in small-bodied populations are primarily smaller than 50cm; the food that is available to these populations does not allow them to grow much larger. Large-bodied populations have a much higher proportion of fish that are larger than 50cm due to the availability of cisco and smelt.

Table 3.11 Number of natural Lake Trout lakes by observed body size and BsM lake size class, FMZ 15. Not all lakes have been classified.

Surface Area (ha)	Small-bodied	Large-bodied
5-50	12	6
50-500	61	47
500-1,500	12	13
1,500-5,000	3	7
>5,000		4
Total	88	77

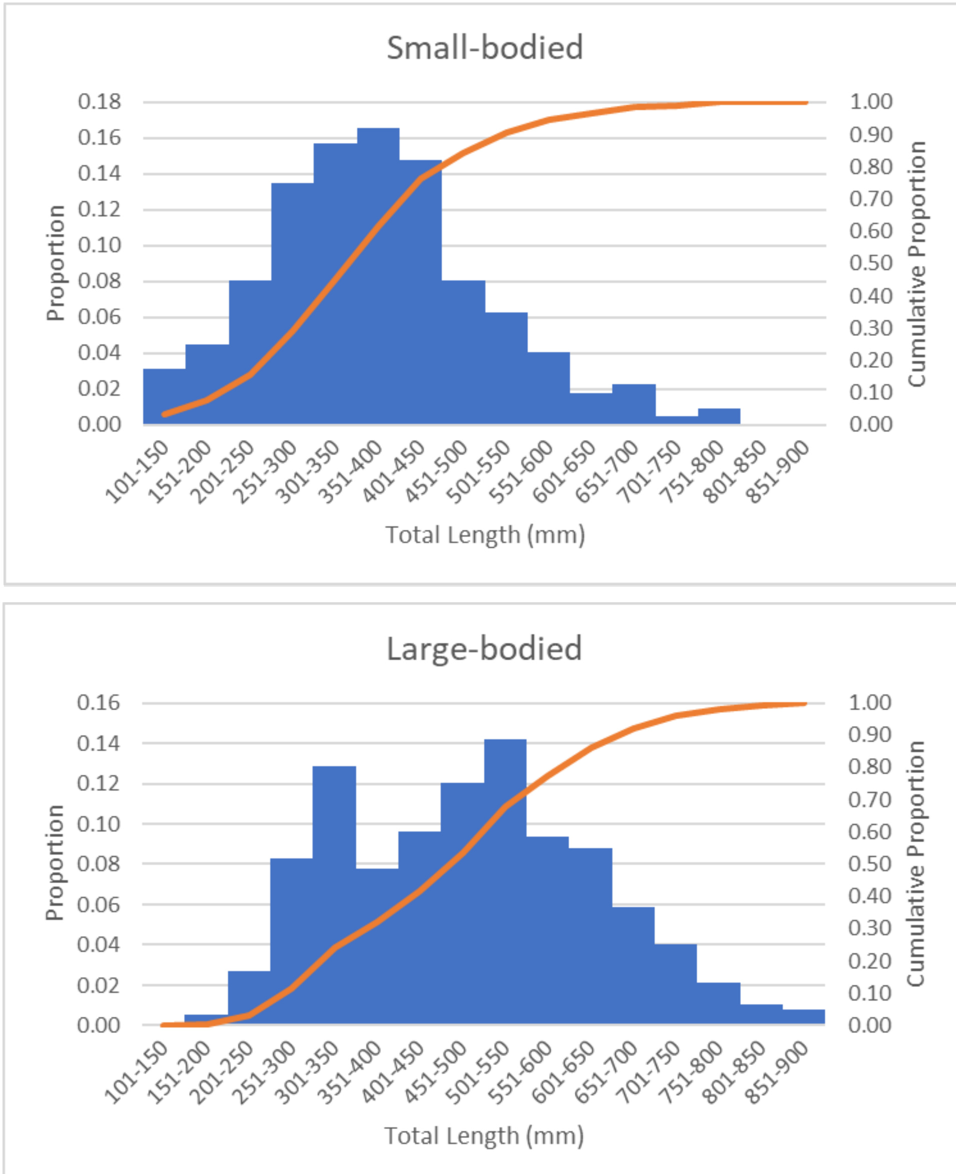


Figure 3.20 Total length (mm) frequency distribution of Lake Trout, by body size classification, FMZ 15, BsM Cycle 1 and 2 combined.

Average size is a manifestation of the rate of entry of small fish into a population, their rate of somatic growth and their rate of mortality. The meaning of average size can't be interpreted without at least some knowledge of these underlying causes. The calculation is also subject to sampling variability due to the small number of fish caught in some lakes. Using only fish of recruitment size and larger eliminates some of the effect of varying recruitment of small fish into the population. The large variation in growth and body size amongst populations of Lake Trout is a major factor constraining the interpretation of this measure on a zone-wide basis.

The average recruitment size Lake Trout (>350mm), in FMZ 15, in Cycle 2 was 565mm which was similar to the overall provincial average and most individual FMZs (Figure 3.21). As with abundance, there was a large amount of lake to lake variation between cycles (Figure 3.22). Slightly more population samples had larger average size in Cycle 2 than smaller average size.

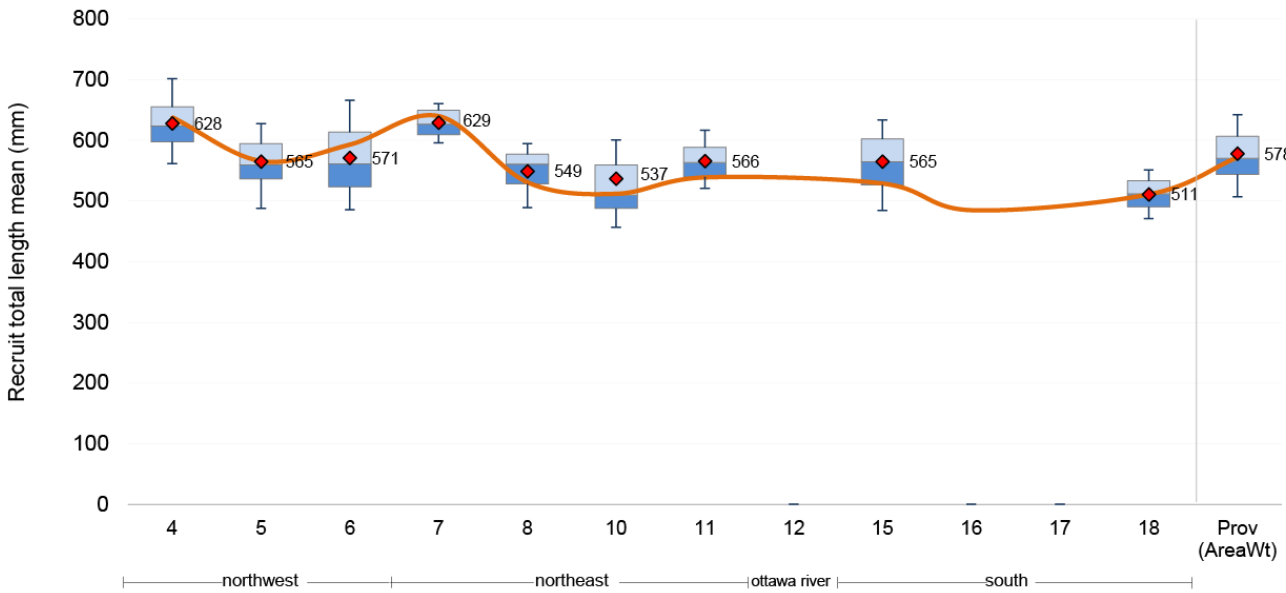


Figure 3.21 Area-weighted average mean total length (mm) of Lake Trout recruits, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

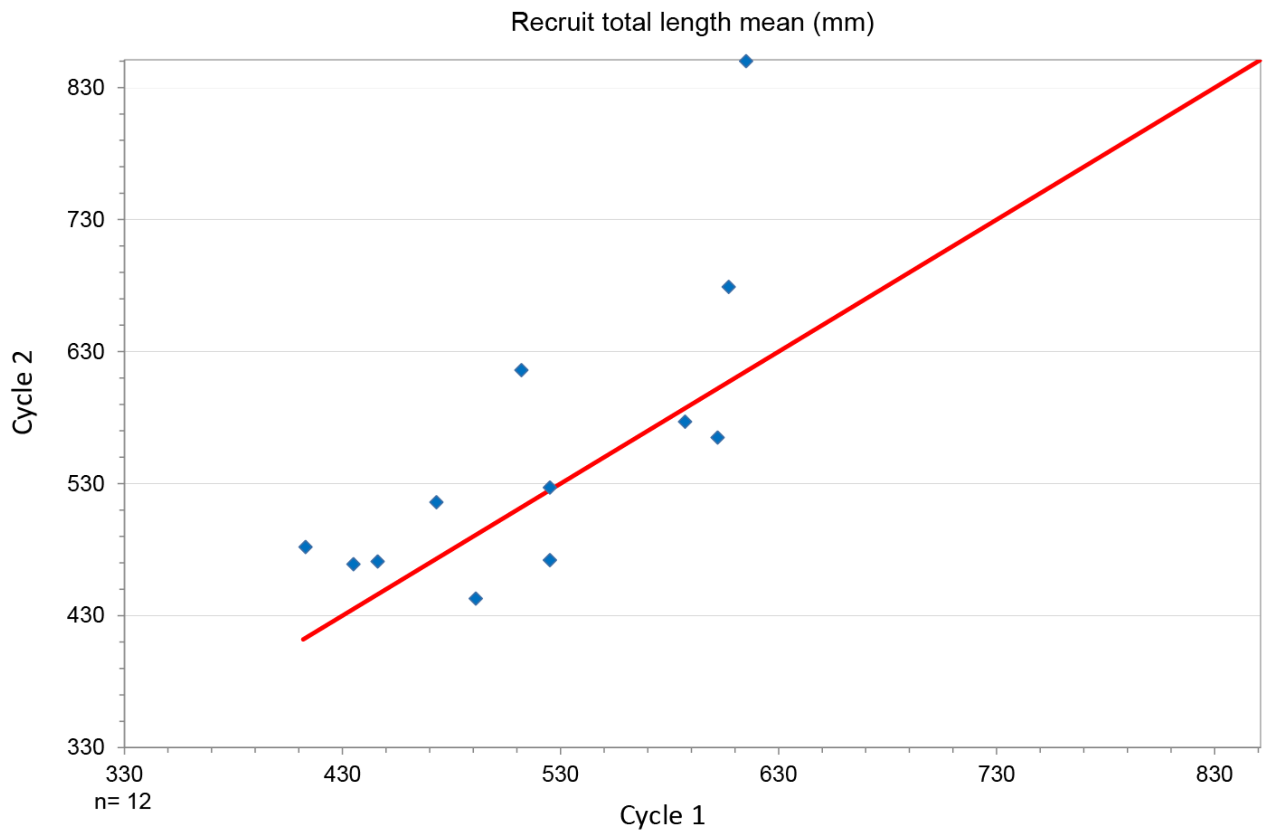


Figure 3.22 Comparison of average mean total length (mm) of Lake Trout recruits, FMZ 15, BsM Cycle 1 and 2.

Age

The age distributions of Lake Trout captured in Cycle 1 and 2 of the BsM program, are shown in Figure 3.23. Fish in small-bodied populations generally have higher mortality so the proportion of older fish is less than observed for large-bodied populations.

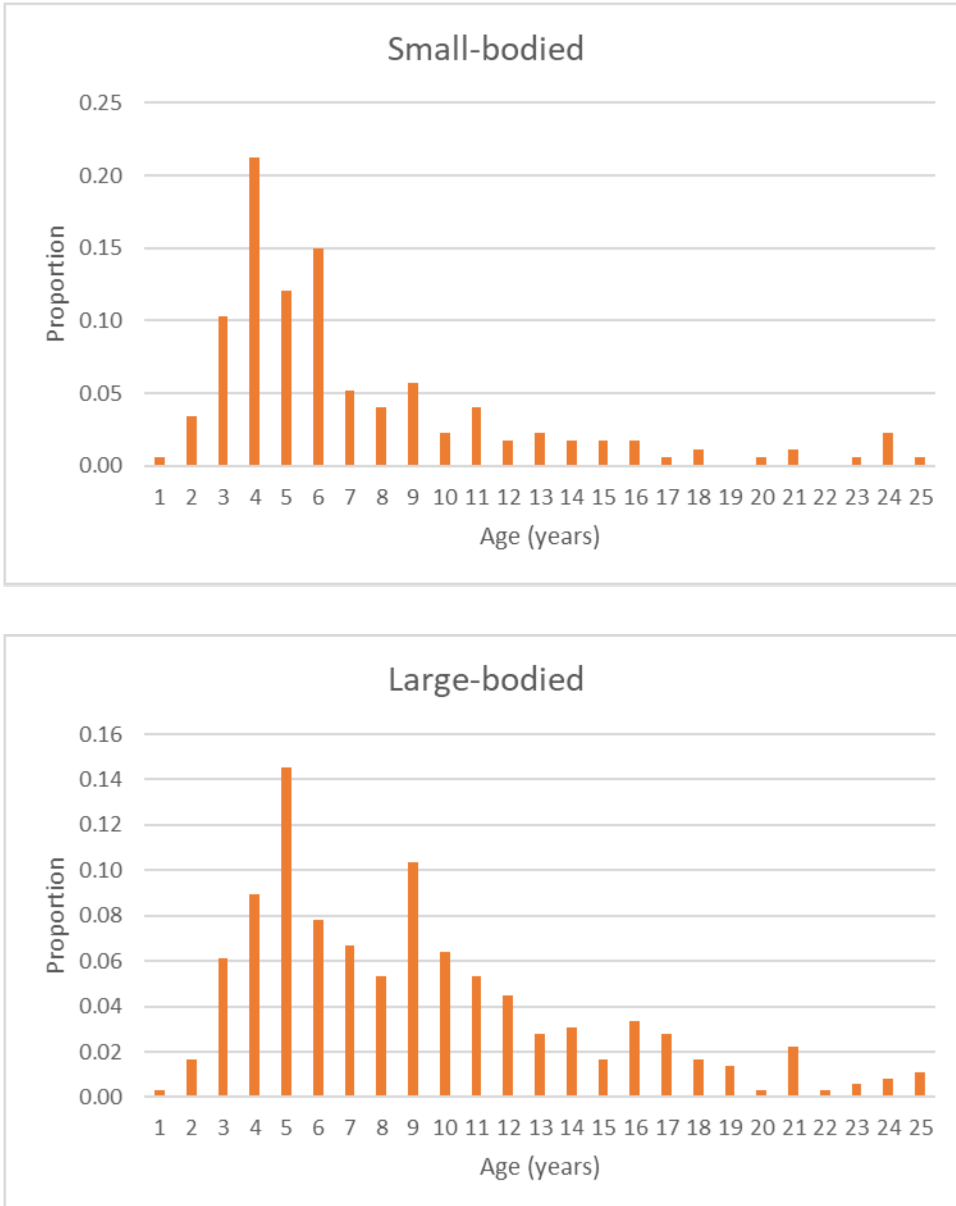


Figure 3.23 Age frequency distribution of Lake Trout, by body size classification, FMZ 15, BsM Cycle 1 and 2 combined.

Measures of the age composition of a population provide more insight than size because the complicating factor of growth rate has been removed. Like size, calculations that use only recruit-sized fish are preferred to dampen the effect of short-term recruitment variability. Very low average ages or numbers of cohorts may indicate excessive mortality while very high mean ages can indicate poor recruitment. Combining data from many lakes tends to mask individual lake imbalances in the age distributions.

The average mean age of Lake Trout recruits in FMZ 15 was 10.8yrs in Cycle 1 and 13.4yrs in Cycle 2 (Figure 3.24). Additional cycles will help determine if the sizeable change between cycles is indicative of a trend or merely short-term variability. The average number of age cohorts observed for FMZ 15 was 6.7 in Cycle 1 and 7.8 in Cycle 2 which were below the provincial average (Figure 3.25). No patterns are apparent when comparing mean age from individual lakes from Cycle 1 to Cycle 2 (Figure 3.26).

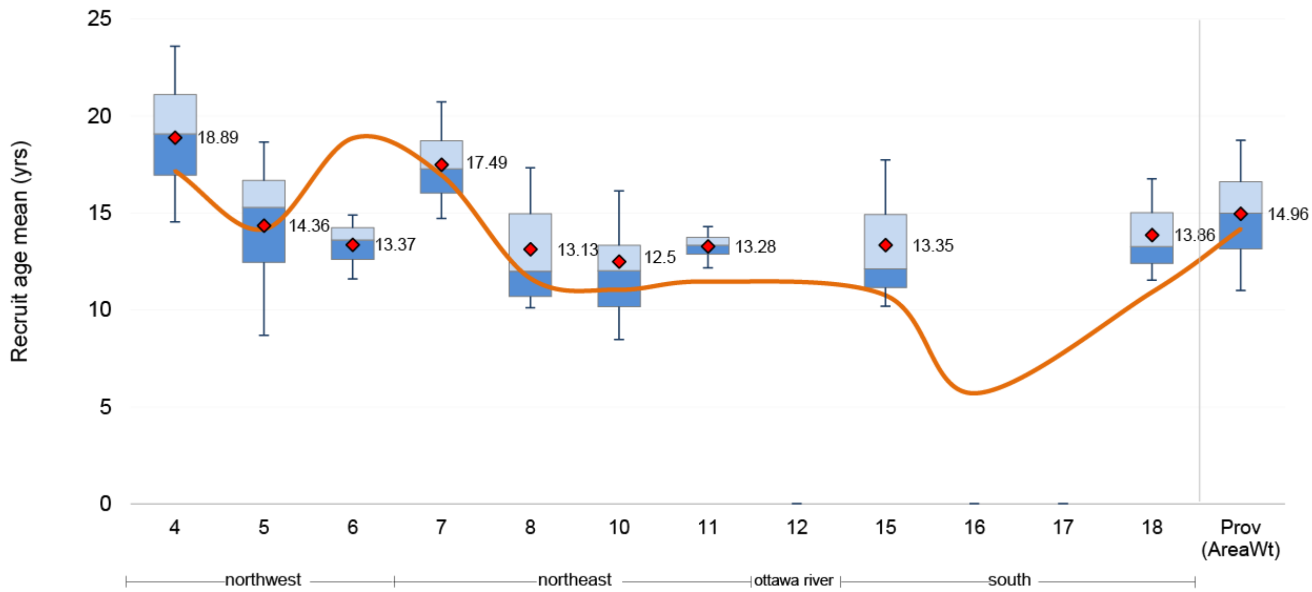


Figure 3.24 Area-weighted average mean age (years) of Lake Trout recruits, by FMZ, BsM Cycle 1 (line) and 2 (box plot).

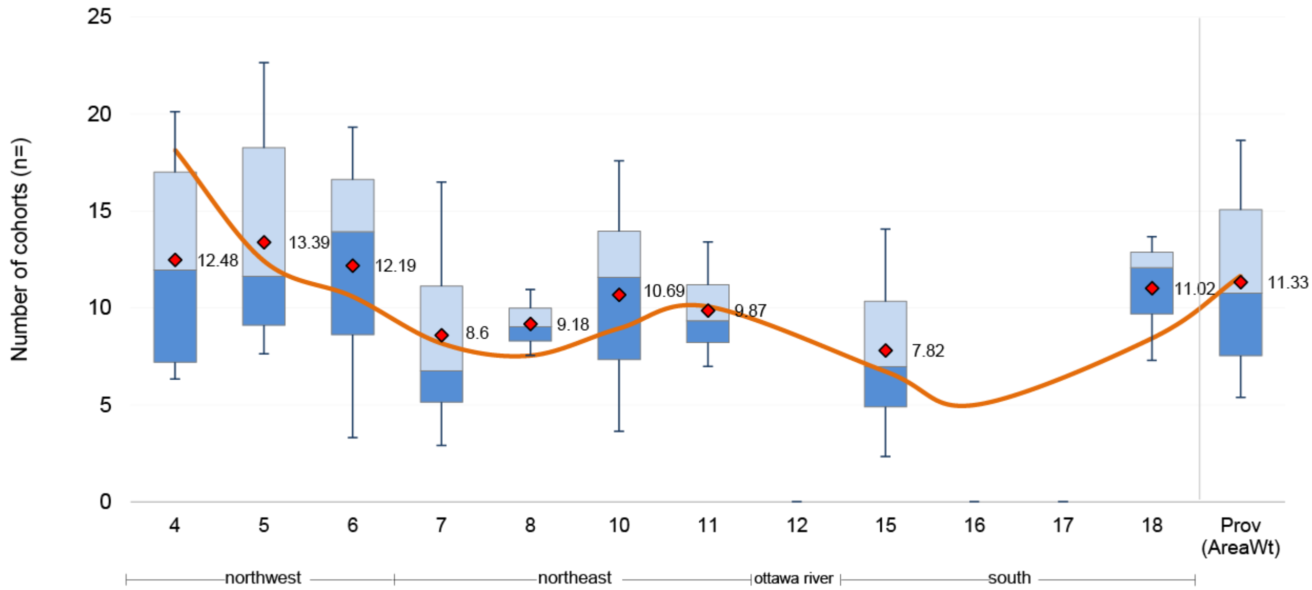


Figure 3.25 Area-weighted average number of age cohorts for Lake Trout trend lakes, by FMZ, BsM Cycle 1 (line) and 2 (box plot).

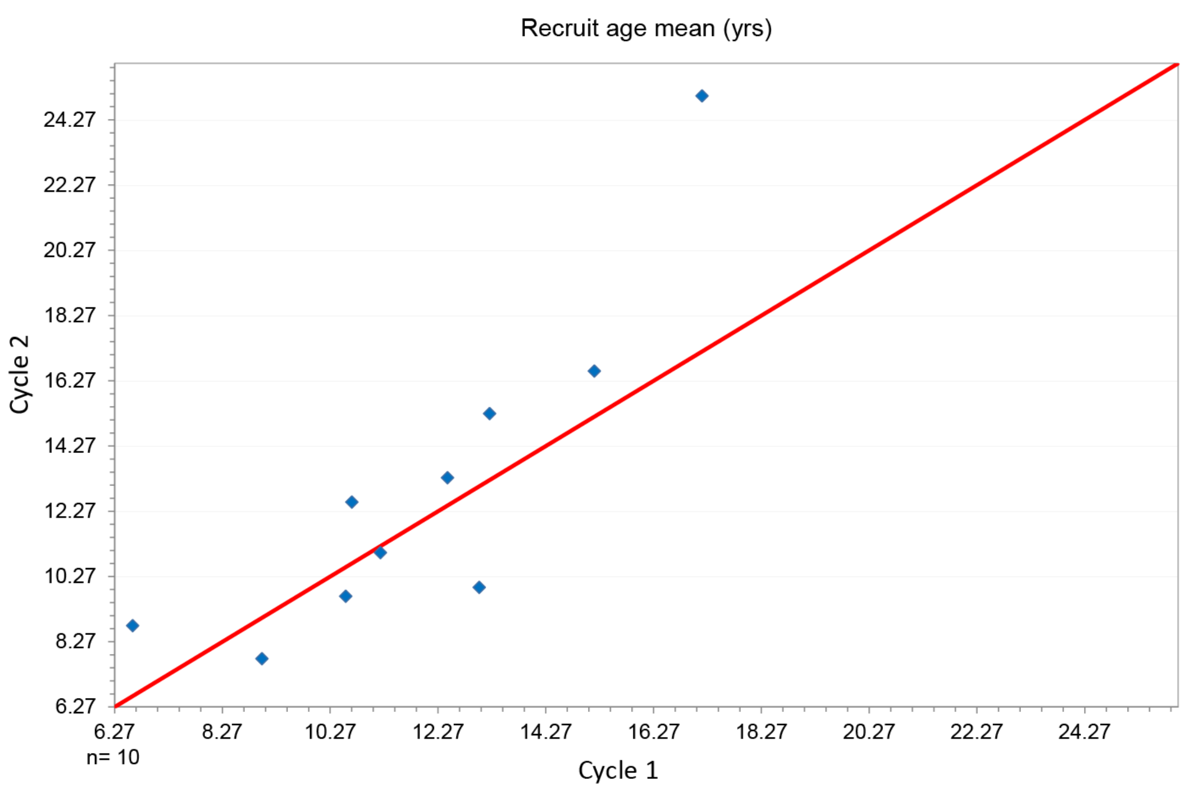


Figure 3.26 Comparison of average mean age of Lake Trout recruits, FMZ 15, BsM Cycle 1 and 2.

Proportional Size Distribution (PSD)

Proportional size distribution provides a visual representation of the size composition of a population that is based on nominal size groupings of interest to anglers (Section 3.2.2). The same caveats that apply to other measures of size apply to PSD as well. The PSD of Lake trout from FMZ 15, by cycle, is shown in Figure 3.27. Overall, the expected pattern of decreasing representation with increasing size is apparent. Source-stock, preferred and memorable Lake Trout are under-represented in the sample because they are not as vulnerable to being caught in the gear as the intermediate-sized (stock and quality) fish are.

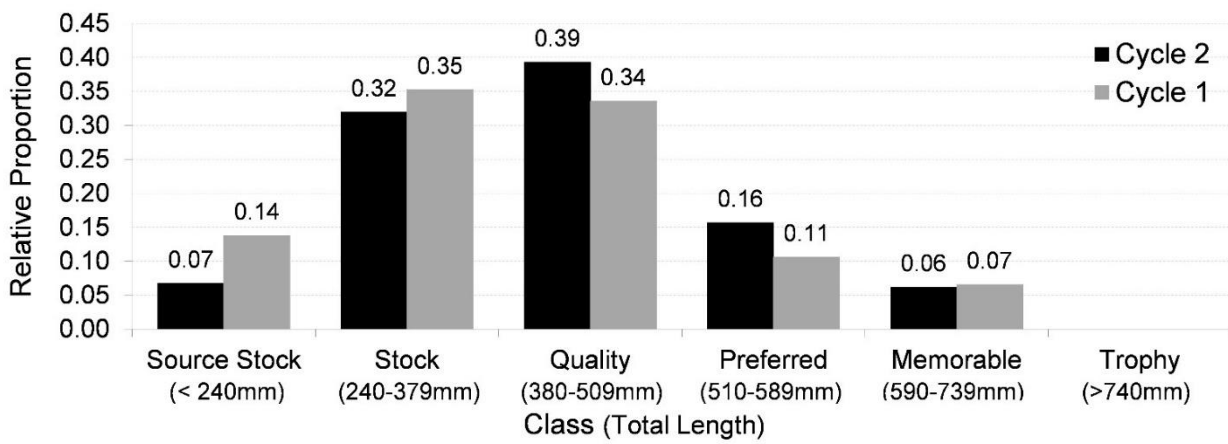


Figure 3.27 Proportional size distribution of Lake Trout, FMZ 15, BsM Cycle 1 and Cycle 2.

Growth and Maturation

Scatter plots of the size by age of individual Lake Trout, by body size classification, are shown in Figure 3.28. The growth of both types is similar until fish are about four years old. Growth rates then diverge; small-bodied fish begin to mature and devote energy to reproduction resulting in slower growth while large-bodied fish continue to grow quickly until they begin to mature several years later.

The proportion of female fish that were mature for each size class, separated small- and large-bodied populations are shown in Figure 3.29. In small-bodied populations, some females began to mature as small as 250mm, about half were mature at 400mm and all were mature at 450mm. In large-bodied populations females in some populations began to mature between 350-400mm, half were mature at about 450mm and most were mature at 500mm

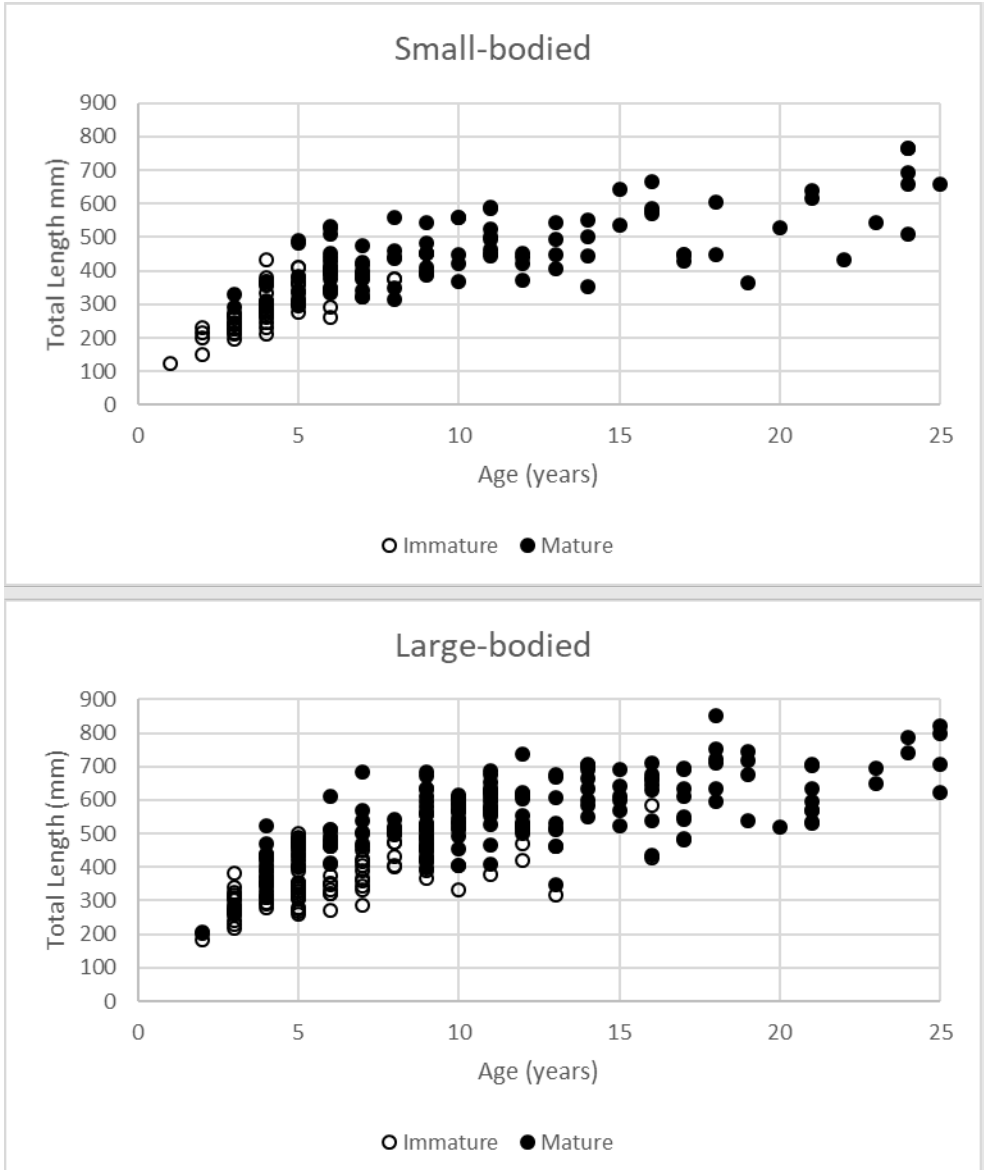


Figure 3.28 Total length (mm) at age of Lake Trout, by body size classification and maturity (open circles: immature, filled circles: mature), FMZ 15, BsM Cycle 1 and 2 combined.

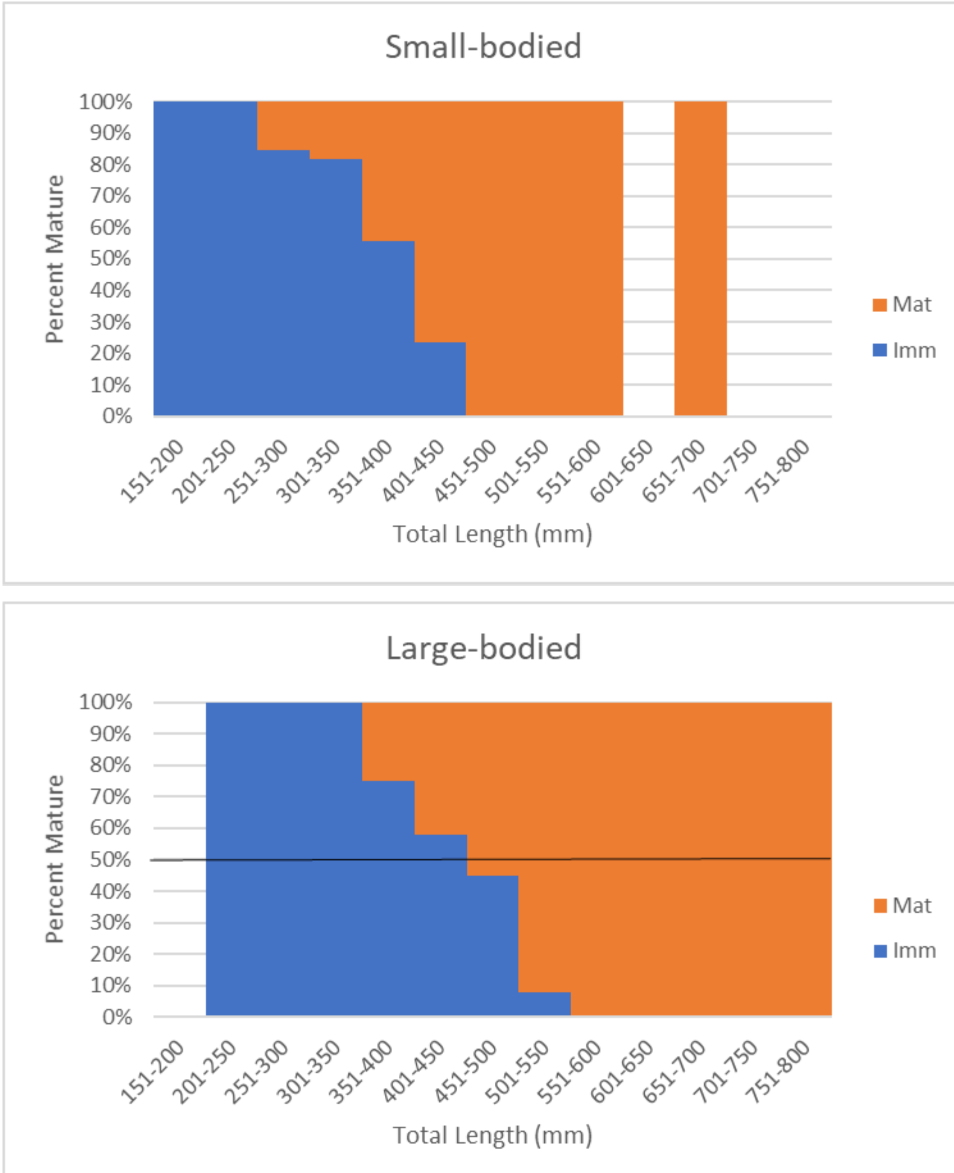


Figure 3.29 Proportion of female Lake Trout that were mature, by total length and body size classification, FMZ 15, BsM Cycle 1 and 2 combined.

3.5.2.6 Biological Reference Points

Abundance and mortality benchmarks have not been fully developed for Lake Trout; therefore, the production of a quadrant plot is not possible at this time.

Mortality/survival estimates were only available from one population in Cycle 1 and six in Cycle 2 due to the large number of fish that are required to be sampled in order to calculate mortality with some rigour. These sample sizes are most often available for the largest lakes because of the higher abundance and larger number of nets that are set. Sample sizes are less likely to be attained in small lakes or those with low abundance (high mortality) therefore the values available are probably not representative of the whole zone.

Nevertheless, the large lakes are important in their contribution to the zone-wide average due to the area-weighting; therefore, the estimates may be meaningful even though the sample size is small and biased.

The single survival estimate available from Cycle 1 was 0.85 from an extra-large lake. Survival estimates were similar for all lakes, ranging from 0.8 to 0.88, with an average of 0.83. This value was very similar to the provincial average (Figure 3.30). The value of 0.83 means that 83% of catchable fish in the population live from one year to the next. Sustainable levels of mortality vary with population characteristics. Shuter et al. (1998) developed a life history based model for Lake Trout in Ontario that estimated various parameters from lake size and productivity. For lakes of moderate productivity, survival at maximum sustainable yield ranged from .63 for small lakes to .70 for large lakes.

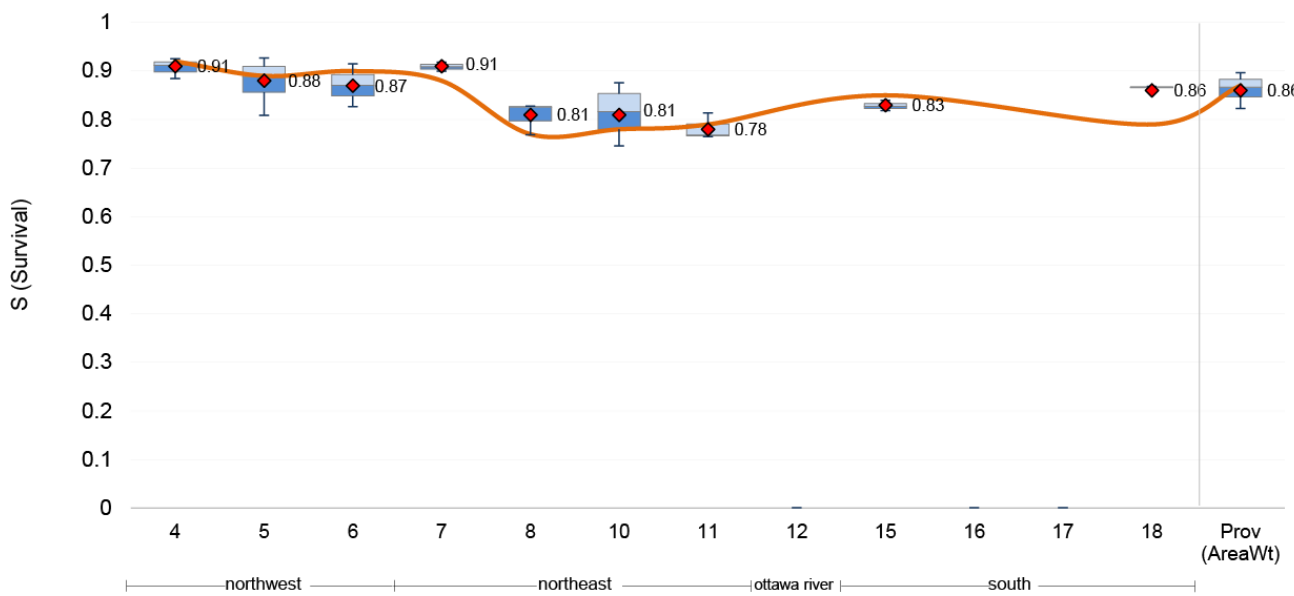


Figure 3.30 Area-weighted average annual survival of Lake Trout recruits, by FMZ, BsM Cycle 1 (line) and 2 (box plot).

3.5.3 Other Trout and Salmon

Rainbow Trout (*Oncorhynchus mykiss*), Kokanee Salmon (*Oncorhynchus nerka*), Brown Trout (*Salmo trutta*) and Atlantic Salmon (*Salmo salar*) have been stocked in the zone. Naturalized, self-sustaining populations of the former two species have become established in three waterbodies:

- Bernard Lake – Rainbow Trout
- Sand Lake – Rainbow Trout
- Boulter Lake - Kokanee Salmon

There are no known reproducing populations of the other two species. Rainbow Trout and Brown Trout continue to be stocked on a PGT basis in many lakes (Section 5.13); the other two species have not been stocked in many years.

The populations of Rainbow Trout and Kokanee are the only occurrences in small inland waters in the province that the planning team is aware of. Very little is known about them other than populations are extant and there are targeted fisheries based on them. Waterbody-specific fish sanctuaries have been in place for many years to protect adults during the spawning season.

3.5.4 Lake Whitefish

3.5.4.1 Description

Lake Whitefish (*Coregonus clupeaformis*) is a coldwater species of the Coregonid sub-family. They occur in deep lakes that thermally stratify and have an oxygenated thermocline and hypolimnion and have a thermal preference between 10-14°C (Christie and Regier 1988). They often co-habit lakes with Lake Trout but are also often able to sustain populations in lakes that do not have adequate deep-water habitat to support Lake Trout. They are primarily a benthic species that feeds on insects, crustacean's, molluscs and small fish. Lake Whitefish spawn in the late fall, using similar habitat as Lake Trout. Lake Whitefish have shown considerable phenotypic plasticity, depending on existing fish communities and habitat availability.

3.5.4.2 Distribution

Unlike most of the other major sport fish species, the range of Lake Whitefish has probably not been significantly altered from its native distribution although there may have been some populations unknowingly extirpated or different forms could have been lost with the introduction of invasives; e.g. *Bythotrephes* (Spiny water flea). The Atlas of Lake Whitefish Waters in Ontario (OMNR 2003) lists 114 waterbodies in the zone excluding Algonquin Provincial Park (Figure 0.31).

In Cycle 2, Lake Whitefish were caught in 17 lakes; 7 Lake Trout lakes, 7 Walleye lakes, 1 Brook Trout lake and 3 state lakes. One (1) lake was both a Lake Trout and a Walleye trend lake. The number of lakes was similar in Cycle 1(19 lakes). They were caught in 11 of 14 lakes greater than 1500 ha and only 8 of 25 lakes smaller than 1500 ha.

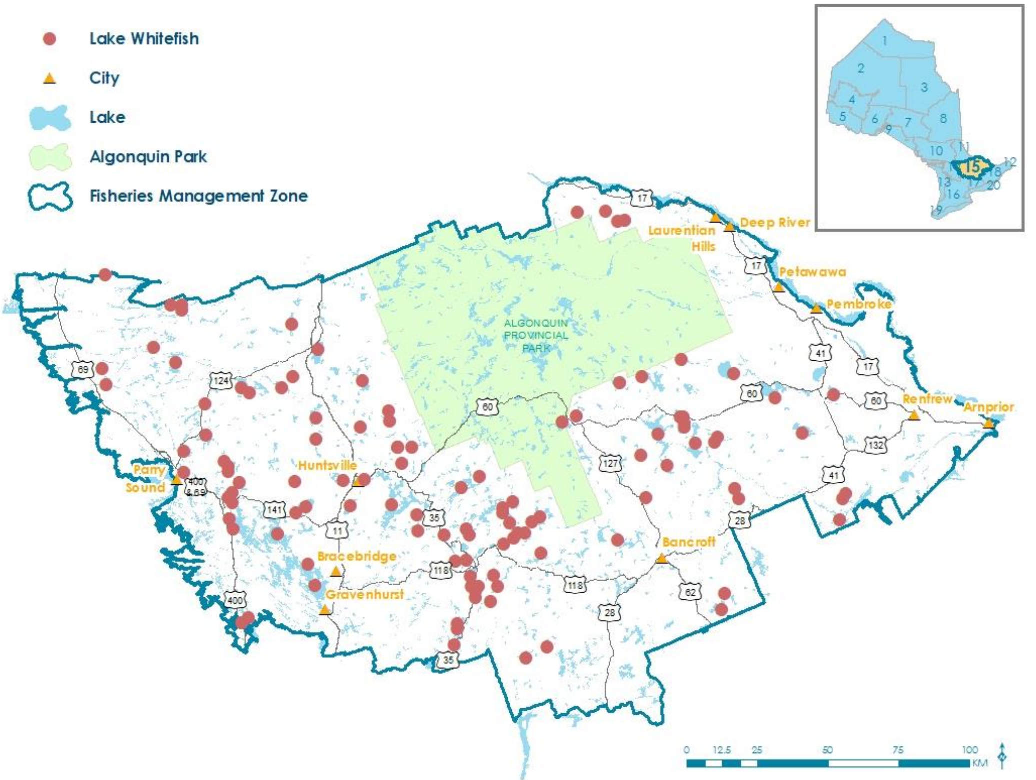


Figure 3.31 Distribution of Lake Whitefish in FMZ 15, excluding Algonquin Provincial Park (OMNR 2003).

3.5.4.3 Habitat and Fish Community

Lake Whitefish are known to inhabit deep, cold inland lakes. They tend to stay within proximity to the bottom of lakes and rivers almost exclusively, regardless of season, as they have evolved physiological characteristics including a sub-terminal mouth for benthic feeding. They often co-exist in fish communities with other coldwater species including Lake Trout, Cisco, and/or Rainbow Smelt. Depending on the fish community, there may be several different body form morphs of whitefish in the same lake.

3.5.4.4 Abundance

Lake Whitefish are not a targeted species within BsM but are caught in Lake Trout and Walleye trend BsM lakes where present. Because they occur in lakes that do not support Lake Trout or Walleye, the chosen lakes are not considered a random sample of the Lake Whitefish resource and as such, extrapolations to the zone scale should be held with an understanding that it may not reflect the true condition of the whitefish resource across the zone.

The relative abundance of Lake Whitefish recruits measured during Cycle 1 and 2 was generally higher in the northwest and northeast, and lower in the south (Figure 0.32). The catch rate in FMZ 15 was lower than the provincial average for both Cycle 1 and 2, at 0.3 and 0.4 fish/net, respectively. FMZs 16, 17 and 18 were the only zones to have lower catches of Whitefish; however, these zones have significantly fewer coldwater lakes that support Whitefish populations.

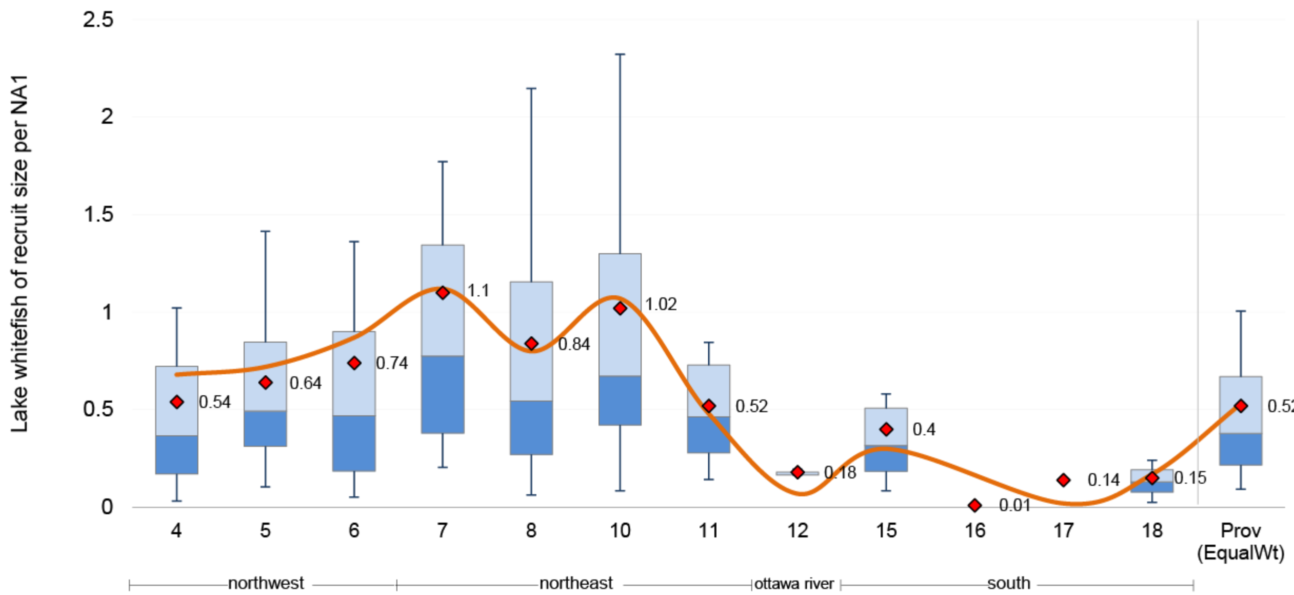


Figure 3.32 Equally-weighted average CUE (number of fish) of Lake Whitefish recruits from all lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

The CUEW of Lake Whitefish recruits showed a similar trend to the CUE across all FMZs in Ontario. The CUEW for both Cycle 1 and Cycle 2 was lower than the provincial average, at 0.42 kg/net and 0.62 kg/net, respectively (Figure 0.33). Similarly, FMZs 16, 17 and 18 all had significantly lower catch rates.

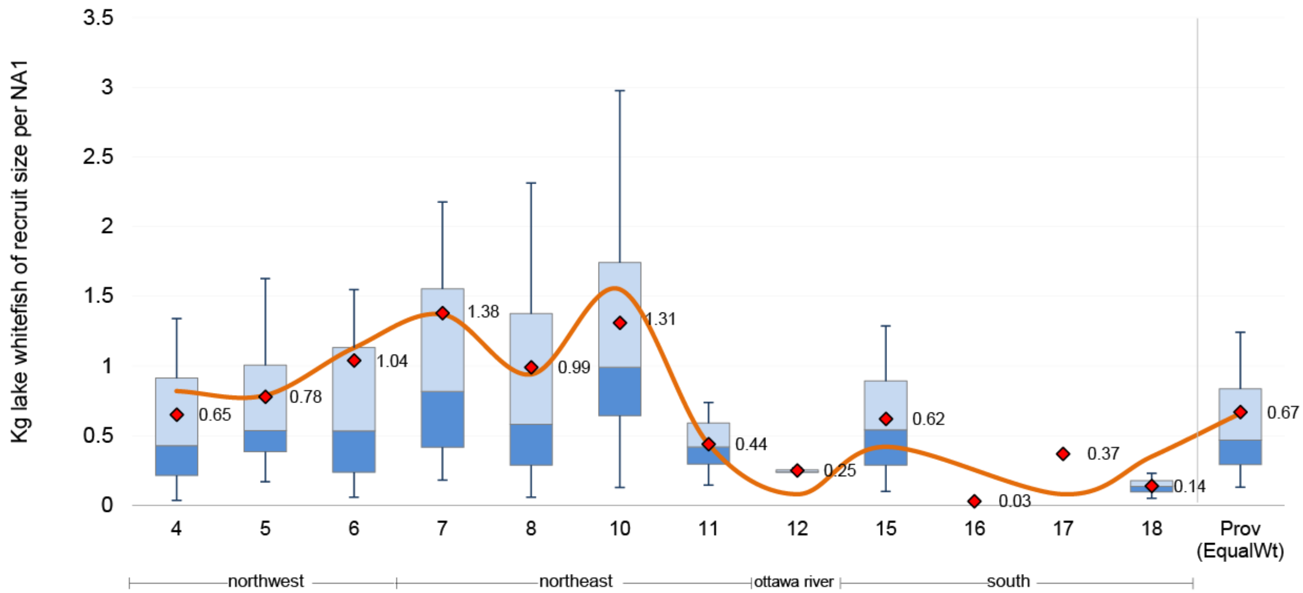


Figure 3.33 Equally-weighted average CUEW (kg/net) of Lake Whitefish recruits from all lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

3.5.4.5 Population Characteristics

Size

The mean size of Lake Whitefish in FMZ 15 was generally large relative to other FMZs. The mean total length of Lake Whitefish recruits (>400 mm) captured during Cycle 1 of BsM was 537 mm, which was larger than the provincial average of 469 mm, and third highest in the province (Figure 0.34). Mean sizes were highest in southern region. In Cycle 2, the mean total length was 519 mm, which was the same as the provincial average. It was the lowest mean length in southern region but the sample sizes from the other zones was very small.

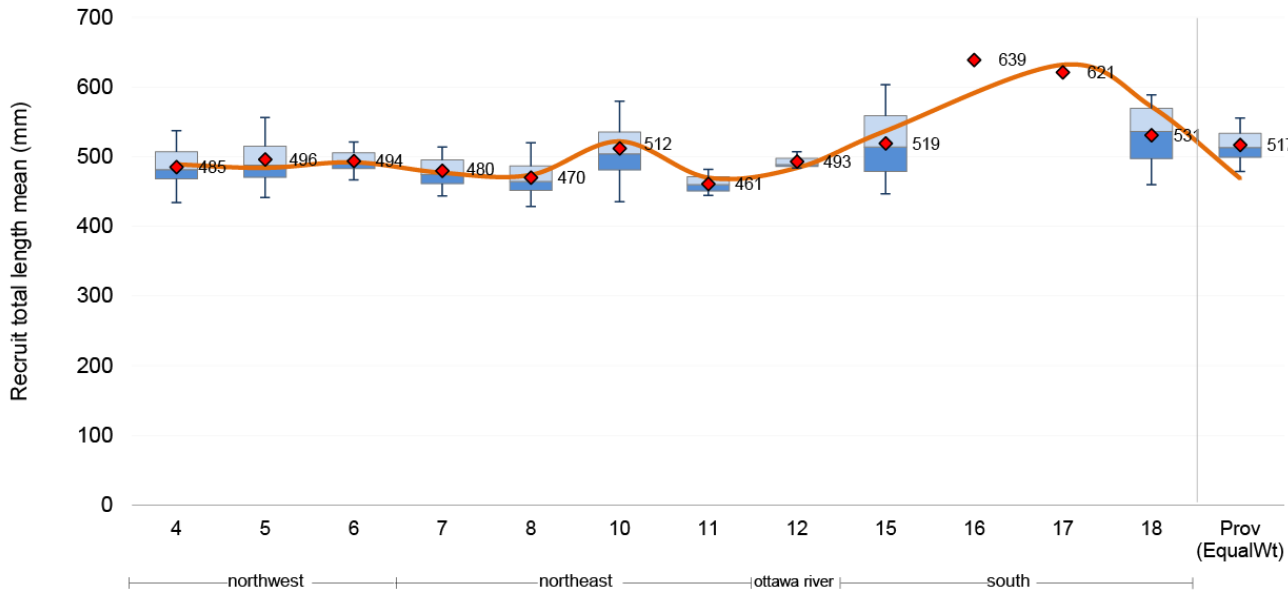


Figure 3.34 Equally-weighted average mean total length (mm) of Lake Whitefish recruits from all lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

Age

The mean age of Lake Whitefish recruits was 13.4 years for Cycle 1, which was similar to the provincial average of 11.8 years (Figure 0.35). The mean age was higher in Cycle 2, at an average age of 19.7, which was above the provincial average of 16.8 and the second highest in the province. These results indicate that overall, the population structure of Lake Whitefish in the zone is good. However, the overall zone averages mask individual differences. In several lakes, very few young Whitefish were caught, suggesting that recruitment is poor. Eleven (11) of 18 lakes in which Lake Whitefish were caught in Cycle 1 also support Rainbow Smelt, which are known to impact the recruitment of Lake Whitefish in some situations.

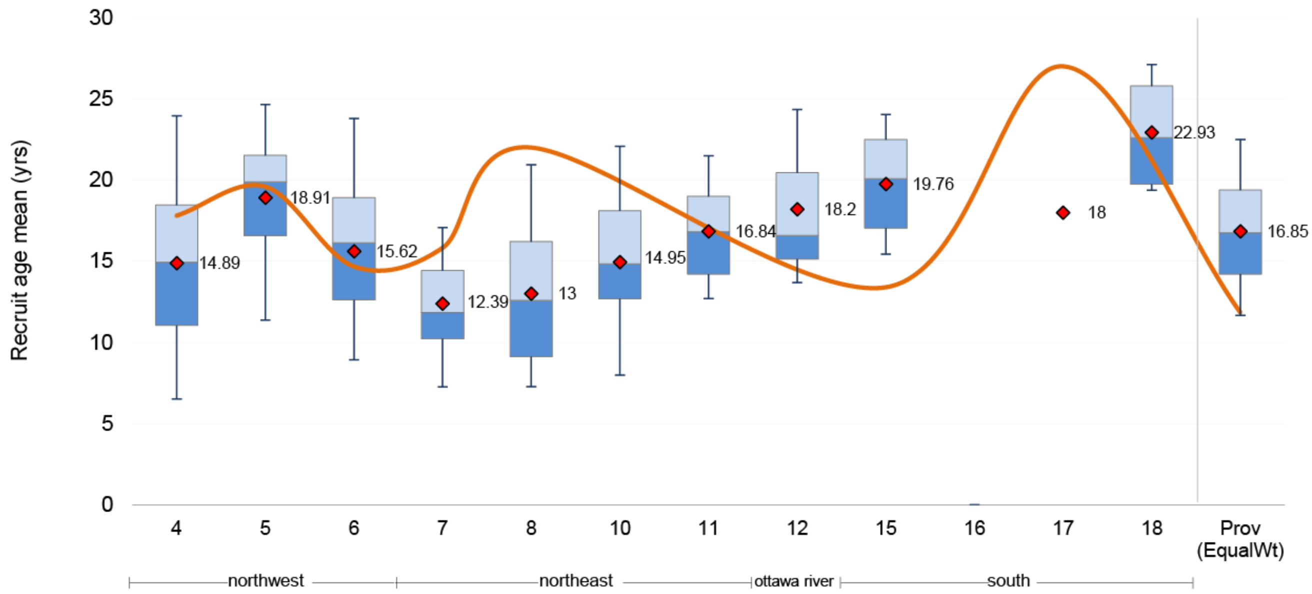


Figure 3.35 Equally-weighted average mean age (years) of Lake Whitefish recruits from all lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

The number of Lake Whitefish cohorts captured during Cycle 2 of BsM varied widely across all FMZs in the province (Figure 0.36). The northeast and northwest regions generally had a significantly higher number of cohorts than those zones in the south. FMZ 15 had 6.3 cohorts, which was the second lowest in the province, behind FMZ 18 (6.2 cohorts), and significantly less than the provincial average of 10.2 cohorts. These numbers may be influenced by the number of fish captured and sampled or may be an indication of potential recruitment issues in the Whitefish populations within the zone.

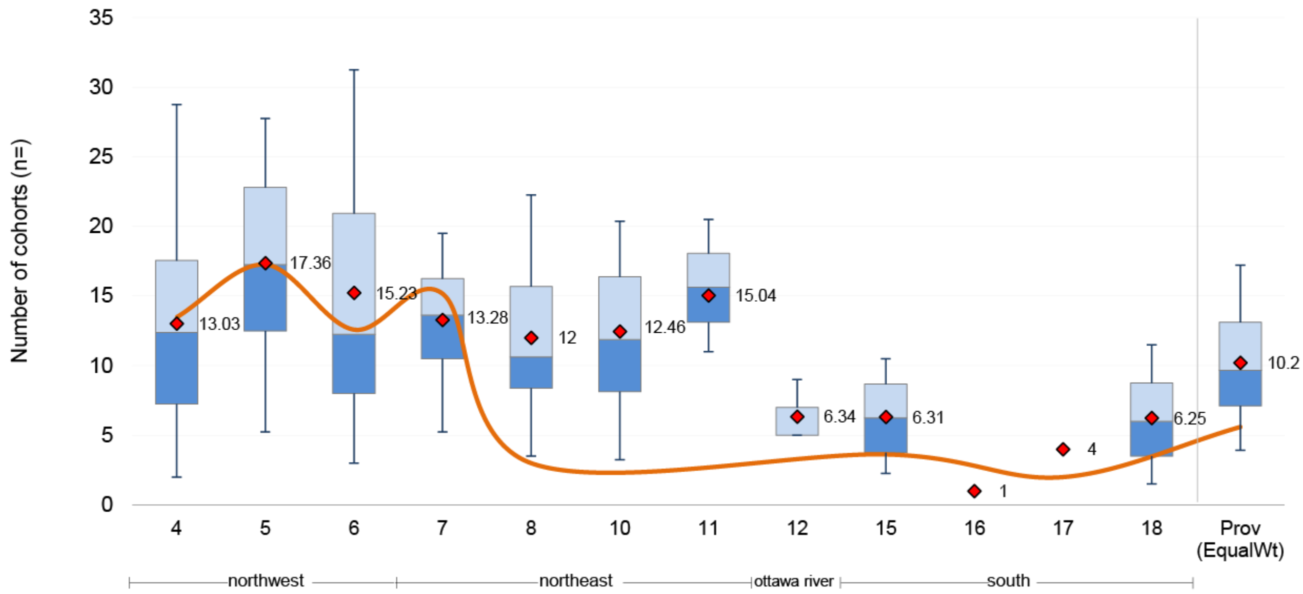


Figure 3.36 Equally-weighted average number of cohorts of Lake Whitefish from all lakes, by FMZ, BsM Cycle 1 (line) and 2 (Box plot).

Proportional Size Distribution

The proportional size distribution groups fish caught into size categories that are meaningful to anglers. In FMZ 15, the greatest proportion of Lake Whitefish caught were in the 'Memorable' size category (Figure 0.37). 'Preferred' and 'Quality' were the second and third-most caught fish.

The proportions between Cycle 1 and Cycle 2 only appear to be similar in the 'Stock', 'Quality' and 'Trophy' categories. Lake Whitefish in the 'Preferred' category decreased from 29% in Cycle 1 to 13% in Cycle 2, whereas the 'Memorable' category increased from 31% in Cycle 1 to 43% in Cycle 2. The proportional size distribution for Lake Whitefish shows that few recruit-sized fish are being captured, and that there is a high proportion of mature spawning-sized fish.

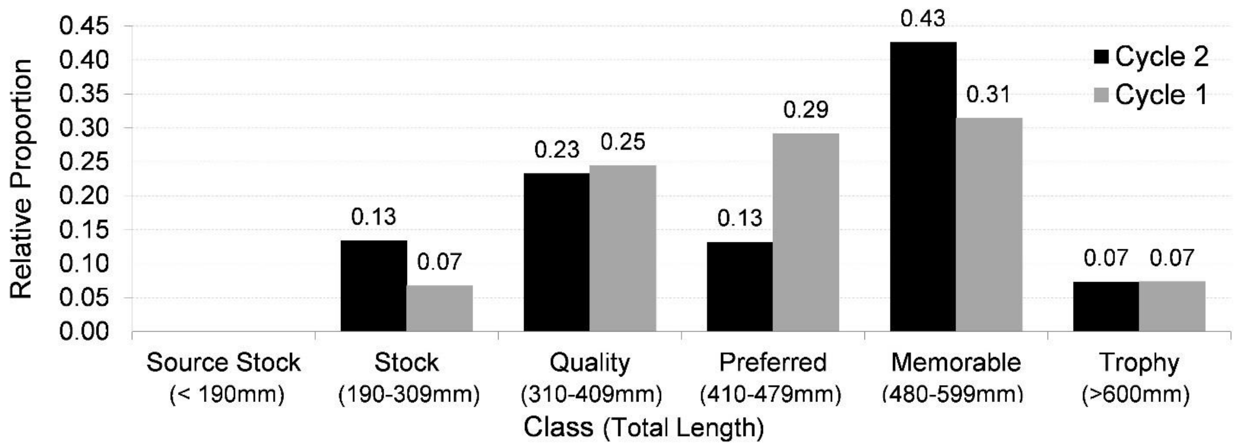


Figure 3.37 Proportional size distribution of Lake Whitefish from all lakes in FMZ 15, BsM Cycle 1 and 2.

Growth and Maturation

Growth of Lake Whitefish is variable, and similar to Lake Trout, can be grouped into generalized body sizes, based on observed maximum size. Scatter plots of size-at-age of whitefish from selected lakes in the zone are shown in Figure 0.38. Most populations display a large body size with asymptotic sizes in the 500-600 mm range. The fish from Aylen Lake are considerably smaller, with an asymptotic size of only about 350 mm.

The state of maturity was only available for a small number of fish, but whitefish first matured at four years old and all were mature at six years old (Figure 0.39). Growth after maturity was very slow.

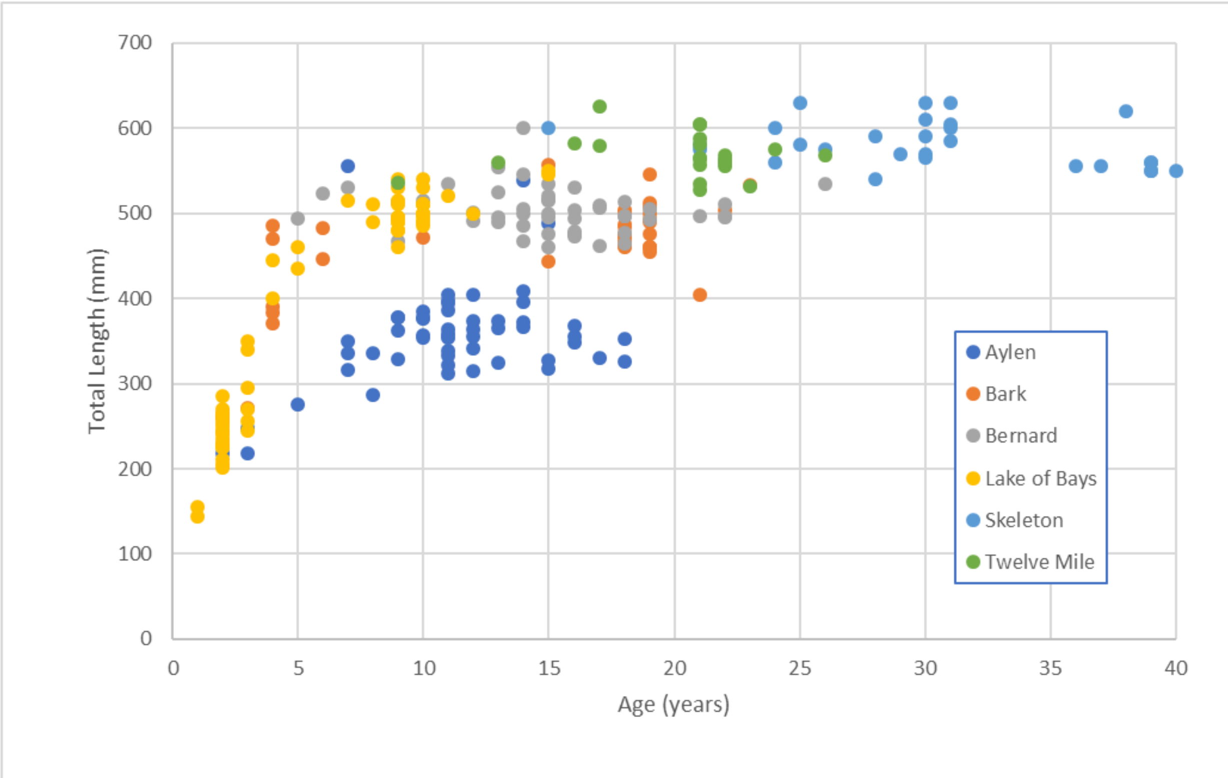


Figure 3.38 Scatter plot of size (mm) at age for Lake Whitefish for selected lakes in FMZ 15, BsM Cycle 2.

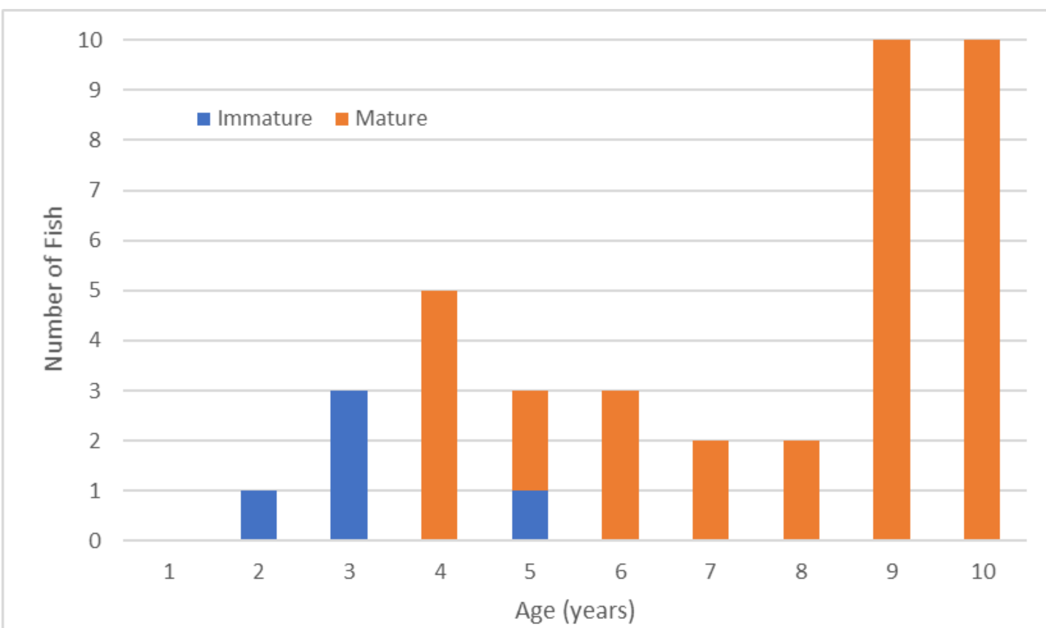


Figure 3.39 State of maturity of female Lake Whitefish, by age, FMZ 15, BsM Cycle 2. Only ages 1 to 10 are shown.

3.5.4.6 Biological Reference Points

Biological reference points for Lake Whitefish have not yet been developed. Also, calibration of netting catches to generate estimates of biomass has not been completed for Lake Whitefish. However, mortality estimates were available from one lake in Cycle 1 (Bernard Lake) and four lakes in Cycle 2 (Bark, Bernard, Lake of Bays, Twelve Mile). An estimate was not available for Aylen Lake, despite the large sample size because the recruit size threshold excluded most fish from the calculation in this small-bodied population. All are relatively large lakes and have high abundance, resulting in enough samples being collected to generate mortality estimates. The estimates are probably not representative of the whole zone however they do include many of the most important fisheries in the zone.

Annual survival (the complement of mortality) was high in all lakes, ranging from 0.8 to 0.9 (Figure 3.40). The combination of rapid early growth, attainment of maturity before being recruited to the fishery, and high survival were common indicators of the highest abundance lakes. The most significant concern with whitefish fisheries is the apparent low rate of recruitment in some populations.

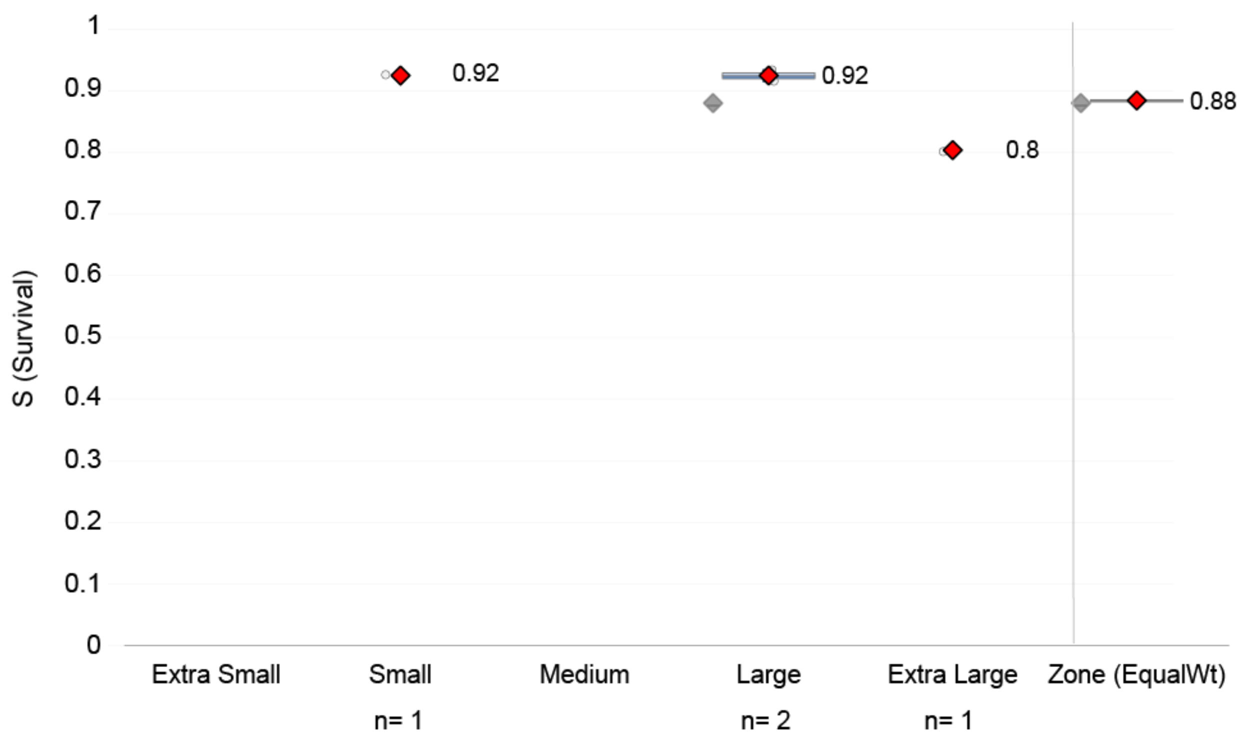


Figure 3.40 Equally-weighted survival of Lake Whitefish recruits, by BsM lake size class, FMZ 15, BsM Cycle 1 (grey diamonds) and Cycle 2 (red diamonds).

3.5.4.7 Fishery

Due to the low catchability and and/or refined angling techniques that are required to catch Lake Whitefish, significant fisheries only develop where their density is high enough to provide reasonable catch rates. Therefore, despite the broad distribution in the zone, the fishery is mostly concentrated in a small number of lakes. For example, out of all creel surveys conducted on lakes throughout FMZ 15 between 1988 and 2004, only 14 waterbodies had reported at least one angler targeting Lake Whitefish. In total, 657 parties were interviewed that were targeting Lake Whitefish, totalling 1141 anglers. The vast majority of the reported harvest from these creel efforts were limited to 3 waterbodies within Parry Sound District including Lake Bernard, Lake of Bays, and Horn Lake (Figure 3.41).

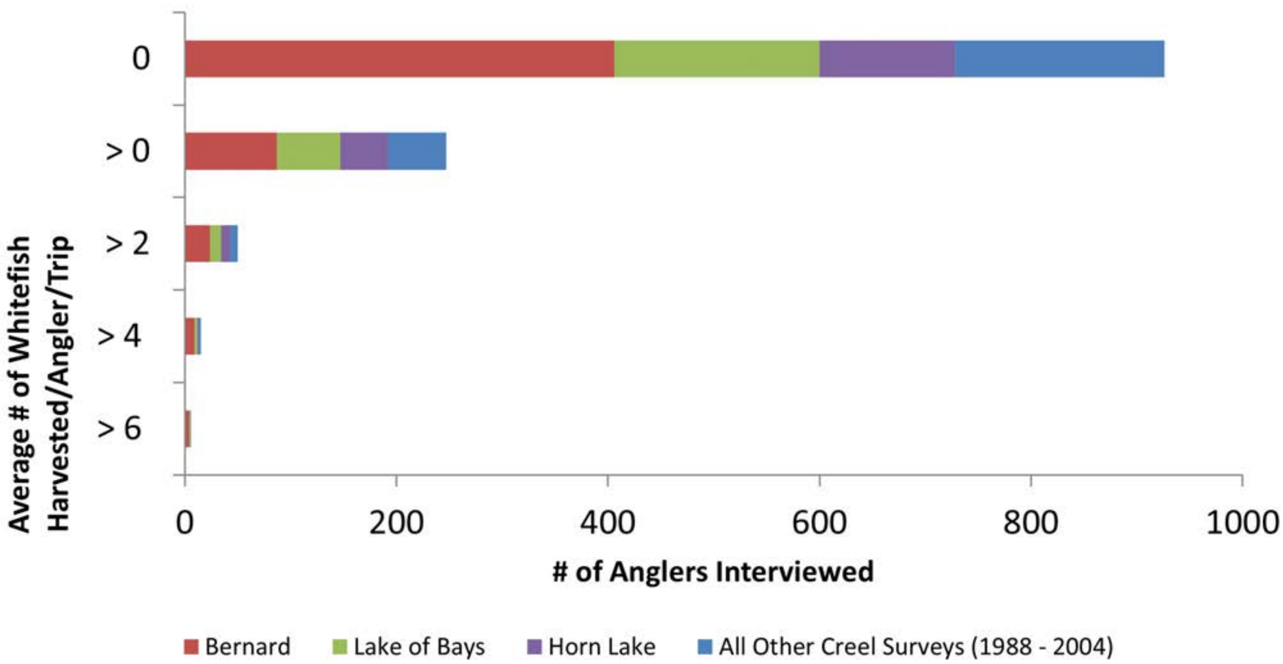


Figure 3.41 Estimated average number of Lake Whitefish harvested/angler/trip from all available creel surveys conducted within FMZ 15 where anglers were reported to be targeting Lake Whitefish, between 1988-2004.

Lake Bernard is generally recognized as the predominant Lake Whitefish fishery within FMZ 15 and has received the most intensive monitoring historically. The most recent creel data from roving winter creel surveys in 2011 suggests that very few parties harvest more than a few Whitefish and in the very rare circumstance, greater than 4 Lake Whitefish were harvested under a daily catch limit of 12 for a Sport Fishing Licence and 6 for a Conservation Licence (Figure 3.42). Based on the 2011 surveys, assuming parties were interviewed on average at the mid-point of their fishing trip and using the mean party size of about two anglers, the total harvest per angler would be similar to the observed harvest per party. If these assumptions are correct, a daily limit of 6 would have reduced harvest by about 15%; a limit of 4, 25%.

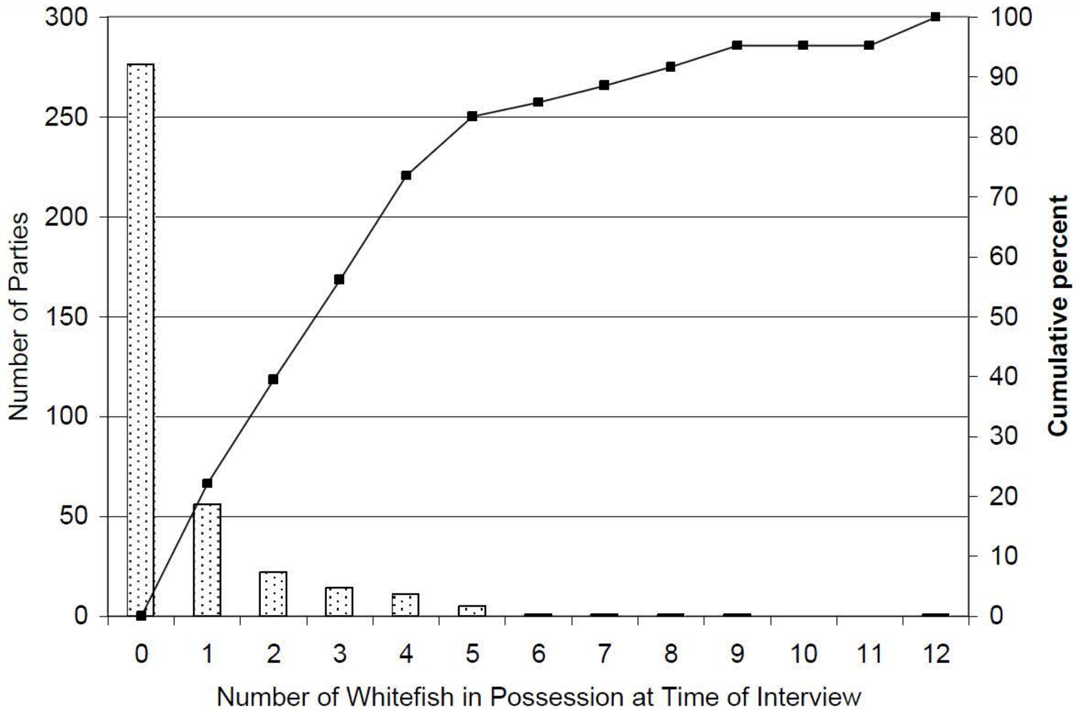


Figure 3.42 Frequency distribution of the number of Lake Whitefish possessed by angling parties at the time of interview, Lake Bernard, winter creel survey, 2011.

3.5.5 Northern Pike

3.5.5.1 Description

Northern Pike (*Esox lucius*) have a broad distribution and are a highly sought-after sportfish in Ontario and throughout its range in Canada (Scott and Crossman 1998; Kerr and Grant 2000). The average length of adult Northern Pike ranges from 18-30 inches long; lengths as great as 120 cm and mass exceeding 20 kg have been recorded (Scott and Crossman 1998). Northern Pike have long, laterally compressed bodies similar to Muskellunge (Scott and Crossman 1998). Colouring and markings are variable, ranging from shades of green and gold to browns, but the arrangement of colours is consistently light markings on a darker body (Scott and Crossman 1998). Northern Pike are a long-lived species, with known ages exceeding 25 years, with females growing larger and living longer than males (Kerr and Grant 2000).

Northern Pike are considered a coolwater species, with optimal thermal habitat preferences between 19-23˚C. However, habitat occupancy is highly variable, depending upon the life stage, weather, water levels, prey base and habitat availability within the specific waterbody (Kerr and Grant 2000). They are characterized as ambush visual predators, staying hidden by vegetative cover until they dart out to capture their prey (Kerr and Grant 2000). Northern Pike are top predators, employing an opportunistic feeding strategy and preferring larger prey items (Kerr and Grant 2000). They will consume small mammals, ducklings, invertebrates and frogs, and more commonly a wide variety of fish, including Yellow Perch, Walleye, Lake Herring, White Sucker and a variety of minnow species (Kerr and Grant 2000).

Spawning commences in early spring in shallow vegetated nearshore areas of the lakes, rivers, streams, and wetlands they inhabit, when surface temperatures range between 4-11.1˚C (Scott and Crossman 1998). Females are usually paired with one or more males, broadcast spawning in the shallows. Fertilized eggs attach to the vegetation, hatching several weeks later. Growth rates are rapid during the early life stages until sexual maturity is attained, usually between 3-4 years of age for females and 2-3 years of age for males (Scott and Crossman 1998).

Northern Pike are known to hybridize with Muskellunge and Grass Pickerel and can have negative effects on populations of these two species by direct predation and displacement (Scott and Crossman 1998; Kerr and Grant 2000).

Given their aggressive predatory instincts, Northern Pike are highly vulnerable to angling, and subsequent over-harvest in situations where harvest is excessively high (Latta 1972; Mosindy et al. 1987; Lentz et al. 1993). Concerns of overharvest led to reductions in daily bag limits across North America during the 1970’s and 1980’s as awareness for this concern grew following the rise of fishery science and management (Paukert et al. 2001).

3.5.5.2 Distribution

The native distribution of Northern Pike in FMZ 15 was limited to lower elevation areas in the west, northwest and east parts of the zone, next to Georgian Bay, the French River and the Ottawa Valley. The precise extent is not well known due to extensive range expansion, by undocumented stocking, natural dispersal and incomplete inventory.

The 1990 Atlas of Northern Pike lakes in Ontario (OMNR 1990c) listed about 237 lakes in the zone. Since 1990, the number of documented lakes has more than doubled to 507 (Figure 3.43). Pike also occur in larger rivers in the zone. The range of Northern Pike is continuing to expand, primarily due to illegal introductions and later dispersal.

Both the BsM program and angler reports have confirmed some occurrences in waterbodies previously not known to contain Pike within FMZ 15.

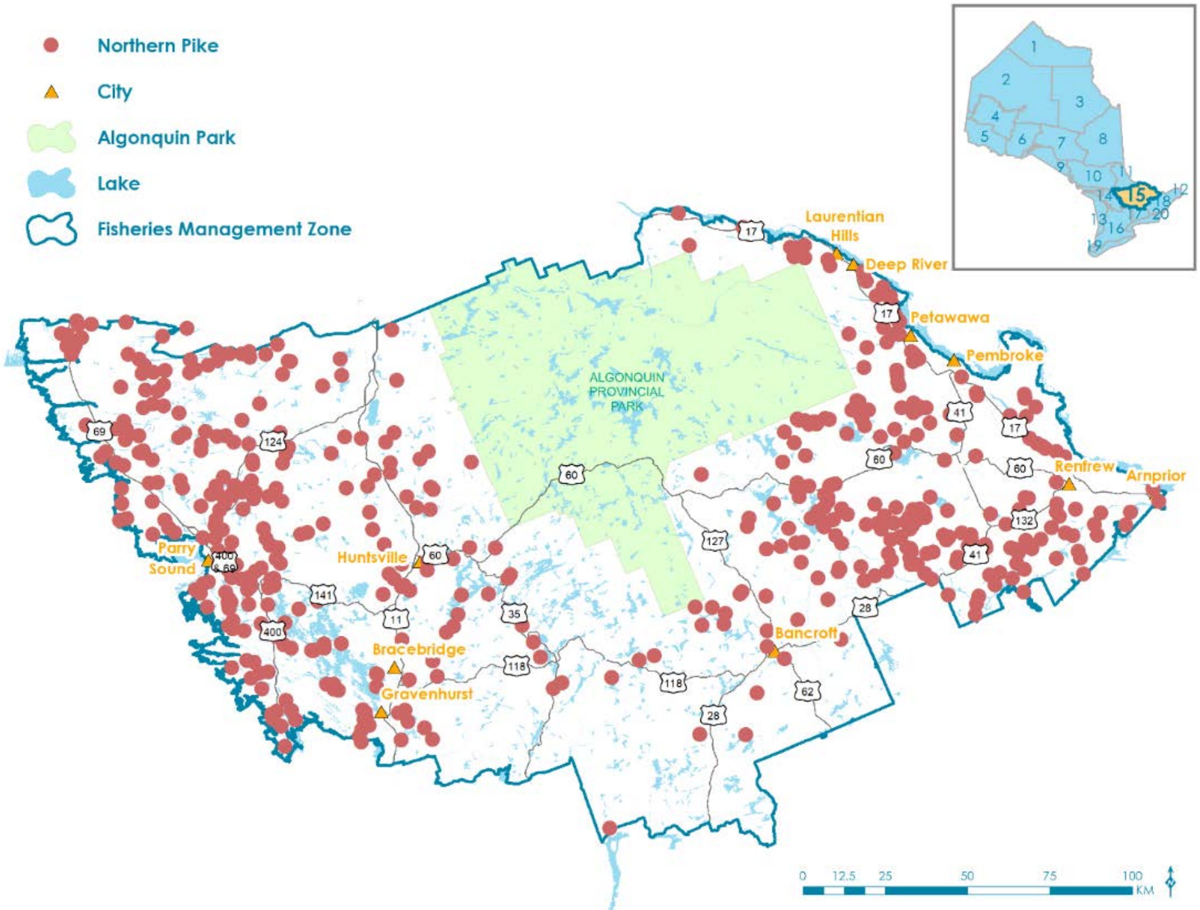


Figure 3.43 Distribution of Northern Pike, FMZ 15, excluding Algonquin Provincial Park.

3.5.5.3 Habitat

Northern Pike occupy a broad range of habitats, but generally prefer the shallow waters of coolwater lakes and slow-moving sections of rivers with abundant aquatic vegetation (Scott and Crossman 1998; Kerr and Grant 2000). Optimal temperatures for growth of Northern Pike range from 19-23˚C, but they will tolerate a wide range of temperatures (Kerr and Grant 2000).

3.5.5.4 Abundance

Northern Pike are not a target species of BsM but are captured in Walleye and Lake Trout trend lakes, where they occur as well as State lakes Northern Pike abundance is generally highest in northwestern Ontario, relative to southern Ontario (Figure 3.44). Northern Pike were captured in 28 waterbodies during Cycle 1 within FMZ 15 and averaged 0.3 fish/net. These values were unchanged in Cycle 2 with an average of 0.3 fish/net.

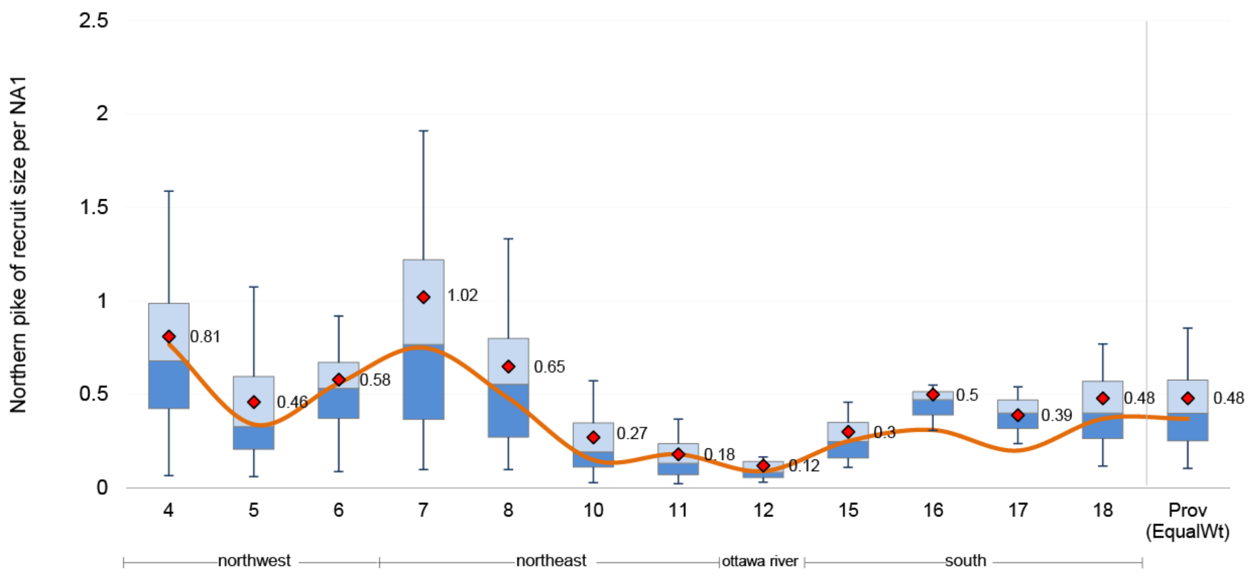


Figure 3.44 Equally-weighted average CUE (number of fish) of Northern Pike recruits from all lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

The CUEW of Northern Pike showed similar trends to CUE across all FMZs in Ontario (Figure 3.45). The CUEW of 0.4 kg/net for Cycle 2 was below the provincial average of 0.7 kg/net, and was the fourth lowest in the province, behind FMZs 10, 11 and 12.

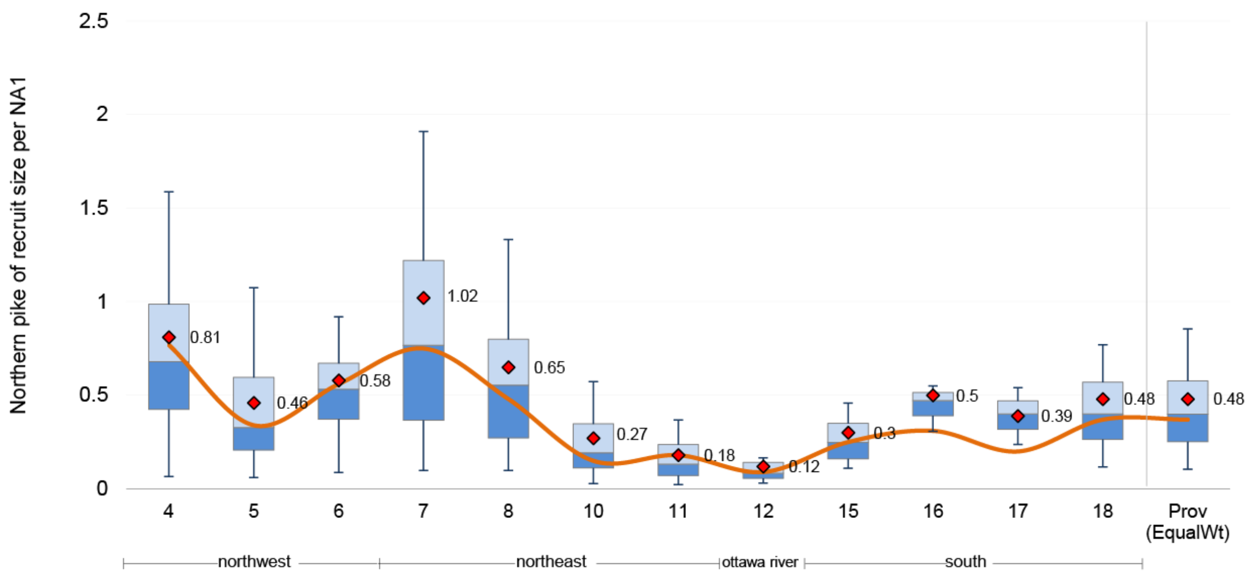


Figure 3.45 Equally-weighted average CUEW (kg/net) of Northern Pike recruits from all lakes, by FMZ, BsM Cycle 1 (line) and 2 (box plot).

3.5.5.5 Population Characteristics

Size

Northern Pike catches from the BsM program resulted in a consistent average size and distribution amongst FMZs provincially. The equally-weighted average mean total length for fish of recruitment size in FMZ 15 was 668 mm for Cycle 1 and was 629 mm for Cycle 2 (Figure 3.46), which was very similar to the provincial average of 638 mm.

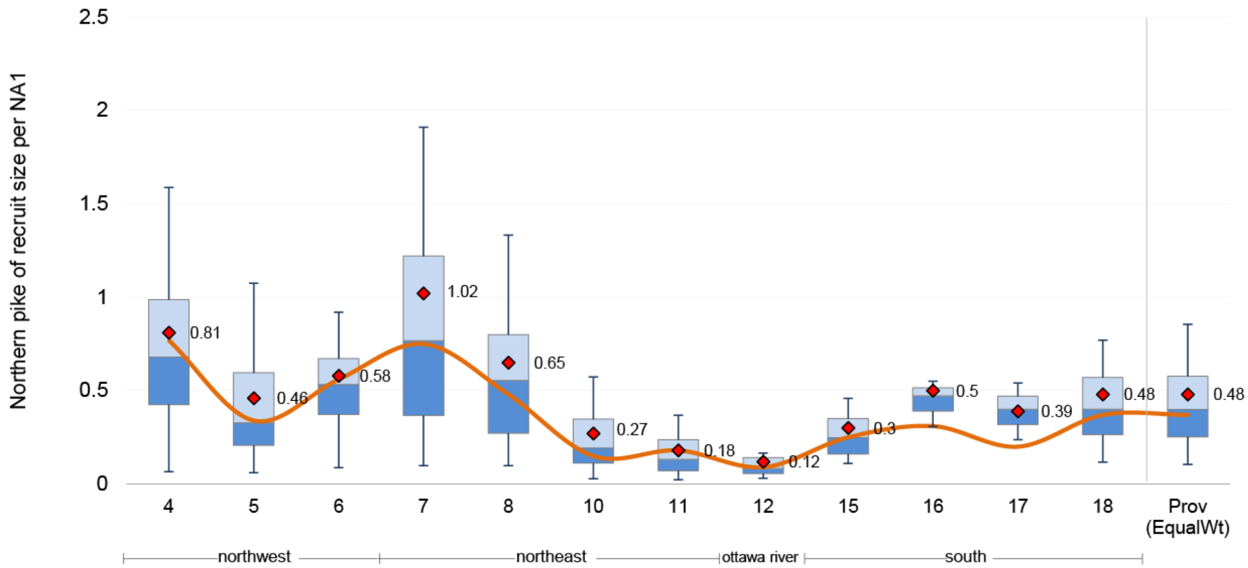


Figure 3.46 Equally-weighted average total length (mm) of Northern Pike recruits from all lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

Age

Northern Pike have been known to live upwards of 26 years of age in slow growing populations in the Canadian Arctic (Scott and Crossman 1998), but generally are limited to ages of 10 years or less. The BsM program has captured Pike as old as 19 years of age with the oldest from FMZ 15 at 14 years of age. The average age of Northern Pike recruits was 6.3 in Cycle 1 and 6.2 in Cycle 2, which was similar to most other zones and the provincial average (Figure 3.47).

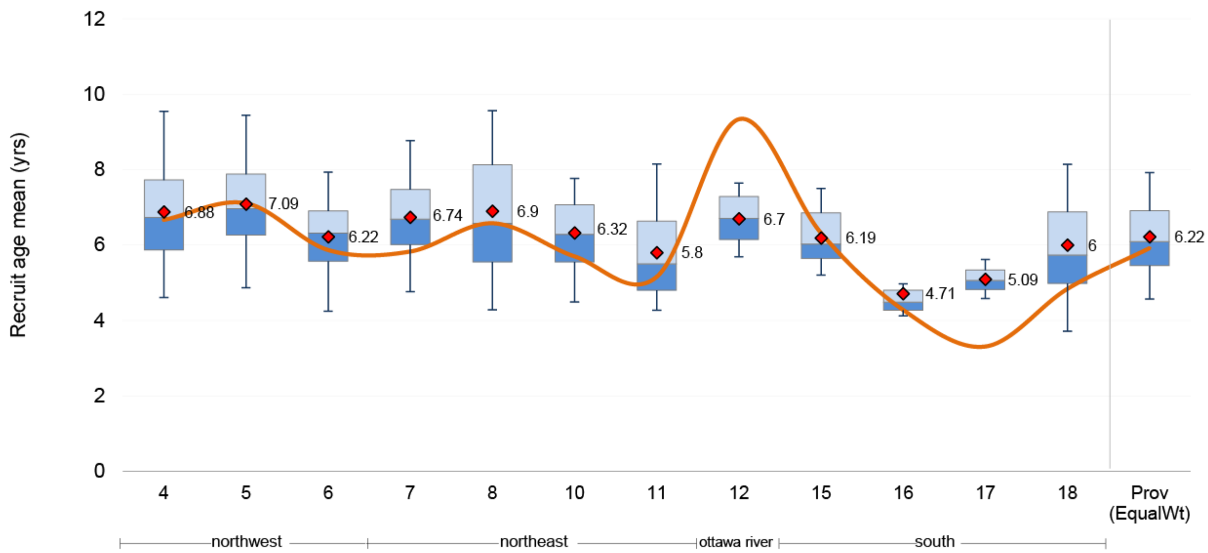


Figure 3.47 Equally-weighted average mean age (years) of Northern Pike recruits from all lakes, by FMZ, BsM Cycle 1 (line) and 2 (box plot).

The number of Northern Pike cohorts captured during Cycle 1 and 2 of BsM varied across all FMZs in the province; northern Ontario FMZs generally have a greater number of unique age cohorts (Figure 3.48). Southern Ontario FMZs generally had fewer cohorts. There were, on average, 3.9 cohorts of Northern Pike within FMZ 15 captured during Cycle 1. This value increased in Cycle 2 to 5.0 cohorts.

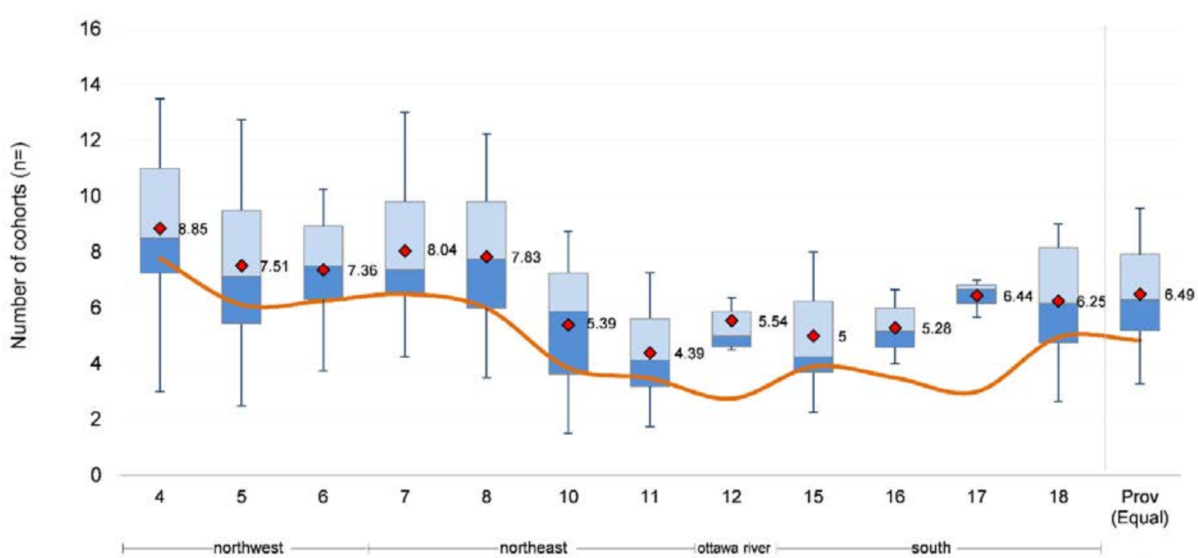


Figure 3.48 Equally-weighted average number of cohorts of Northern Pike from all lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

Proportional Size Distribution

Northern Pike can attain large sizes in the appropriate habitat and prey fish conditions. Catches showed Northern Pike within FMZ 15 have demonstrated the potential to achieve 'Preferred', 'Memorable' and 'Trophy' sizes (Figure 3.49). There is some variation in the relative proportion of Northern Pike caught between Cycles 1 and 2 for the larger size bins. For example, fewer memorable (0.11) and no trophy sized pike were caught in Cycle 2 however this may be due to several factors including the sampling gear, time of sampling within the season, and the behavior of the species relative to the gear.

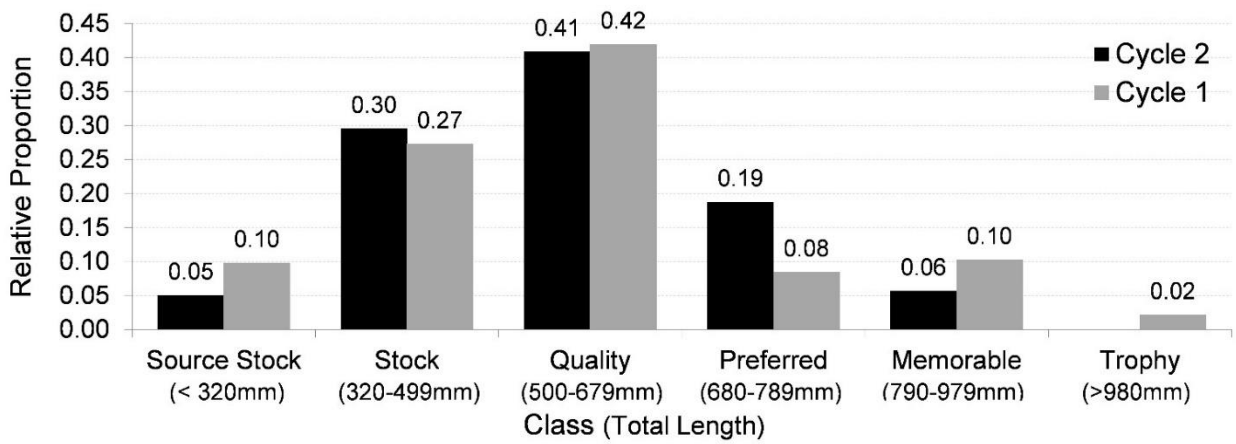


Figure 3.49 Proportional size distribution of Northern Pike from all lakes, FMZ 15, BsM Cycle 1 and Cycle 2.

Growth and Maturation

A scatter plot of the observed size at age, by sex of Northern Pike is shown in Figure 3.50. Growth was essentially linear between ages 1 and 10 with no observable difference between sexes. Insufficient numbers of Northern Pike were captured during Cycle 1 and 2 to calculate growth curves by lake size class.

Determination of the state of maturity during the summer sampling period can be inconclusive resulting in many fish not being classified. It appears that male pike begin to become mature at two years of age and most are probably mature at 3. Females begin to mature at three years of age and most are mature at 4.

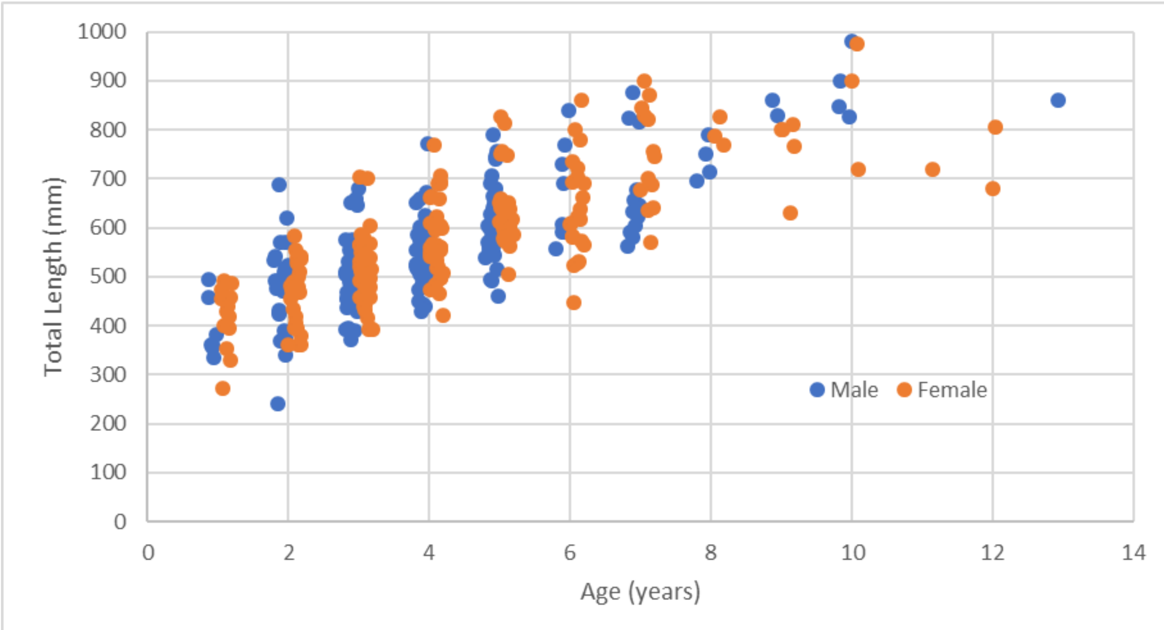


Figure 3.50 Scatter plot of total length (mm), by age and sex, of Northern Pike, BsM Cycle 1 and 2 combined, FMZ 15.

3.5.5.6 Biological Reference Points (Biomass and Mortality)

Mortality and survival estimates were only available for Cycle 2, where sufficient samples from 7 lakes were obtained. The average survival rate of recruits was 0.6, similar to the provincial average and other zones in the southern region. Populations in northwestern Ontario tended to have somewhat higher survival (Figure 3.51).

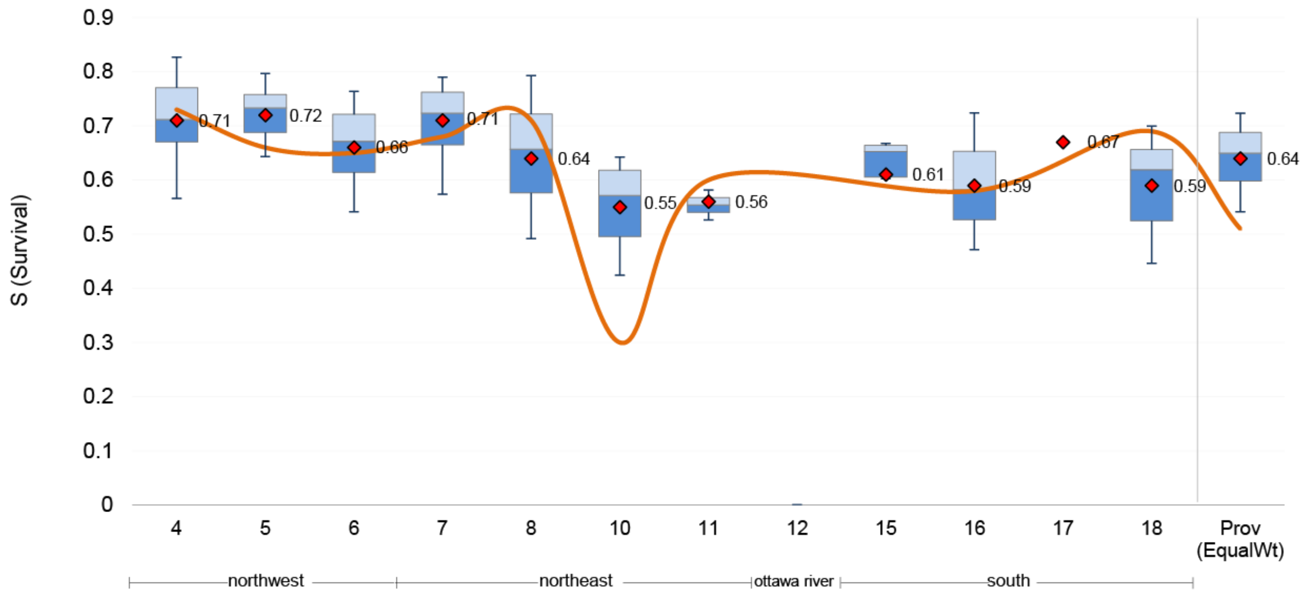


Figure 3.51 Equally-weighted survival of Northern Pike recruits, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

Biomass and mortality reference points have not yet been developed for Northern Pike.

3.5.6 Muskellunge

3.5.6.1 Description

Muskellunge (*Esox masquinongy*), also known as Musky or Muskie, is Canada's second largest freshwater fish (Scott and Crossman 1998) and is highly sought after as a trophy sport fish in Ontario. Average lengths of adult Muskellunge range from 70-120 mm (28-48 in.), and weights range between 2.2-16 kg (5-36 lbs) (Scott and Crossman 1998). Like Northern Pike, Muskellunge bodies are long and laterally compressed. Colouring and markings are variable, ranging from greenish gold to brown or grey, with dark markings along the body. This long-lived species ages greater than 30 years; females have a longer lifespan than males (Kerr and Grant 2000).

Muskellunge spawn in spring, shortly after ice-out, when water temperatures are between 9.4-15˚C (Scott and Crossman 1998; Kerr and Grant 2000). Spawning occurs in shallow water near-shore or in flooded areas which are heavily vegetated. Eggs hatch in 8-14 days and the fry stay in the nursery habitat at or near to the spawning areas (Scott and Crossman 1998; Kerr and Grant 2000).

After spawning, adult Muskellunge move to summer habitat, where they stay until water temperatures begin to decline in the fall, at which time they begin movements back to wintering areas. This species is a "sit and wait" predator that feeds by sight, staying hidden in amongst vegetation until they dart out to capture their prey (Kerr and Grant 2000). As a top predator, Muskellunge consume a wide variety of prey species including frogs, invertebrates and ducklings; but most of their diet consists of fish, including Bluntnose Minnow, Golden Shiner, White Sucker, Bluegill, Pumpkinseed, Yellow Perch and Rock Bass (Kerr and Grant 2000). Cannibalism is known to occur with this species (Kerr and Grant 2000).

Limiting factors for Muskellunge include water quality and presence of Northern Pike. They are visual predators, so waters with increased turbidity may hinder their ability to locate prey. In waterbodies that have both Northern Pike and Muskellunge, competition for both food and habitat occurs. Northern Pike spawn and hatch earlier than Muskellunge, and as a result, the Muskellunge fry often become prey items for pike. Northern Pike are generally the more aggressive species and can displace Muskellunge from areas providing food and cover (Kerr and Grant 2000). These two species can hybridize, producing a Tiger Muskellunge (*Esox amentus)* (Scott and Crossman 1998).

3.5.6.2 Distribution

Muskellunge have a limited distribution in FMZ 15. They occur naturally in a small number of lakes and rivers. The 1987 Atlas of Muskellunge Lakes in Ontario (OMNR 1987a) listed 72 waters of which only 8 were believed to be native populations. Of the other 64, 48 were introduced, while 16 were of unknown origin. Since 1987, 30 more lakes have been identified; 8 introduced and 22 of unknown origin (Figure 3.52). Due to the paucity of data, it is not known how many of the 30 more lakes were newly established since 1987, versus simply newly recognized lakes. The largest proportion of lakes occurs in the central part of the zone in Bancroft District (Table 3.12)

Table 3.12 Muskellunge lakes, by origin, FMZ 15, 1987 and 2016.

		1987		**2016**	
	Native	**Introduced**	**Unknown**	**Introduced**	**Unknown**
Bancroft	2	41	15	43	24
Parry Sound	6	4	1	5	6
Pembroke	8	3		8	8
Total		48	16	56	36

The Atlas of Muskellunge Streams and Rivers in Ontario (Kerr 2001) listed 17 streams that supported Muskellunge. By 2016, no more watersheds had been reported to support Muskellunge, but more river or tributary reaches had been identified in systems in Pembroke District.

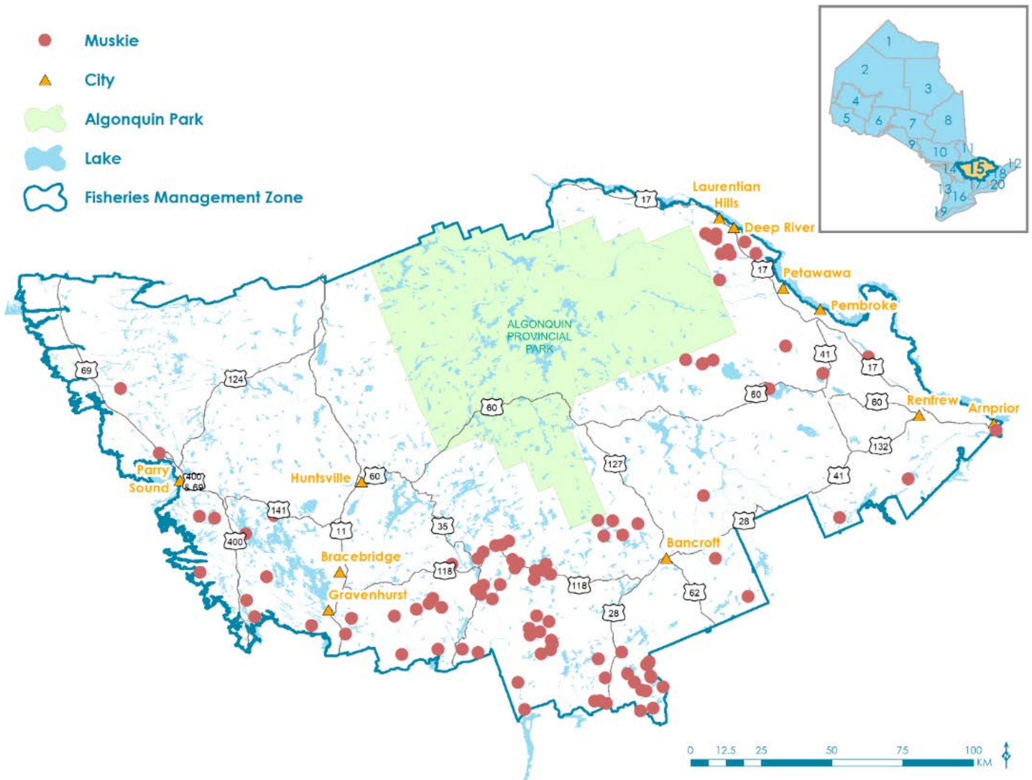


Figure 3.52 Distribution of Muskellunge, FMZ 15, excluding Algonquin Provincial Park.

3.5.6.3 Habitat and Fish Community

Muskellunge inhabit cool to warmwater lakes and slow-moving sections of rivers, where vegetation grows more densely (Scott and Crossman 1998; Kerr and Grant 2000). Scott and Crossman (1998) described preferred habitat as warm, weedy lakes and bays and slow, heavily vegetated rivers, with both having dense growth of water lilies, pondweeds, and other emergent and sub-emergent vegetation and fallen trees. Kerr and Grant (2000) reported temperatures of 25-25.6˚C as being optimal for growth; but temperatures reaching as warm as 32.2˚C can be tolerated.

Known or potential spawning areas and habitat have been mapped for several lakes, either through directed surveys or incidental encounters and reports. Minimal monitoring of these areas has occurred.

3.5.6.4 Abundance

The primary source of abundance and biological data on muskellunge is the Muskies Canada (MCI) Angler Diary program. Available data are reported in Section 4.1.4 – Local Fishery Monitoring.

Neither the BsM program nor local monitoring projects catch adequate numbers of Muskellunge to give any meaningful information on abundance or population characteristics.

3.5.6.5 Population Characteristics

Size

The MCI angler diary program was the sole information source for size-related information on the FMZ 15 Muskellunge population and fishery. The program relies on volunteer angler reporting so the sizes reported may not be representative of the broader fishery across the zone. Lengths of 897 fish were available. They ranged from 305 mm (12 inches) to 1372 mm (54 inches) in total length and averaged 889 mm (35 inches) total length (Figure 3.53) of reported fish were longer than the current minimum size limit of 910 mm, that applies to most lakes in the zone.

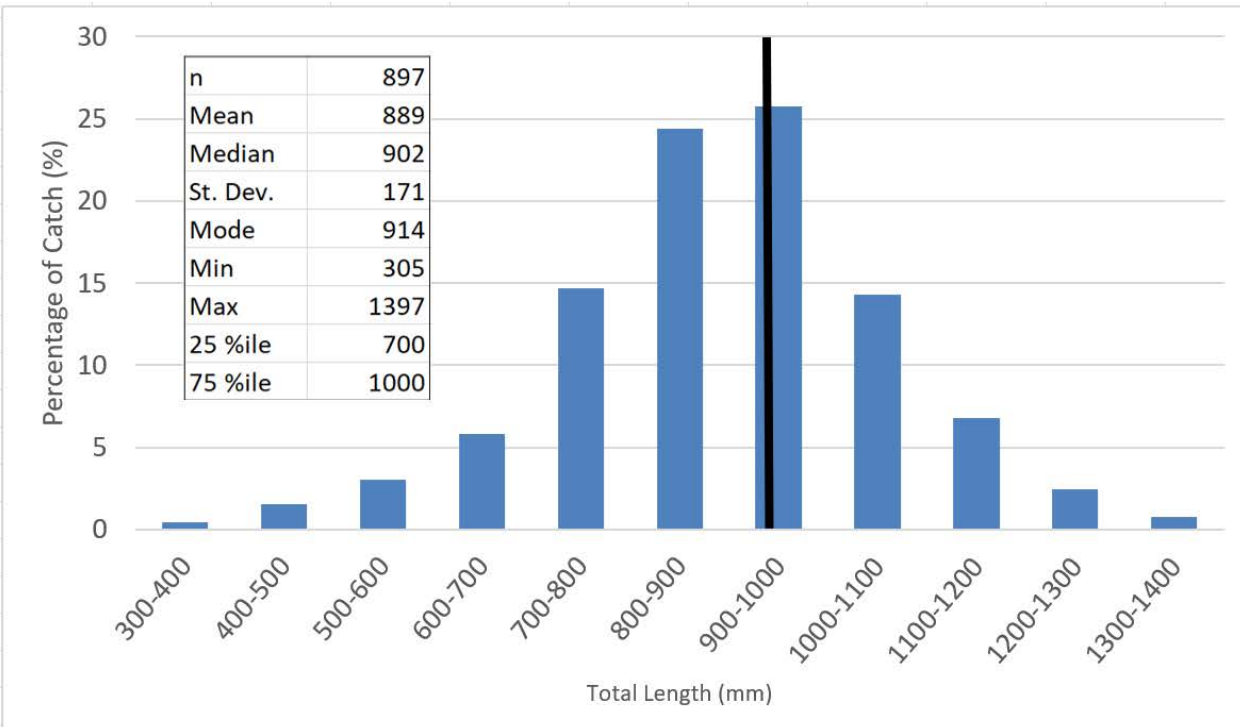


Figure 3.53 Total length (mm) distribution of all Muskellunge captured within FMZ 15 from MCI Angler Diaries between 1995-2016. Current zone-wide minimum size limit (910 mm, 36 inches) included as a black line for reference.

The growth rate and growth potential of fish in a Muskellunge population can be inferred from angler diaries where the sample size is large enough to have confidence in the observations. That enables consideration of individual waters for application of waterbody-specific minimum size regulations (Section 5.5). Overall, angler diary reporting was relatively low on most waterbodies and there were only a few waterbodies which exhibited the potential for consideration of a greater minimum size limit to protect the trophy fishery (Figure 3.54).

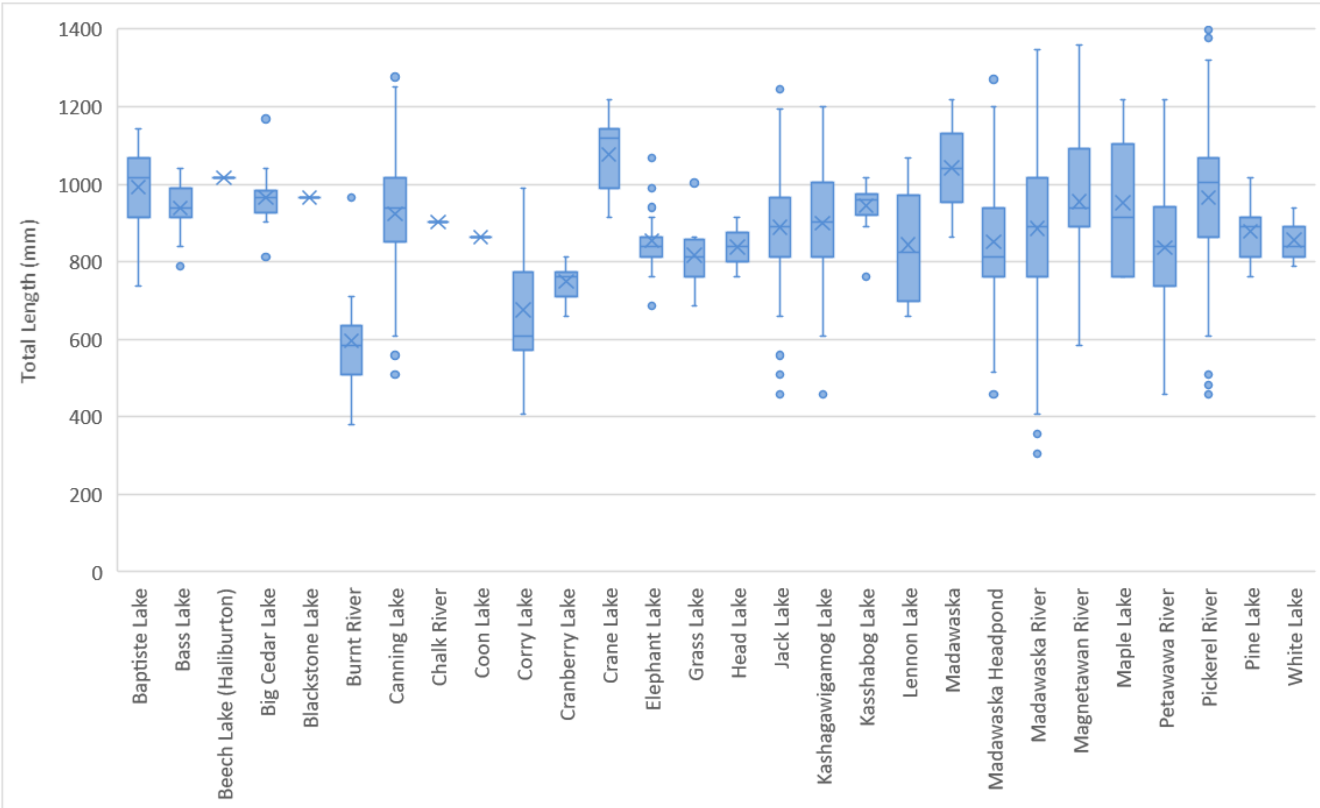


Figure 3.54 Box plots of total length (mm), by waterbody, of Muskellunge reported from MCI angler diaries, FMZ 15, 1996-2016.

Age

Insufficient numbers of Muskellunge were captured during Cycle 1 and 2 to provide age estimates for the species within FMZ 15. Muskellunge caught as part of the MCI Angler Diary program are released and therefore there is no age data available.

Growth and Maturation

Insufficient numbers of Muskellunge were captured during Cycle 1 and 2 to provide growth curves and size at maturation for the species within FMZ 15. Muskellunge caught as part of the MCI Angler Diary program are released and therefore there is no age data available.

3.5.6.6 Biological Reference Points

Insufficient numbers of Muskellunge were captured during Cycle 1 or 2 to provide biomass and mortality estimates for the species within FMZ 15. The MCI Angler Diary program is voluntary, and effort is unstandardized. Due to the limited angling effort and catch data within the zone, no biological reference points were able to be derived at this time.

3.5.7 Walleye

3.5.7.1 Description

In Ontario, including FMZ 15, Walleye is highly prized and the most desired sport fish species (OMNRF 2015a). Walleye occur in lakes with a wide range of fish communities. Common cohabiting species include Northern Pike and Smallmouth and Largemouth Bass. Important forage species include Yellow Perch, Cisco, Rainbow Smelt and a variety of small fish species. Largemouth Bass, Rainbow Smelt and Black Crappie are species that have been associated with declines in Walleye populations in certain circumstances. Walleye can impact populations of other piscivorous fish by competing directly for food resources. Walleye can be highly cannibalistic if small Yellow Perch or other forage fish are unavailable (Scott and Crossman 1998). The abundance of other forage species may impact Walleye year class abundances (Forney 1974).

Walleye are a coolwater species that reach greatest densities in large, cool, mesotrophic lakes of moderate depth and low water clarity. Spawning occurs in the spring soon after ice-out (Schneider et al. 2010); most often in fast water areas of tributary streams, but also on exposed lakeshore shoals. Spawning is characterized by groups of one large female and two smaller males or two females with up to six males (Scott and Crossman 1998). Eggs are released and left unguarded and are dependent upon a constant supply of cool oxygenated water for successful development. Eggs hatch within 12-18 days of spawning with the young dispersing 10-15 days later. Newly hatched fry first feed on zooplankton and aquatic insects, switching to feeding primarily on fish during their first summer. Fingerling and older Walleye are generally benthic. A comprehensive synthesis of their biology is available in Barton (2011).

The eye of the Walleye is adapted to low light conditions (Holm et al. 2009), hence giving the species a competitive advantage and tendency to reach their highest abundance in lakes with low water clarity. Larger individuals generally stay in turbid water during hours of sunlight or move to deeper waters with enough oxygen. Cover, in the form of aquatic vegetation, is an important habitat part. In clearer lakes, Walleye seek deep water if available.

As a top predator, Walleye tend to accumulate mercury in their tissue, resulting in significant consumption advisories, particularly in larger fish and fish from lakes with elevated levels of dissolved organic carbon.

Sauger, a closely related species to Walleye, shares many of the same life history characteristics. An important difference is its smaller size, reducing its attractiveness to anglers, especially in waters where both species occur. Sauger prefer more turbid waters, though of similar trophic state.

3.5.7.2 Distribution

The precise native distribution of Walleye in the zone is uncertain due to extensive range extension from historical stocking and incomplete inventory. Walleye generally occur naturally only in the far west, northwest and east ends of the zone in lower elevation waters close to Georgian Bay, the French River and the Ottawa River.

The current distribution of Walleye in FMZ 15 is further complicated by ongoing range expansion due to illegal stocking and subsequent dispersal. The greatest uncertainty in the current distribution of Walleye is in the reproductive status of many small lakes, many of which were stocked (both legally and illegally) in the past but have not since been assessed to determine whether they are self-sustaining. Though numerous, these lakes do not form a major part of the resource, due to their collective small surface area.

The 1987 Atlas of Walleye Lakes in Ontario (OMNR 1987b) listed 169 waterbodies in FMZ 15, of which 65 were believed to be of native origin, 44 introduced and the remainder unknown but a district review in 2016 could only confirm that Walleye occur in 118 of the 169 lakes listed in the 1987 atlas (Table 3.13).

Table 3.13 Summary of lakes with records of Walleye occurrence, FMZ 15, 1987 and 2016.

	Present (2016)	Absent (2016)	Unconfirmed (2016)	Total
Present (1987 Atlas)	118	8	43	169
Absent (1987 Atlas)	76	33	99	208
Total	194	41	142	377

In 2016, self-sustaining populations of Walleye were known, or believed, to occur in about 194 lakes in the zone (118 lakes from the atlas plus 76 more lakes) (Table 3.13). There are 142 other lakes where Walleye have been documented in the past, but the current presence or status of the populations hasn't been confirmed. A large proportion of these records are from past stocking events or anecdotal reports. Many of these stocking events occurred in small lakes and Walleye are likely not present or present as marginal populations only.

The distribution of Walleye in the zone continues to expand, primarily through illegal introductions and subsequent dispersal.

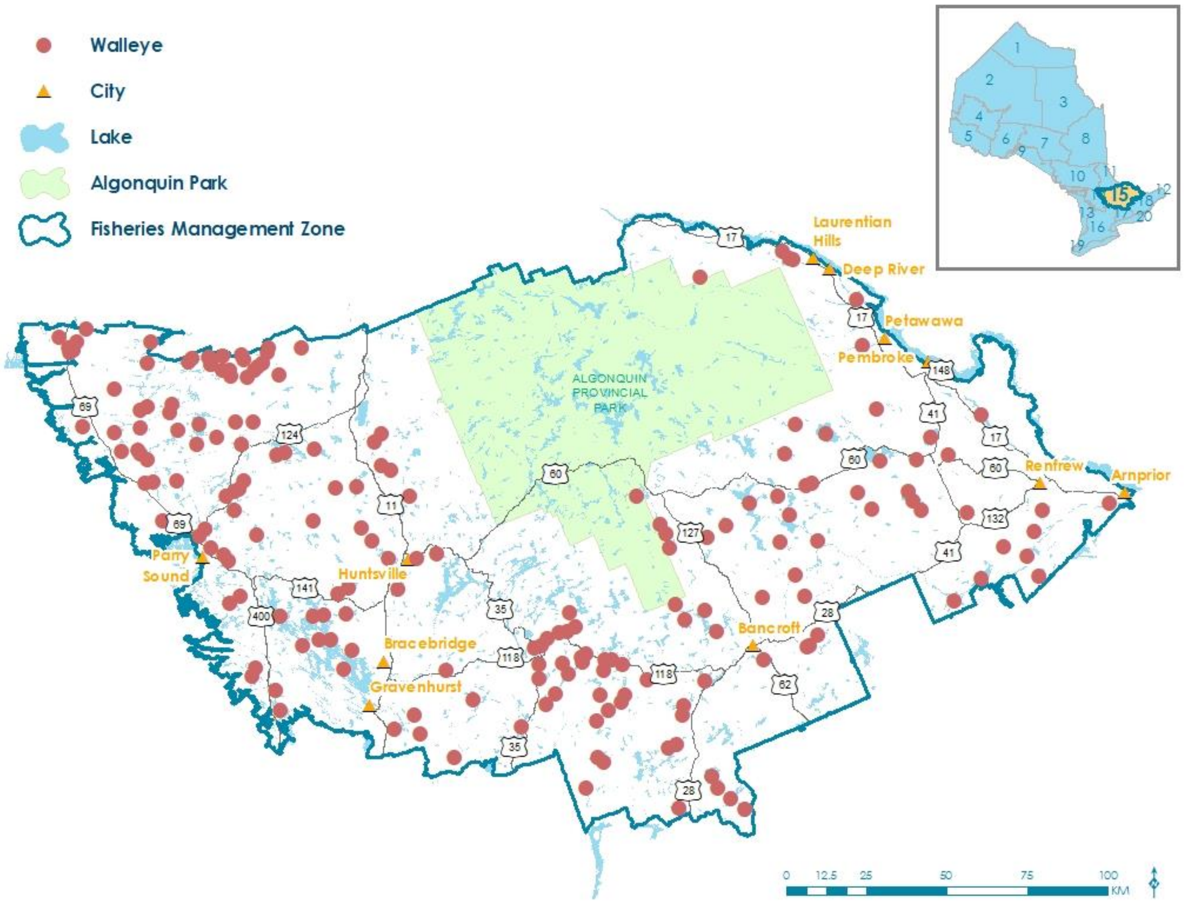


Figure 3.55 Distribution of Walleye lakes in FMZ 15, excluding Algonquin Provincial Park, 2016.

Walleye lakes less than 500 ha are most common in the zone and form a small proportion of the surface area for all lakes in the zone. Only a small proportion of these lakes are sampled by the BsM program (Table 3.14). About one quarter of the lakes are larger than 500 ha and form about 80% of the surface area and are sampled more intensely.

Table 3.14 Number and surface area (ha) of all Walleye lakes and BsM Cycle 1 Trend lakes, FMZ 15.

Size	Total Number	Total Area (ha)	Number of BsM Trend Lakes	Area of BsM Trend Lakes (ha)
5-50	40	1,056	1	27
50-500	104	18,204	6	770
500-1500	33	28,864	6	6,292
1500-5000	13	30,793	7	17,189
>5000	3	24,356	1	12,487

Walleye also occur in rivers in the zone. Segments of about 20 rivers have been identified as having resident populations. An undefined number of other rivers and streams have seasonal occurrence of Walleye primarily in the form of spring spawning runs.

Walleye stocks in FMZ 15 have a varied genetic ancestry based on post-glacial colonization and subsequent stocking (Wilson 2012). Native populations originated primarily from the Atlantic and Mississipian refugia. The subsequent complex stocking history has resulted in no clear distinctions between major stock sources and regional populations (Figure 3.56). Genetic drift or divergence has resulted from founder effects from small numbers of families being used from donor populations during stocking events, as well as ecological limits on subsequent local population sizes. General recommendations from the study were that donors from the most locally available watershed should be used and that, in general, Lake Manitou strain should be used for watersheds that flow into Georgian Bay and Bay of Quinte strain used for the remaining, south and east portions of the zone.

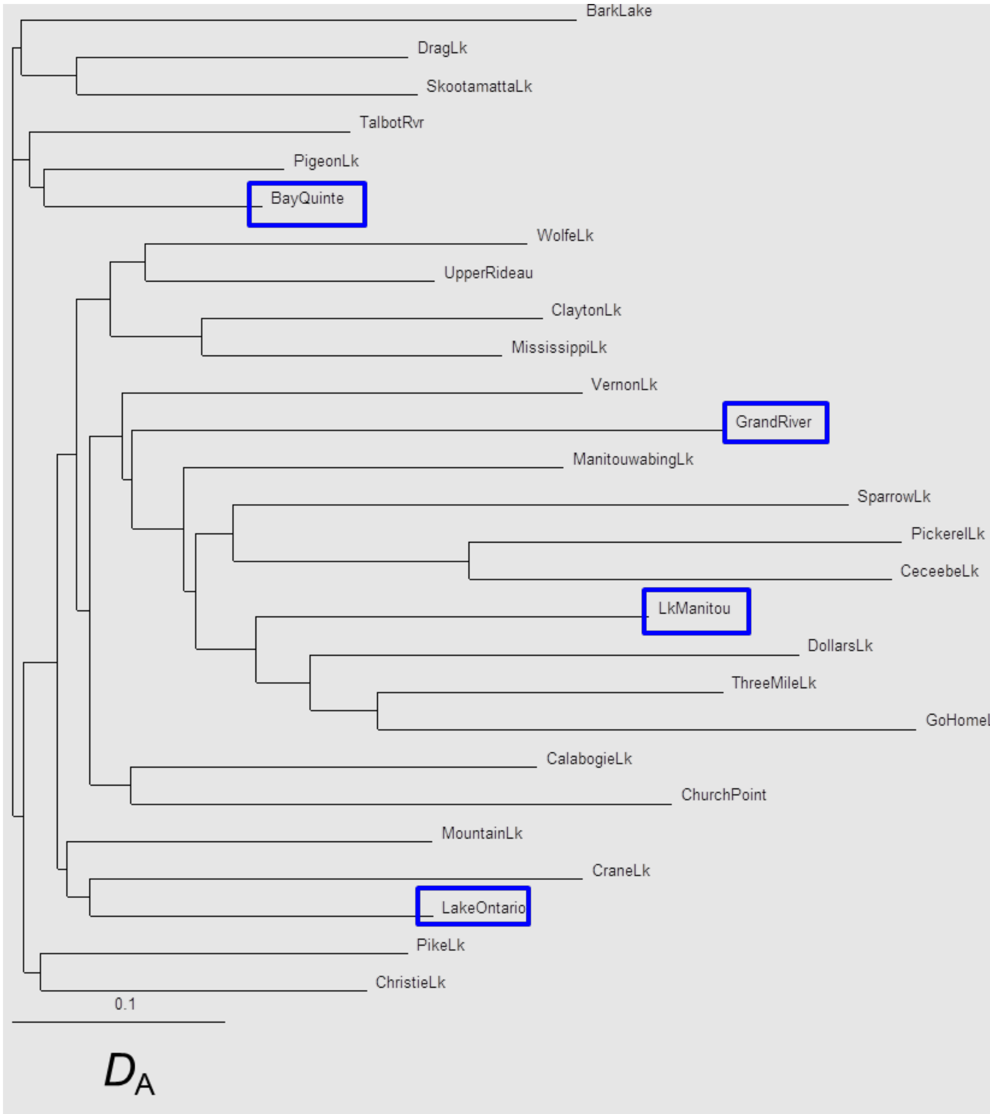


Figure 3.56 Cluster diagram (dendogram) of the genetic relationships between selected Walleye populations in southern Ontario. Major donor stocks (provincial stocking sources) are highlighted in blue. The horizontal axis of the dendrogram represents the genetic distance or dissimilarity between clusters. The vertical axis shows the objects and clusters, but does not indicate differences in itself. The horizontal position of the split, shown by the short vertical bar, gives the genetic distance (dissimilarity) between the two clusters.

Sauger have a limited distribution in the zone. They have been recorded regularly only from Cecebe Lake in the north part of Parry Sound district and occasionally Ahmic Lake, immediately downstream. Both Lakes also support Walleye populations.

3.5.7.3 Habitat and Fish Community

The production of Walleye in freshwater lakes is affected by several factors. Early studies and models about productivity based on the quantity of nutrients and the depth of lakes. Generally, shallow lakes with high levels of nutrients were found to be most productive (Ryder 1965). More recently, an improved understanding of the importance of both water clarity and temperature has led to an improved understanding of the production dynamics of Walleye (Lester et al. 2004).

Walleye generally inhabit the littoral zone; the warm shallow, near-shore area of lakes and rivers. Lakes with shallower mean depths have a larger proportion of the lake area that is littoral zone and typically have better habitat for and abundance of Walleye. The average percent littoral area for a walleye trend lake in Zone 15, for both Cycle 1 and Cycle 2, was 38%, lower than the averages for the FMZs at the provincial (48%) and southern region (59%) levels (Figure 3.57).

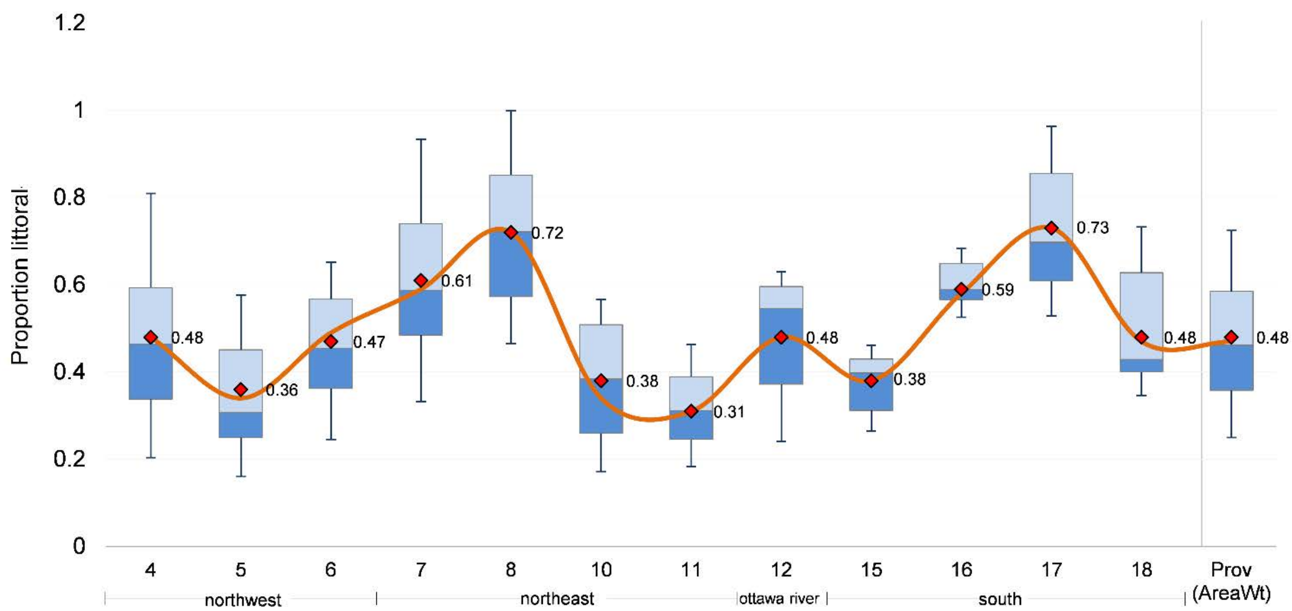


Figure 3.57 Area-weighted average percent littoral area of Walleye trend lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

The mean depth of monitored Walleye trend lakes in the zone for Cycle 1 and Cycle 2 was 10.5 m and 10.4 m, respectively, which is high and most like FMZ 5, 10 and 11 and higher than the provincial zone average of 8.7 m and 8.5 m for Cycles 1 and 2 (Figure 3.58).

The abundance of Walleye is expressed as a lake-wide average. Deep lakes have large areas of deep pelagic volume, which is generally not Walleye habitat, which results in lower estimates of lake-wide abundance, even though the catch rate in useable Walleye habitat may be considerably higher.

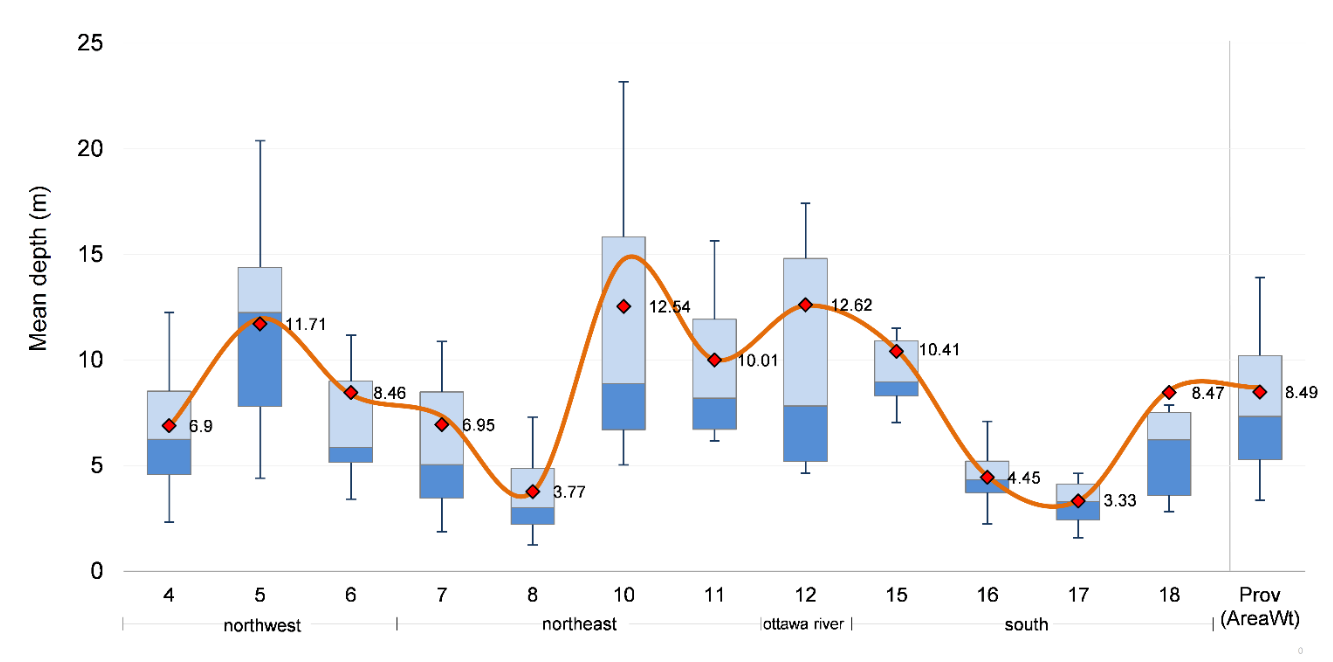


Figure 3.58 Area-weighted average mean depth (m) of Walleye trend lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

Optimal water clarity (secchi depth) for Walleye is about 2 m, with habitat suitability decreasing with increasing clarity. Clarity is influenced by dissolved organic carbon and turbidity caused by suspended algae and inorganic particles. Walleye lakes in FMZ 15 are relatively clear, averaging 3.9 m secchi depth in Cycle 1 and 3.6 m secchi depth in Cycle 2. Only lakes in FMZ 10 and 11 had higher average clarity and lower dissolved organic carbon (Figure 3.59, Figure 3.60). The higher-than-preferred average clarity is offset somewhat by the high average depth, which allows Walleye to access deeper water where more suitable light conditions exist. In FMZ 15, differences in Walleye population characteristics were examined across lake size class (Small, Medium, Large and Extra Large) and water clarity (dark lakes: Secchi depth ≤3 m and clear lakes: Secchi >3 m).

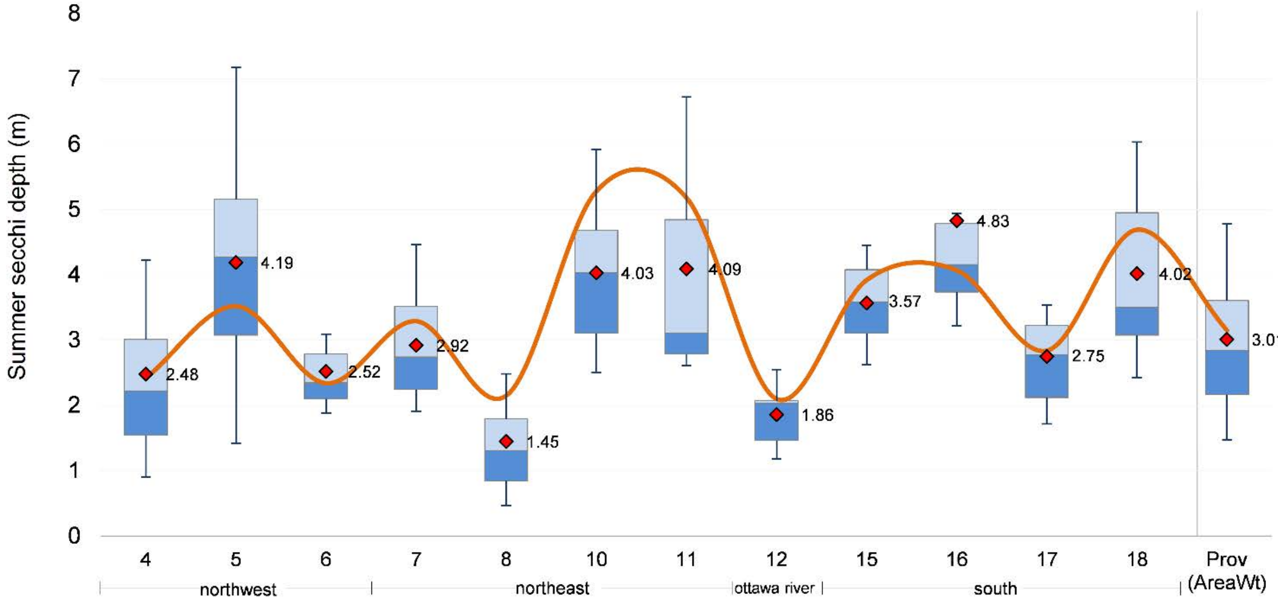


Figure 3.59 Area-weighted average summer Secchi depth (m) of Walleye trend lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

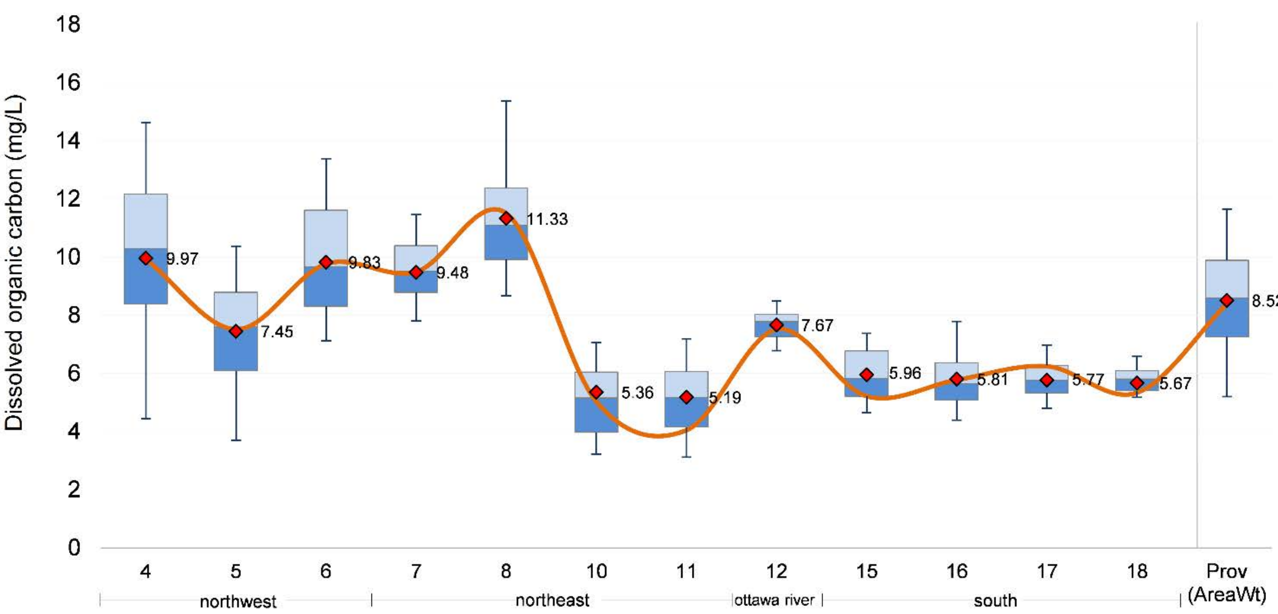


Figure 3.60 Area-weighted average dissolved organic carbon (DOC, mg/l) of Walleye trend lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

Clear lakes had fewer Walleye than dark lakes, regardless of lake size (Figure 3.61). These results suggest that abundance of Walleye in these sampled lakes may be more strongly affected by water clarity than lake size. In FMZ 15, 20 of the 27 Walleye lakes sampled had summer Secchi depths greater than or equal to ≥3 m for Cycle 1 and 13 of 19 Walleye lakes sampled had summer Secchi depths greater than or equal to ≥3 m for Cycle 2.

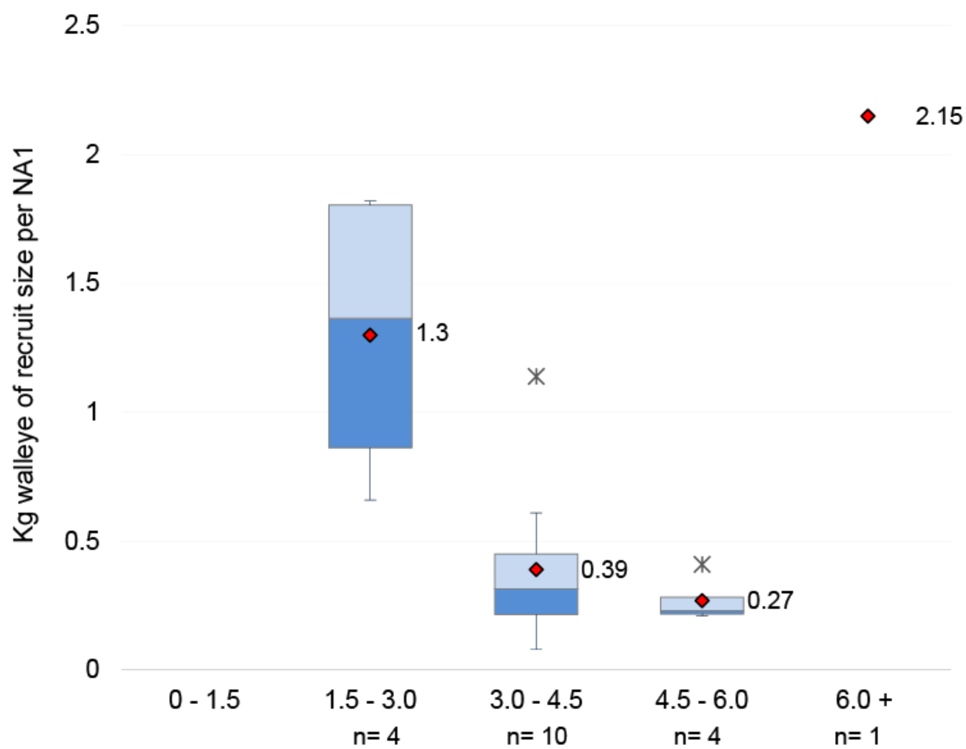


Figure 3.61 CUEW (kg/net) of Walleye recruits, by Secchi Depth of Walleye Trend Lakes, FMZ 15, BsM Cycle 2.

Phosphorus is a critical nutrient controlling the amount of primary productivity of inland lakes, and thereby, effecting fish productivity (see Section 3.3). The average total phosphorus concentration in FMZ 15 Walleye trend lakes was 10.5 µg/l for Cycle 1 and 12.5 µg/l for Cycle 2; indicative of mesotrophic conditions. This was like many other zones because of the similar bedrock and soil conditions that prevail on the Canadian Shield. FMZ 10 and 11 had lower phosphorus levels. Among zones with higher average phosphorus levels, FMZ 8 has many lakes located in the productive clay belt and FMZ 16 and 17 are primarily on limestone bedrock, off the Canadian Shield.

Climate influences Walleye populations by the amount of habitat of preferred temperature that is supplied, by controlling life history limits such as early growth, maturation and the rate of natural mortality and by the suitability of the lake for other species that interact with Walleye, in particular, warmwater competitors. When exposed to warmer ambient temperatures (above 5˚C) Walleye grow faster and mature at a younger age (Venturelli et al. 2010). Located in central Ontario, the climate of FMZ 15 is intermediate compared to other zones (see Section 2.4 and 3.3). For Cycle 1, Walleye trend lakes within FMZ 15 received an average of 1816 GDD per year between 1981-2010. The average number of GDD's for all FMZs in the province was 1588 while that for the FMZs in southern region was 1952. In Cycle 2, very similar results were seen; Walleye trend lakes within FMZ 15 received an average of 1823 GDD per year between 1981-2010. The average number of GDD's for all FMZs in the province for Cycle 2 was 1588 while that for the FMZs in southern region was 1954. FMZ 15 Walleye trend lakes receive on average 228 (Cycle 1) and 235 (Cycle 2) more growing degree days per year than the mean number for the province and more than any zone in the northeast or northwest regions.

Female Walleye generally mature after accumulating 10,000 GDD (Venturelli et al. 2010) which may be contributing to earlier maturity in southern Walleye populations including FMZ 15. Within the zone, the climate is cooler in the higher elevation area in the central part of the zone, but the differences are not enough to significantly influence Walleye population characteristics.

Walleye lakes in FMZ 15 have moderately complex fish communities compared to other FMZs. On average in Cycle 1, 6.2 species were caught in Walleye trend lakes in FMZ 15, compared to 9.4 for all provincial FMZs. Cycle 2 saw a slight increase in fish species found in Walleye trend lakes in the zone, at 6.9 compared to the provincial average of 9.3. Among Walleye trend lakes in FMZ 15, smaller lakes averaged fewer fish species than larger lakes. The smallest size group of lakes averaged fewer species than the largest group of lakes, 10 and 15 species respectively. Larger Walleye trend lakes within the zone generally had higher clarity and lower nutrient levels and are generally less well-suited to Walleye production.

Several major predator and competitor species in Walleye lakes varied greatly by zone (Figure 3.62, Figure 3.63). In southern region zones, including FMZ 15, several of the major competitor/predator species occurred in a large proportion of the lakes. In contrast, the northern zones had lower frequencies of lakes with these species. Cumulatively, only FMZ 18 had a higher occurrence of these species than FMZ 15, for Cycle 1. Overall, most Walleye lakes in FMZ 15 also had Northern Pike (86%), Smallmouth Bass (90%), Rock Bass (90%) and Largemouth Bass (57%), while a significant proportion had Lake Trout (29%), Rainbow Smelt (33%) or Black Crappie (29%). However, in Cycle 2, FMZ 15 had the highest occurrence of competitor and predator species in the entire province. This may likely be a sampling artifact, as many of the zones had significantly fewer Walleye trend lakes sampled during Cycle 2. In FMZ 15, there was an increase in the number of Walleye lakes where Largemouth Bass (79%), Lake Trout (36%) and Black Crappie (43%) were caught, while the proportion of other species remained fairly constant.

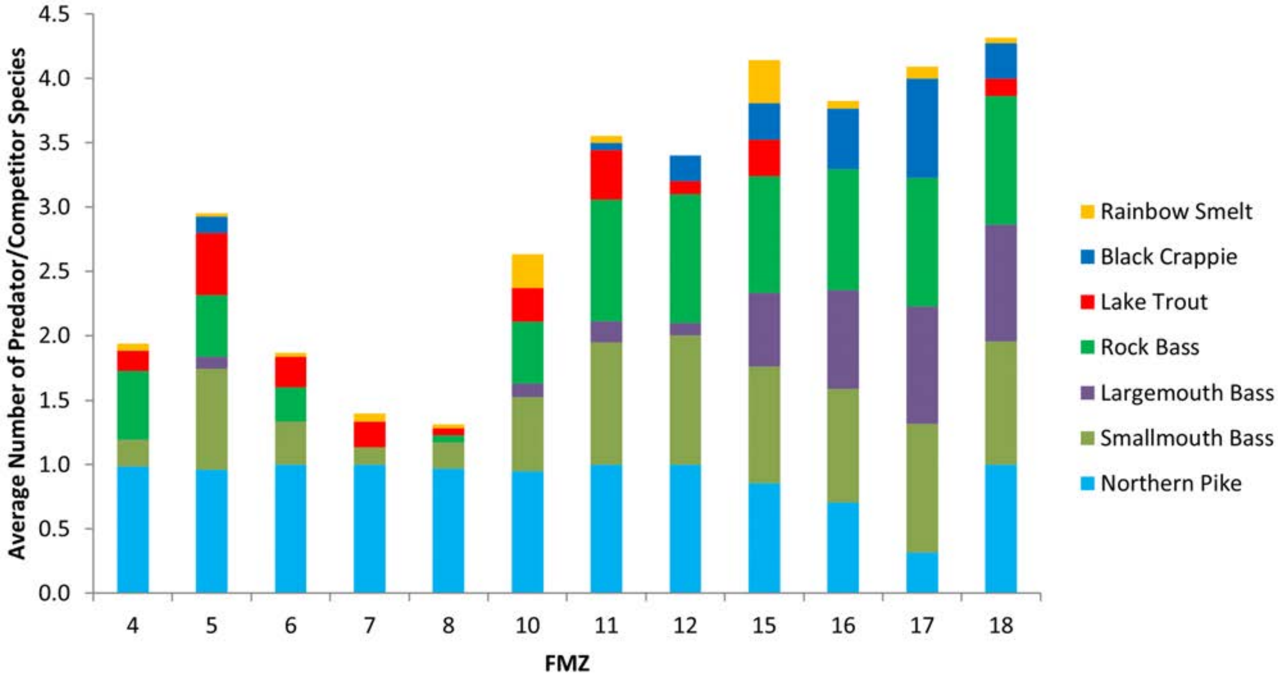


Figure 3.62 Average number of major predator and competitor species in Walleye trend lakes, by FMZ, BsM Cycle 1.

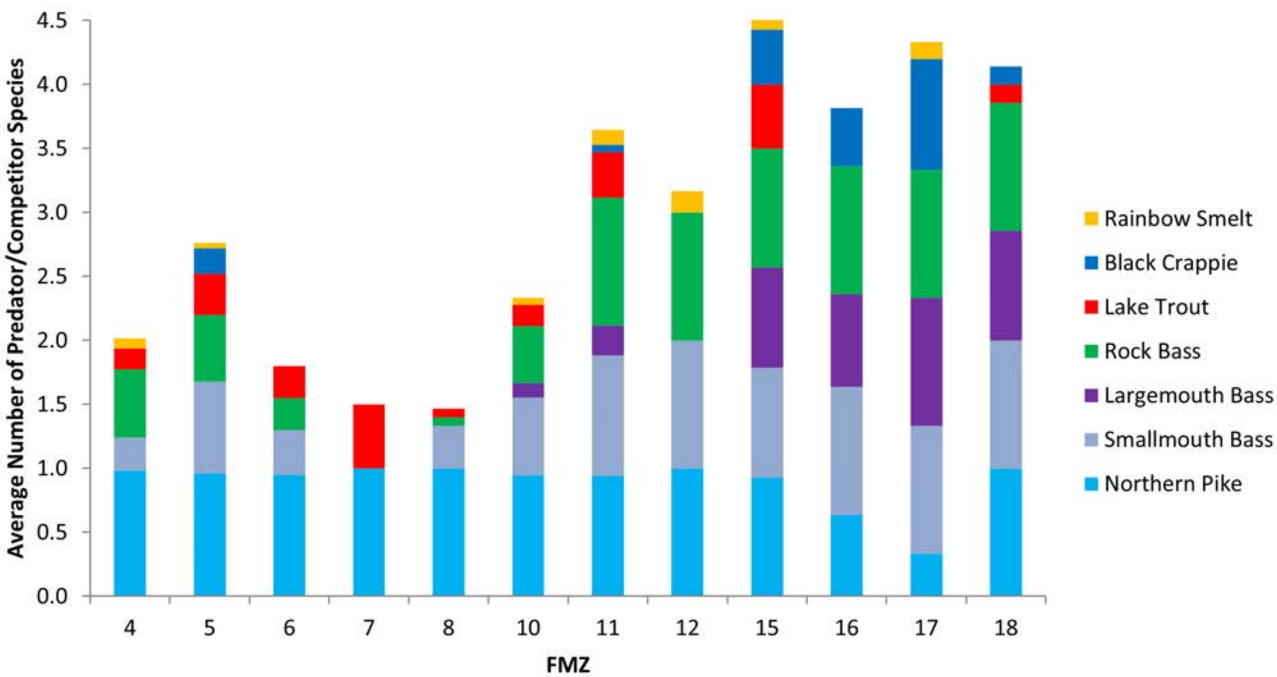


Figure 3.63 Average number of major predator and competitor species in Walleye trend lakes, by FMZ (excluding zones 1-3 due to no catches), BsM Cycle 2.

3.5.7.4 Abundance

There are approximately 194 lakes in FMZ 15 that are known to support self-sustaining populations of Walleye. About 10% of these lakes were selected randomly for BsM sampling in Cycle 1 (2008-2012) and represent the current status of Walleye in the zone. For Cycle 1, of the 27 lakes selected in FMZ 15 as Walleye trend lakes, there were no Walleye captured in 4 lakes, indicating that Walleye are either not present, or they are present but at extremely low abundance. In Cycle 2, for FMZ 15, Walleye were captured in all 19 Walleye trend lakes (lakes in which no Walleye were caught in Cycle 1 were replaced by other randomly selected lakes in Cycle 2).

The average area-weighted CUE of recruits from Walleye trend lakes in Cycle 1 was 0.57 fish/net. For Cycle 2 the average area-weighted CUE remained relatively unchanged at 0.57 fish/net (Figure 3.64).

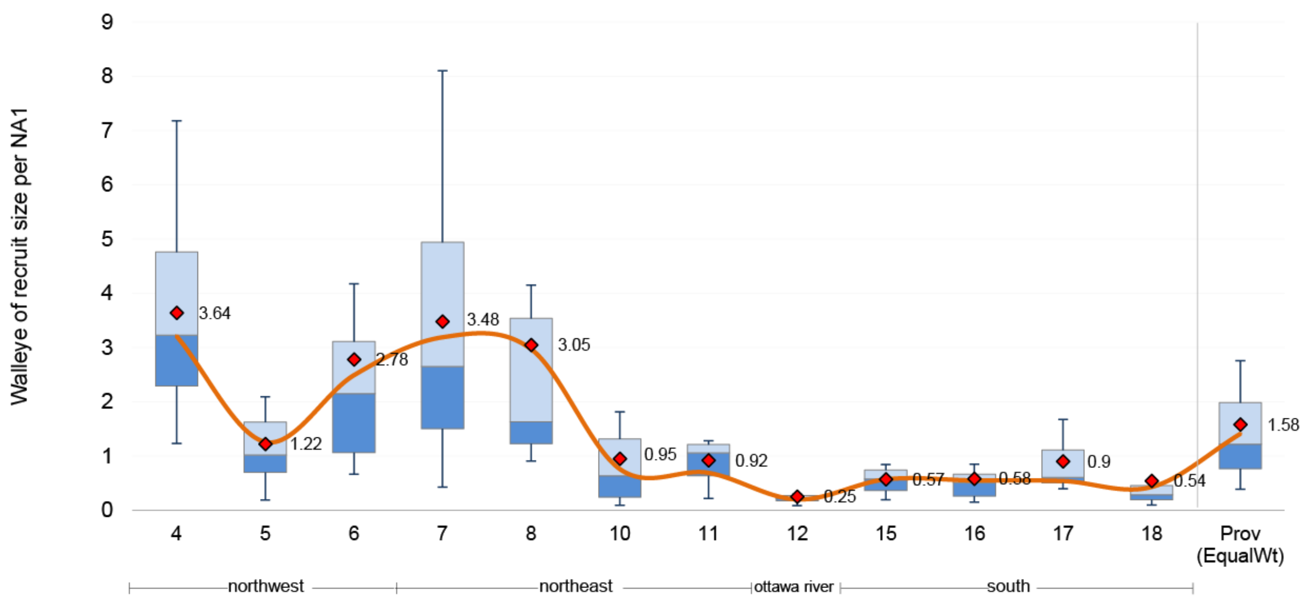


Figure 3.64 Area-weighted CUE (number of fish) of Walleye recruits for Walleye trend lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

The Walleye catch rate varied by lake size class (Figure 3.65). For Cycle 1, the 6 medium lakes had the highest average CUE of 1.0 fish/net. Small lakes had the next highest abundance (0.5 fish/net) average. The average catch from large lakes was 0.4/net, but the average was highly skewed by the catch from Lake Clear (2.5 fish/net); the 7 other large lakes had an average of only 0.17 fish/net, which was similar to the catch from Lake Muskoka, the only extra-large Walleye trend lake (0.25 fish/net).

Similar trends can be seen for Cycle 2, as the 7 medium lakes again had the highest average CUE (1.2 fish/net) followed by the small lakes (0.5 fish/net). For Cycle 2, although the average catch for large lakes decreased to 0.2 fish/net, this value is the same as Cycle 1, when Lake Clear, which highly skewed the CUE in Cycle 1, is omitted.

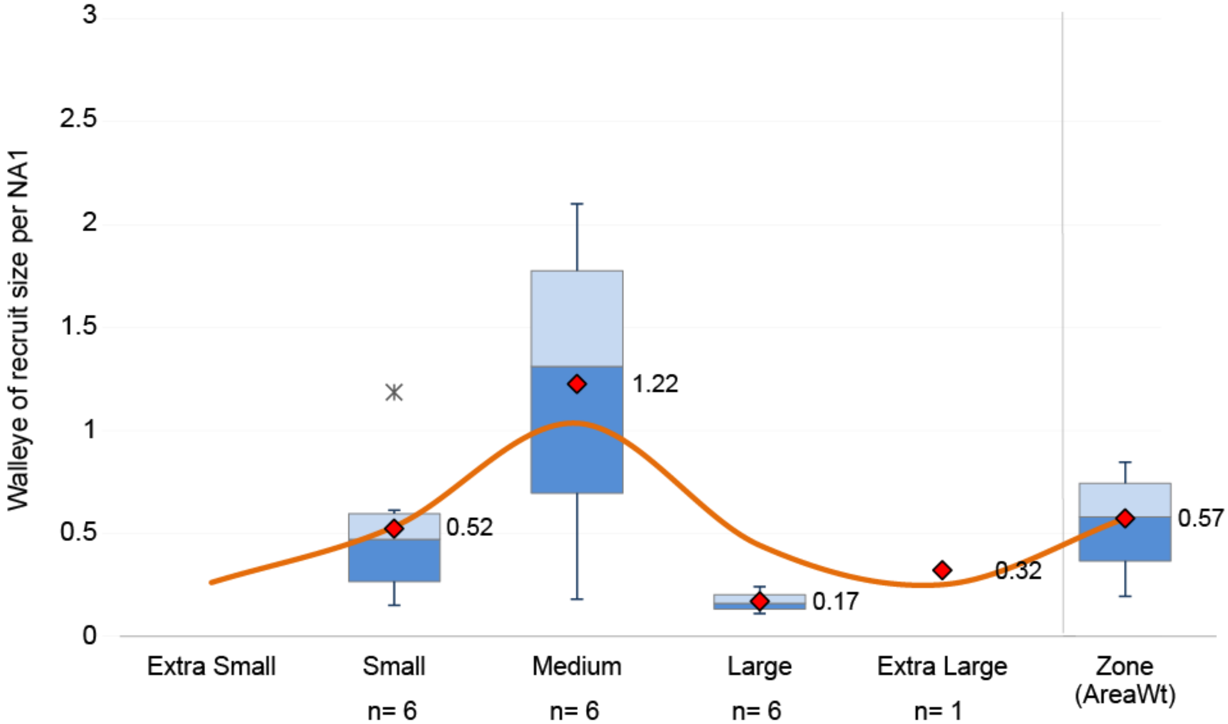


Figure 3.65 CUE (number of fish) of Walleye recruits, for Walleye trend lakes, by lake size class, FMZ 15, BsM Cycle 1 (line) and Cycle 2 (box plot).

The CUEW for FMZ 15, for both Cycle 1 and Cycle 2, was comparable with other zones in the Southern region as well as FMZs 10 and 11, but only about 25% of the provincial average (Figure 3.66). Within the zone, CUEW showed similar trends to CUE, with the highest weight being caught in medium lakes, followed by small lakes for Cycle 1 and 2 (Figure 3.67).

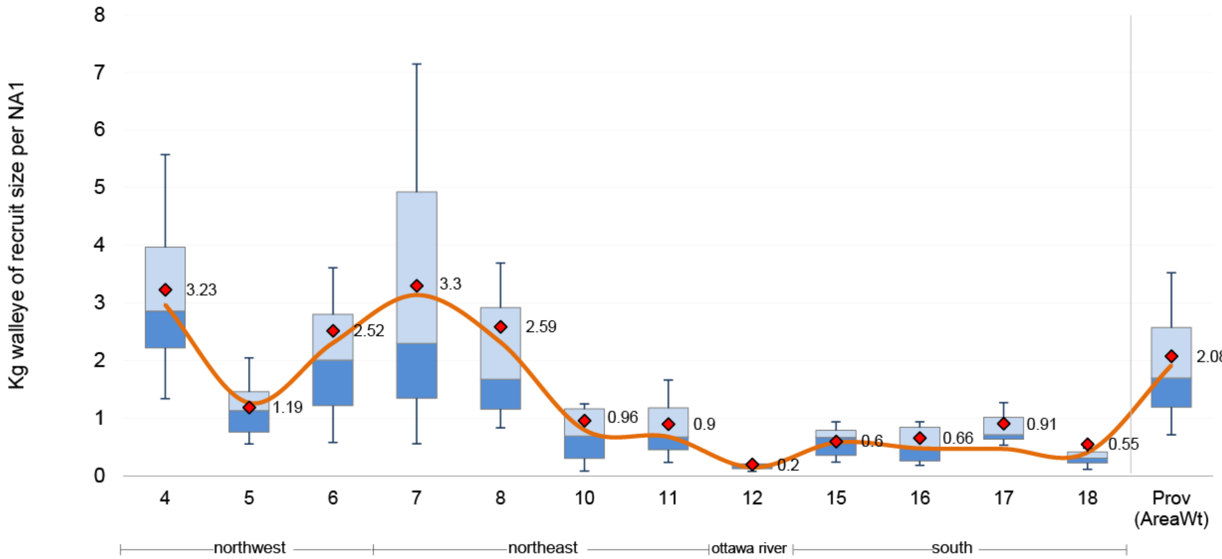


Figure 3.66 Area-weighted CUEW (kg/net) of Walleye recruits for Walleye trend lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

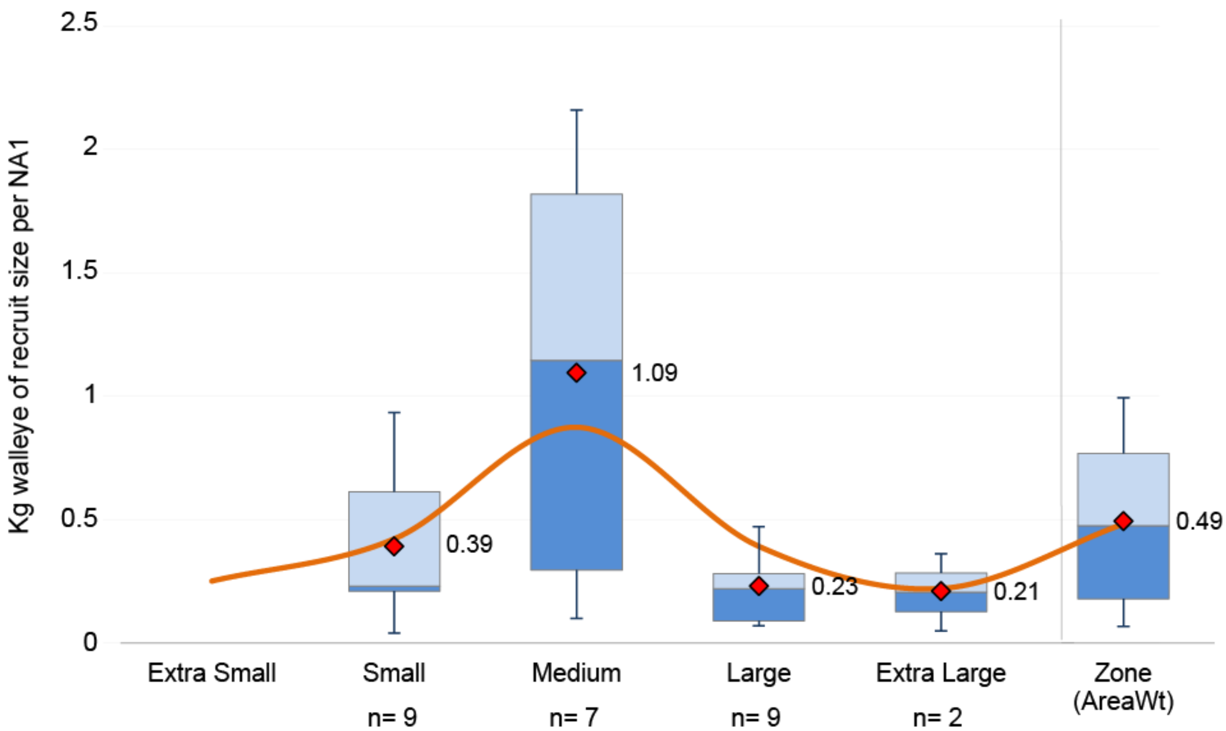


Figure 3.67 CUEW (kg/net) of Walleye recruits for Walleye trend lakes, by lake size class, FMZ 15, BsM Cycle 1 (line) and Cycle 2 (box plot).

The catch rates (CUE and CUEW) were similar across lake dominated zones (i.e. excluding FMZ 12) in southern region. While the lower values for these metrics show lower abundance and biomass overall, the relative proportion of Walleye of the total catch also differs among FMZs across the province (Figure 3.68). For both cycles, this metric compared closely to all southern region zones as well as FMZ 10 and 11 but was lower than all zones in the northwest region and FMZs 7 and 8 in the northeast region.

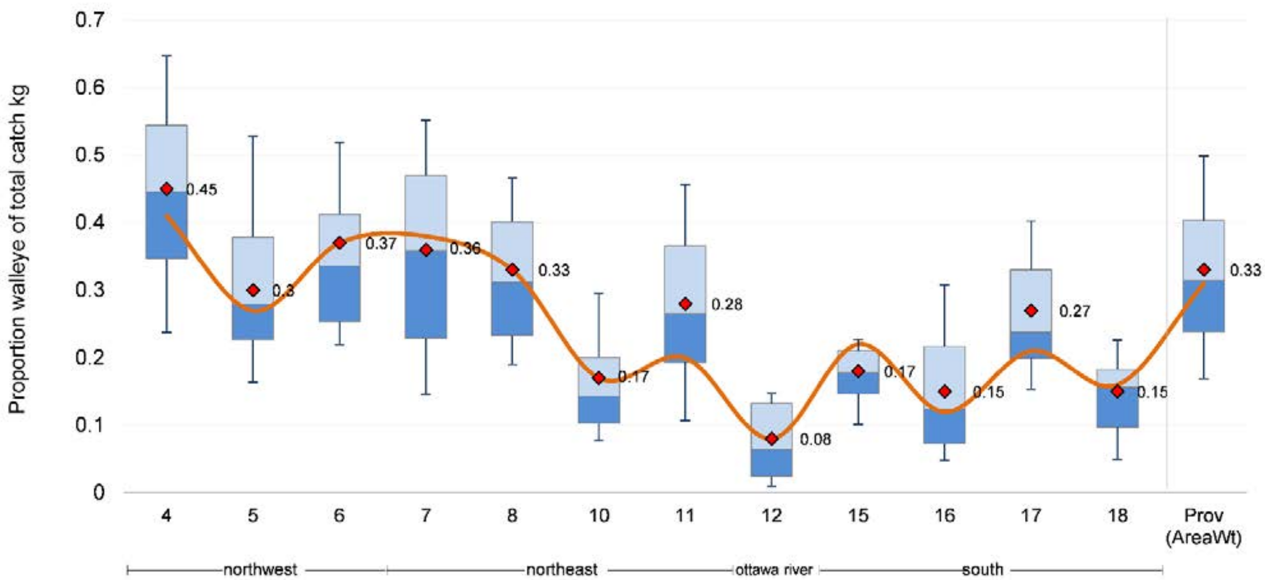


Figure 3.68 Area-weighted proportion of Walleye, by weight (kg), of the total catch of all species, for Walleye trend lakes by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

Provincially, there were two broad groups of zones with similar Walleye abundance. FMZ 15 was similar to FMZs 10 through 18 which were all lower than FMZ 4 to 8. The consistency across southern zones and disparity with the northern zones is indicative of systematic differences in factors such as habitat suitability, fish community and fishing effort. The relative uniformity of catch rate within the southern zones suggests that the potential abundance of Walleye is fundamentally constrained by these factors and unlikely that abundance could ever reach that seen in the northern zones.

The CUEW of recruitment-sized Walleye increased from Cycle 1 to Cycle 2 (Figure 3.69), from 0.50 to 0.62 kg per net ($p = 0.14$, $N=20$, 2 tail $alpha = 0.10$, $P = 0.46$). Lakes below the red 1:1 line had a higher catch rate in Cycle 1, while those above the line had a higher catch rate in Cycle 2. Overall, more lakes had higher catches in Cycle 2; but it is not possible at this time to determine the cause of these differences. Its important to note that a reduction in possession limits occurred prior to the BsM Cycle 1. Results from future BsM Cycles will be required to determine if a trend is occurring.

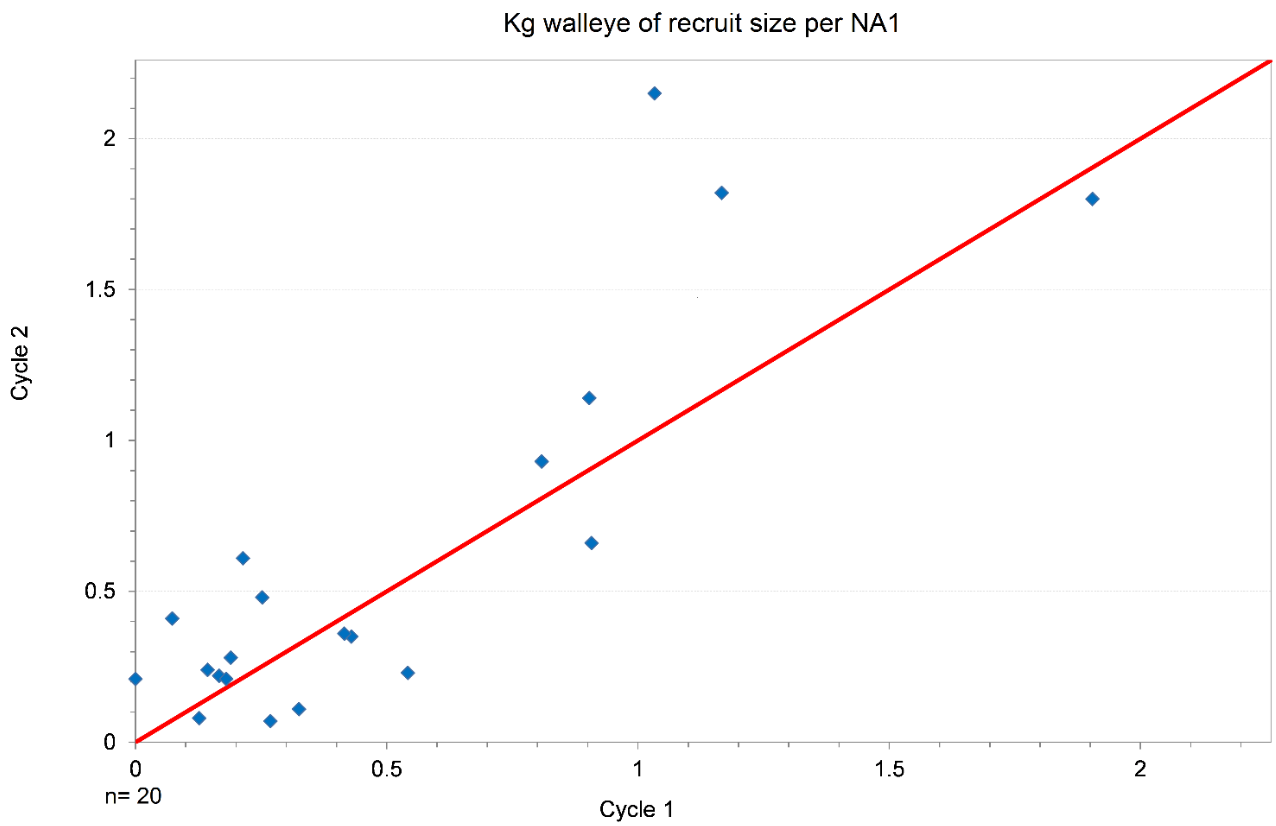


Figure 3.69 Comparison of CUEW (kg/net) of Walleye recruits for Walleye trend lakes, FMZ 15, BsM Cycle 1 and 2.

Eleven lakes in FMZ 15 have a catch and size limit regulation exception (Sport licence limit of 2 and Conservation licence limit of 1; and must be greater than 50 cm). The catch rate from the five exception lakes which are BsM trend lakes were compared to other lakes of similar size but have a standard zone regulation (lakes 1000-5000 ha included in analysis; Table 3.15). The lakes with the exceptions had a similar catch rate overall as those with the zone-wide regulation in Cycle 1. The exception lakes had a lower catch rate in Cycle 2, but most of the difference was due to the absence of a value for Lake Clear in Cycle 2; the catch rate in the other exception lakes was similar to that of the standard regulation lakes.

Overall, the regulation exception does not appear to have increased abundance, relative to other lakes, but the comparison was confounded by differences in properties of the lakes that are known to affect Walleye abundance. The average secchi depth, total dissolved solids and total phosphorus values were similar across regulation types but there were lakes with extreme values which strongly skew the results and make meaningful comparisons difficult. Overall, it could not be definitively concluded whether the regulation exception has improved abundance relative to other lakes in the zone.

Table 3.15 CUEW (kg/net) of Walleye from lakes 1,000 - 5,000ha, by angling regulation, FMZ 15, BsM Cycle 1 and 2.

Lake	Regulation	Surface Area (ha)	Mean Depth (m)	Secchi Depth (m)	TDS (mg/l)	TP (ug/l)	CUEW Cycle 1	CUEW Cycle 2
Black Donald L.	Exception	1500	16	4.0	55	11.2	0.13	0.08
Dore, L.	Exception	1513	8	3.4	130	15.4	0.17	0.22
Golden L.	Exception	3612	9	4.0	57	11.7	0.54	0.23
Clear, L.	Exception	1737	8	4.0	170	17.9	1.57	
Calabogie L.	Exception	1353	5	5.6	68	7.1	0.43	0.35
Jack L.	Standard	1343	7	3.9	101	9.8	0.14	0.24
Muskrat L.	Standard	1215	18	1.6	205	43.1	1.90	1.80
Bark L.	Standard	4024	24	3.0	23	6.8	0.19	0.28
Round L.	Standard	2970	13	3.7	38	8.6	0.27	0.07
Baptiste L.	Standard	2233	5	3.0	30	8.7	0.18	0.21
Kamaniskeg L.	Standard	2211	9	4.3	28	6.2	0.07	0.41
Average	Exception	1943	7.6	3.4	62	9.1	0.57	0.22
Average	Standard	2333	13	3.3	71	14	0.46	0.50

3.5.7.5 Population Characteristics

Size

The observed mean total length of Walleye in FMZ 15 was 492 mm for Cycle 1, the highest in the province (Figure 3.70). This compares to the provincial mean of 466 mm. Similar trends were seen in Cycle 2 where the observed mean total length was 480 mm, the third highest of any zone in the province, behind FMZ 16 and 17. This value was also higher than the provincial average weighted mean of 466 mm. The mean total length of Walleye sampled in Cycle 1 and Cycle 2 was relatively consistent among lake size classes. Monitoring mean size through time is a useful indicator of population status; but more Cycles are required to determine if any trends in mean size are occurring.

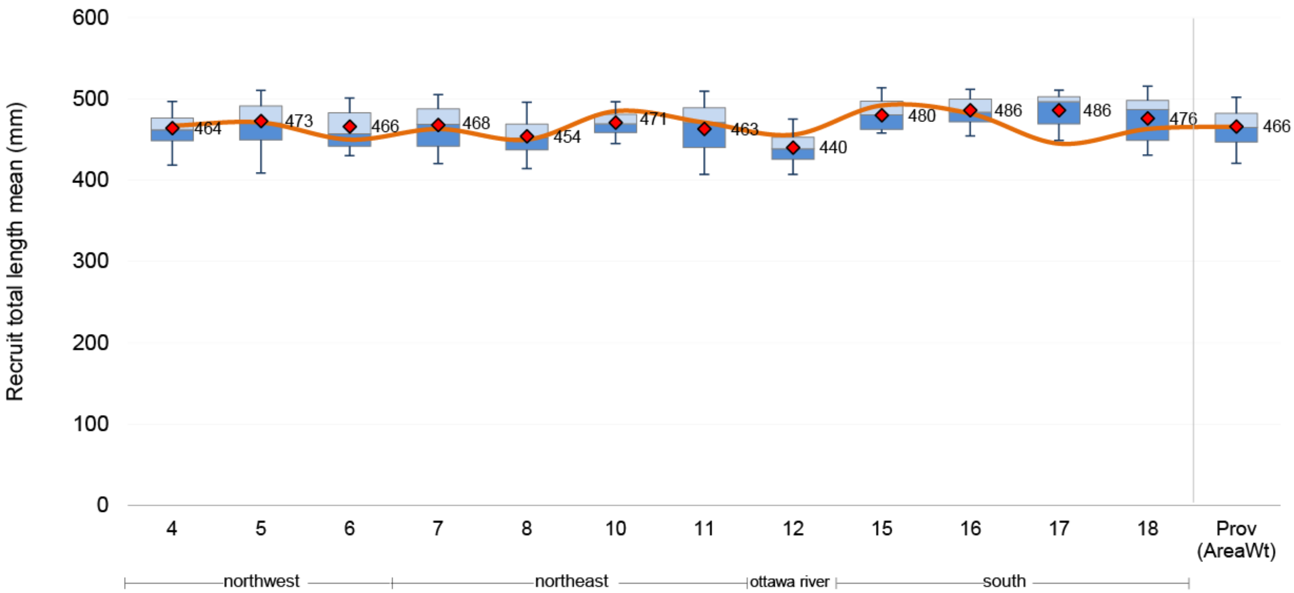


Figure 3.70 Area-weighted average mean total length (mm) of Walleye recruits for Walleye trend lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

Age

The age structure of a population is a product of the rates of recruitment and mortality. Changes in population age structure may result from changes in mortality rates and/or emergence of strong year classes in response to management actions, making it important to track changes in age metrics.

The area-weighted average age of Walleye captured during Cycle 1 was 6.2 years (Figure 3.71). This value was the same in Cycle 2. For Cycle 1, the average age of Walleye, in FMZ 15 was slightly higher than all the other zones in the southern region, except for FMZ 12. The results from Cycle 2 differ from Cycle 1, as the average age of Walleye in FMZ 15 was found to be slightly lower than all of the other zones in southern region, except for FMZ 16 which had a very similar average age compared to FMZ 15.

Only small differences were seen in the average age of Walleye across lake size classes in FMZ 15 (Figure 3.72). For Cycle 1 the average age range was 5.6 years to 7.1. years for Small, Medium and Large lakes and for Cycle 2 the average age range was 6.0 years to 6.8 years for Small, Medium and Large lakes.

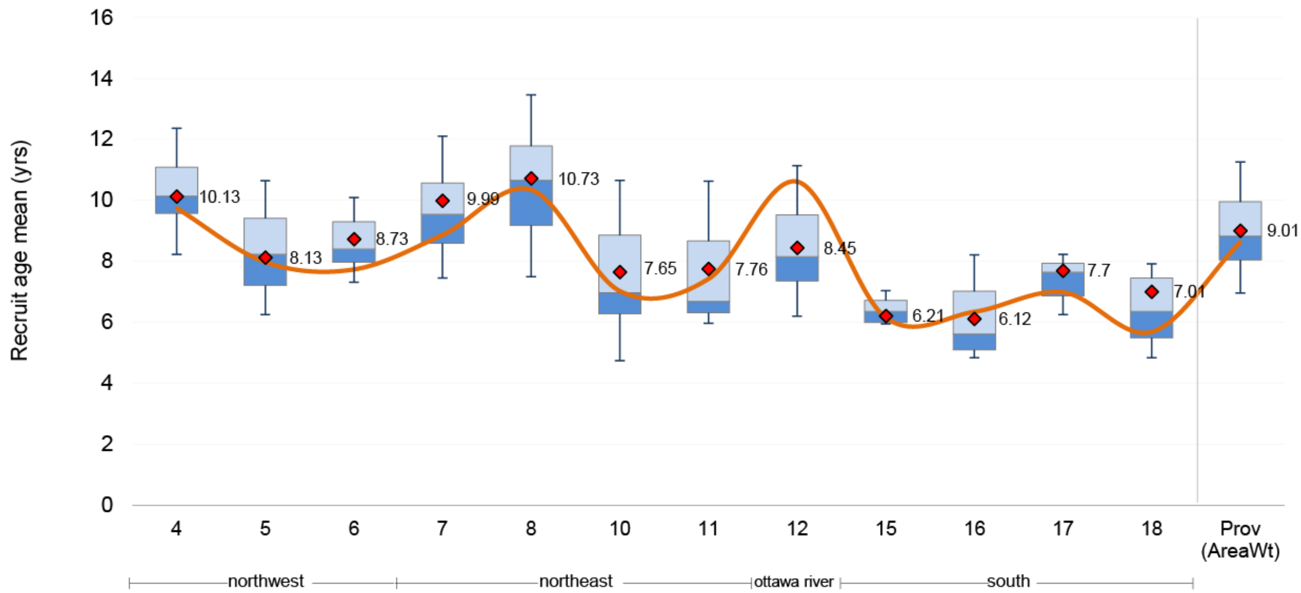


Figure 3.71 Area-weighted average mean age (years) of Walleye recruits for Walleye trend lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

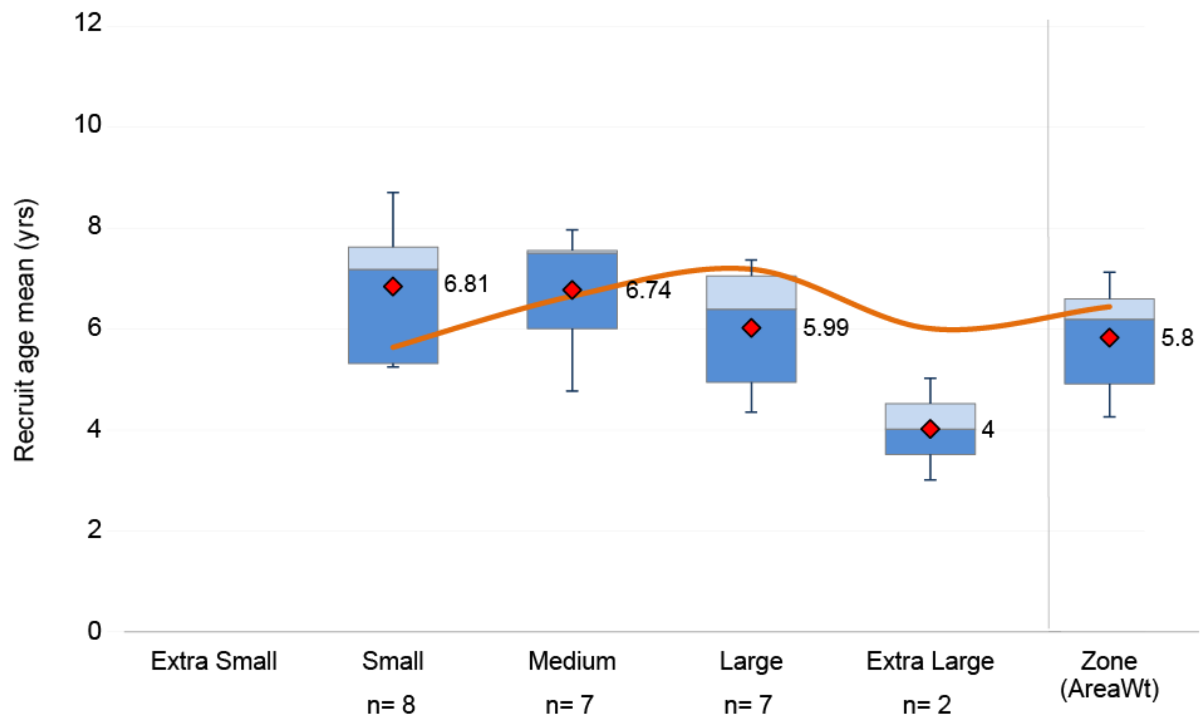


Figure 3.72 Mean age (years) of Walleye recruits for Walleye trend lakes, by lake size class, FMZ 15, BsM Cycle 1 (line) and Cycle 2 (box plot).

Generally, it is understood that fast growth in fish commonly results in lower life expectancy. During Cycle 1, Walleye in FMZ 15 grew faster than those from more northern zones in the province and grew at rates similar to other southern region zones, except for FMZ 12 (Ottawa River) (Figure 3.73).

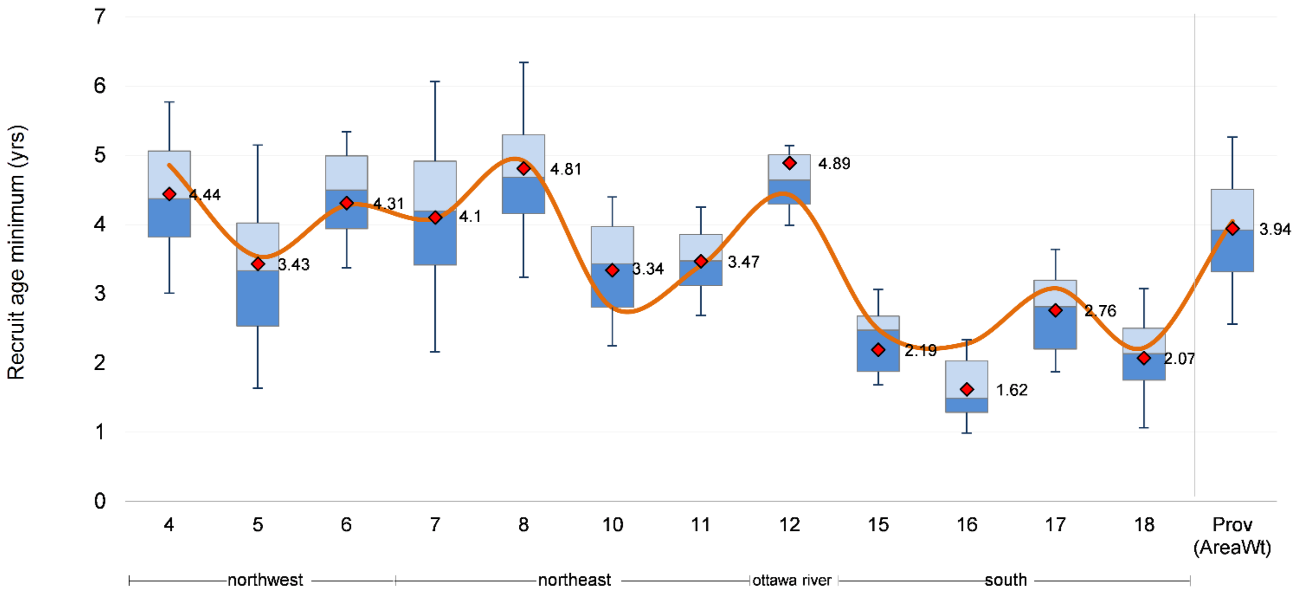


Figure 3.73 Area-weighted average minimum observed age (years) of Walleye recruits for Walleye trend lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

A higher maximum age and a larger number of age classes are indicative of successful recruitment and adult survival. A larger number of cohorts suggests lower mortality and greater resilience to stresses such as angling pressure. Like size comparisons across zones must acknowledge the inherent differences in natural mortality resulting from differences in climate, growth and other factors.

The average maximum observed age of Walleye in Cycle 1 for FMZ 15 was 11.1 years. (Figure 3.74). That was similar to other FMZs in southern region, except for FMZ 12, but considerably lower than the provincial average of 16.9 years and below the value for all FMZs in the northwest and northeast regions. Cycle 2 results showed a higher average maximum observed age of Walleye at 13.6 years. This value was like all other FMZs in southern region, but again considerably lower than the provincial average of 18.3 years and lower than all FMZs in the northwest and northeast regions.

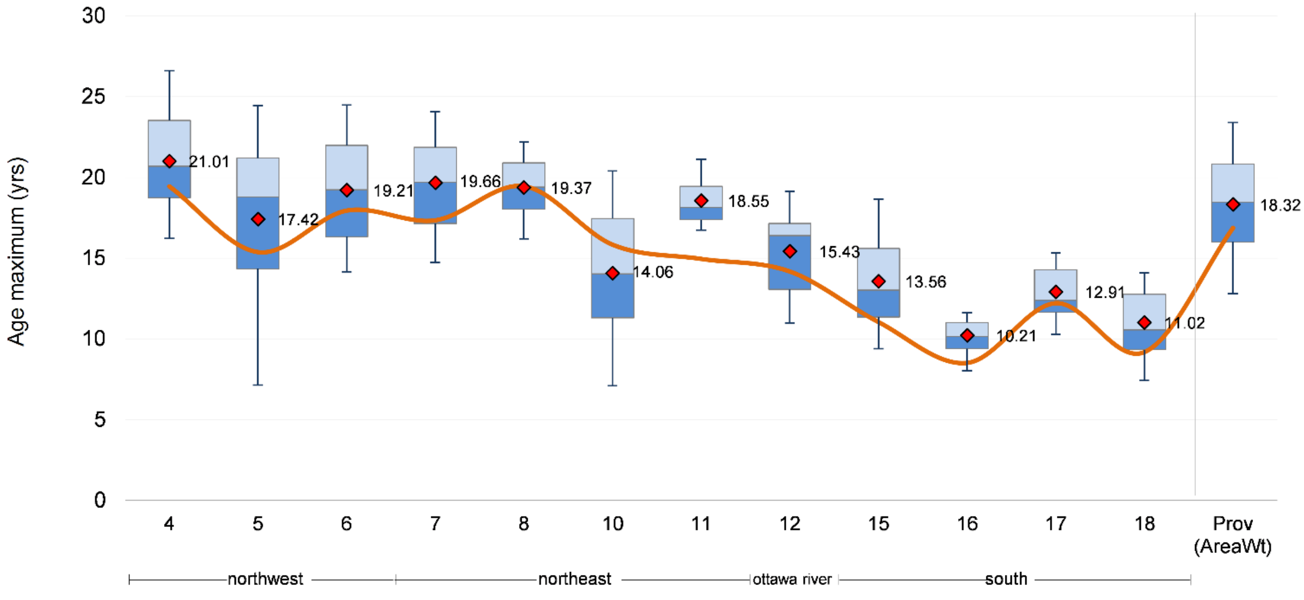


Figure 3.74 Area-weighted average maximum observed age (years) of Walleye for Walleye trend lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

For Cycle 1, Walleye populations in FMZ 15 had an average of 7.2 cohorts in the large mesh nets (Figure 3.75). This was considerably less than the provincial average of 12.2 cohorts and fewer than all other FMZs across the northwest and northeast regions. Similar values were seen for Cycle 2, as the average number of cohorts for FMZ 15 was 7.0 and the provincial average was considerably higher at 13.2 cohorts. The average number of cohorts for Cycle 2 was again lower than all other FMZs in the northwest and northeast regions, but like those values found in southern region. Some of the differences may be due to smaller sample sizes in FMZs with lower Walleye abundance.

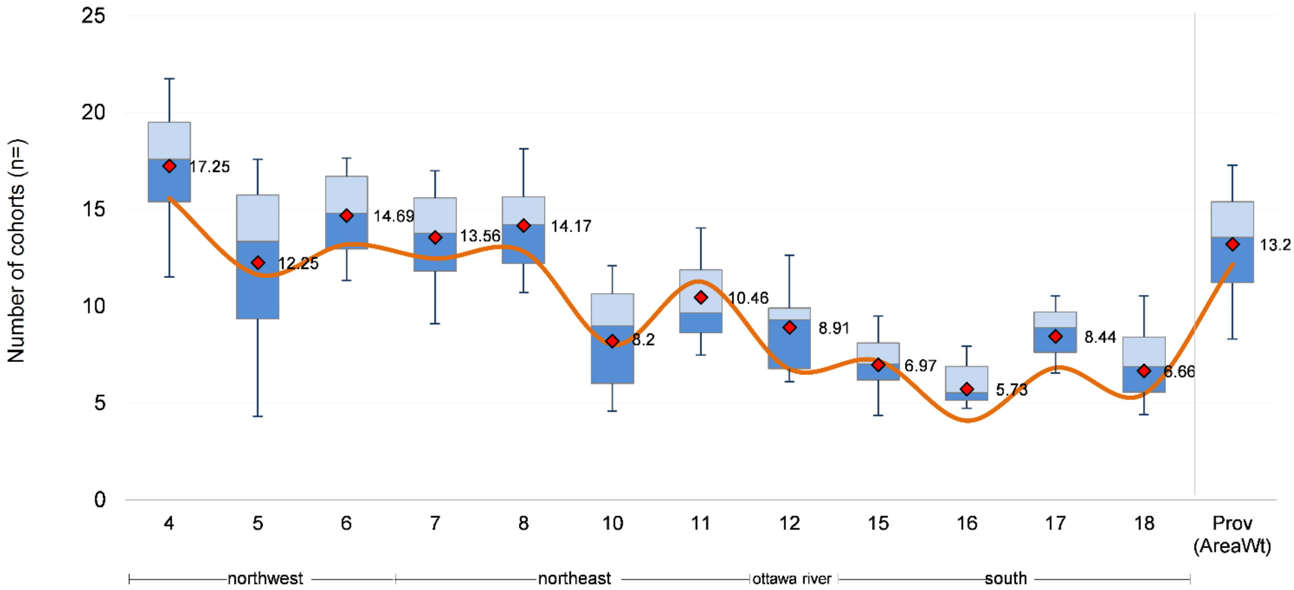


Figure 3.75 Area-weighted average number of Walleye cohorts for Walleye trend lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

Proportional Size Distribution (PSD)

The pattern of the PSD's of Walleye from Cycles 1 and 2 are similar (Figure 3.76). In both Cycles, there were a high proportion of individuals at or near maturity (~ 350 mm). In Cycle 1, 'Stock' and 'Quality'-sized fish formed 69% of the population compared to 71% in Cycle 2. Walleye populations appear to show signs of high mortality in larger size classes, as the percentage of fish larger than 510 mm ('Preferred' and larger) was only 18% and 22% in Cycles 1 and 2, respectively. No 'Trophy' individuals were captured in either Cycle, but a greater proportion of fish were in the 'Quality', 'Preferred' and 'Memorable' size categories in Cycle 2. If this shift continues one may start to see trophy size fish in the populations, if they live long enough.

The Relative Size Distribution-Q (RSD-Q) is the ratio of the proportion of fish of 'Quality' size and greater to the proportion of fish of 'Stock' size or greater. The RSD-Q values for Walleye from Cycle 1 and 2 were 60 (50/83) and 66 (61/93), respectively, which shows the proportion of fish captured in BsM nets that were an acceptable (i.e., harvestable) size to anglers. Gabelhouse (1984) suggest that values of 40-60 or 30-70 for RSD-Q represent "balanced" populations. This may, or may not be true, depending on the management strategy proposed. For instance, in FMZ 15, even though the RSD-Q values appear high, there are few Walleye of 'Memorable' or 'Trophy' size that occur in the FMZ 15 populations.

Differences between Cycle 1 and 2 are more likely due to the short-term influence of different year classes versus a long-term change in the overall composition of the Walleye population. Overall, a balance between small fish entering the fishery and large mature fish supporting reproduction fish is desirable, which now is the case. The lack of trophy size fish could be due to fishing pressure. Future Cycles of BsM will be needed to assess whether a long-term trend in the size composition is occurring.

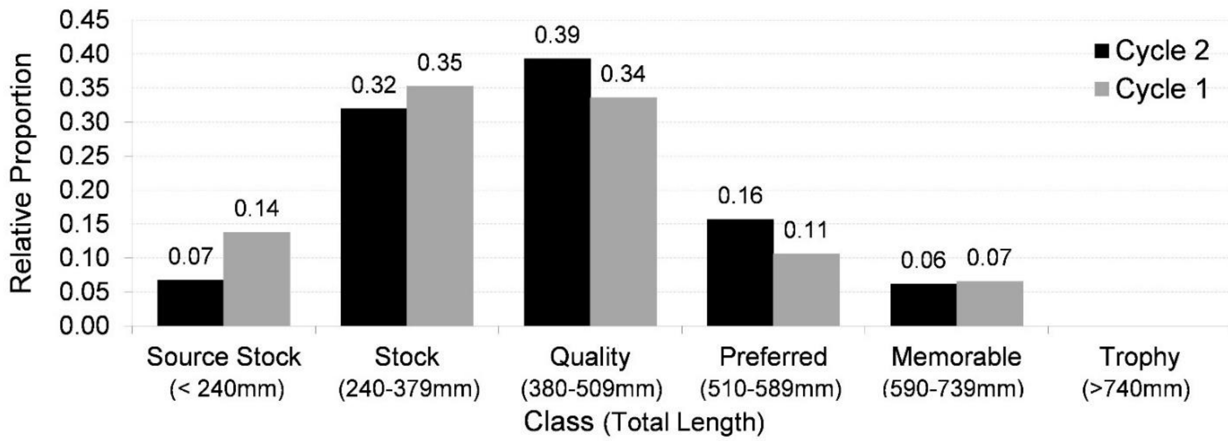


Figure 3.76 Proportional size distribution of Walleye for Walleye trend lakes, FMZ 15, BsM Cycle 1 and 2.

Growth and Maturation

The growth rate of Walleye is dependent on multiple factors, including food availability, habitat quality, water temperature and gender (Venturelli et al. 2010). Generally, growth in females is faster and they grow to larger sizes than males (Lester et al. 2000). The positive relationship between female size and egg production and the high input of energy spent by males during spawning are possible causes for the differences in male and female growth rates and maximum size. Interpreting the significance of growth rate is complicated by multiple influences including climate, lake productivity, fish community and exploitation. Under low abundance, high growth rates of Walleye are often observed, that may show high prey availability. Alternatively, high growth rates may occur under conditions of high angler exploitation rates. Rapid growth and associated earlier maturation in southern Ontario Walleye populations allow for higher sustainable harvest rates compared to more northern populations.

Walleye in FMZ 15 grow relatively quickly; the average pre-recruitment growth rate in Cycle 1 was 166 mm/year (Figure 3.77). This growth rate was well above the provincial average of 100 mm/year and surpassed only by FMZ 18. Cycle 2 results were comparable to Cycle 1; the average pre-recruitment growth rate for Cycle 2 was 173 mm/year. This was again well above the provincial average of 101 mm/year and was surpassed only by FMZ 16.

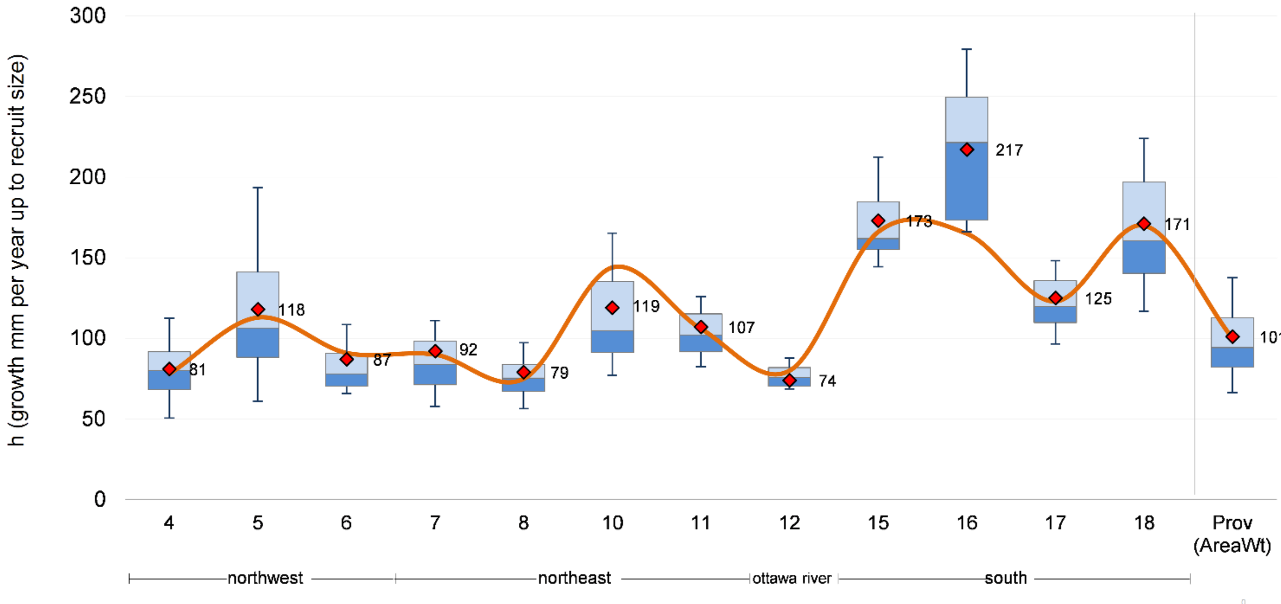


Figure 3.77 Area-weighted average pre-recruitment growth rate (mm/year) of Walleye from Walleye trend lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

3.5.7.6 Biological Reference Points (Biomass and Mortality)

Recent studies (Lester et al. 2004, Lester et al. 2014), using models, have developed Walleye abundance and sustainable fishing reference points that link to lake productivity. These reference points provide insight and understanding as to whether current levels of Walleye harvesting are sustainable. Lester and Dunlop (2003) developed a quadrant plot (Kobe Plot) that displayed the ratio of observed biomass/expected biomass (Y-axis) against observed mortality/sustainable mortality (X-axis). The quadrant plot was used to characterize the status of Lake Trout populations into four separate quadrants). This approach is adapted here to characterize the status of Walleye populations in FMZ 15.

The biomass limit reference value (Lester and Dunlop, 2003) is calculated by dividing the biomass (kg/ha) estimate of recruit-sized fish (> 350 mm total length) by the expected biomass and the mortality reference value is the total mortality rate (Z) divided by the predicted natural mortality rate (M). Using a population model to examine sustainable exploitation rates, Lester et al. (2014) recommended “safe” reference points for managing Walleye fisheries. This approach is especially useful for predicting safe rates of exploitation when population and harvest data are not available or when the capacity to monitor numerous populations exceeds capacity of management agencies. In this background report, we use a safe reference biomass point of 1.3 times the expected biomass at maximum sustainable yield. The safe mortality reference point is 0.75 times the predicted natural mortality rate (M). Reference points are shown for each Walleye trend lake and the observed biomass and mortality compared to the reference values is displayed for each lake by size class.

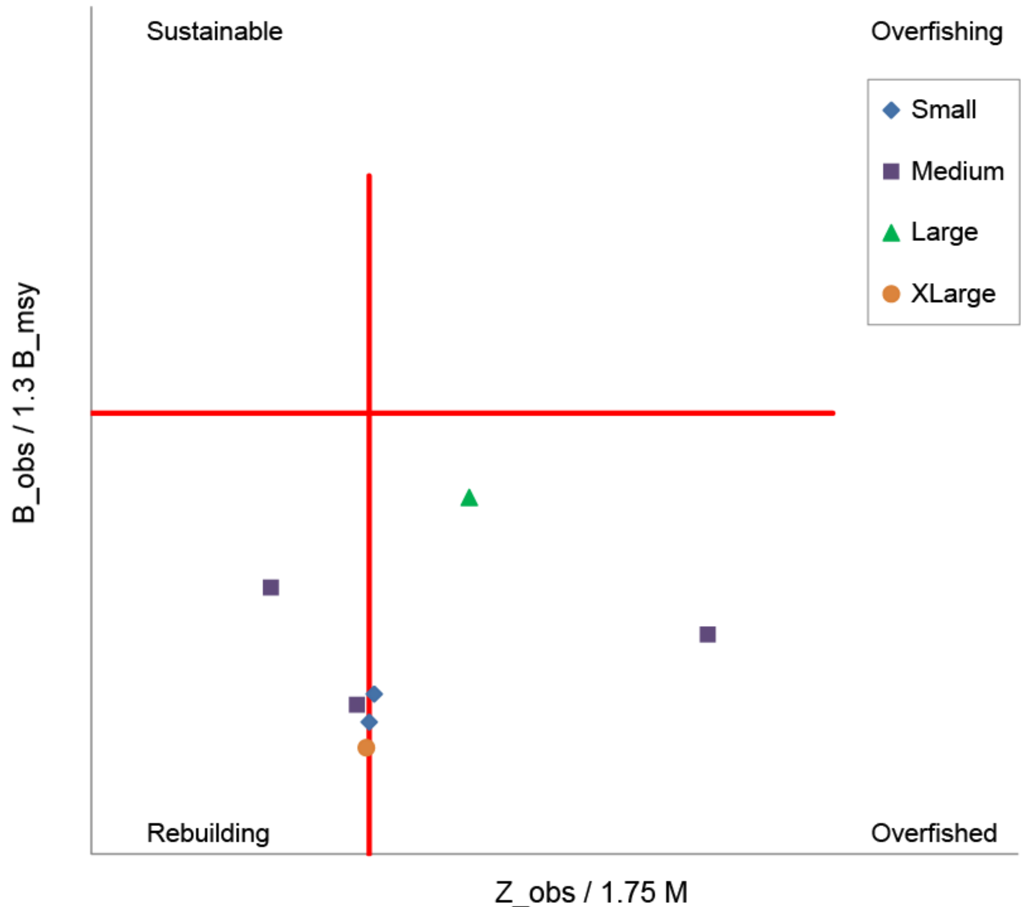
Results of the quadrant analysis for Cycle 1 suggest reasons for concern over Walleye populations in FMZ 15. First, only 7 of 20 Walleye trend lakes in Cycle 1 had enough data to calculate the indices; 2 Small lakes, 3 Medium lakes, 1 Large lake and 1 Extra Large lake (Figure 3.78). Cycle 2 results of the quadrant analysis also had data limitations, with only 7 of the 19 Walleye trend lakes having enough data to calculate the indices: 1 Small lake, 4 Medium lakes, 1 Large lake and 1 Extra Large lake (Figure 3.79). With almost 200 Walleye lakes occurring in the zone, the sample of 7 lakes is not representative of the entire Walleye resource.

Second, none of the 7 lakes with an adequate sample size lie in the healthy quadrant (Sustainable – Stage 1). All of the lakes in both BsM cycles occur in the lower left and right quadrants suggesting that both biomass and mortality levels are of concern. Figure 3.80 shows the range of observed biomass estimates for each lake size bin and an area weighted zone average (far right in figure) for Walleye in BsM cycle 1 with respect to the safe limit reference point (1.3 B_{MSY}). This figure characterizes the zone as the percentage of Walleye trend lakes that fall either above or below the reference point. Figure 3.80 shows that 100% of the Walleye trend lakes are below the safe biomass reference point in FMZ 15 (7 of 7 lakes monitored). Similarly, based on results from lakes where sufficient samples were collected to estimate mortality, approximately 50% of FMZ 15 Walleye lakes exceeded the safe mortality reference point (Figure 3.81). The pattern was very similar in BsM cycle 2 where 100% of the walleye lakes fell below the safe biomass reference point (Figure 3.82) while 71% of the lakes exceeded the safe mortality reference point (Figure 3.83). Importantly, these values represent the baseline values that will be used to measure progress against.

Many of the lakes with inadequate data likely fall in the lower half of the graph on either the lower left or lower right quadrants. Being in a state of low abundance and low mortality should be a transitory state as populations recover from earlier higher rates of mortality. The presence of so many lakes in the two lower quadrants suggests that their present state may not be transitory. Rather, these populations may be locked in a steady state at a low level of abundance, despite low mortality. That is, the biomass at MSY line is lower than expected, possibly due to fish community shifts, species introductions or easy access, making it difficult for populations under current conditions to recover to their expected theoretical levels of abundance.

Alternatively, the quadrant reference lines, calculated from generalized population models, do not correctly show conditions in the zone. For instance, the original biomass benchmark may be too high and/or the mortality benchmark too low. It may be difficult for populations to shift to neighbouring quadrants from their current position.

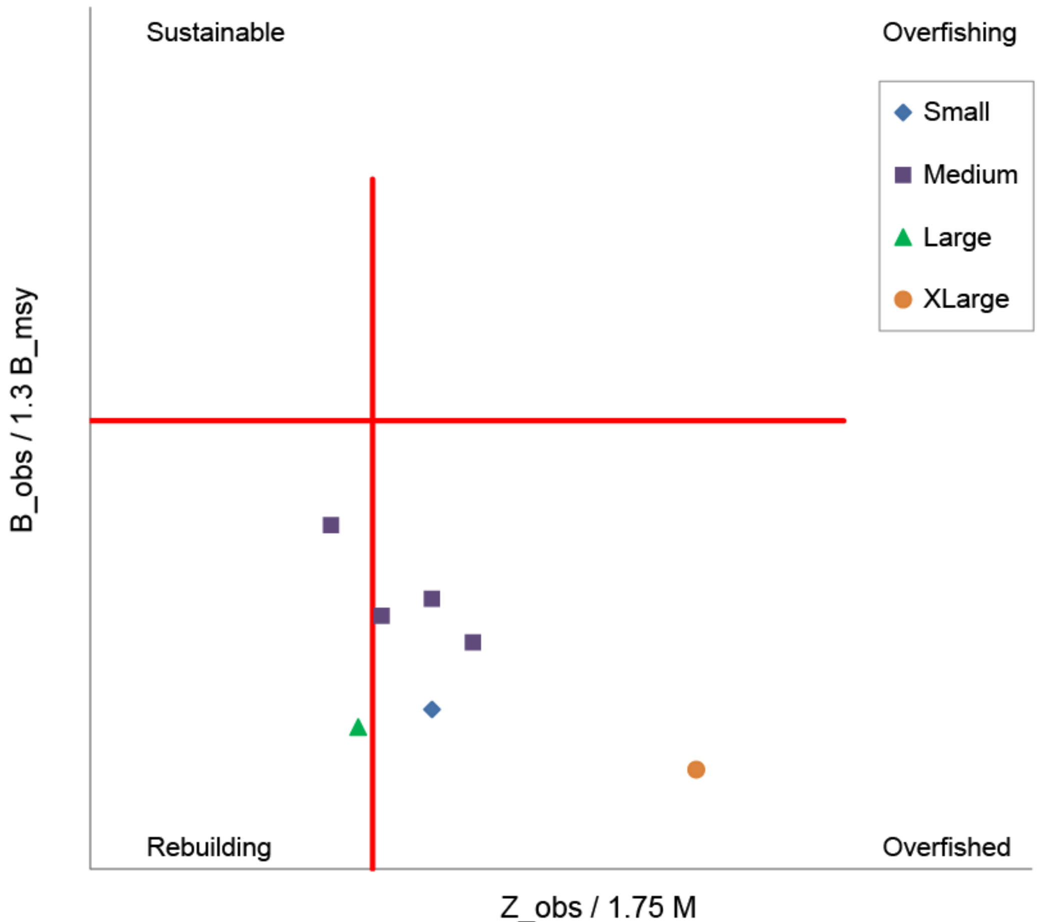
Regardless, the reference lines are just that. The position of lakes compared to the reference lines is less important than how the position of individual lakes, or the group of lakes, may change over time.



	XSmall	Small	Medium	Large	XLarge	Total	
Sustainable		0%	0%	0%	0%	0%	
Overfishing		0%	0%	0%	0%	0%	
Overfished		100%	33%	100%	0%	57%	
Rebuilding		0%	67%	0%	100%	43%	
n=		2	3	1	1	7	
no. n/a	0	4	3	6	0	13	65%

n/a are lakes with insufficient data

Figure 3.78 Quadrant (Q)-plot of Walleye recruit biomass and Walleye recruit mortality for Walleye trend lakes, FMZ 15, BsM Cycle 1. The reference lines (red) represent a value of one. All lakes in this plot fall below the biomass reference line (sustainable biomass of 1.3 x BMSY.). Lakes situated to the right of the red reference line have estimated mortality rates that exceed the mortality reference point (safe mortality rate of 1.75 x M).



	XSmall	Small	Medium	Large	XLarge	Total	
Sustainable		0%	0%	0%	0%	0%	
Overfishing		0%	0%	0%	0%	0%	
Overfished		100%	75%	0%	100%	71%	
Rebuilding		0%	25%	100%	0%	29%	
n=		1	4	1	1	7	
no. n/a	0	5	2	5	0	12	63%

n/a are lakes with insufficient data

Figure 3.79 Quadrant (Q)-plot of Walleye recruit biomass and Walleye recruit mortality for Walleye trend lakes, FMZ 15, BsM Cycle 2 (2013-2017). The reference lines (red) represent a value of one. All lakes in this plot fall below the biomass reference line (sustainable biomass of 1.3 x BMSY.). Lakes situated to the right of the red reference line have estimated mortality rates that exceed the mortality reference point (safe mortality rate of 1.75 x M).

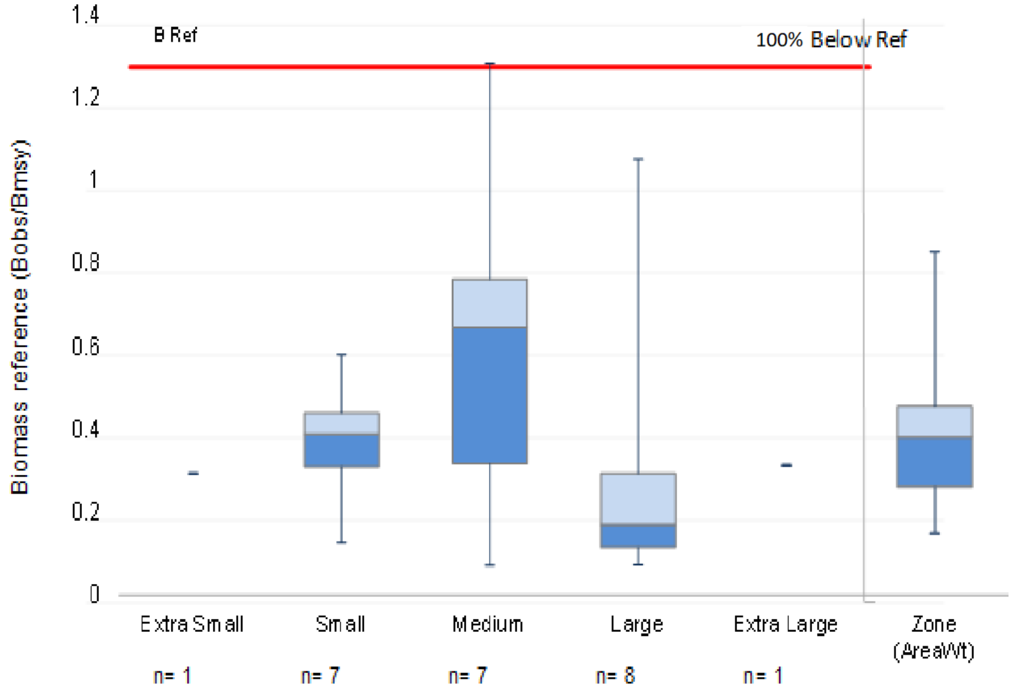


Figure 3.80 Biomass reference point for Walleye by lake size for Walleye trend lakes, FMZ 15, BsM, Cycle 1 (2008-2012). Red reference line indicates a safe biomass reference point of 1.3.

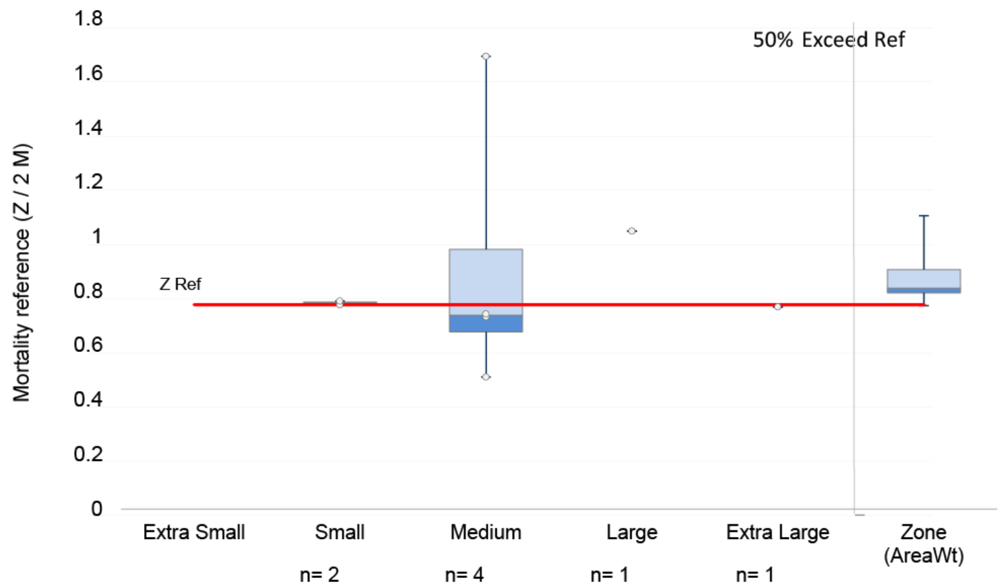


Figure 3.81 Mortality reference point for Walleye by lake size for Walleye trend lakes, FMZ 15, BsM, Cycle 1 (2008-2012). Red reference line indicates a safe mortality reference point of 0.75.

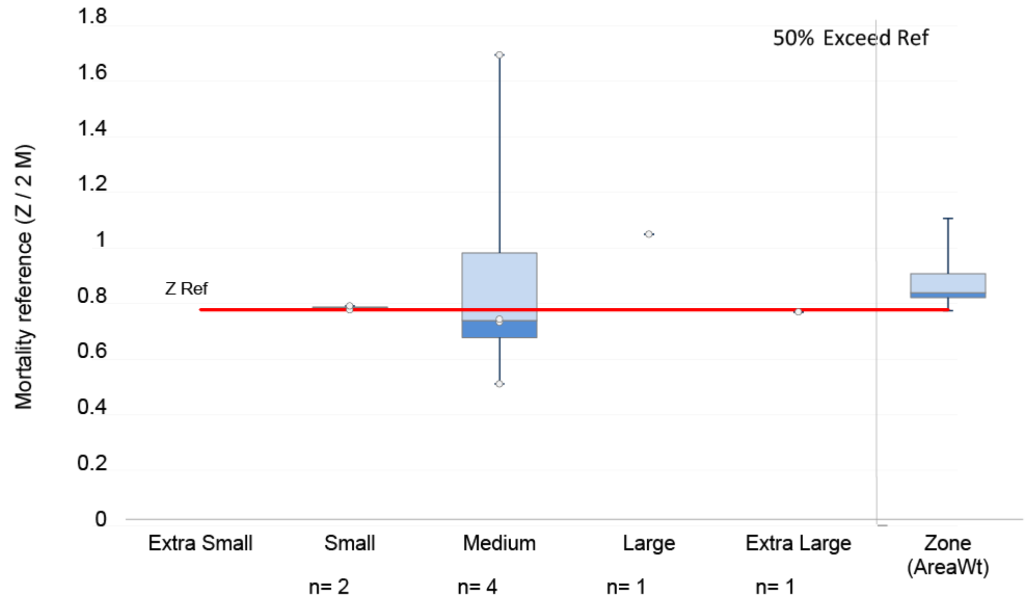


Figure 3.82 Biomass reference point for Walleye by lake size for Walleye trend lakes, FMZ 15, BsM, Cycle 2 (2017-2017). Red reference line indicates a safe biomass reference point of 1.3.

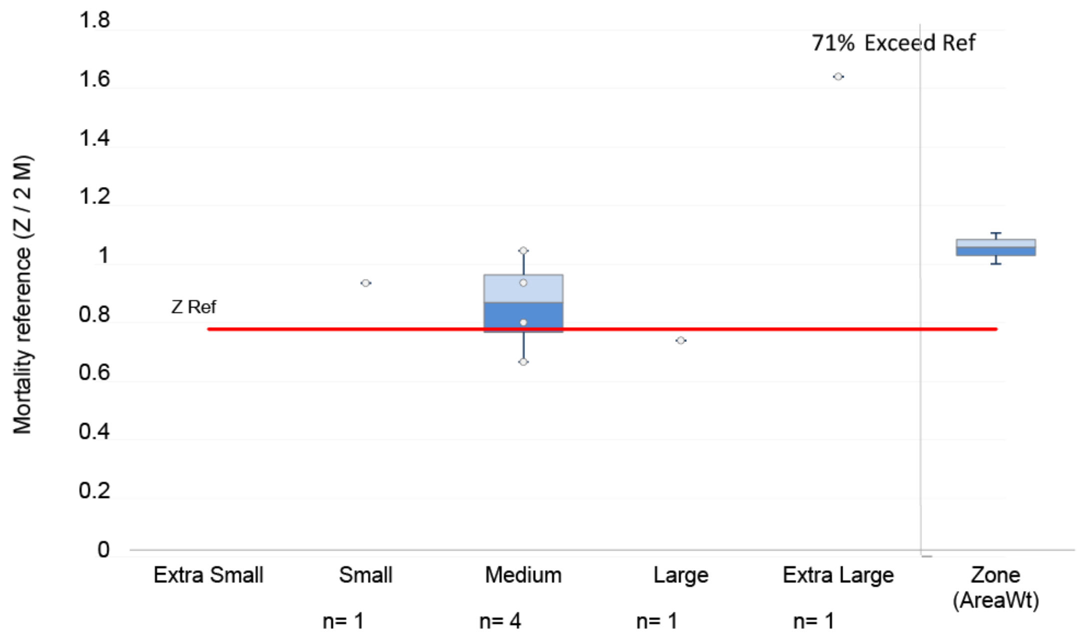


Figure 3.83 Mortality reference point for Walleye by lake size for Walleye trend lakes, FMZ 15, BsM, Cycle 1. Red reference line indicates a safe mortality reference point of 0.75.

3.5.8 Smallmouth and Largemouth Bass

3.5.8.1 Description

Smallmouth and Largemouth Bass are members of the Centrarchid family. They are a popular sport fish. Smallmouth Bass was the most desired, targeted and harvested species by anglers in FMZ 15 in 2010 (OMNRF 2015a). Both species have been widely introduced throughout Ontario, including FMZ 15. Early stocking was primarily done by the government but in recent decades unauthorized stocking has been dominant.

Both Smallmouth and Largemouth Bass spawn in spring and early summer and are nest builders and defenders. In spring, males, followed by females, move into the littoral areas of lakes and rivers to spawn (Ridgway et al. 1989). Males build nests and females select mates among nesting males based on their body size, with larger males being preferred (Wiegmann et al. 1992). The male aerates the nest and guards the nest from predators (Miller 1975; Scott and Crossman 1998). Nest predators include fish species such as the Bluegill (*Lepomis macrochirus*), other sunfishes (*Lepomis* spp.), minnows (*Cyprinidae*) as well as aquatic insects and crayfish. There is evidence that males have strong nest site fidelity (Ridgway et al. 1991; Toline et al. 1994) and consistently return to the same summer and winter home ranges (Miller 1975; Savitz et al. 1993; Ridgway and Shuter 1994). Displacement affects Smallmouth and Largemouth Bass differently; return rates are higher for Smallmouth Bass, while Largemouth Bass take longer to return or do not return at all to their original home range (Ridgway 2002).

The diet of Smallmouth Bass is likely influenced by the overall abundance and availability of prey. In general, the food of adult Smallmouth Bass consists of insects, crayfish and fishes. Crayfish is the preferred food of older Smallmouth Bass and makes up close to two thirds of its diet (MacKay 1963). Food items listed in literature also include zooplankton, insects, leeches, amphibians, plant material, mammals and many fish species and their eggs.

Largemouth Bass feed from mid-April to mid-October in central Ontario or until water temperatures drop below 10˚C (Hamilton and Powles 1983). Largemouth Bass are top predators known to prey upon numerous fish species. While Largemouth Bass are known to eat a variety of organisms (Sternburg 1996; Scott and Crossman 1998), their diet is formed mainly of fish, crayfish and frogs (Hamilton and Powles 1983).

Factors such as habitat loss, shoreline development, water level and temperature fluctuations, predation, and angling can negatively affect spawning success of both Smallmouth and Largemouth Bass. A warming climate will likely benefit bass populations given that warmer water temperatures result in higher growth rates, increased productivity and the potential for range expansion (Lynch et al. 2016).

Largemouth Bass are not caught in adequate numbers in BsM surveys to allow reporting at this time. As BsM cycles continue this will improve over time.

3.5.8.2 Distribution

Historically, the native range of Smallmouth Bass was limited to the Great Lakes – St Lawrence system in Ontario (Scott and Crossman 1998) but as a result of introductions (many in the early 1900's) to provide angling opportunities (Jackson 2002) it now occupies lakes and rivers throughout southern Ontario, including most of the lakes within FMZ 15 (Funnell 2012).

The native range of Largemouth Bass includes the lower Great Lakes (Scott and Crossman 1998) but was more limited than that of Smallmouth Bass. The greatest abundance of Largemouth Bass in inland waters in Ontario exists in south central Ontario (Mandrak and Crossman 1992). Most Largemouth Bass populations in FMZ 15 were introduced.

The Atlas of Smallmouth Bass Lakes in Ontario (OMNR 1987c) lists 840 lakes with Smallmouth Bass within FMZ 15 (not including Algonquin Provincial Park). Only 100 of these are identified as being of "native" origin; the remainder were introduced or of unknown origin.

The Atlas of Largemouth Bass Lakes in Ontario (OMNR 1990b), lists over 473 lakes with Largemouth Bass within FMZ 15, not including Algonquin Provincial Park.

The ranges of both species have expanded significantly since the atlases were compiled over 30 years ago. In 2021, the Aquatic Resource Area (ARA) database included 990 lakes with Smallmouth and 716 with Largemouth Bass (Table 3.16,Figure 3.84, Figure 3.85). A total of 206 lakes had only Largemouth, 480 only Smallmouth and 510 lakes had both species, for a total of 1196 lakes. Discrepancies between the two databases haven't been reconciled but there are probably about 50-100 more occurrences of each species than are currently recorded in the ARA database.

Table 3.16 Number of lakes with Smallmouth and Largemouth Bass, FMZ15. Number in brackets is the number of lakes with only the listed species of bass).

	Atlas (1987/1990)	ARA (2021)	Change (%)
Largemouth Bass	473	716 (206)	+51
Smallmouth Bass	840	990 (480)	+18

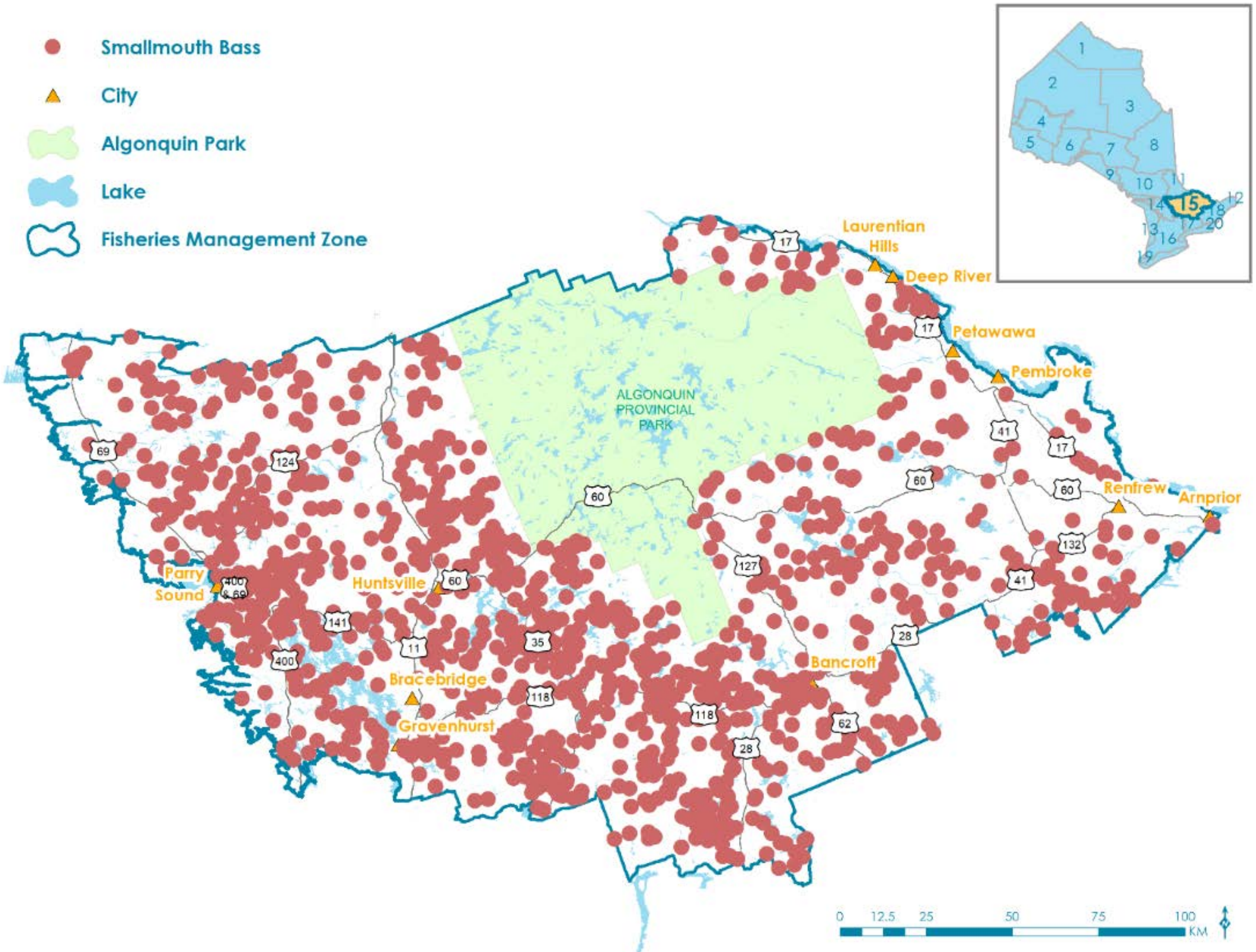


Figure 3.84 Distribution of Smallmouth Bass, FMZ 15, excluding Algonquin Provincial Park.

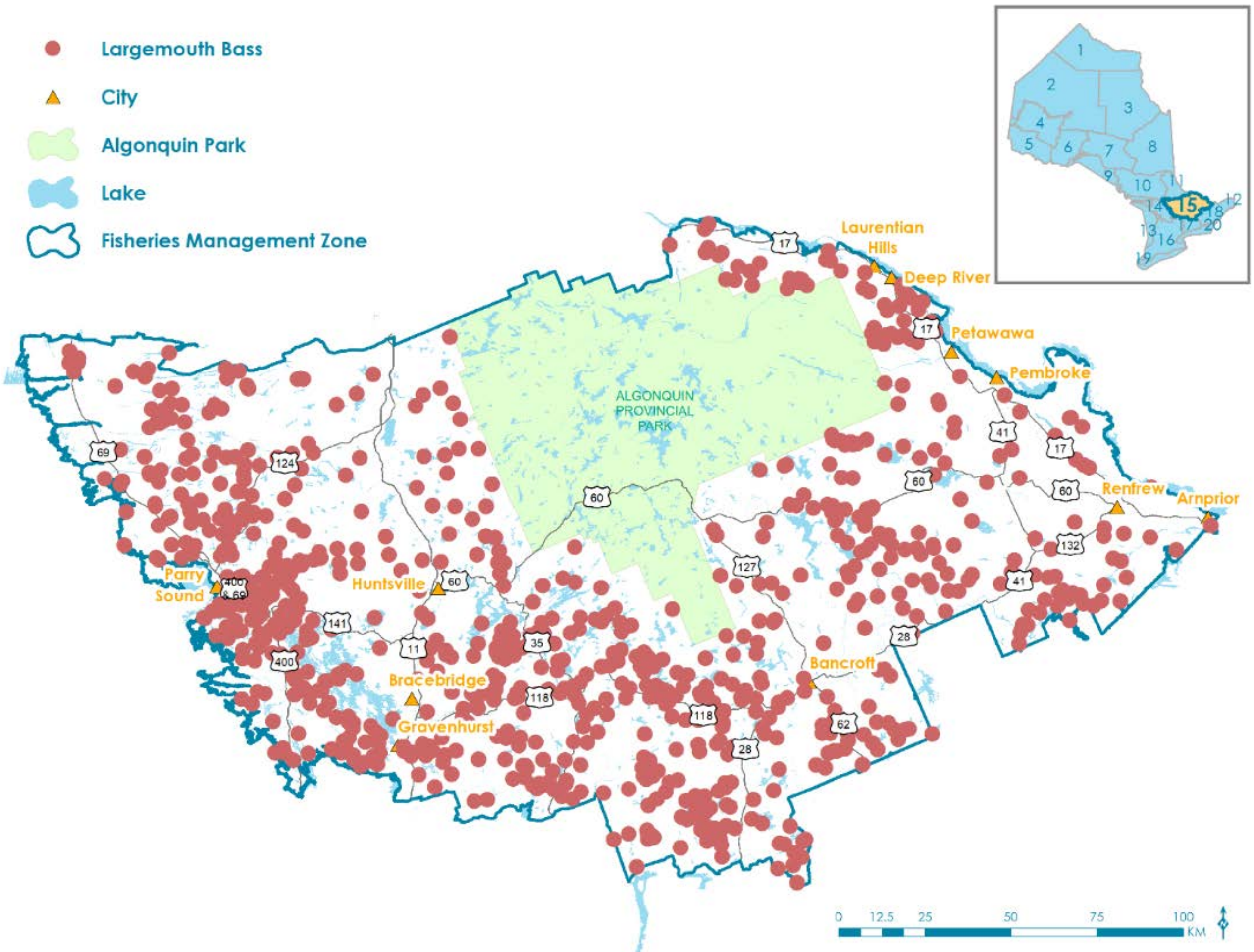


Figure 3.85 Distribution of Largemouth Bass, FMZ 15, excluding Algonquin Provincial Park.

Smallmouth Bass were caught in 43 (81%) lakes sampled in FMZ 15 during Cycle 1 of BsM (2008-2012). All lakes sampled greater than 500 ha had Smallmouth Bass, while the majority of 50-500 ha lakes did as well (Table 3.17). In Cycle 2, Smallmouth Bass were caught in 30 (76%) lakes sampled and were caught in all lake sizes.

Largemouth Bass were caught in 18 (37%) lakes sampled during Cycle 1 of BsM. There were only 3 lakes sampled by BsM where Largemouth were caught but Smallmouth were not (Bigwind, Fosters and Gurd Lakes); otherwise, the two species distributions overlapped. In Cycle 2, Largemouth Bass were caught in 16 (41%) lakes sampled. Largemouth Bass probably occurred in more lakes than those in which they were detected, due to the lower catchability resulting from their sedentary nature.

Table 3.17 Number of lakes in which Smallmouth or Largemouth Bass were caught, by lake size class, BsM, FMZ 15.

				1 Cycle			Cycle 2		
Lake Size (ha)	# Lakes in FMZ 15	% Lakes with Small-mouth Bass	% Lakes with Large-mouth Bass	# Trend Lakes	# Lakes Where SMB Caught	# Lakes Where LMB Caught	# Trend Lakes	# Lakes Where SMB Caught	# Lakes Where LMB Caught
0-50	5990	10%	8%	5	2 (40%)	0	7	1 (14%)	0
50-500	755	57%	37%	21	15 (71%)	6 (29%)	12	7 (58%)	1 (8%)
500-1500	75	64%	51%	12	12 (100%)	6 (50%)	9	9 (100%)	9 (100%)
1500-5000	18	89%	72%	10	10 (100%)	6 (60%)	9	9 (100%)	6 (67%)
>5000	5	80%	80%	4	4 (100%)	0	4	4 (100%)	0

3.5.8.3 Habitat and Fish Community

Smallmouth Bass prefer clear, cool waters of lakes, bays and rivers and are often found in areas of rocky bottoms with various cover such as sunken logs and boulders. They are less often associated with vegetation compared to Largemouth Bass. Adults have a wide temperature preference throughout the year and preferred water temperatures cited in the literature range from 19.4˚C (Sternburg 1996) to 30.8˚C (Stauffer et al. 1976). Average summer temperature of many Ontario bass waters is 21.4˚C (Scott and Crossman 1998). There are several different types of habitats or home ranges used by Smallmouth Bass over the course of a year. They prefer shallow waters in spring and early summer moving into deeper waters following the nesting season. During winter, bass often congregate in deeper water, while reducing their movement and feeding activity (Hartviksen and Momot 1987). They are generally inactive at low water temperatures (<7-10˚C). Smallmouth Bass are sensitive to low pH (<6) and low dissolved oxygen and moderately tolerant to turbidity (Scott and Crossman 1998).

Largemouth Bass are adaptive and tolerate a wide range of habitat and conditions. They are often found in shallow lakes with moderate to high nutrient levels, soft bottoms and significant amounts of vegetation (Sternburg 1996).

Preferred temperatures may be related to geographic location, but preferred values are reported as 20-30˚C. Growth and feeding rates decline when temperatures are less than 10˚C. Low dissolved oxygen levels are tolerated but more than 1.5 mg/L is needed (Scott and Crossman 1998).

Smallmouth and Largemouth Bass are typically associated with other warmwater species such as Rock Bass. However, due to their natural and assisted increase in distribution, they are now found in most lakes within FMZ 15 and can be associated with both cool and warmwater species. Both bass species can also be found in cold oligotrophic lakes due to continued expansion of their range.

Smallmouth Bass coexist with many other species, including top predators, but do best in lakes with enough habitat and prey to reduce overlap with other species. Interactions between Bass and other predatory species are not well understood. Smallmouth Bass have been found to negatively impact year class strength of Walleye populations (Schumacher 1964; Johnson and Hale 1977) and potentially Yellow Perch. Bass compete with other Centrarchids including Black Crappie and Rock Bass. Bass have negative impacts on Lake Trout (Vander Zanden et al. 2004). There are many examples of Smallmouth Bass having a negative impact on Brook Trout (Ryder and Johnson 1972; Martin and Fry 1973; Ryder and Kerr 1984). Watson (1955) also reported that, when introduced to coldwater lakes, Smallmouth Bass soon outnumbered resident salmonids. Smith (1985) concluded that the introduction of Smallmouth Bass into the Adirondacks had a profound impact on resident trout and the items trout fed upon.

Based on existing surface water temperature data (1970s to 2000s), Casselman (2008) found that the mean surface water temperature increased by 3°C above the long-term average. This temperature increase is correlated with a 15-fold change in year class strength in Smallmouth Bass, an 8-fold increase in Rock Bass, and a 20-fold decrease in Lake Trout. Casselman (2008) also found growth rates and distributions increased for warmwater species as well as an increase in aquatic invasive species, resulting in a new increased dominance of warmwater fish communities.

3.5.8.4 Abundance

The catch-per-unit-effort (CUE) of recruit-sized (> 200 mm) Smallmouth Bass in FMZ 15 in Cycle 1 (0.77/net) was higher than the provincial average of 0.57 fish/net and third highest among FMZs in the province (Figure 3.86). Only FMZ 16 and 17, which have lakes with much higher primary productivity, had higher catch rates of Smallmouth Bass. The CUE declined moderately in Cycle 2 (0.67 fish/net), however, it still remained above the provincial average.

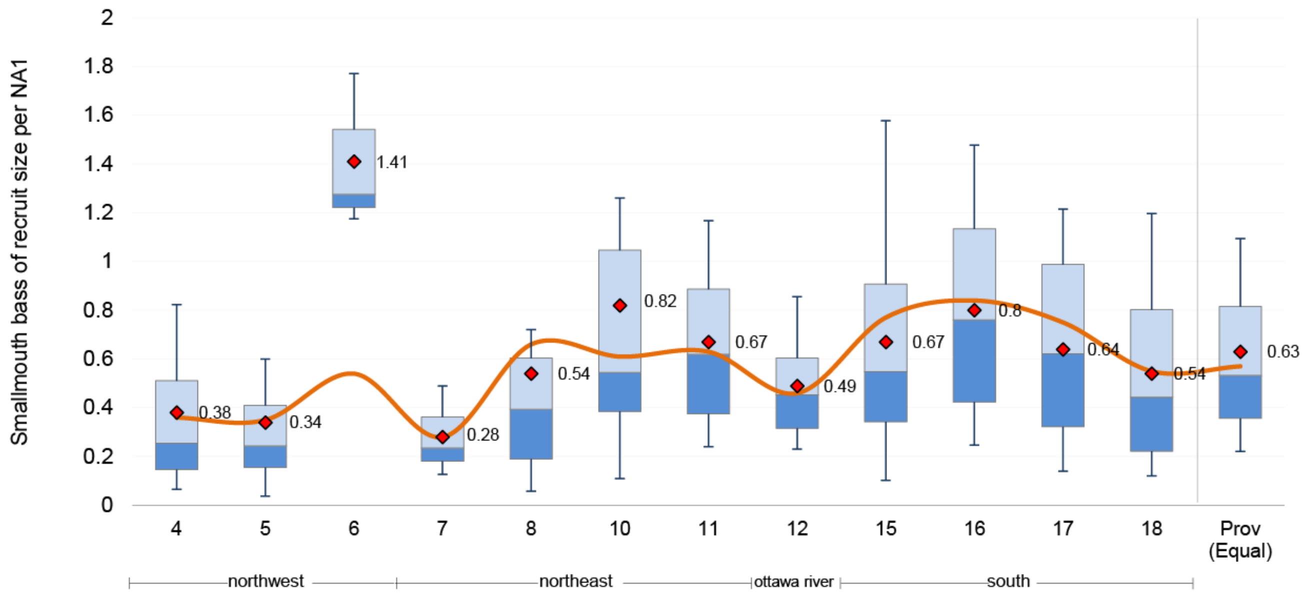


Figure 3.86 Equally-weighted average CUE (number of fish/net) of recruited size (>200mm) Smallmouth Bass from all lakes sampled by BsM across FMZs in Ontario; Cycle 1 (line) and Cycle 2 (box plot). Catch in FMZ 6 in Cycle 2 was highly skewed by catches in two lakes.

The catch-per-unit-effort of Smallmouth Bass showed similar trends to the CUEW across all FMZs in Ontario for Cycle 2. The CUEW of 0.45 kg/net for FMZ 15 was similar to the provincial average of 0.44 kg/net and was surpassed by FMZ 6 and 16, which had values of 0.9 kg/net and 0.53 kg/net, respectively (Figure 3.87).

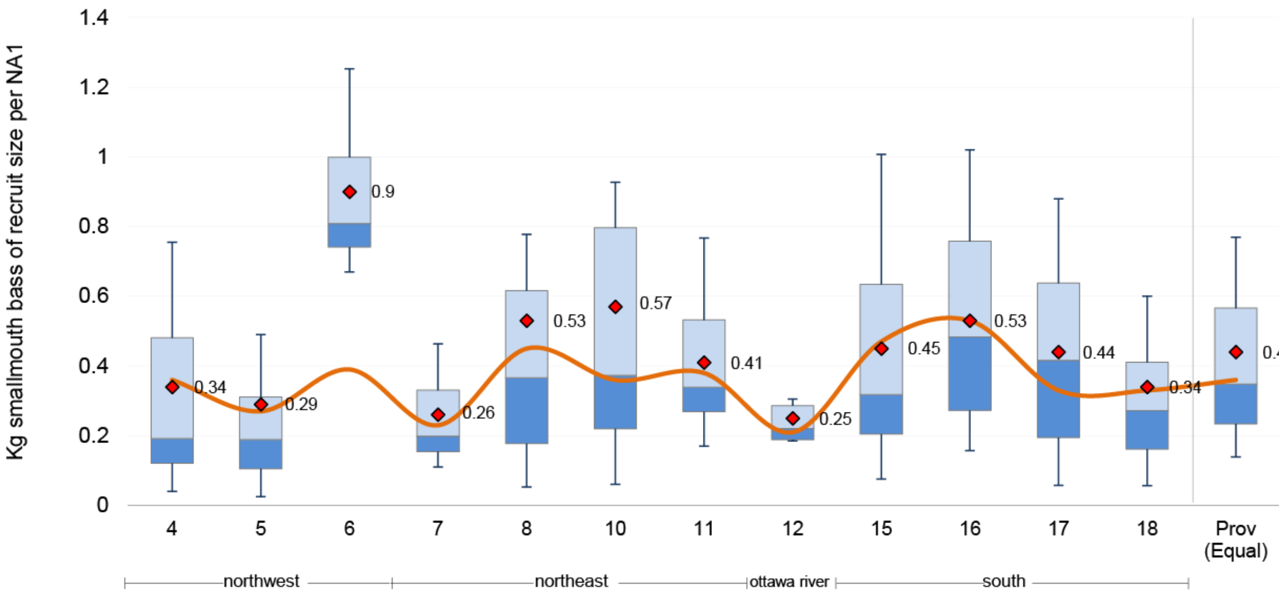


Figure 3.87 Equally-weighted average CUEW (kg number of fish/net) of recruited size (>200mm) Smallmouth Bass from all lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot). Catch in FMZ 6 in Cycle 2 was highly skewed by catches in two lakes.

Within FMZ 15, there was a general trend of higher catches in smaller lakes (other than very small lakes), but the differences were not significant due to a large amount of variability within and between lake size categories (Figure 3.88).

The CUE for Largemouth Bass in cycle 1 of BsM was 0.35 and 0.63 (fish/net) in large and small mesh nets, respectively (note: this was for all Largemouth Bass captured and not restricted to recruit size fish). Largemouth Bass were captured in 13 (25%) and 19 (37%) of the lakes sampled in large and small mesh nets, respectively.

In cycle 2, the CUE for Largemouth Bass in large and small mesh nets was 0.43 and 0.30, respectively. Largemouth Bass were captured in 20 (40%) and 14 (28%) of the lakes sampled in large and small mesh nets, respectively. No lakes in the extra-small lake size category (0-50 ha) were sampled in cycle 1 and may explain, in part, the discrepancy in the number of lakes in which Largemouth Bass were captured in large and small mesh nets between cycles. Both the distribution and the proportion of lakes occupied by Largemouth Bass is considerably less than that for Smallmouth Bass in FMZ 15.

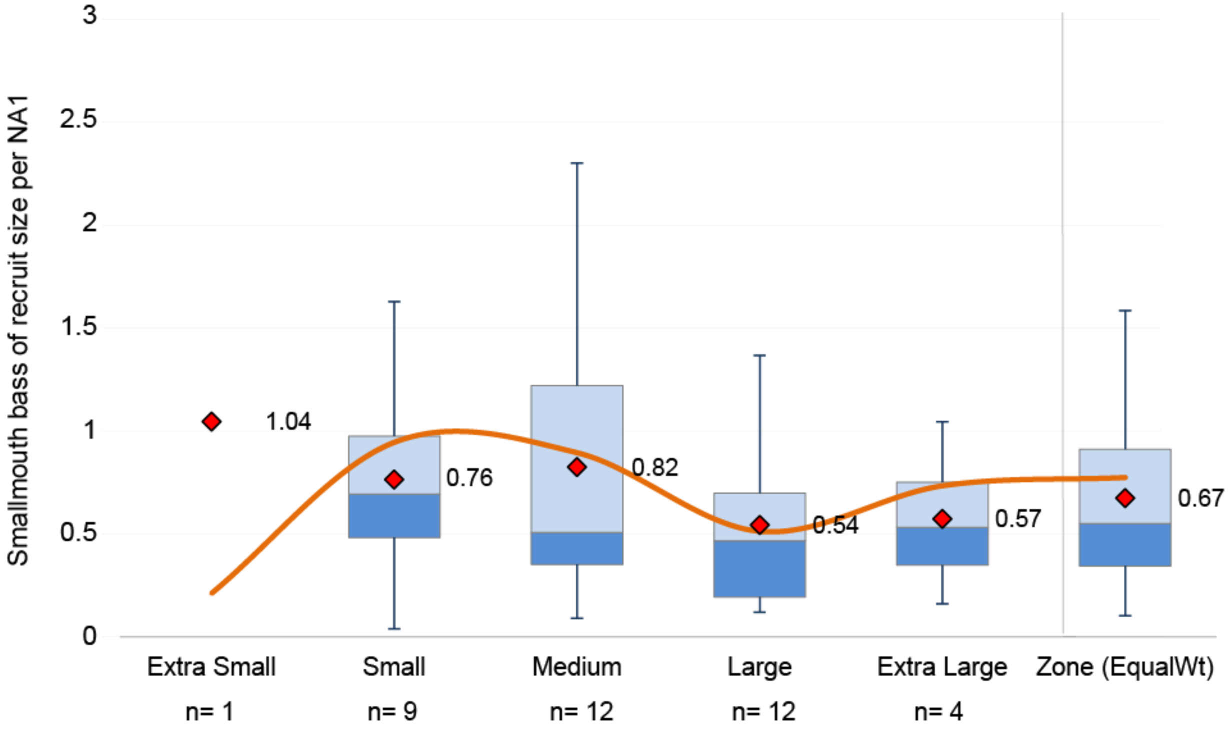


Figure 3.88 Equally-weighted average CUE (number of fish) of Smallmouth Bass recruits, from all lakes, by lake size class, FMZ 15, BsM Cycle 1 (line) and Cycle 2 (box plot).

The biomass (CUEW) of Smallmouth Bass in Cycle 1 was highest in Brook Trout target lakes (0.67 kg/net), followed by Walleye target lakes (0.50 kg/net) and least in Lake Trout target lakes (0.39 kg/net; Table 0.18). The CUEW for Cycle 2 showed a similar pattern, but there was a significant decrease in the biomass of Smallmouth Bass caught in Brook Trout target lakes (0.29 kg/net). The high variability in biomass of Smallmouth Bass within and between BsM cycles may be due, in part, to fish community and habitat variability. Subsequent BsM cycles will allow for a more robust interpretation of bass biomass and abundance trends across FMZ 15.

Table 3.18 CUEW (kg/net), by BsM trend lake target species, for Smallmouth Bass (SMB), BsM Cycle 1 and 2.

Trend Lake	Cycle 1			Cycle 2		
Target Species	**All Species**	**SMB**	**% SMB**	**All Species**	**SMB**	**% SMB**
All Lakes	3.11	0.48	15.4	3.0	0.46	15.3
Brook Trout	3.19	0.66	20.7	2.55	0.29	11.3
Lake Trout	2.85	0.42	14.7	2.81	0.37	13.1
Walleye	2.94	0.51	17.4	3.44	0.63	18.3

Population Characteristics

Size

The size of Smallmouth Bass is related to many factors including, rates of recruitment, growth, density, mortality (exploitation) and habitat variability, making interpretation of differences in size amongst zones challenging. High population density and low mortality rates result in smaller mean sizes, while low density, higher mortality tend to result in larger mean sizes. The relationship between average size and population density in Smallmouth has been previously identified (Chu et al. 2006).

The mean length of recruited size Smallmouth Bass captured during Cycle 1 was 340mm (Figure 3.89). This was similar to values for other FMZs in the southern and the northeast regions. Mean sizes were highest in the northwest region. This may be density related as it shows the opposite trend to regional CUE values where the lowest relative abundance was in northwest region, with the highest mean size and highest abundance was in the south with the lowest mean size. Mean size trends are similar within FMZ 15 and across the province for Cycle 2.

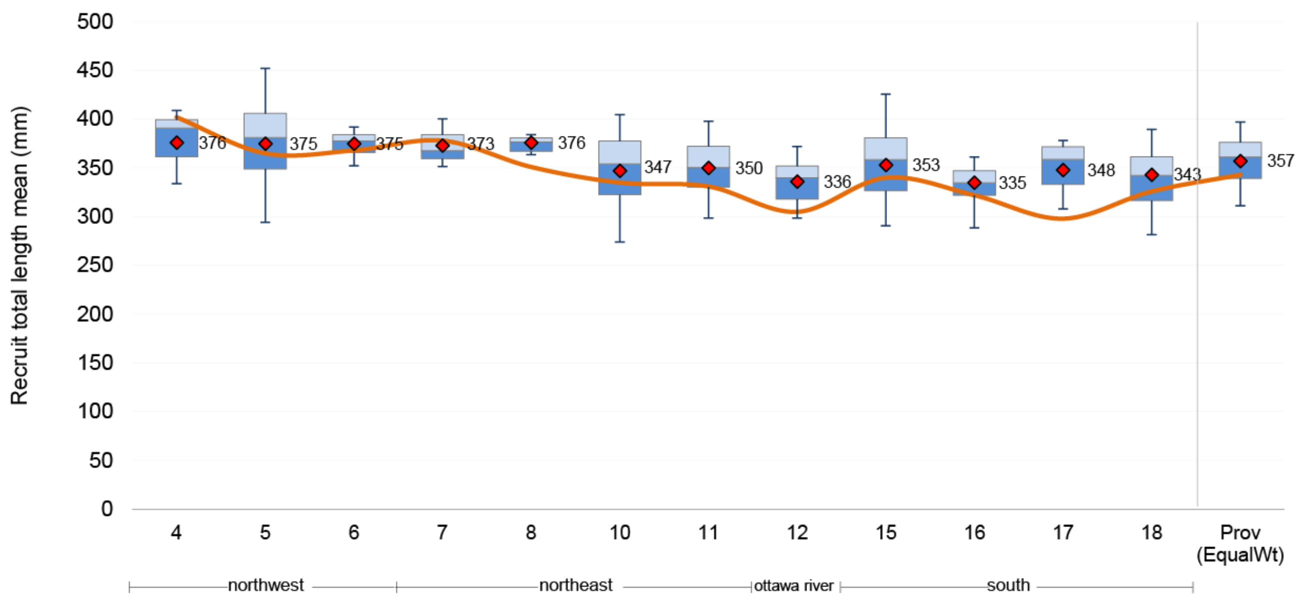


Figure 3.89 Equally-weighted mean total length (mm) of recruit size Smallmouth Bass from all BsM sampled lakes in FMZ 15; Cycle 1 (line) and Cycle 2 (box plot).

Age

In Canada, the maximum age for Smallmouth Bass has been recorded at 15 years (Scott and Crossman 1998). The mean age of recruit size (>200mm) Smallmouth Bass in Cycle 1 for FMZ 15 was 6.8 years, which was the highest in southern region and similar to values for Smallmouth Bass from the northeast zone (Figure 3.90). The highest mean ages were from FMZs in the northwest region. The mean age of Smallmouth Bass caught in Cycle 2 showed a similar trend, with a mean age in FMZ 15 of 7.22 years, which was similar to the provincial average of 7.39 years, and well below the mean ages 8.65 years in the northwest.

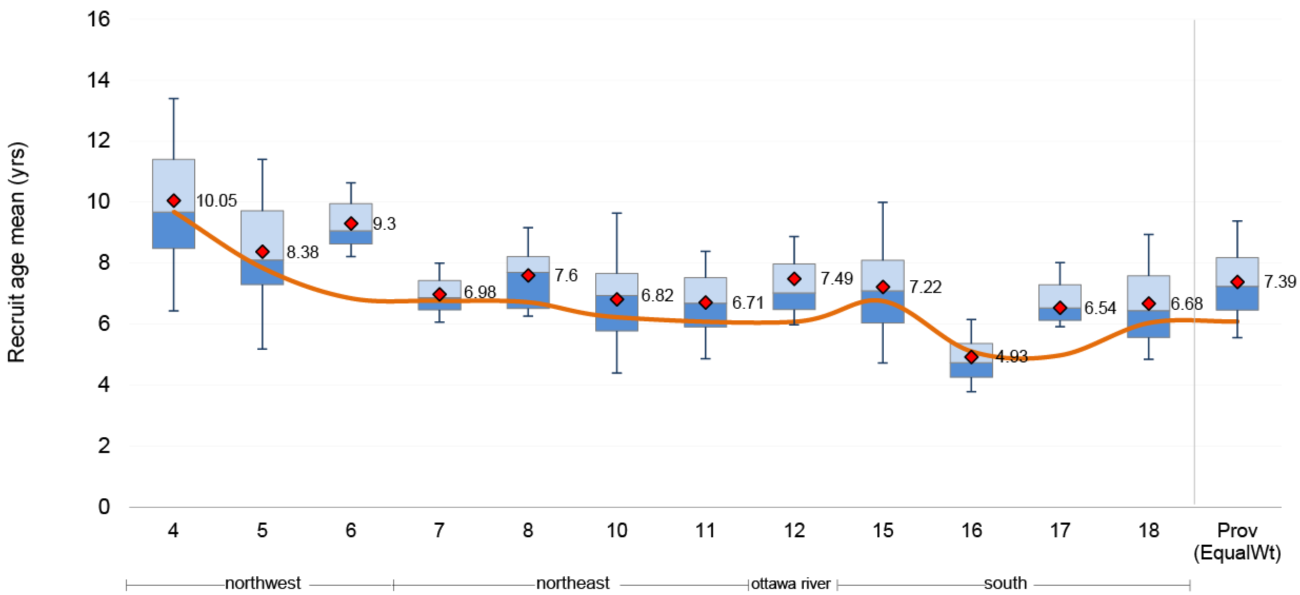


Figure 3.90 Equally-weighted average mean age (years) of recruit size Smallmouth Bass from all lakes sampled by BsM in FMZ 15; Cycle 1 (line) and Cycle 2 (box plot).

Average maximum age is also an indication of adult survival, where a higher value is indicative of successful recruitment and adult survival. The maximum ages for FMZs across the province for Cycle 1 and 2 range from 7.8 years to 14.5 years (Figure 3.91). FMZ 15 had the highest maximum age in southern region (11.1 years), third highest in the province and higher than the provincial average of 10.1 years for Cycle 1. The maximum age in FMZ 15 during Cycle 2 was 14.3 years, 3.2 years higher than Cycle 1. The maximum age values for FMZ 15 indicate that adult survival is particularly good in the zone.

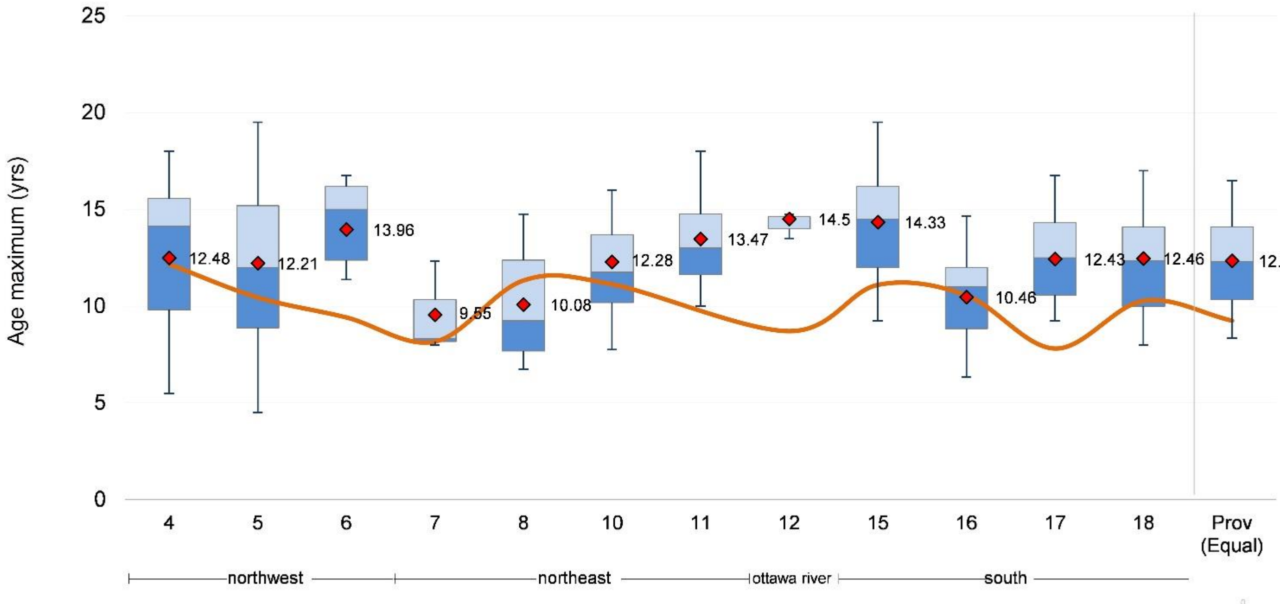


Figure 3.91 Equally-weighted average maximum observed age (years) of Smallmouth Bass from all lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

The number of Smallmouth Bass cohorts captured during Cycle 1 and Cycle 2 of BsM varied across all FMZs in the province (Figure 3.92). FMZ 15 had 6.5 cohorts in Cycle 1, the second highest in southern region, and third highest in the province and above the provincial average of 5.45 cohorts. In Cycle 2, FMZ 15 had an average of 8.2 cohorts, which is the highest in southern region, the third highest in the province and much higher than the provincial average of 6.8 cohorts. Interestingly, the number of cohorts increases from cycle 1 to cycle 2 in all but three zones across the province. The cohort numbers suggest good adult survival, and low mortality within the zone. These numbers should be interpreted cautiously, as they may reflect low recruitment which would result in higher mean ages as well as higher cohort values.

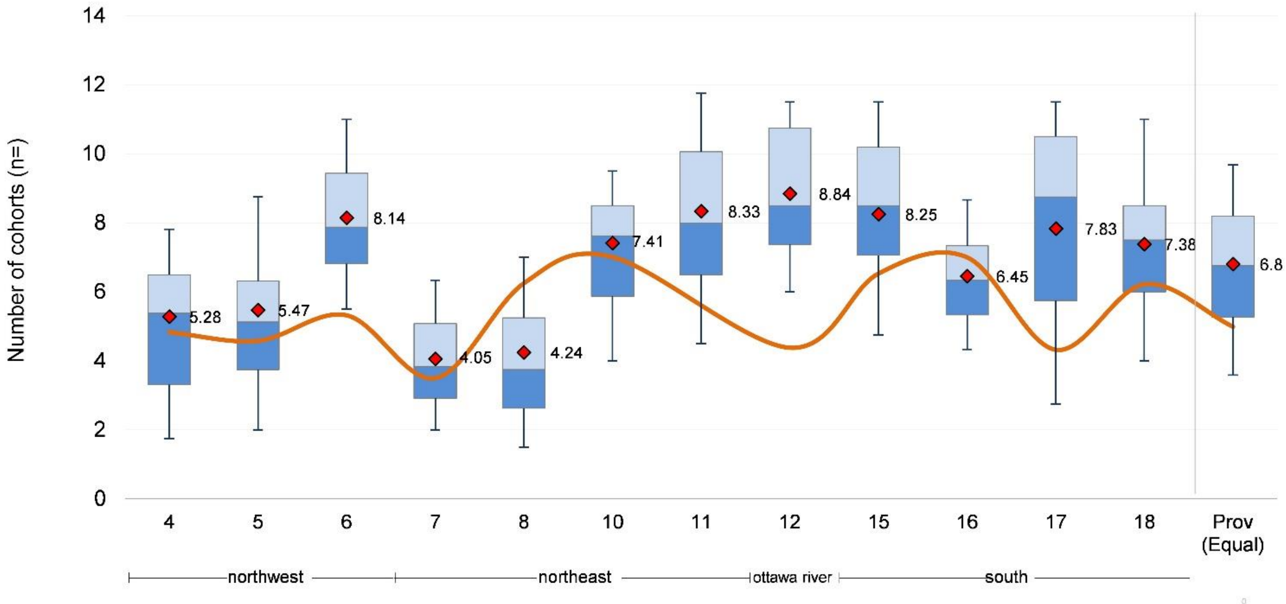


Figure 3.92 Equally-weighted average number of cohorts of Smallmouth Bass from all lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

In Cycle 1, the number of cohorts observed was positively related to lake size class (Figure 3.62) with the number of cohorts being highest in the largest lake size class. This trend was not as apparent in Cycle 2 because of the high number of cohorts observed in the medium sized class of lakes (9.58 cohorts).

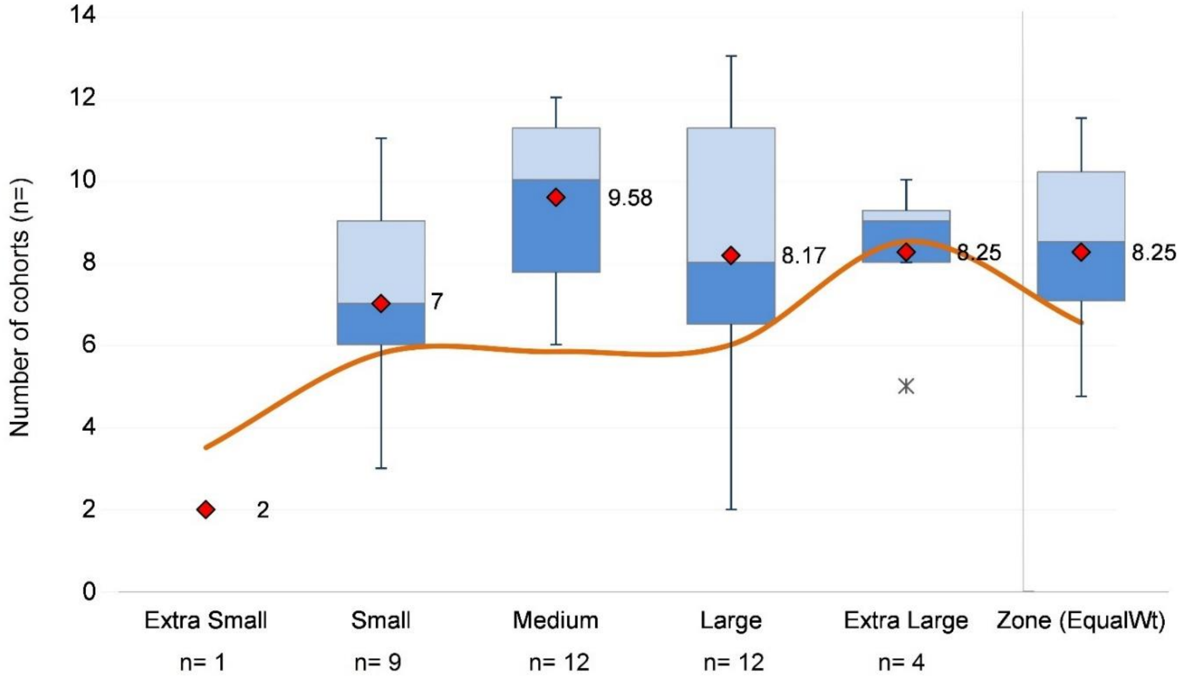


Figure 3.93 Number of cohorts of Smallmouth Bass from all lakes, by lake size class, FMZ 15, BsM Cycle 1 (line) and Cycle 2 (box plot).

Proportional Size Distribution

In FMZ 15, the greatest proportion of Smallmouth Bass were in the 'Stock' category (Figure 3.94). The second most abundant was the 'Quality' category.

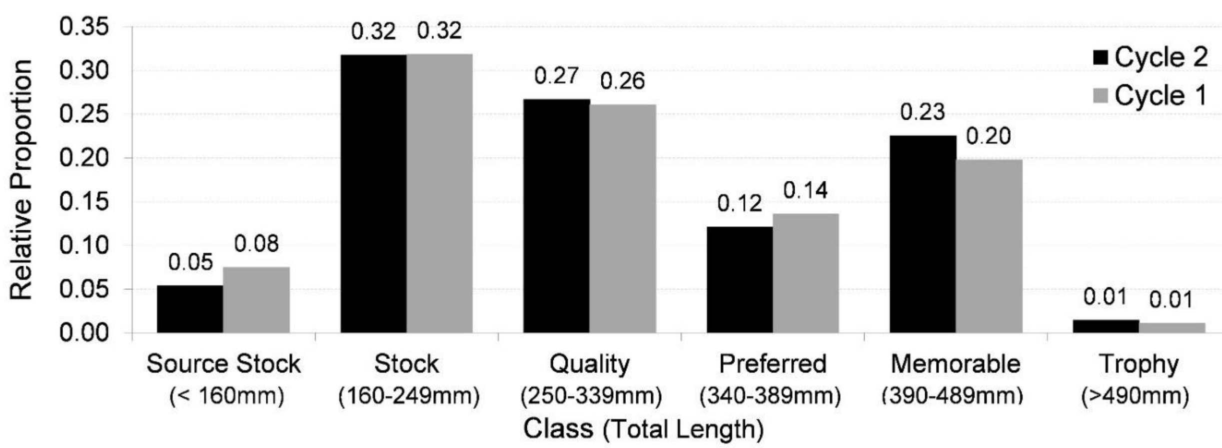


Figure 3.94 Proportional size distribution of Smallmouth Bass from all lakes, FMZ 15, BsM Cycle 1 & 2.

The proportion of fish in the various size categories varied little between Cycle 1 and Cycle 2. In Cycle 2, 36% percent of the Smallmouth Bass caught were in the 'Preferred' and greater size category, with 27% in the 'Quality' category, which is also the size at which Smallmouth mature. Thus, the size distribution of Smallmouth Bass in FMZ 15 shows a high proportion of mature, spawning-sized fish, as well as high quality angling opportunities for fish in the quality, preferred and memorable classes.

Growth and Maturation

Water temperatures and availability of prey strongly influence growth rates of Smallmouth Bass. Over the summer, during the first few months of life, growth rates are high, but decline in the fall when water temperatures begin to cool (Scott and Crossman 1998).

Pre-recruitment growth rates reflect the rate of growth of juvenile Smallmouth Bass up to a size of 200mm when bass reach recruitment size. The average pre-recruitment growth rates of bass in FMZ 15 were 102 and 110 mm/year in cycle 1 and 2, respectively. These values were below the provincial average of 113 and 117 mm/year in cycles 1 and 2, respectively.

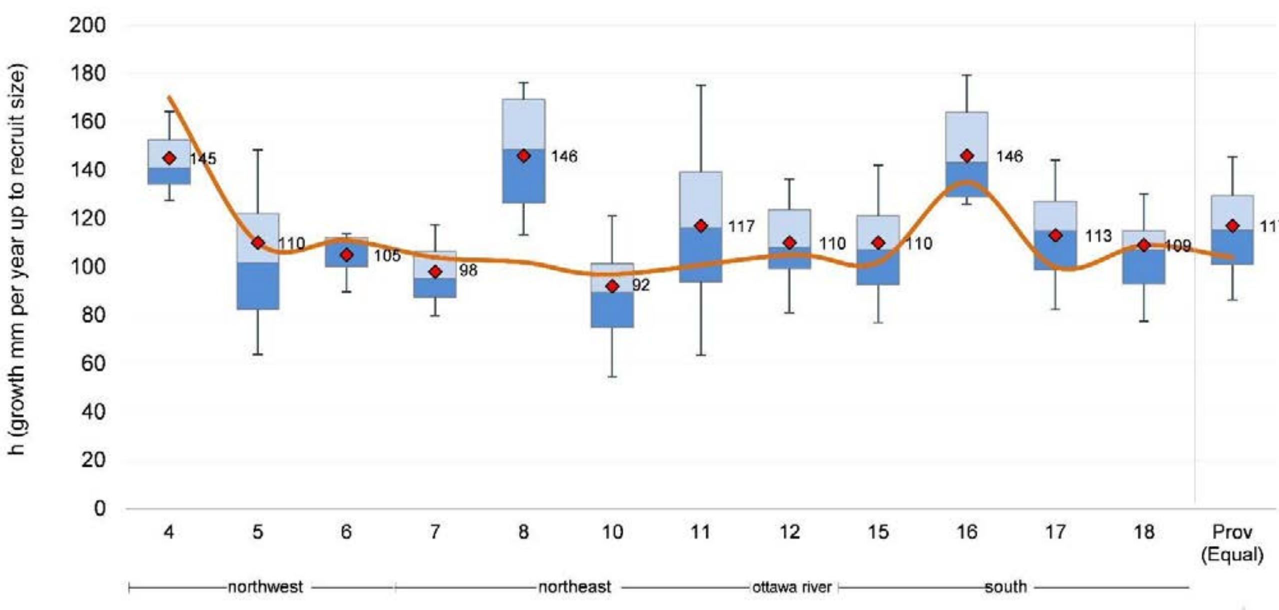


Figure 3.95 Equally-weighted average pre-recruitment growth rate (mm/year) of Smallmouth Bass from all lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

There was considerable variability in pre-recruitment growth rate within lake size categories as well as between lake size categories within the zone, as well as fluctuations between Cycle 1 and 2 (Figure 3.96). Average growth rate decreased for Small lakes between Cycle 1 and 2 from 124 to 102 mm/cycle. Conversely, pre-recruitment growth rates either remained the same, or increased in Medium, Large and Extra Large lakes between Cycle 1 and 2.

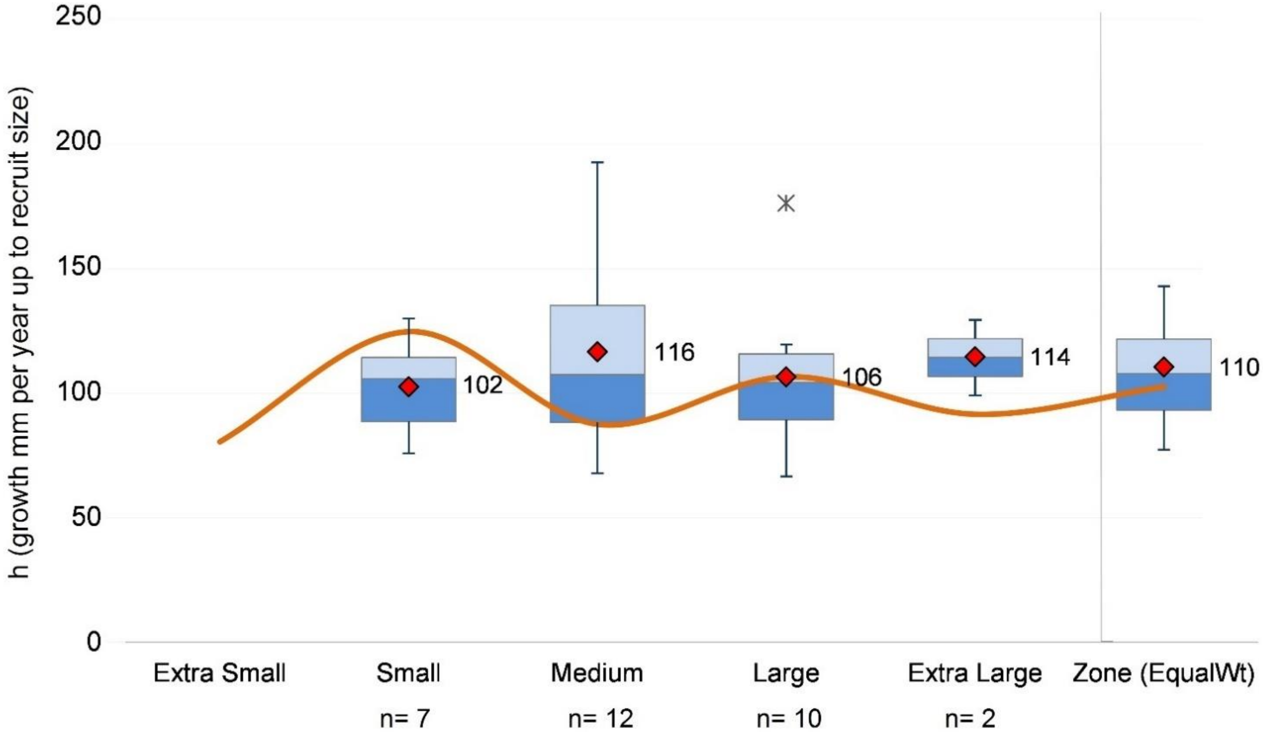


Figure 3.96 Pre-recruitment growth rate (mm/year) of Smallmouth Bass from all lakes, by lake size class, FMZ 15, BsM Cycle 1 (line) and Cycle 2 (box plot).

Age at maturity for Smallmouth Bass ranges from 3-4 years for males and 4-5 years for females (Mandrak and Crossman 1992). Male Smallmouth Bass reach maturity and begin spawning between 220 mm and 420 mm fork length, while females begin spawning between 250 mm and 420 mm fork length (Ridgway 1988). Length at age curves were created for all FMZs by lake size, except for Extra Small lakes. In FMZ 15, Smallmouth Bass showed similar growth trends in all lake sizes. Figure 0.97 shows equally-weighted total length (mm) at age for Smallmouth Bass with cooler zones like zone 4 showing less growth and warmer zones like zone 16 showing more growth.

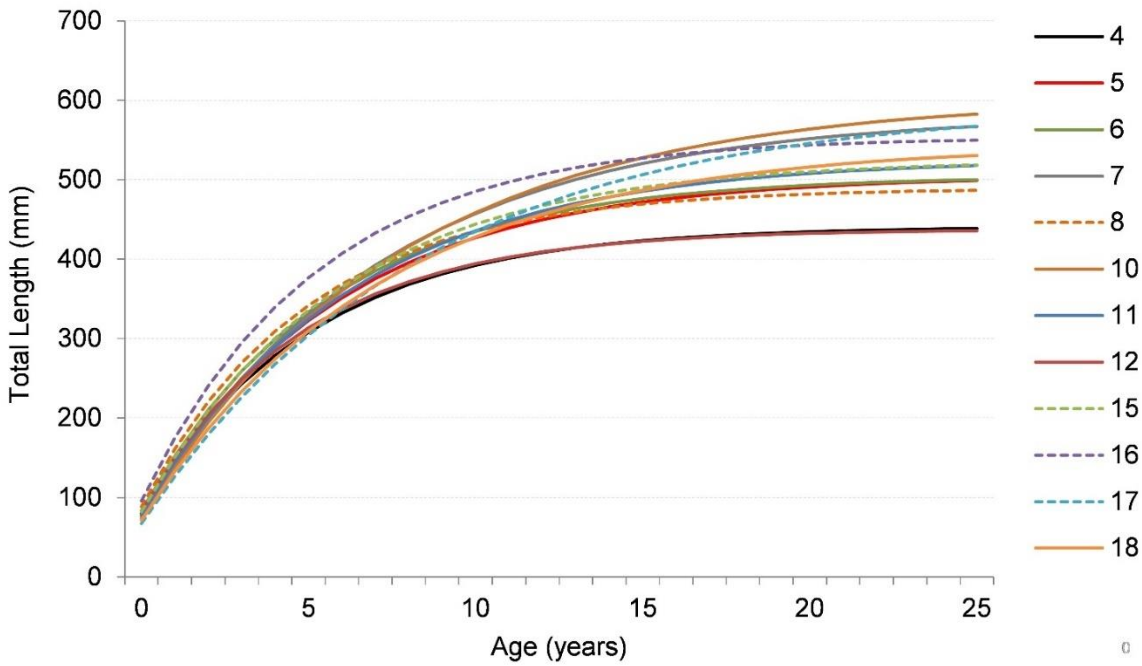


Figure 3.97 Equally-weighted total length (mm) at age (years) for Smallmouth Bass from large lakes, by FMZ, BsM Cycle 1 and Cycle 2 combined.

3.5.8.6 Biological Reference Points

Insufficient numbers of Smallmouth or Largemouth Bass were captured during Cycle 1 and Cycle 2 to provide biomass and mortality estimates within FMZ 15.

3.5.9 Black Crappie

3.5.9.1 Description

Black Crappie is a member of the Centrarchid family. As with other members of the Sunfish family, Black Crappie are nest builders and spawn in late spring and early summer when water temperatures reach about 15˚C. Crappies nest in colonies with territories set up by males. Males will aggressively defend the nest from predators. They mature by 3-4 years and are prolific breeders (McNeil 1992; Scott and Crossman 1998) Adults are known to get as large as 356 mm but are relatively short-lived, seldom reaching 8 years of age (Goodson 1966).

Black Crappie are an open-water predator and often suspends over deeper water (McNeil 1992). As Crappies grow, their diet shifts from one of mainly zooplankton and insects to one of mainly other fish. Yellow Perch, Bluegill, Pumpkinseed and Walleye fry and fingerlings become an important food source for young Crappie and throughout their life (Krishka et al. 1996).

Little is known about the popularity of the Crappie fishery; they are included with Panfish species in the Survey of Recreational Fishing in Canada (OMNRF 2015a). However, Panfish made up a significant proportion of the total fish harvested in 2010, at 24%.

3.5.9.2 Distribution

Black Crappie are native to Ontario and are abundant in the upper St. Lawrence River, Rideau Lakes, Ottawa River, and eastern sections of Georgian Bay and Lake of the Woods (Scott and Crossman 1998). Many populations in Ontario waters are the result of intentional but unauthorized introductions (Krishka et al. 1996).

In FMZ 15, Black Crappie may have been native to a small number of lakes close to Georgian Bay area. In 2002, there were about 27 waterbodies (26 lakes, 1 river) in FMZ 15 known to have Black Crappie populations; all in the western part of Parry Sound District (OMNR 2002a). As of 2016, about 85 Black Crappie populations (83 lakes, 2 rivers) had been documented within FMZ 15, a threefold increase in 14 years (Table 3.19, Figure 3.98). There are undoubtedly more lakes where they occur but have not yet been documented. All the new populations are believed to originate from illegal introductions and later dispersal.

Table 3.19 Number and total surface area (ha) of lakes where Black Crappie have been documented in FMZ 15, 2002 and 2016.

District	2002	2016
Bancroft		9 (8,937)
Parry Sound	26 (21,105)	63 (43,490)
Pembroke		11 (11,446)
Total	26 (21,105)	83 (63,872)

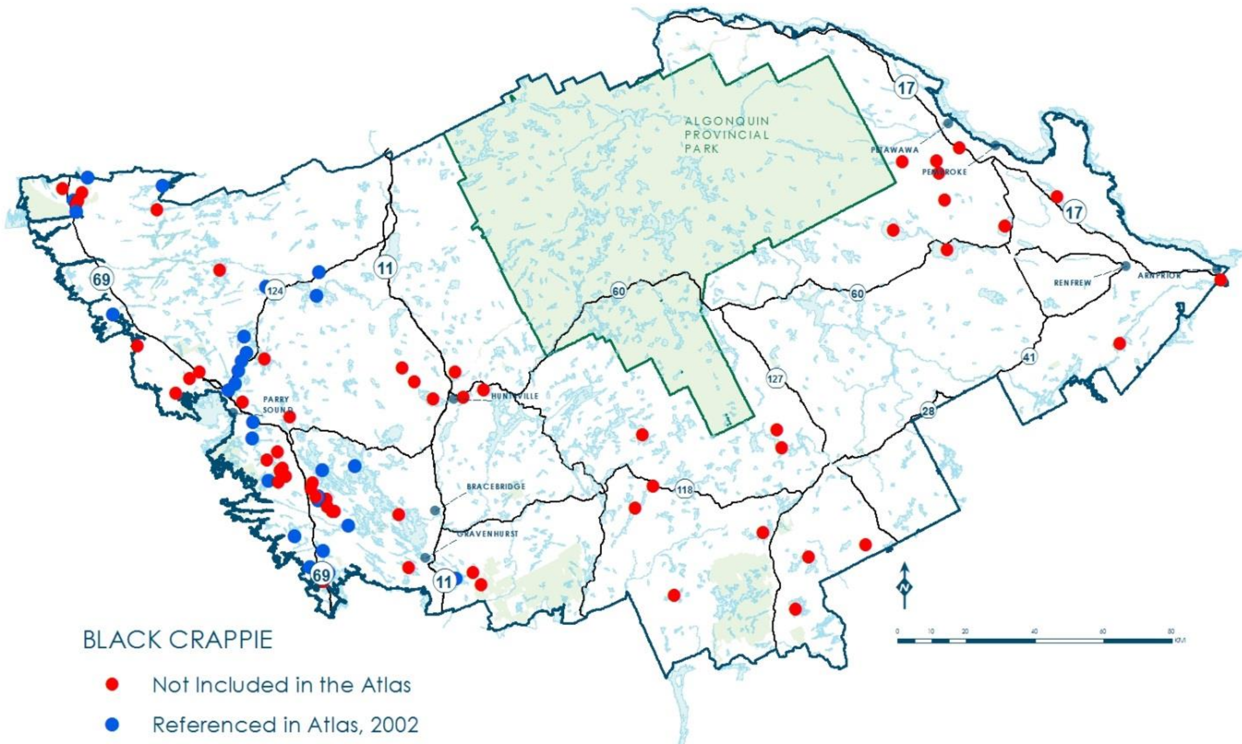


Figure 3.98 Black Crappie distribution in FMZ 15, excluding Algonquin Provincial Park.

3.5.9.3 Habitat and Fish Community

Black Crappie prefer relatively shallow productive lakes, bays, and rivers with extensive areas of aquatic plants (Scott and Crossman 1998; Kerr and Grant 2000). They are found most often in clear, calm water and prefer summer water temperatures of 20-25˚C (Kerr and Grant 2000). Crappies are known to tolerate lower oxygen levels than other members of the sunfish family although they prefer dissolved oxygen levels greater than 5.0 mg/L (McNeil, 1992).

Research shows that Black Crappie introductions can have a negative influence on native fish populations; especially Yellow Perch and Walleye populations (Kerr and Grant 2000). Black Crappie have been found to prey on Walleye fry and fingerlings and impact Walleye populations through both direct predation and competition for food. They can also have negative impacts on Largemouth Bass and other Panfish species (Kerr and Grant 2000).

3.5.9.4 Abundance

Black Crappie are not a target species for BsM, but they are caught in both trend and state lakes regularly. Their abundance is highest in southern Ontario (Figure 3.99). They were captured only in four waterbodies (medium and large) during Cycle 1 within FMZ 15, averaging 0.06 kg/net, which was similar to the provincial average of 0.08 kg/net.

However, during Cycle 2, Black Crappie were captured in six FMZ 15 waterbodies, averaging 0.16 kg/net, which was higher than the provincial average of 0.1 kg/net. There is a higher CUE for Black Crappie in Cycle 2.

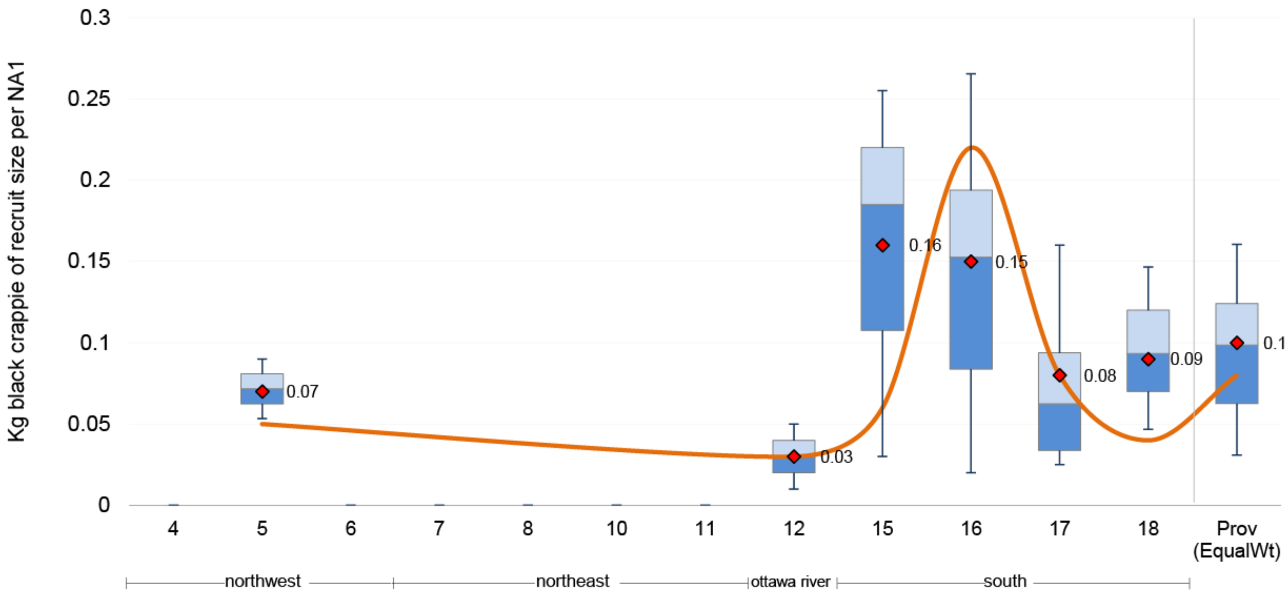


Figure 3.99 Equally-weighted average CUEW (kg/net) of Black Crappie recruits from all lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot). No Black Crappie were caught in zone 6 through 11.

3.5.9.5 Population Characteristics

Size

Like many other fish species, the growth rate and size of Crappies is not only density-dependent but impacted by the size and productivity of the available habitat. These factors make data interpretation on a zone-wide scale difficult.

Black Crappie captured in FMZ 15 had the second highest mean sizes in the province (Figure 3.100), at 274 mm for Cycle 1, compared to the provincial average of 265 mm. They are comparable in size to those caught in FMZ 12. Average length was similar between Cycle 1 and Cycle 2.

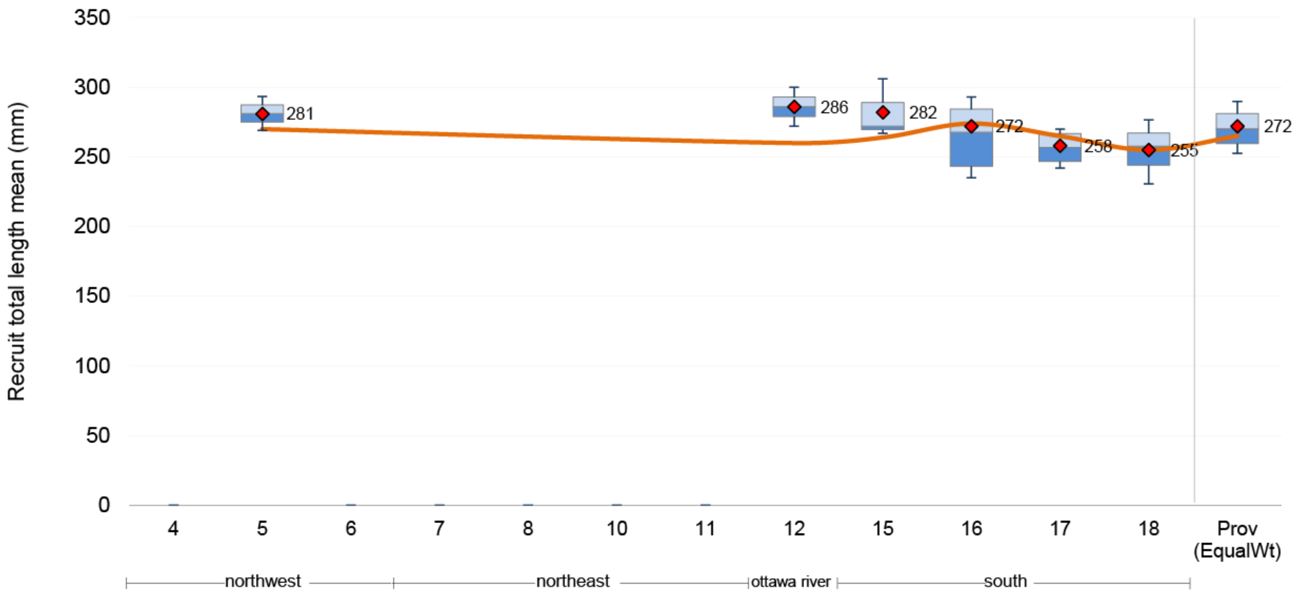


Figure 3.100 Equally-weighted average total length (mm) of Black Crappie recruits from all lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

Age

Black Crappie were only aged during Cycle 2 in FMZ 15. The maximum age of Black Crappie is estimated to be 8-10 years (Scott and Crossman 1998). The average age of Black Crappie captured in FMZ 15, during Cycle 2 was 5.9 years, which is similar to most other zones in the province (Figure 3.101, the extremely high value for FMZ 12 may be a sampling artefact such as a small sample size).

The number of Black Crappie age cohorts identified in the zone during Cycle 2 was 4.5 cohorts, which was the highest in the province (Figure 3.102). This indicates that Black Crappie recruitment in FMZ 15 is successful, as well as adult survival.

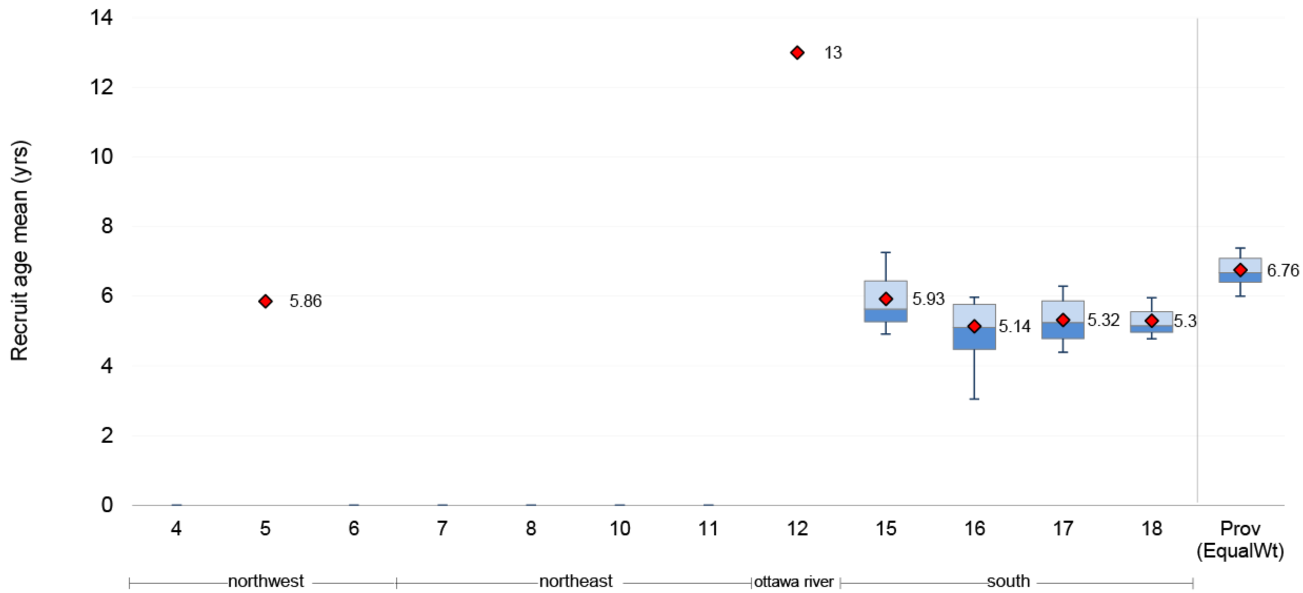


Figure 3.101 Equally-weighted average mean age (years) of Black Crappie recruits from all lakes, by FMZ, BsM Cycle 2.

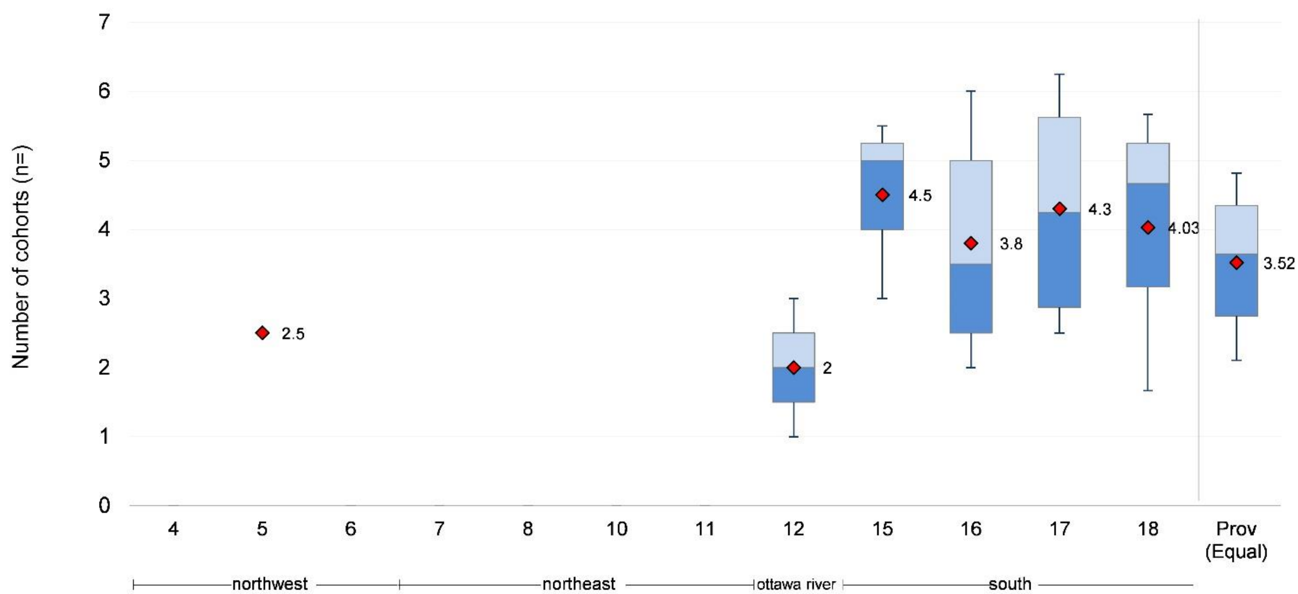


Figure 3.102 Equally-weighted average number of cohorts of Black Crappie from all lakes, by FMZ, BsM Cycle 2.

Proportional Size Distribution

In FMZ 15, the greatest proportion of Black Crappie in Cycle 2 were in the 'Memorable' category, followed by 'Preferred' (Figure 3.103).

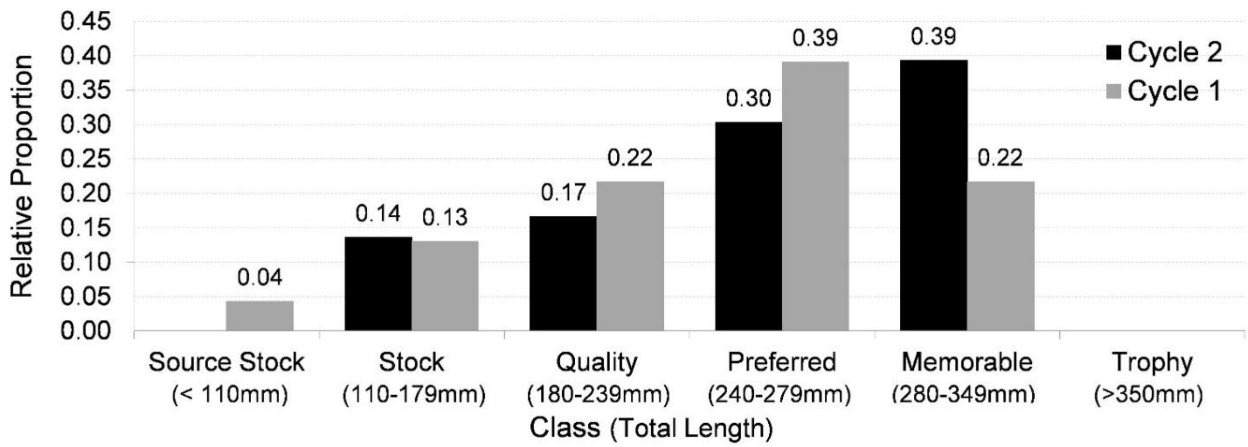


Figure 3.103 Proportional size distribution of Black Crappie from all lakes, FMZ 15, BsM Cycle 1 and Cycle 2.

Growth and Maturation

Insufficient numbers of Black Crappie were captured during Cycle 1 and Cycle 2 to provide growth curves and size at maturation for the species within FMZ 15.

3.5.9.6 Biological Reference Points

Insufficient numbers of Black Crappie were captured during Cycle 1 and Cycle 2 to provide mortality estimates within FMZ 15. Biomass and mortality references points have not yet been developed for Black Crappie.

3.5.10 Panfish (Yellow Perch, Sunfishes and Rock Bass)

3.5.10.1 Sunfishes and Rock Bass

Description

Pumpkinseed, Bluegill and Rock Bass are members of the Centrarchid family and are native to eastern and central North America, including many waterbodies in Ontario. They are all warmwater species, with deep laterally compressed bodies, and similar habitat preferences and habits. Although Panfish species are not necessarily targeted as part of the recreational fishery in FMZ 15, they make up a large proportion of the total catch in the zone, at 32% (OMNRF 2015a). Similarly, they make up a portion of the total harvest, with Panfish having a harvest rate of 24% (OMNRF 2015a).

All three species spawn from late spring to early summer and are colonial nesters. Males prepare nests by clearing a depression in a sand or gravel bottom and will guard eggs and young fry. Most Panfish species will spawn multiple times in a season. All three species can hybridize and produce fertile offspring (Scott and Crossman 1998).

3.5.10.1.2 Distribution

Pumpkinseed, Bluegill and Rock Bass are all native to Ontario; Pumpkinseed and Rock Bass are more widely distributed throughout the province, and FMZ 15, while Bluegill are found mostly in the southern part of the province and have a limited distribution in FMZ 15 (Figure 3.104). These species are being introduced into many inland lakes in the zone, through unauthorized introductions.

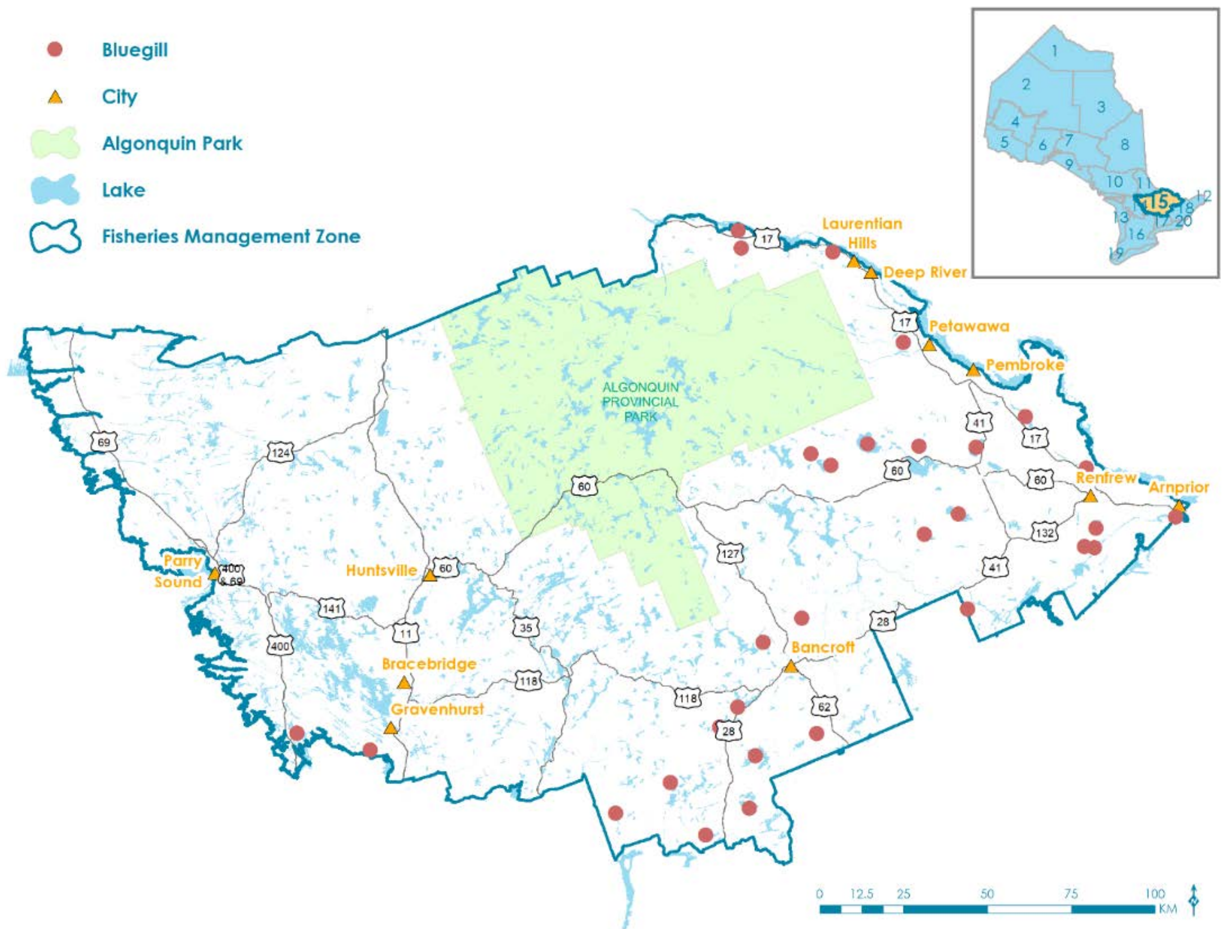


Figure 3.104 Distribution of Bluegill, FMZ 15, excluding Algonquin Provincial Park.

3.5.10.1.3 Habitat and Fish Community

Panfish species share many similarities in habitats and habits. They prefer shallow, cool to moderately warm waters of lakes, ponds or streams. Pumpkinseed and Bluegill tend to be found in more vegetated areas with Rock Bass in more rocky bottoms with sparse vegetation. Bluegill prefer slightly warmer temperatures (23.9-26.7˚C) than both Rock Bass (20.6-23.3˚C) and Pumpkinseed (21.1-23.9˚C) (Kerr and Grant 2000). Young and small individuals of all three species are an important food source for many predatory fish (Scott and Crossman 1998).

Panfish can be a major predator of Largemouth and Smallmouth Bass fry (Eipper 1975) and compete for food items. Rock Bass are known to compete directly with Smallmouth Bass for food and habitat and may limit their abundance (Scott and Crossman 1998). Although factors such as habitat loss, shoreline development, water level and temperature fluctuations, predation, and angling can affect spawning success, a warming climate may be helpful to most panfish. Climate change studies have also found that warmer water temperatures result in higher panfish growth rates.

3.5.10.1.4 Abundance

Pumpkinseed are not a target species in the BsM program, but they are often caught in both trend and state lakes. They are the only species of panfish, besides Yellow Perch, that are caught in large enough numbers to provide metrics.

Their abundance is higher in southern Ontario, with FMZ 16, 17 and 18 having the highest CUEs in the province (Figure 3.105). In Cycle 1, the catch rate for FMZ 15 was 0.05 kg/net, which was similar to the provincial average of 0.06 kg/net. Cycle 2 data showed similar trends; with a catch rate of 0.09 kg/net, again, similar to the provincial average but lower than the highly productive waters in zones to the south.

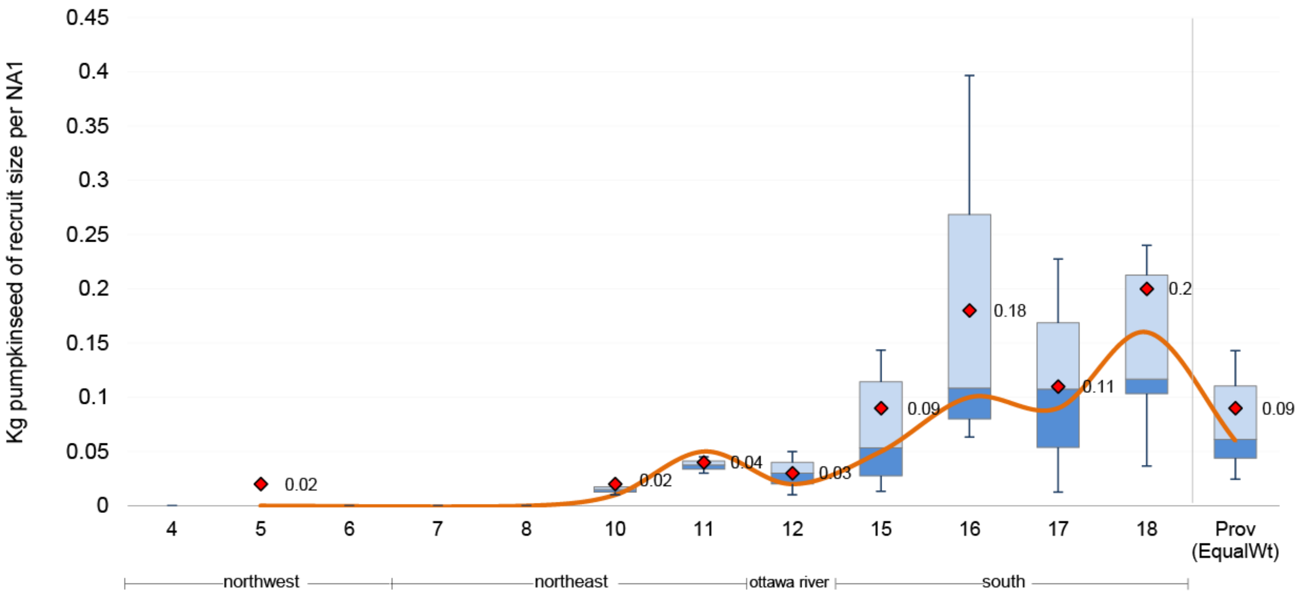


Figure 3.105 Equally-weighted average CUEW (kg/net) of Pumpkinseed recruits from all lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

3.5.10.1.5 Population Characteristics

Size

The mean size of Pumpkinseed recruits captured during Cycle 1 of BSM was 190 mm, the fourth highest in the province, and slightly higher than the provincial average of 184 mm (Figure 3.106). Cycle 2 data showed similar results; the mean size for FMZ 15 was 184 mm.

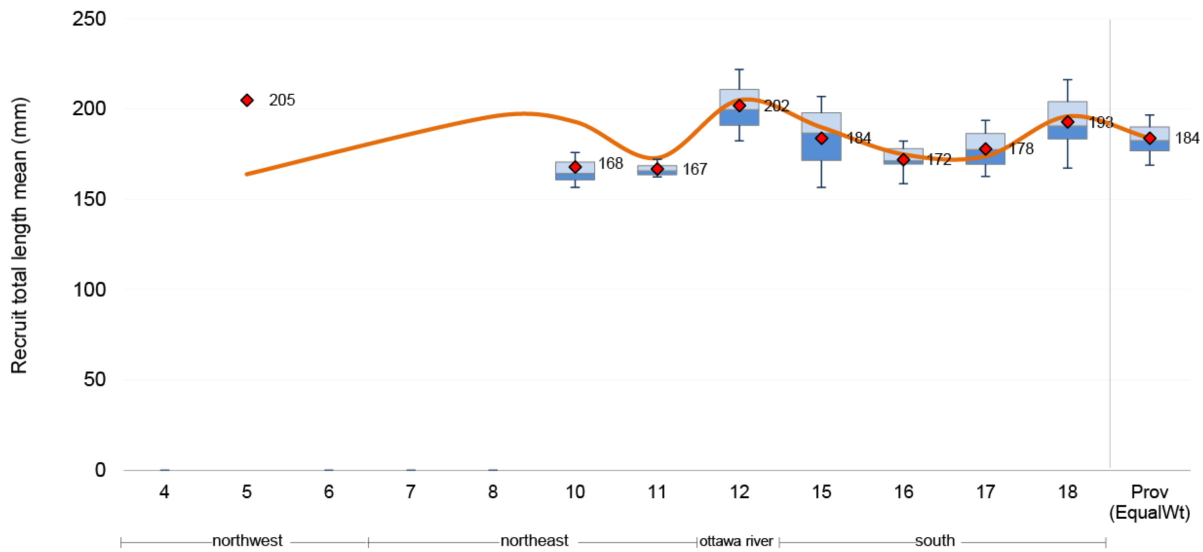


Figure 3.106 Equally-weighted average total length (mm) of Pumpkinseed recruits from all lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

Age

Panfish species are not targeted species for the BsM program and are only sampled opportunistically, therefore, there is little to no data available for age.

Proportional Size Distribution

There is no Proportional Size Distribution curve available for Pumpkinseed for FMZ 15.

Growth and Maturation

Insufficient numbers of Pumpkinseed were captured during Cycle 1 and Cycle 2 to provide growth curves and size at maturation for the species within FMZ 15.

3.5.10.1.6 Biological Reference Points

Insufficient numbers of Pumpkinseed were captured during Cycle 1 and Cycle 2 to provide biomass and mortality estimates within FMZ 15.

3.5.10.2 Yellow Perch

3.5.10.2.1 Description

Yellow Perch, a member of the Percidae family is related to the Walleye and Sauger. Perch are a native species occurring throughout Ontario. They are extremely adaptable to different habitats within the aquatic ecosystem and are generally found in open water areas of large, clear water lakes. They are a recreationally and commercially important species and make up 11% of the total catch and harvest of species in FMZ 15.

Yellow Perch spawn in the spring, usually from April 15 to early May, in water temperatures of 6.7-12.2˚C. Adults migrate shoreward into the shallows of lakes, and often into tributary rivers to spawn. Spawning takes place during the night and early morning, usually near rooted vegetation, submerged brush, or fallen trees (Scott and Crossman 1998). Contrary to all other species of Panfish, if no nest is built, and no protection is given the egg masses or young, by the parents. The eggs hatch in 8-10 days.

Yellow Perch are opportunistic feeders and often feed in open water. Their diet as reported in Kerr and Grant (2000) consists of zooplankton, insects and larvae, amphibians, molluscs, crayfish, fish, fish eggs and larvae, and leeches. Adults are piscivorous and prey fish include Bluegill, minnow species, carp, Alewife as well as other perch. Perch compete for resources with many other species including all trout species, Pumpkinseed, Walleye, White Sucker, Lake Herring, bass, crappie and Bluegill (Scott and Crossman 1998).

3.5.10.2.2 Distribution

Yellow Perch is native to North America, and has a widespread distribution across Ontario, and in FMZ 15. Their native distribution is not well documented, and they have been introduced to many lakes in the zone. They are now ubiquitous, except for some small lakes in high elevation areas of the zone.

3.5.10.2.3 Habitat and Fish Community

Yellow Perch are very adaptable and can utilize both warm and coolwater environments, including ponds, lakes and rivers; however, they are most abundant in the open water of lakes with a firm bottom and sparse to moderate vegetation (Sternburg 1996). They prefer warmwater (18-22˚C) and typically following a temperature regime of between 20-21˚C (Scott and Crossman 1973). Perch are tolerant of low dissolved oxygen but prefer levels greater than 5 mg/L.

Perch have been documented to alter ecosystems and populations of their prey items. They can alter benthic biomass by 60% (Post and Cucin 1984). Predation by Yellow Perch on Lake Trout and Brook Trout eggs and larvae has been documented in several instances. The impacts of Perch on both native and stocked Salmonid populations have been implicated in the decline of many fisheries. Survival and growth of trout is poor in waters where Yellow Perch are present (Fraser 1978).

3.5.10.2.4 Abundance

Yellow Perch are not a targeted species for BsM but are often captured during the sampling of both trend and state lakes. Yellow Perch are widely distributed across the entire province (Figure 3.107). During Cycle 1, FMZ 15 had an average CUEW of 0.1 kg/net, which was below the provincial average of 0.17 kg/net. In Cycle 2, the catch rate was the same.

Yellow Perch can impact population dynamics within a waterbody and have contributed to the decline of certain fisheries. Looking at the abundance of Yellow Perch by Trend Lakes and targeted species in both Cycle 1 and Cycle 2, it is apparent that there is a higher proportion of Yellow Perch in Lake Trout Trend Lakes, 1.35 fish/net and 2.49 fish/net, respectively (Table 3.20).

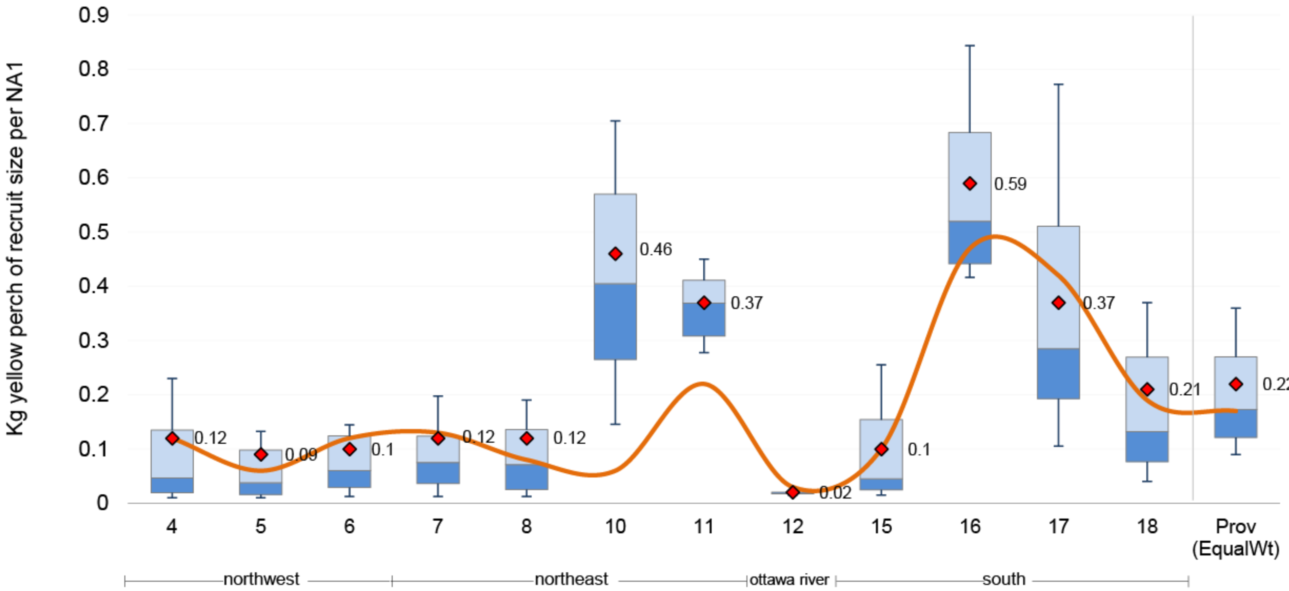


Figure 3.107 Equally-weighted CUEW (kg/net) of Yellow Perch from all lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

Table 3.20 Catch-per-unit-effort (fish/net) by BsM Trend lake target species, for Yellow Perch, BsM Cycle 1 and Cycle 2.

	Cycle 1			Cycle 2		
Trend Lake Target Species	**All Species**	**Yellow Perch**	**% Yellow Perch**	**All Species**	**Yellow Perch**	**% Yellow Perch**
All Lakes	6.08	1.19	19.6	6.17	1.08	17.5
Brook Trout	6.03	0.59	9.8	4.88	0.76	15.5
Lake Trout	5.80	1.35	23.3	6.27	2.49	39.7
Walleye	6.21	1.3	20.9	6.91	1.39	19.5

3.5.10.2.5 Population Characteristics

Size

The mean size of Yellow Perch did not differ significantly between Cycle 1 and Cycle 2 (Figure 3.108), with mean total lengths of 187 mm and 191 mm, respectively. The mean sizes were relatively consistent across the entire province, for both cycles. This result is probably caused by the selectivity of the sampling gear; most perch are caught in the smallest mesh panels and only the largest ones tend to be caught.

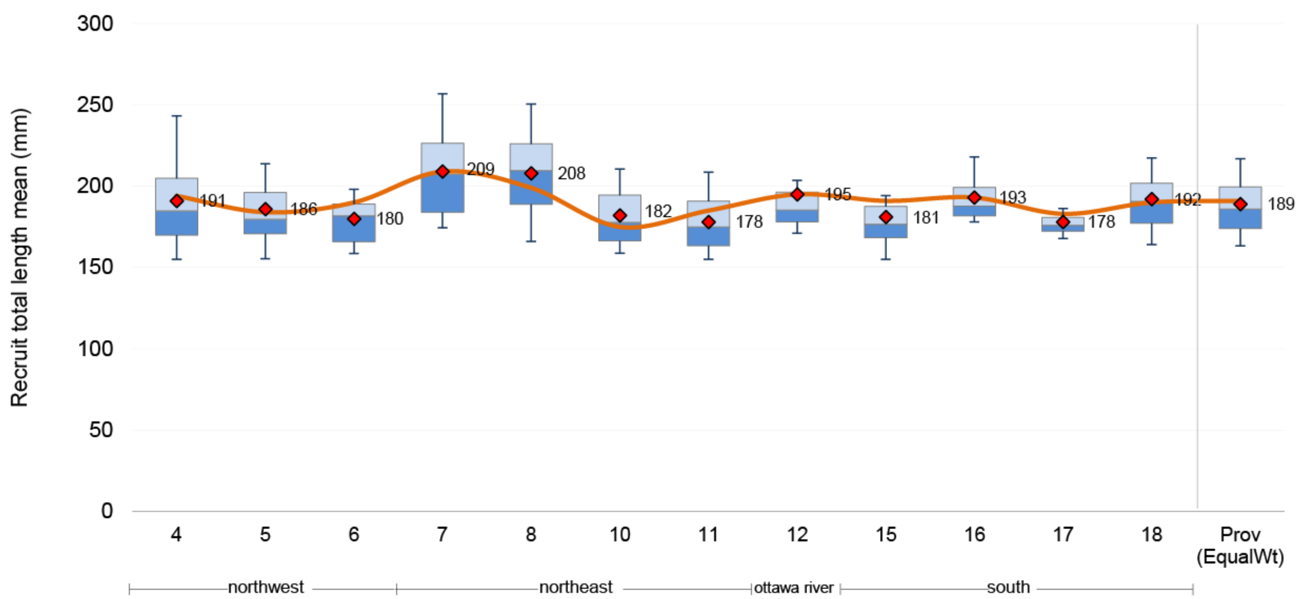


Figure 3.108 Equally-weighted mean total length (mm) of Yellow Perch recruits from all lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

Age

Yellow Perch often reach a maximum age of 9 to 10 years old; the oldest record was aged at 11+ years (Scott and Crossman 1998). In FMZ 15, Yellow Perch were not aged in Cycle 1; however, the average age captured during Cycle 2 was 4.6 years (Figure 3.109). Similar to size, there was not a lot of variation in age across the province.

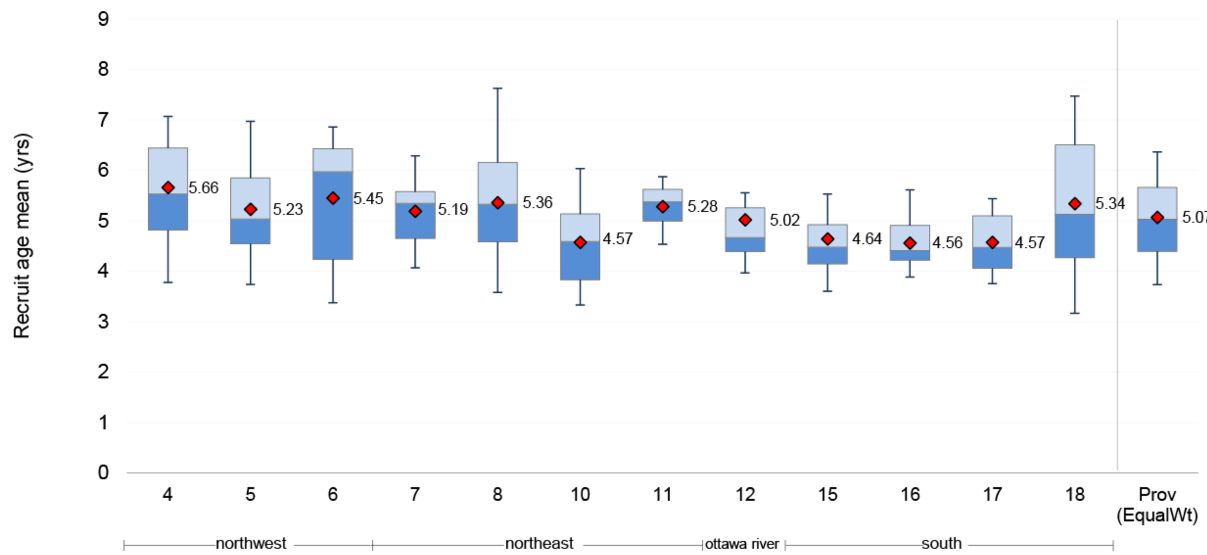


Figure 3.109 Equally-weighted average mean age (years) of Yellow Perch recruits from all lakes, by FMZ, BsM Cycle 2.

The number of year classes, or cohorts represented with the BsM catches in FMZ 15 for Yellow Perch was only available for Cycle 2. Zones in southern Ontario had higher numbers of cohorts caught compared to the rest of the province (Figure 3.110). On average, there were 3.5 cohorts of Yellow Perch in lakes within FMZ 15.

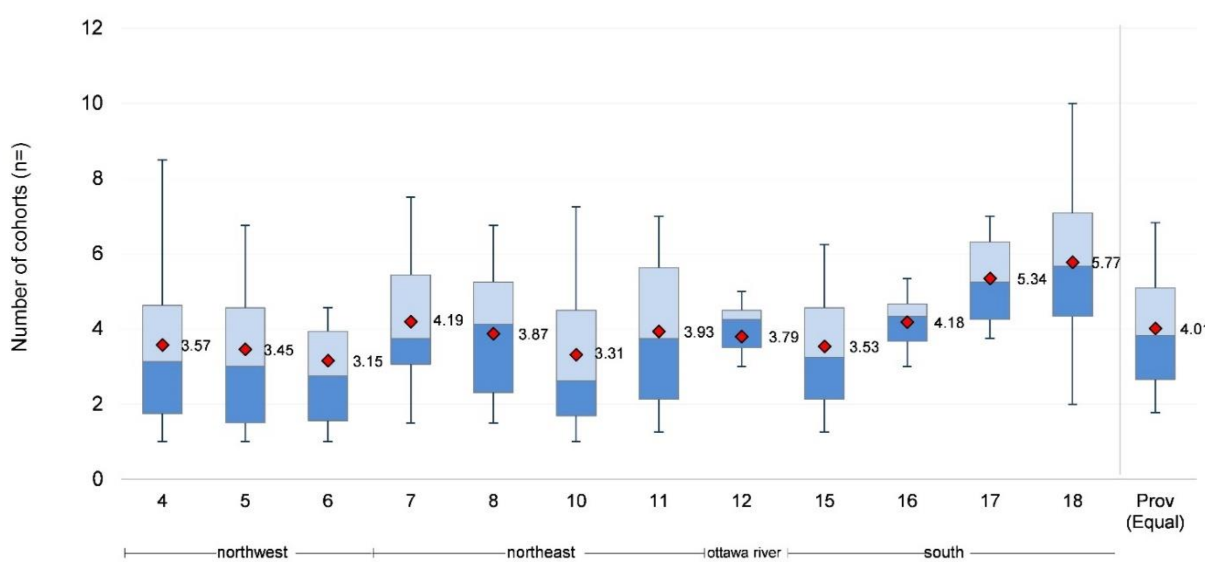


Figure 3.110 Equally-weighted average number of cohorts of Yellow Perch from all lakes, by FMZ, BsM Cycle 2.

Proportional Size Distribution

The proportional size distribution groups the fish caught into size categories that are meaningful to anglers. In FMZ 15, the greatest proportion of Yellow Perch in both Cycle 1 and Cycle 2 were in the 'Stock' category, followed by 'Quality' (Figure 3.111).

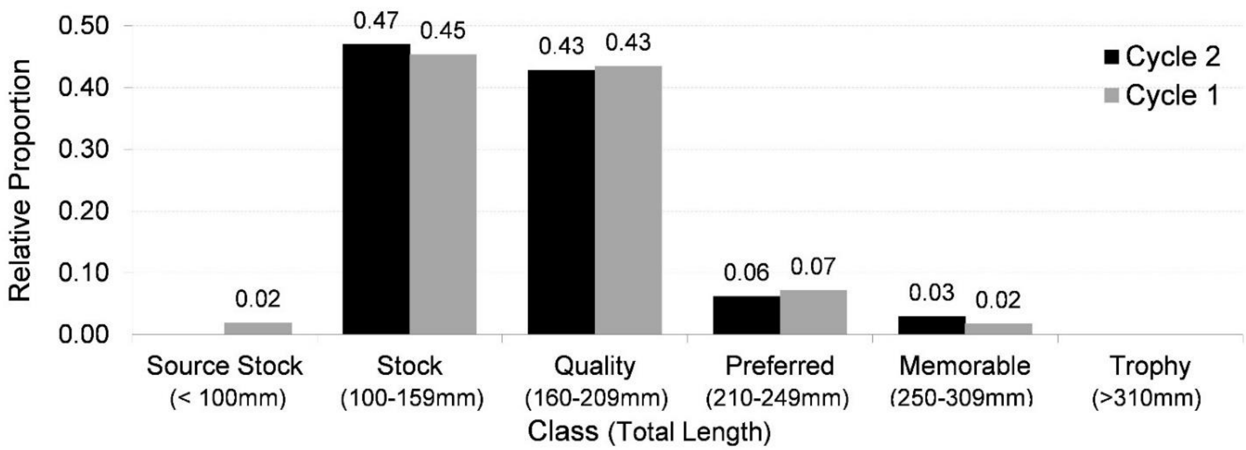


Figure 3.111 Proportional size distribution of Yellow Perch from all lake, FMZ 15, BsM Cycle 1 and Cycle 2.

Growth and Maturation

Insufficient numbers of Yellow Perch were captured during Cycle 1 and Cycle 2 to provide growth curves and size at maturation for the species within FMZ 15.

3.5.10.2.6 Biological Reference Points

Insufficient number of Yellow Perch were captured during Cycle 1 and Cycle 2 to provide biomass and mortality estimates for the species within FMZ 15.

3.6 Status of Species-at-Risk

The Endangered Species Act (ESA) (2007) came into effect on June 30, 2008 and provides protection to species at risk and their habitats. The responsibilities under the ESA originally were with MNRF; however, they have transitioned to MECP, as of April 1, 2019.

More than 200 species of plants and animals are at risk of disappearing from Ontario. The ESA gives automatic protection for species classified as endangered or threatened. The act also prohibits the damage or destruction of habitat for species classified as endangered or threatened. The Act sets out timelines for producing strategies and plans to recover at-risk species, gives legislative tools to help reduce the impact of human activity on species and their habitats, as well as tools to encourage protection and recovery activities.

Species are assessed by an independent body based on the best-available science and Indigenous Traditional Knowledge. At a federal level, assessments are undertaken by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). COSEWIC makes recommendations to the Federal Minister of the Environment, which may result in the species being listed under the Species at Risk Act, 2002 (SARA 2002). Provincially, species are assessed by the Committee on the Status of Species at Risk in Ontario (COSSARO). COSSARO makes recommendations to the provincial Minister of Environment, Conservation and Parks, which results in the species being listed under the Endangered Species Act, 2007 (Ontario Government 2007). Both acts have provisions affording protection to species and habitat.

Ten aquatic species at risk occur within FMZ 15 (Table 3.21).

Table 3.21 Aquatic species at risk in FMZ 15, 2019.

English Name	Scientific Name	Provincial Status	Taxon
American Eel	*Anguilla rostrata*	Endangered	Fish
Lake Sturgeon	*Acipenser fulvescens*	Endangered	Fish
Northern Brook Lamprey	*Ichthyomyzon fossor*	Special Concern	Fish
River Redhorse	*Moxostoma carinatum*	Special Concern	Fish
Shortjaw Cisco	*Coregonus zenithicus*	Threatened	Fish
Grass Pickerel	*Esox americanus vermiculatus*	Special Concern	Fish
Engelmann's Quillwort	*Isoetes engelmannii*	Endangered	Aquatic Plant
Ogden's Pondweed	*Potamogeton ogdenii*	Endangered	Aquatic Plant
Hickorynut	*Obovaria olivaria*	Endangered	Mussel

3.6.1 Northern Brook Lamprey

Northern Brook Lamprey (*Ichthyomyzon fossor*) is a small, non-parasitic lamprey that grows to a length of 86-166 mm in Ontario (COSEWIC 2007; Scott and Crossman 1998). It has an eel-like appearance and the characteristic features of a lamprey including a round, jawless mouth with teeth arranged in a circle and seven gill openings, a continuous dorsal fin and no pectoral or pelvic fins. Adults are dark greyish-brown on the back and sides, with pale grey or silvery white on the belly (Scott and Crossman 1998).

Northern Brook Lamprey has multiple stages of development – eggs, larva and adult. When the eggs hatch, the larvae, called ammocoetes, make burrows in soft mud and spend about six to seven years growing. Once developed, they emerge in the spring from the sediment and disperse as adults to the spawning grounds. Adults persist for only 4-6 months, do not feed, and die shortly after spawning has occurred (Fisheries and Oceans Canada 2016).

In FMZ 15, Northern Brook Lamprey is known to occur in a tributary of the Bonnechere River, which drains into the Ottawa River (Figure 3.112). Ammocoetes can be difficult to detect; and is likely that they are present in other tributaries of the Ottawa River as well (K. Punt pers. comm.). They may also occur in tributaries of Georgian Bay.

Lampricide used for the control of the invasive Sea Lamprey has likely contributed to declines in Northern Brook Lamprey populations around the Great Lakes where the two fishes coexist. Other threats to the Northern Brook Lamprey include pollution and changes in water levels and temperature (COSEWIC 2007). Northern Brook Lamprey is listed as special concern under Ontario's ESA.

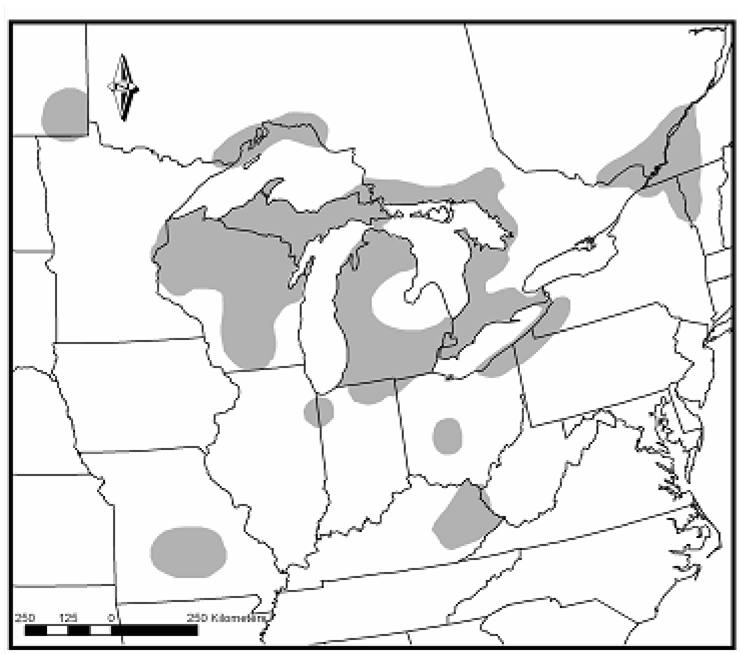


Figure 3.112 Distribution of Northern Brook Lamprey (COSEWIC 2007).

3.6.2 American Eel

American Eel has a long, snake-like body and fins that extend along its back, around the tail and along its underside; scales are small. It has thick lips with a lower jaw that is slightly longer than its upper jaw, resembling an under bite. Juveniles are yellowish-green or brown. Adults are grey with a white or cream belly. Adult females may reach over a metre in length while males reach less than 40 centimetres (Scott and Crossman 1998; MacGregor et al. 2013).

Over the course of its life, American Eel can be found in both salt and fresh water (Figure 3.113). It begins life in the Sargasso Sea in the North Atlantic Ocean and migrates along the east coast of North America. In Canada, they can be found in fresh water and salt-water areas that are accessible from the Atlantic Ocean. This area extends from Niagara Falls in the Great Lakes up to the mid-Labrador coast. In Ontario, American Eel have not been found for many decades in Algonquin Provincial Park. Once the Eels mature (10-25 years) they migrate downstream to the Sargasso Sea to spawn.

In FMZ 15, American Eel occur in the tributaries of the Ottawa River, including the Petawawa, Madawaska and Bonnechere Rivers and their tributaries (Figure 3.114). American Eel within the Ottawa River watershed, and within FMZ 15, are a distinct subpopulation, characterized by larger females with increased fecundity (MacGregor et al. 2013). When American Eel was abundant, it was dominant in the fish community, often representing more than 50% of the fish biomass in the waterbody (MacGregor et al. 2013). Adult eel feed primarily on invertebrates (i.e. crayfish) and small fish.

Threats to this species include habitat loss and fragmentation due to dams and other in-water barriers, direct mortality due to hydro-electric turbines, invasive species and chemical contaminants. Historic over-harvest also caused a decline in American Eel populations. Climate change may also pose a threat as changes to the Gulf Stream patterns may interfere with migration (COSEWIC 2012; MacGregor et al. 2013). American Eel is listed as endangered under Ontario's ESA.

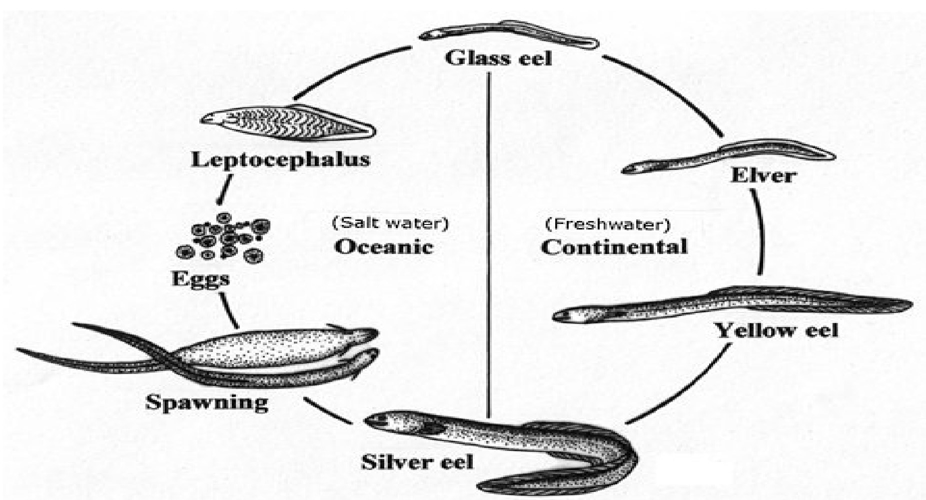


Figure 3.113 American Eel life cycle (MacGregor et al. 2013).

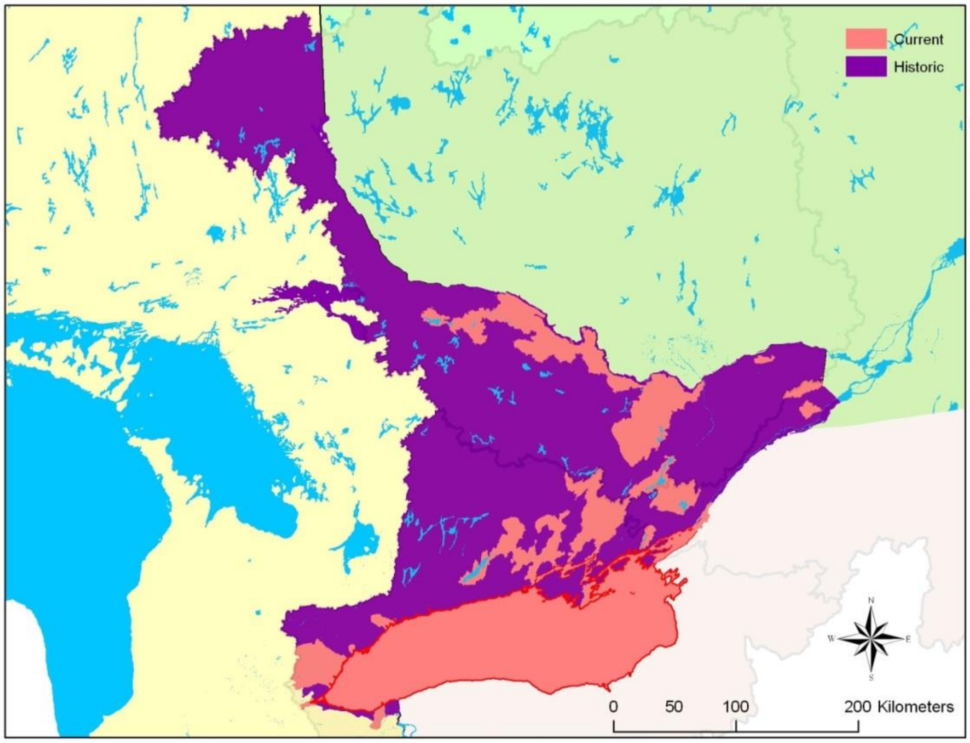


Figure 3.114 Distribution of American Eel in Ontario (adapted from MacGregor et al. 2013).

3.6.3 Lake Sturgeon

Lake Sturgeon (*Acipenser fulvescens)* is Ontario's largest and longest-lived freshwater fish, weighing up to 180 kilograms and reaching over two metres long. It has an extended snout with four barbels (whisker-like sensory organs) hanging near the mouth (Scott and Crossman 1998; Golder Associates Ltd. 2011). Lake Sturgeon has ancestral ties to related species dating back 200 million years. It can live more than 100 years (OMNRF 2016c).

Lake Sturgeon live almost exclusively in freshwater lakes and rivers with soft bottoms of mud, sand or gravel. They are usually found at depths of 5-20 m. Spawning occurs in the spring, in relatively shallow, fast-flowing water (usually below waterfalls, rapids, or dams) with gravel and boulder substrate, but they will spawn in deeper water where habitat is available. They also are known to spawn on open shoals in large rivers with strong currents (OMNRF 2016c). They are bottom-feeders, and consume a variety of items, including molluscs, crayfish, and aquatic invertebrates (Scott and Crossman 1998; Golder Associates Ltd. 2011).

Within Ontario, three subpopulations of Lake Sturgeon: Great Lakes - Upper St. Lawrence River, Northwestern Ontario, and Southern Hudson Bay - James Bay. Lake Sturgeon within FMZ 15 are part of the Great Lakes – Upper St. Lawrence Population. Lake Sturgeon can be found on the large tributaries of the Ottawa River, including the Petawawa River (upstream into Algonquin Provincial Park), the Muskrat, Indian, and Bonnechere Rivers. On the west side of FMZ 15, they occur in the Pickerel River (T. Baker pers. comm.; S. Scholten pers. comm.).

Historically, overharvesting, dams and other river barriers, habitat loss and fragmentation, and poor water quality were responsible for the decline of Lake Sturgeon throughout North America. Their life history traits - slow growing, late maturation, low egg production and intermittent spawning make them susceptible to overexploitation (Golder Associates Ltd. 2011; OMNRF 2016c). Lake Sturgeon is listed as threatened (Great Lakes - Upper St. Lawrence population) under Ontario's ESA.

3.6.4 Shortjaw Cisco

Shortjaw Cisco, (*Coregonus zenithicus*) are members of the Whitefish family. They can grow up to 40 cm long and weigh up to 1 kilogram. They have an olive-tan to greenish back, silvery-coloured sides, a purple sheen and a white belly. Shortjaw Cisco has large eyes, a small head, a small mouth with no teeth, and a small lower jaw (Scott and Crossman 1998).

This species spends most of the year in deep water, usually between 55-180 m. During the breeding season, which can be spring or fall depending on the lake, they migrate to shallower water (10-60 m) to mate and lay eggs. They feed primarily on zooplankton, but also consume aquatic insects, crustaceans, and freshwater shrimp. Shortjaw Cisco are an important prey item for Lake Trout in lakes where they co-occur (Scott and Crossman 1998).

Its current distribution is not well understood, but is thought to be restricted to Lake Superior, Lake Nipigon, a few large lakes in northern and northwestern Ontario and one location within Algonquin Provincial Park (COSEWIC 2003). Distribution within FMZ 15 is unknown.

Ontario's Shortjaw Cisco population was greatly reduced by commercial overfishing in the Great Lakes in the early 1900's and more recently from habitat degradation along with competition and predation from species not native to the lakes, including Rainbow Smelt and Sea Lamprey (COSEWIC 2003). Shortjaw Cisco is listed as a threatened species under Ontario's ESA.

3.6.5 River Redhorse

River Redhorse, is a long-lived and late-maturing species and is one of the seven species of the genus Moxostoma which occur in Canada (COSEWIC 2006). It is a large, thick-bodied sucker with a large, flat-topped head, a prominent snout and a red-tinted tail fin. It has a white belly, brown or olive green back and brassy, yellowish-green or coppery sides. It can grow to a size nearing 80 cm and weigh more than 5.5 kilograms (Scott and Crossman 1998). The oldest recorded age for River Redhorse in Canada is 28 years old (COSEWIC 2006).

This species inhabits medium to large-size riverine habitats with heavy flows. In May and June, adults migrate from deeper, slower moving pools and run habitats to shallow riffle-run habitats having coarse substrate and moderate to swift flow (Scott and Crossman 1998). Suitable interconnected riverine habitats are necessary for the River Redhorse to complete all its life stages. River Redhorse feed mainly on benthic invertebrates, including mollusks and crayfish (COSEWIC 2006).

In FMZ 15, River Redhorse have been documented in the large river tributaries flowing into the Ottawa River, including the Petawawa, Muskrat and Madawaska Rivers (Figure 3.115).

River Redhorse requires clear and unpolluted water and is susceptible to siltation and turbidity that can result from farming and urban development. Dams are also a threat as they can alter habitat conditions and prevent migrating fish from reaching traditional spawning areas and other important habitats, as well as restricting gene flow between populations (COSEWIC 2006). River Redhorse is listed as special concern under Ontario's ESA.

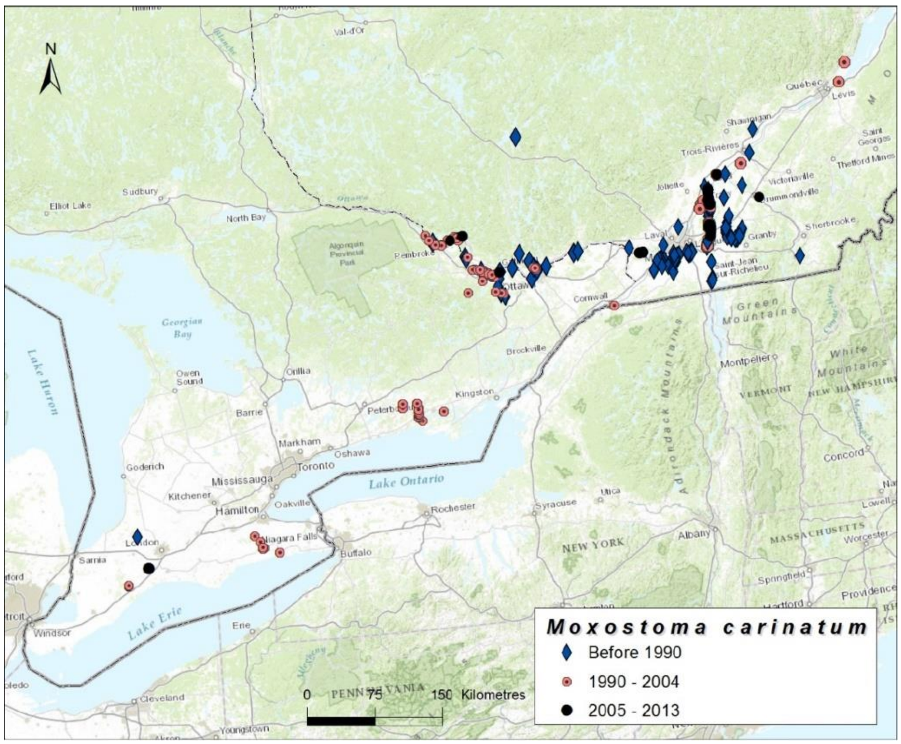


Figure 3.115 Distribution of River Redhorse in Canada (Source: COSEWIC 2015).

3.6.6 Grass Pickerel

Grass Pickerel, a subspecies of the Redfin Pickerel, is a small member of the Pike family. Usually less than 30 cm long, they are seldom seen, can be mistaken for small Northern Pike or Muskellunge and are not a sport fish species in Ontario (Scott and Crossman 1973).

It has a restricted distribution in Ontario, occurring primarily in eastern Ontario near the St. Lawrence River, the Niagara area and near Lake St Clair. A disjunct population has been documented in FMZ 15 in the Kahshe Lake watershed and neighbouring tributaries of the Severn River, in the southern part of Parry Sound District. At the time of the 2005 COSEWIC status report, observations were restricted to collections made in Kahshe Lake and connected Bass Lake in the 1980's (Crossman and Holm 2005). Since that time, several more observations have been made by consultants working for MTO on highway projects, by a University researcher (Colm 2015) and targeted MNRF surveys conducted by Parry Sound district. These observations are restricted to the Kahshe River watershed, Jevins Creek and waterbodies on the Severn River in FMZ 16, into which both watersheds flow (Figure 3.116). Information on the population is restricted to occurrence observations. The overall distribution is not well understood, and no information is available on abundance, population characteristics or stresses. In 2015 tissue samples were collected from Grass Pickerel for genetic analysis that may give insight into the origin of the occurrences in FMZ 15.

Grass Pickerel is listed as Special Concern under Ontario's ESA.

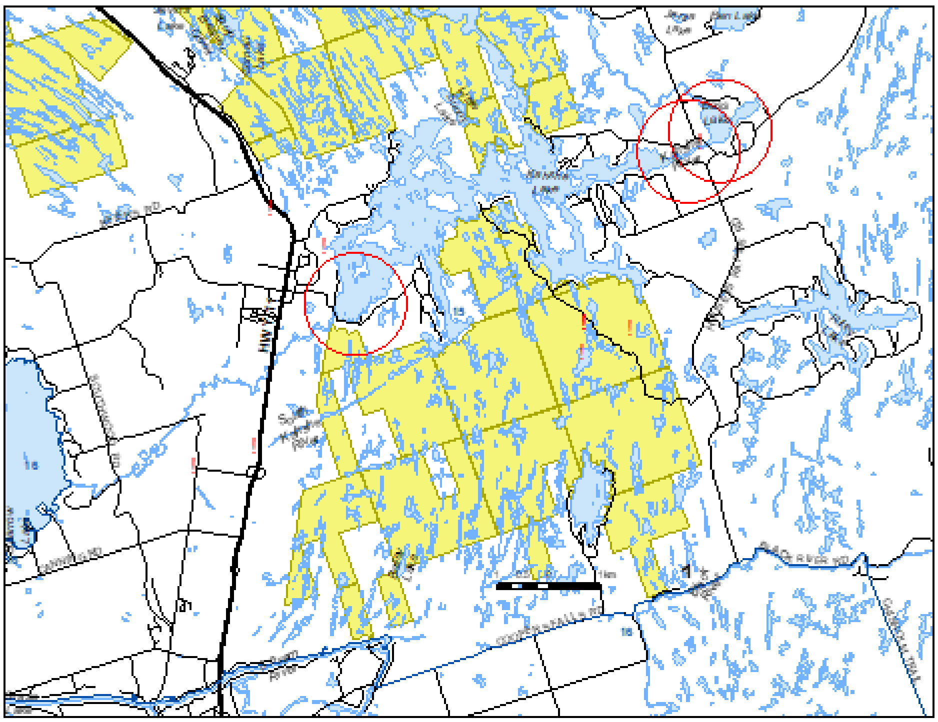


Figure 3.116 Distribution of Grass Pickerel in FMZ 15, 2015. Filled circles: ARA Survey Point, Open Circles: Species Observations Provincially Tracked.

3.7 Invasive species

Alien species are species of plants, animals, and microorganisms introduced by human action outside their natural past or present distribution. Invasive species are defined as harmful alien species whose introduction or spread threatens the environment, the economy, and/ or society including human health. They may include species of plants, animals, and microorganisms introduced by human action outside their natural past or present distribution. Ontario's definition of an invasive species may include those species which are native to a part of the province but are not native elsewhere.

Ontario has the highest number of invasive species in Canada and is also at the greatest risk of new species invasions owing to its large and mobile human population and its geographic location which makes it an important economic and transportation hub (OMNR 2012). These factors combine to create numerous opportunities for the introduction and spread of invasive species. Invasive species are also spread throughout the province through recreational activities including the release of live fish and bait and the movement of boats and gear between waterbodies. The construction of canals and waterways which increases the connectivity of waterbodies, ongoing disturbance to aquatic ecosystems, and climate change are all additional factors that can facilitate new invasions into Ontario and promote the spread of invasive species that are already established.

The environmental and economic threats posed by invasive species in Ontario are significant (Nienhuis and Wilson 2018). Once established, invasive species are extremely difficult and costly to control and eradicate and their ecological effects are often irreversible. For example, invasive species have been identified as one of the leading causes of the loss of global biodiversity, second only to habitat loss (OBC 2011) and are a significant threat to species at risk (OBC 2010).

In response to the increasing threat of invasive species impacts in the province, Ontario released the Ontario Invasive Species Strategic Plan in 2012, and in 2015 passed the Invasive Species Act (ISA)—the first stand-alone invasive species legislation in Canada. Preventing invasive species from arriving and becoming established in Ontario is the primary objective of the Act. On November 3, 2016, the ISA, along with its first suite of regulations, came into force. At that time, 20 species were listed as either prohibited or restricted, including the initial 16 species identified on the Conference of Great Lakes and St. Lawrence Governors and Premiers' aquatic invasive species "Least Wanted List".

Beyond introducing the ISA, the Ministry of Natural Resources and Forestry has made significant investments in the fight against invasive species through on-going funding agreements with key partners to help with public awareness, research and management. For example, since 1992, MNRF has partnered with the Ontario Federation of Anglers and Hunters (OFAH) to deliver the Invading Species Awareness Program (ISAP) through annual funding contributions. Key objectives of the Program include generating education and awareness, monitoring and tracking the spread of new invaders found in Ontario, and addressing key pathways contributing to invasive species spread.

Within FMZ 15, at least 18 aquatic invasive species (AIS) have been reported over time up to 2017 (Table 3.22). This list includes 5 invasive fish species, 6 aquatic invertebrates and 7 aquatic or semi-aquatic plants. Confirmed invasive species reports within the zone derive from various data sources including: BsM, EDDMaps Ontario (the invasive species tracking system managed through ISAP), and collections made by the Royal Ontario Museum. It should be noted that while all are confirmed sightings or reports, it doesn't necessarily mean that all of these species have actually established self-sustaining populations within the zone. The list does not include non-native salmonids that have been deliberately stocked/introduced to provide social and economic benefits to Ontarians and which are managed accordingly under the Fish and Wildlife Conservation Act (FWCA), 1997. It also does not include species such as Smallmouth Bass, which are native to some parts of the zone, but which have also become established and spread in many other lakes as a result of widespread historical stocking or unauthorized introductions (Kerr and Grant 2000). Several of the invasive species with the most realized or potential ecological impacts in the zone will be discussed in greater detail in the sections that follow.

Table 3.22 List of aquatic invasive species in FMZ 15.

Common name	Scientific name	Taxonomic Group
Rainbow Smelt	*Osmerus mordax*	Fish
Round Goby	*Neogobius melanostomus*	Fish
Sea Lamprey	*Petromyzon marinus*	Fish
Goldfish	*Carassius auratus*	Fish
Common Carp	*Cyprinus carpio*	Fish
Zebra mussel	*Dreissena polymorpha*	Invertebrate
Spiny waterflea	*Bythotrephes longimanus*	Invertebrate
Rusty crayfish	*Orconectes rusticus*	Invertebrate
Banded mysterysnail	*Viviparus georgianus*	Invertebrate
Chinese mysterysnail	*Cipangopaludina chinensis*	Invertebrate
Freshwater jellyfish	*Craspedacusta sowerbyi*	Invertebrate
Eurasian water-milfoil	*Myriophyllum spicatum*	Aquatic plant
European frogbit	*Hydrocharis morsus-ranae*	Aquatic plant
Carolina fanwort	*Cabomba caroliniana*	Aquatic plant
European common reed	*Phragmites australis* subsp. *australis*	Aquatic/semi-aquatic plant
Purple loosestrife	*Lythrum salicaria*	Aquatic/semi-aquatic plant
Narrow-leaved cattail	*Typha angustifolia*	Aquatic/semi-aquatic plant
Reed canarygrass	*Phalaris arundinacea*	Aquatic/semi-aquatic plant

Invasive species data collected throughout FMZ 15 indicate that the number of AIS within the zone has increased steadily over time (Figure 3.117) and suggests that most of the invasions by aquatic species have occurred relatively recently (within the last 20 years). Prior to the mid-1950s, only 2 aquatic invasive species were known to occur within FMZ 15: Rainbow Smelt and Sea Lamprey. The most recent invaders in the zone include Round Goby, Chinese Mystery Snail, Narrow-Leaved Cattail and Reed Canarygrass.

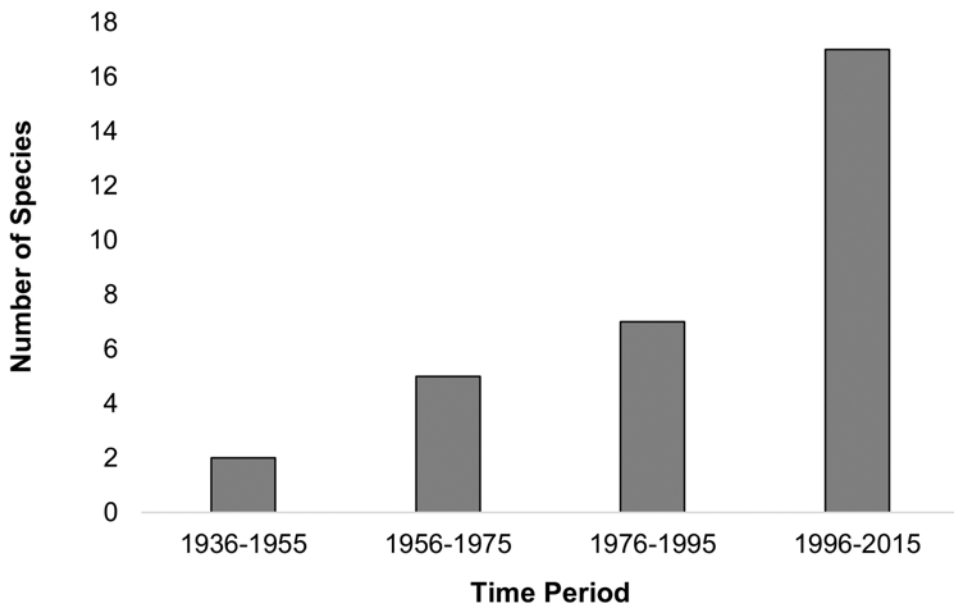


Figure 3.117 Total number of aquatic invasive species detected/reported over an incremental series of 20-year time periods in FMZ 15. Data derive from BsM, EDDMaps Ontario, and collections made by the Royal Ontario Museum.

Examination of the zooplankton haul data collected as part of the BsM program to monitor the presence of Spiny Waterflea and Zebra Mussel in FMZ 15 (Table 3.23) suggests that these species continue to be introduced in lakes across the zone. Between sampling conducted during Cycle 1 and Cycle 2, the number of lakes where Spiny Waterflea was detected increased from 13 to 19, while the number of lakes where the presence of Zebra Mussel veligers was confirmed nearly quadrupled, from 5 lakes to 19. As discussed in more detail below, the detection of Zebra Mussel veligers does not necessarily confirm that the species has established self-sustaining populations within a lake. However, the increase in number of detections of veligers in lakes does demonstrate that there are ongoing pathways for the introduction of this, and potentially other, invasive species across the zone. For both Spiny Waterflea and Zebra Mussel, the primary pathways for introduction and overland spread across inland lakes are linked to watercrafts and other associated gear and equipment (Yan et al. 2011; DeVentura et al. 2016).

Table 3.23 Number of trend lakes where Spiny Waterflea or Zebra Mussels were detected, by BsM cycle.

	Cycle 1	Cycle 2
Spiny Waterflea	13	19
Zebra Mussel	5	19

All invasive species maps below are a compilation of data from EDDmaps, BsM data and ROM data.

Rainbow Smelt

Rainbow Smelt (*Osmerus mordax*) is likely the invasive species with the greatest realized or potential impact on fish communities in FMZ 15. This species is a glacial relict that is native to a number of lakes and rivers along the eastern portion of FMZ 15, specifically within Renfrew County and the Ottawa Valley (Figure 3.118). Records from the mid 1900's indicate that Smelt are native to areas including Lake Dore (Scott 1956), Golden Lake (MacKay 1963) and Muskrat Lake (Scott 1956, MacKay 1963), while more recent genetic testing indicates smelt are native to the Ottawa River (FMZ 12) system, into which many FMZ 15 watersheds drain (Table 3.24). However, this species has also been widely introduced outside of its native range, either intentionally or unintentionally (e.g., through the bait pathway) and has subsequently spread through interconnected waterbodies throughout the rest of FMZ 15 (Figure 3.119). Most occurrences are in waterbodies in the west part of the zone, possibly due to their proximity to source populations in Georgian Bay.

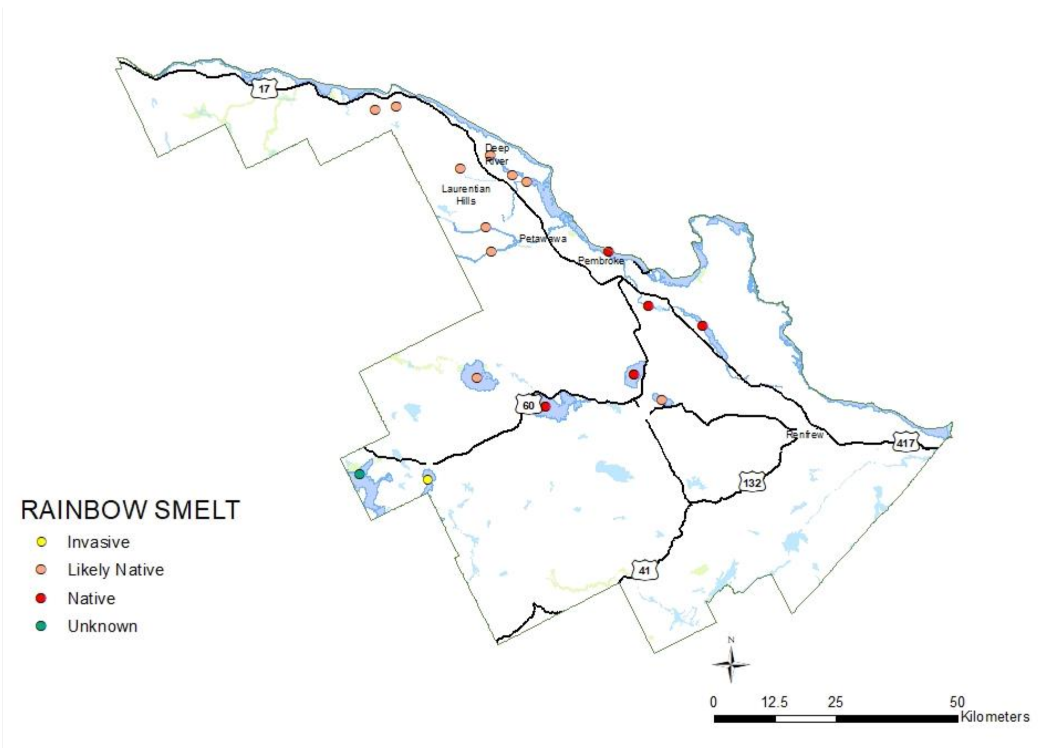


Figure 3.118 Distribution and origin of Rainbow Smelt in Pembroke District.

Table 3.24 Status and genetic origin of Rainbow Smelt, Pembroke District.

Waterbody	Status	Genetic Origin
Bark Lake	Unknown	Genetic testing required
Barron River	Likely Native	Tributary to Ottawa R.
Golden Lake	Native	Same as Round L; different than Great Lakes and Ottawa R.
Kamaniskeg Lake	Invasive	Possibly introduced, similar to L. Huron
Lake Dore	Native	Within Muskrat Watershed
Maskinonge Lake	Likely Native	Tributary to Ottawa R.
Muskrat Lake	Native	Confirmed, similar to Ottawa R.
Muskrat River	Native	Confirmed, similar to Ottawa R.
Ottawa River	Native	Confirmed; similar to Champlain Sea, Atlantic Coastal, St. Lawrence R. Glacial Refugia
Otterson Lake	Likely Native	Tributary to Ottawa R.
Petawawa River	Likely Native	Tributary to Ottawa R.
Roney Lake	Likely Native	Tributary to Ottawa R.
Round Lake	Native	Same as Golden L.; different than Great Lakes and Ottawa R.
Sturgeon Lake	Likely Native	Tributary to Ottawa R.
Tee Lake	Likely Native	Tributary to Ottawa R.
Tucker Creek	Likely Native	Tributary to Ottawa R.

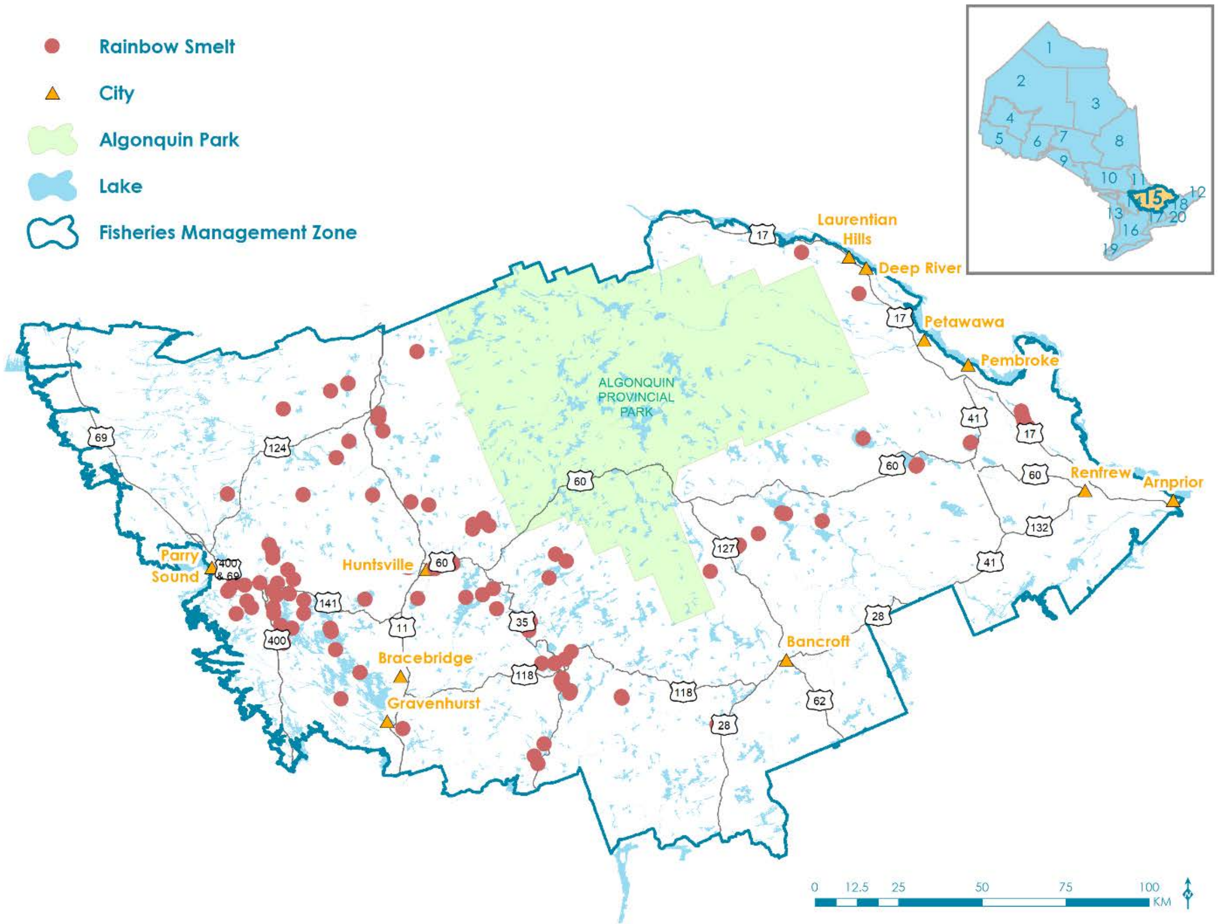


Figure 3.119 Distribution of Rainbow Smelt in FMZ 15, 2019, excluding Algonquin Provincial Park.

Rainbow Smelt are aggressive and efficient predators, capable of out-competing native species for food and resources. For example, Rainbow Smelt invasions have often been associated with declines in the abundance of native species with similar food and habitat requirements, including Yellow Perch, Cisco and Lake Whitefish (Scott and Crossman 1998). Their broad diet and habitat tolerances can lead to interactions across various trophic levels, with impacts ranging from declines in zooplankton, to competition and predation of juvenile game fish, to the acceleration of eutrophication initiated by a trophic cascade (Rooney and Paterson 2006). Invasions of Smelt have also resulted in declines in the natural reproduction of Lake Trout, Walleye and Cisco (Loftus and Hulsman 1986; Mercado-Silva et al. 2007). Smelt can also be an important food item, contributing to increased growth and larger ultimate size of predatory species including Lake Trout and Walleye.

Sea Lamprey

The Sea Lamprey (*Petromyzon marinus*) is a primitive species native to the northern Atlantic Ocean and the Baltic, western Mediterranean and Adriatic seas (ISAP 2012a). The opening of the Welland Shipping Canal in 1829 first gave Sea Lamprey access to the upper Great Lakes, but it wasn't discovered within Lake Erie until 1921 (Scott and Crossman 1998). While it took nearly 100 years to invade Lake Erie, in the 25 years that followed this species was able to quickly spread throughout the remainder of the Great Lakes and the lower reaches of their watersheds.

Within FMZ 15, the species is restricted primarily to the lower reaches of tributaries of Georgian Bay where the non-parasitic larvae live in the sediments. The parasitic adult phase is only known to occur in Georgian Bay (FMZ 14). The federal Department of Fisheries and Ocean Seas Lamprey Control Program treats tributaries with lampricide to control Sea Lampreys. In FMZ 15, there are ongoing lampricide treatments on several Georgian Bay tributaries including the Naiscoot, Boyne and Magnetawan Rivers (Sullivan and Mullet 2018). Lampricide treatment may cause unintended mortality of benign native lamprey species that use the same habitat.

Spiny Waterflea

Spiny Waterflea (*Bythotrephes longimanus*) is an invasive zooplankton species, originating from Eurasia and introduced to the Great Lakes in ballast water from ocean-going ships. These small organisms are easily spread across inland waterbodies through contaminated watercrafts, gear, and equipment (i.e., anchor lines), to which they readily attach. Once introduced, a few animals can multiply quickly, reproducing sexually or asexually by cloning, leading to rapid establishment. As a result, the species continues to spread throughout the province including throughout FMZ 15. As evidenced by BsM results, over a 10-year period there has been almost a 50% increase in the number of sampled lakes within the zone where the species has been detected (Table 3.23). The species is now broadly distributed across the zone (Figure 3.120) and will likely continue to spread as it appears to prefer large, clear lakes (Weisz and Yan 2010) which characterize many of the lakes in FMZ 15.

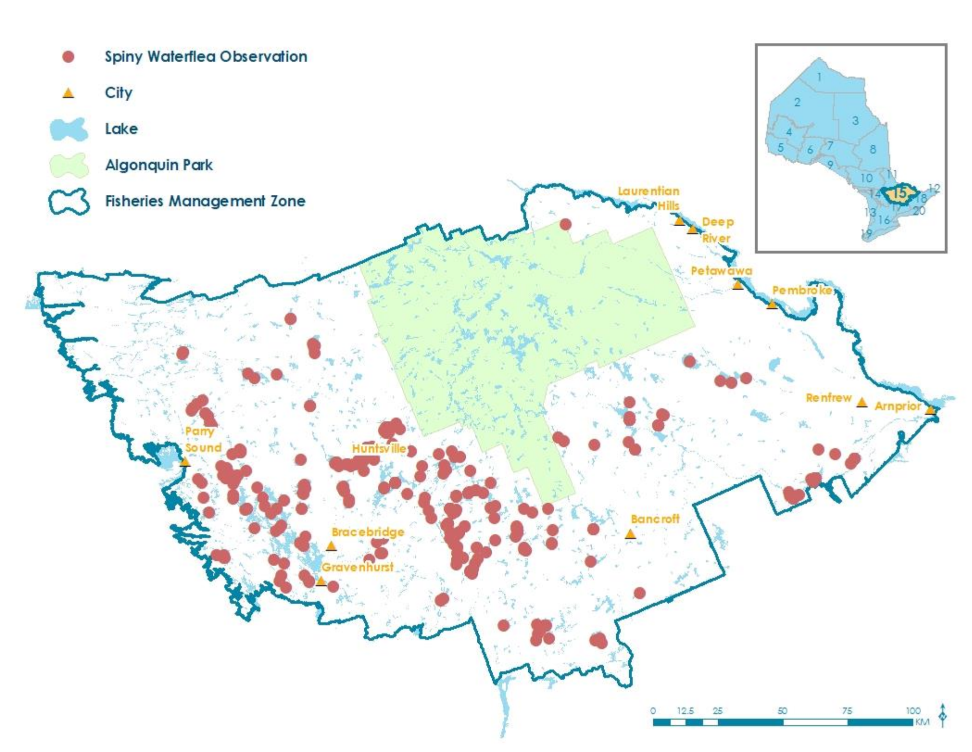


Figure 3.120 Distribution of Spiny Waterflea in FMZ 15, 2019, excluding Algonquin Provincial Park.

The impacts of Spiny Waterflea on native zooplankton species are well documented (Yan et al. 2011). As a voracious predator, the Spiny Waterflea has been shown to reduce the abundance and diversity of several smaller native zooplankton species which can cause dramatic changes to zooplankton communities (Yan et al. 2002). Cascading impacts to fish are therefore likely, given the dependence of many baitfish and young sportfish on native zooplankton species for food. Furthermore, the large size and spine of the Spiny Waterflea make them difficult for young fish to consume, which combined with the loss of edible prey may lead to negative impacts on the growth and recruitment of native fish species (Hoffman et al. 2001). Finally, Spiny Waterflea populations can affect recreational angling and commercial fishing by catching on fishing equipment, making it difficult to reel in lines, and clogging commercial nets and trawl lines.

Zebra Mussel

The Zebra Mussel (*Dreissena polymorpha*) was introduced to North America in 1986 through contaminated ballast water that was discharged into the Lake St. Clair – Detroit River region of the Great Lakes. Since that time, the species has spread rapidly throughout the Great Lakes and other interconnected waterbodies, as well as into hundreds of smaller inland lakes and rivers via secondary spread as a result of human activity, particularly boating and fishing (DeVentura et al. 2016).

Zebra Mussel invasions cause significant changes to aquatic ecosystems. They are extremely efficient feeders that filter out large quantities of phytoplankton, resulting not only in changes to food webs, but also to the clarity and light penetration of the water column. The latter, in turn, impacts the growth of native vegetation as well as the fish community composition. Fish species that are sensitive to light, such as Walleye are forced to find habitats that are deeper and darker. Zebra Mussels directly threaten native mussel populations, including several Species at Risk mussels, by colonizing their shells and smothering them. Socioeconomic impacts from Zebra Mussels include fouling of boats, docks and water intake pipes, and the costs associated with removing the mussels.

Zebra Mussels have been detected in a number of lakes throughout FMZ 15 (Figure 3.121). However, many of these reports derive from observations of Zebra Mussel veligers (i.e., larvae), including those deriving from BsM zooplankton sampling. The detection of veligers alone does not indicate that adult mussels have established, or that Zebra Mussel populations have reached high densities in a lake. In fact, the low calcium and pH levels in most Precambrian Shield lakes in FMZ 15 make it unlikely that Zebra Mussels will be able to colonize and become established in them (Neary and Leach 1992; McMahon 1996; Claudi et al. 2012). Numerous studies have indicated that the minimum concentration of calcium required for long-term survival of mussels is approximately 15 g/L, while the minimum pH for long term survival is approximately 7.5 (Claudi and Prescott 2011). While many of the lakes where veligers were detected during BsM do not have appropriate water chemistry to support survival and colonization of adult Zebra Mussels, there are other lakes in the zone where the species has not yet been detected, but which have high enough calcium and pH levels to support an invasion, particularly lakes in the Ottawa Valley where pockets of limestone bedrock and calcareous soils occur. Given that pathways for the introduction and spread of Zebra Mussels continue to exist, these lakes may be at risk of future invasions.

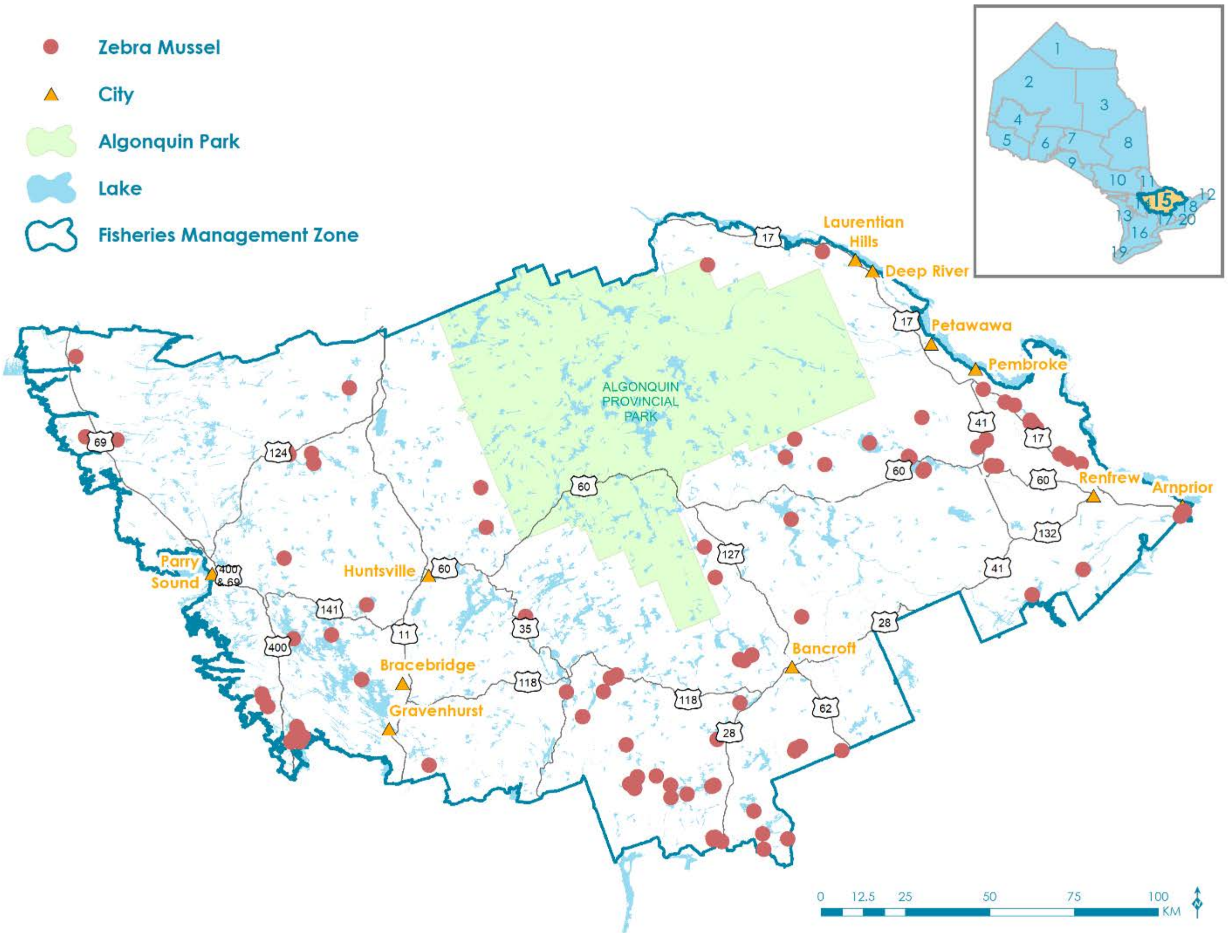


Figure 3.121 Locations of observations of zebra mussels, in FMZ 15, 2019, excluding Algonquin Provincial Park.

Eurasian Water-Milfoil

Eurasian Water-Milfoil (*Myriophyllum spicatum*) is a submergent perennial aquatic plant native to Europe, Asia and northern Africa. It typically grows in relatively shallow water (1-3 m) near the shore but can be found as deep as 10 m. This plant spreads readily through small fragments, and is easily transported on boat propellers, fishing gear, and water currents. Eurasian Water-Milfoil grows aggressively, and will out-compete native vegetation, establishing dense monoculture mats which reduce light and oxygen in the water column (ISAP 2012b). The reduction in light and oxygen can both displace and kill fish, and the resultant stagnant water offers ideal breeding habitat for mosquitoes. Socioeconomic impacts from Eurasian Water-Milfoil include fouling of swimming areas and hindering other recreational activities including boating and fishing (ISAP 2012b).

Since the time that Eurasian Water-Milfoil was first detected in Canada within Lake Erie in 1961, it has now spread to all of the Great Lakes and many inland waterbodies within southern and central Ontario. In FMZ 15, its distribution is largely confined to the western and southern regions of the zone (Figure 3.122). Like Zebra Mussels, the distribution and spread of Milfoil in FMZ 15 may be limited by the low nutrient levels and high average depth of many oligotrophic lakes in the zone.

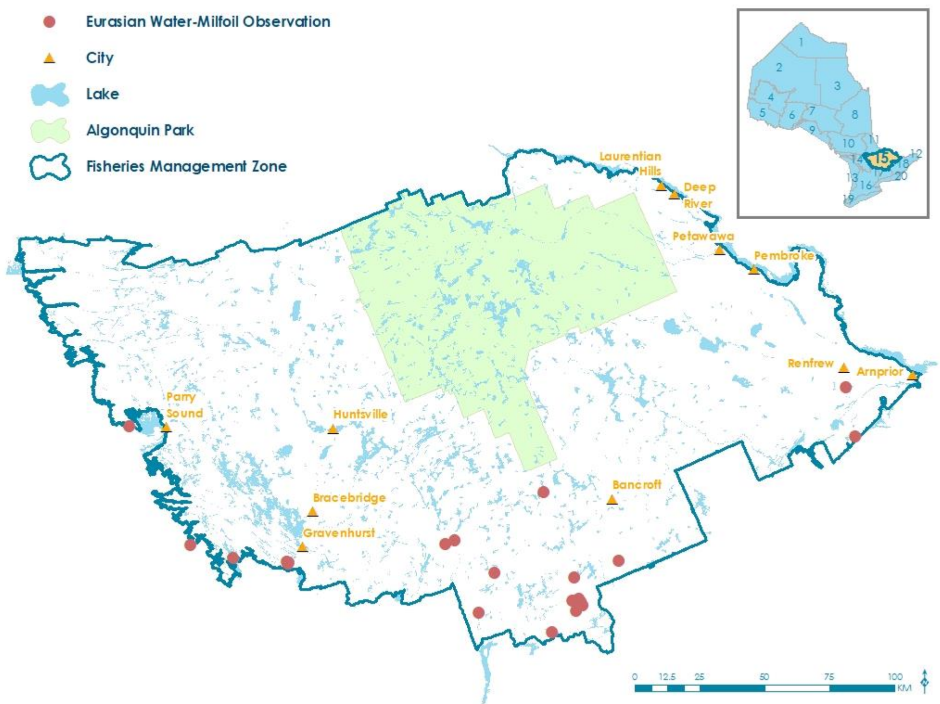


Figure 3.122 Distribution of Eurasian water-milfoil in FMX 15, 2019, excluding Algonquin Provincial Park.

European Common Reed (Phragmites)

Phragmites (*Phragmites australis* subsp. *australis*) has been described as Canada's "worst" invasive plant (OMNR 2011). It is a perennial grass that grows very quickly reaching heights of up to 5 meters, crowds out native vegetation, and spreads rapidly, reducing biodiversity and destroying habitat for other species, including species at risk. Phragmites is commonly found within wetlands, inland marshes, fens, and along river or lake edges. It is also found in disturbed areas with exposed soils and high nutrient levels, including drains, roadside ditches, agricultural fields and construction sites. While it is not known exactly how the species arrived in North American from Eurasia, from its initial establishment along the Atlantic coast it has quickly spread throughout most of the continent including much of southern Ontario. In FMZ 15 it is relatively widespread along the southern boundary of the zone as well as along the Georgian Bay coastline (Figure 3.123).

In 2016, Ontario classified Phragmites in regulation as a restricted invasive species under the Invasive Species Act making it illegal to import, deposit, release, breed/grow, buy, sell, lease or trade in the province. It is also illegal to bring Phragmites into provincial parks and conservation reserves – and to possess, transport, deposit or release them in these protected areas. This action will help address the spread of this invasive plant within Ontario. Beyond regulating the species, the Government of Ontario has also worked with partners and provided funding and support to various organizations to control Phragmites in environmentally sensitive areas of the province, with a focus on ecologically valuable coastal wetlands. For example, in FMZ 14, a dedicated group of individuals associated with Georgian Bay Forever continues to lead the fight against invasive Phragmites in the area, providing training to over 30 communities and partners, and removing tens of thousands of kilograms of this invader from Georgian Bay shorelines.

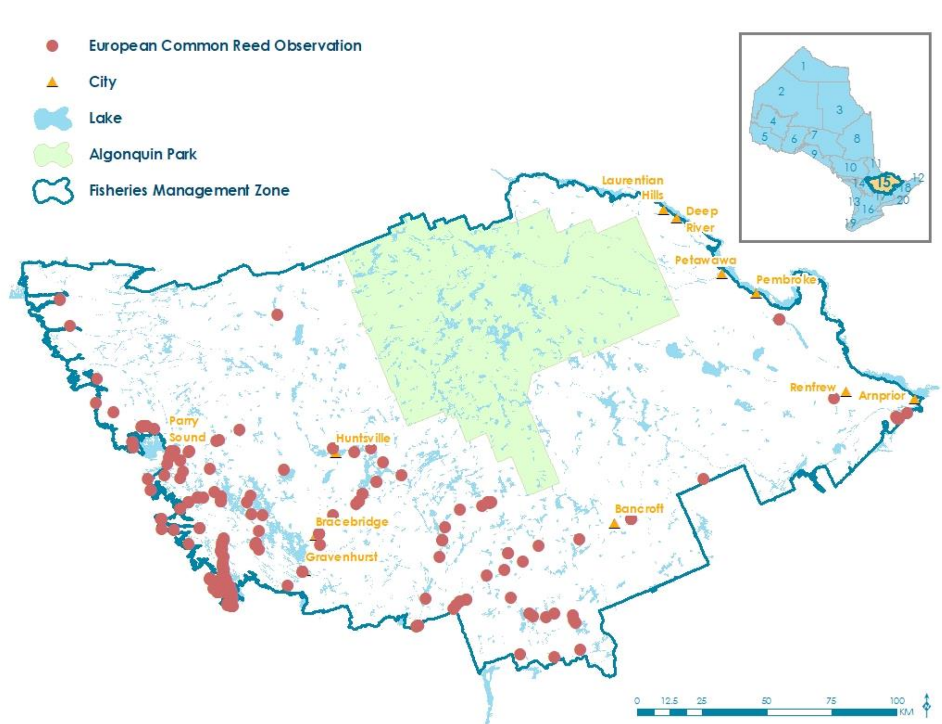


Figure 3.123 Distribution of European common reed in FMZ 15, 2019, excluding Algonquin Provincial Park.

Round Goby

The Round Goby is native to the Black and Caspian Sea basins. It was introduced from Europe in ballast water and first discovered in the St. Clair River in 1990. They have spread naturally as populations expanded. It may be unintentionally spread through the use of live baitfish. Gobies live in lakes and the middle and lower reaches of rivers, in nearshore and deep-water environments. They prefer cobble, gravel and sandy substrates, with or without vegetation and can withstand low levels of dissolved oxygen. They may impact other species through eating eggs and larvae of native game fish species and competing with and/or preying on native benthic fish species.

To date, Gobies have only been documented on the periphery of FMZ 15, particularly in Georgian Bay and the Kawartha Lakes.

The Ontario Government has taken actions to prevent the spread of this invasive species by banning the possession of live Round Goby and the use of this species as baitfish under the Fisheries Act. However, because the Round Goby has the potential to be mistaken for some baitfish species, including native sculpin, it may be unintentionally spread through the use of live bait. It is also conceivable that they will be spread intentionally by anglers who perceive that Gobies are a food source for game fish. Based on the current distribution and pathways of introduction, it is highly likely that Gobies will be detected in the inland waters of FMZ 15 soon and in time will become distributed in many lakes in the zone.

3.8 Disease

Diseases have the potential to impact fish populations through increased mortality, including acute die-offs. Diseases may also impact the fishery making fish unsuitable for consumption and the creation of regulations that control the movement of fish, in particular baitfish.

Viral hemorrhagic septicemia (VHS) is the disease of greatest threat in the zone. VHS is a viral disease that was earlier found in several species of freshwater and saltwater fishes along the Pacific and Atlantic coasts of North America as well as Europe and Japan. VHS does not pose a threat to human health; but it may pose a threat to fish stocks in FMZ 15. It has recently been documented in the Great Lakes and has been associated with large fish die-offs in Lake Ontario. The first incidence of VHS found in Ontario was in association with a die-off of Freshwater Drum in 2005 along the Bay of Quinte. VHS was also found in Yellow Perch, Muskellunge and Round Goby die-offs in 2005 and 2006, in the St. Lawrence River.

Koi Herpes Virus (KHV) is another fish disease that has caused large scale mortality in fish. Large-scale die-offs of Common Carp were seen in the Peterborough area in 2007 and in Lake Simcoe in 2008, as a result of KHV. To date, there have been no reports of VHS or KHV in FMZ 15, nor have there been any large-scale die-offs associated with the disease in the zone.

MNRF has created a VHS Management Zone and Lake Simcoe Management Zone to try to manage the risk of VHS spreading through the movement of fish, including bait fish and aquaculture products. These zones encompass small parts of FMZ 15, along Georgian Bay and the Severn River. In 2020, Ontario approved the new Sustainable Bait Management Strategy (OMNRF 2020b), which provides policy direction for the sustainable use, movement and harvest of bait (i.e., baitfish and leeches). The strategy introduces four Bait Management Zones (BMZs) in which are defined regions within which anglers and commercial operators may move their bait. Under the strategy, anglers and commercial operators are only allowed to move their bait within the zone where the bait was harvested, with a few exceptions. Upon implementation of the BMZs, the existing VHS and Lake Simcoe Management Zones will no longer apply.

A Fish Die-off Response Protocol has also been developed. The main purpose for the protocol is to guide the response of MNRF and agency partners in the event of a large-scale fish die-off. Where die-offs are associated with the mandate of either MECP (e.g., chemical spills) or the DFO (e.g., sedimentation or blasting event), their approved protocols will be followed.

3.9 Contaminants in Fish

MECP monitors the levels of contaminants in fish and publishes consumption guidelines in the Guide to Eating Ontario Fish. MNRF contributes samples collected through BsM and local collections. Mercury is the primary contaminant that results in consumption advisories in FMZ 15. Mercury originates from natural weathering of rock and atmospheric deposition from natural and anthropogenic sources. Concentrations of mercury in fish tissue are dependent on the availability in the environment, and the size, age and trophic position of the fish. Waterbodies with large watersheds and more wetland area tend to have higher levels of methyl mercury, the form that is toxic. Large, old fish that feed on other fish accumulate more mercury in their tissue. Levels of contaminants are an important factor that should be included in consideration of size limits.

Consumption guidelines for the major predatory sport fish species in FMZ 15 are shown in Figure 3.124. For the general population, the recommended number of meals per month generally decreases at a near linear rate with increasing length. For the sensitive population (women of child-bearing age and children) the pattern is similar but significant restrictions begin at smaller fish sizes. Generally, Walleye greater than 50 cm and Smallmouth Bass greater than 40 cm are not recommended for consumption by the sensitive population.

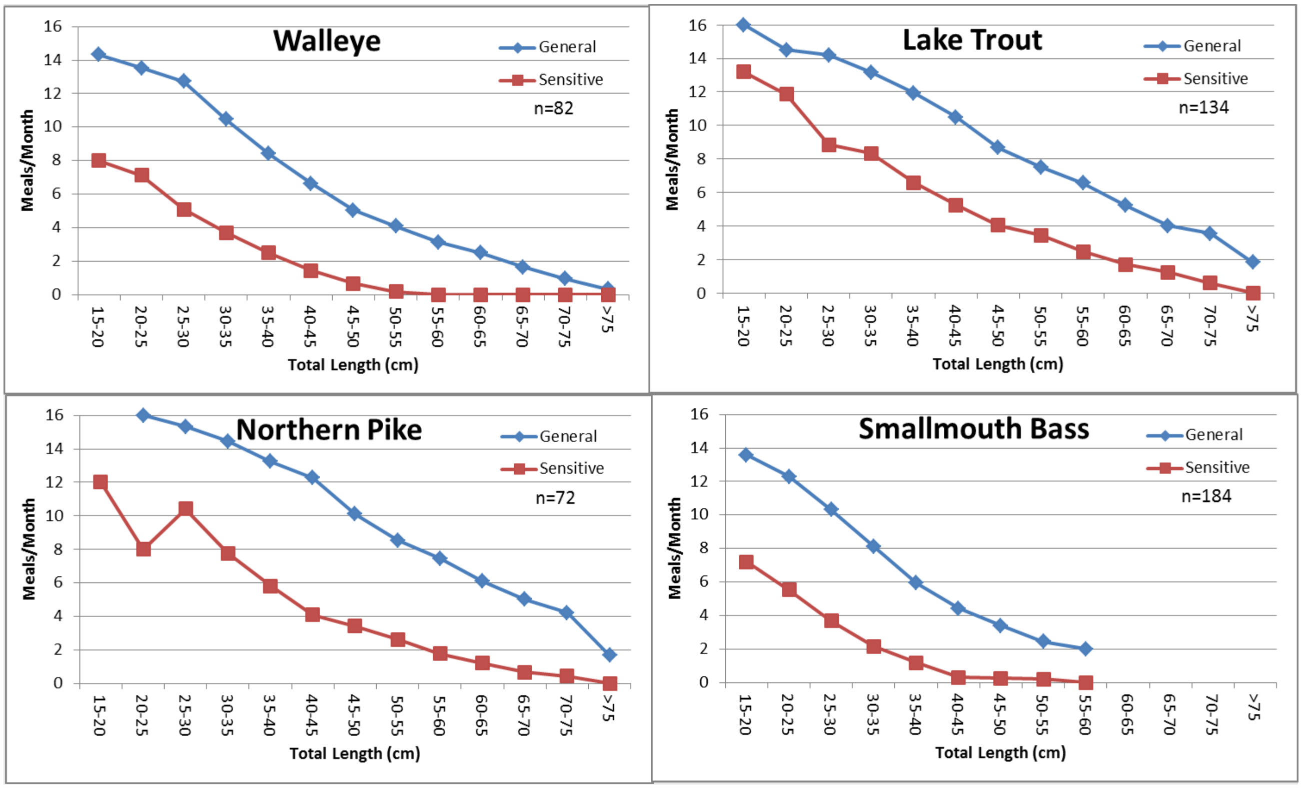


Figure 3.124 Average consumption guidelines for Walleye, Lake Trout, Northern Pike and Smallmouth Bass, FMZ 15, 2016. There is a large amount of variation between lakes that is not shown.

4 Description of the Fishery

4.1 Recreational Fishery

4.1.1 Survey of Recreational Fishing in Canada

The Survey of Recreational Fishing in Canada is conducted by DFO in partnership with the Government of Ontario. The survey is mailed to a stratified random sample of licensed anglers and collects data about fishing effort, catch and harvest, as well as angler demographics, opinions and their investments and expenditures related to fishing. The survey asks the names of the waterbodies on which an angler fished, the towns closest to them, the number of days fished, and fish caught and kept by species and by waterbody. These questions allow for the generation of spatially explicit estimates of fishing effort, catch and harvest. The most recent results available are from the 2010 survey (OMNRF 2015a). A limitation of this survey is that it only includes licenced anglers (generally those between 18 and 65 years old).

Most anglers surveyed in 2010 who fished in FMZ 15 were Ontario residents who were 18-65 years old (90%), or greater than 65 years old (4%) (Figure 4.1). Six % were non-residents of Canada (mostly U.S. residents). FMZ 15 had the highest proportion of resident anglers of any zone in the province.

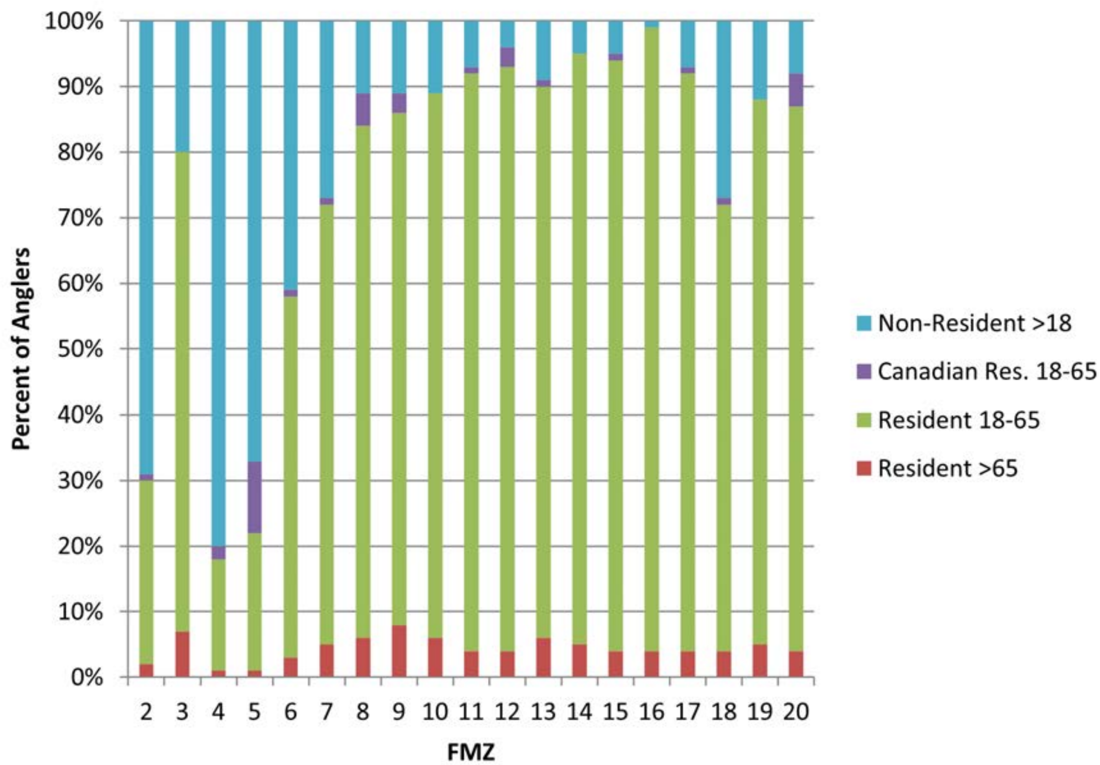


Figure 4.1 Angler origin, by FMZ, Survey of Recreational Fishing in Canada, 2010 (OMNRF 2015a).

Ontario residents who fished in FMZ 15 lived primarily in areas with postal codes that began with K, L or N corresponding to eastern, central and southwestern Ontario (Figure 4.2). Based on projections, the population is expected to increase the greatest outside of the zone in the GTA and surrounding census divisions and in the south and west part of the zone (Muskoka and Haliburton).

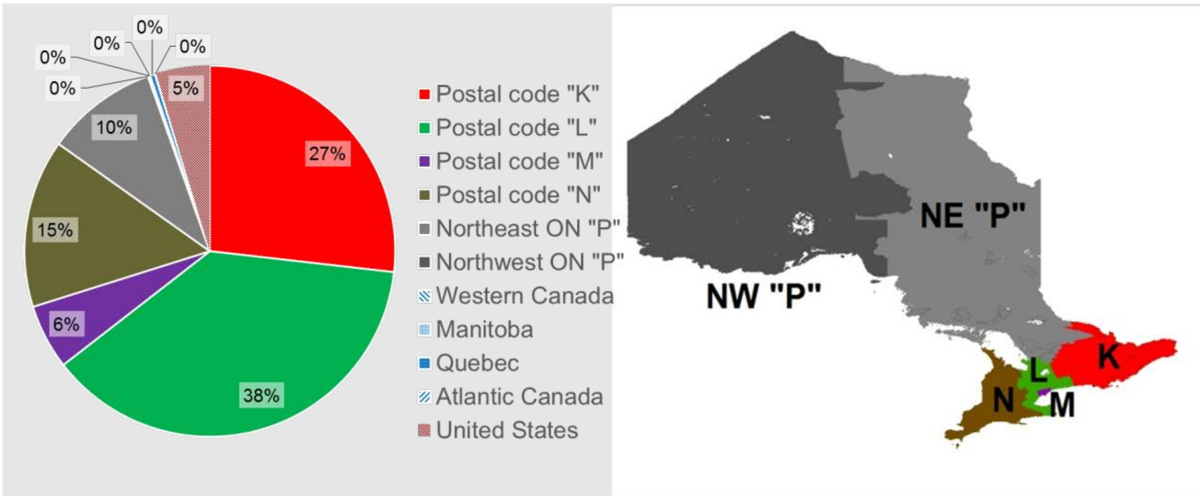


Figure 4.2 Source of fishing effort, by postal code region, FMZ 15, Survey of Recreational Fishing in Canada, 2010.

In order of preference, the most preferred sport fish species in the zone were Walleye, Largemouth and Smallmouth Bass, Lake Trout, Northern Pike and Brook Trout. Somewhat inconsistent with angler preference, the greatest proportion (42%) of fishing effort in the zone was targeted at Bass, with lesser amounts targeted at Walleye (18%), Northern Pike (14%) and Lake Trout (9%) (Figure 4.3). The remaining 17% was targeted at a variety or combination of other species including Brook Trout (3%), Trout (species not specified) (4%) and Black Crappie (1%).

Reported fishing effort was equivalent to 27.6 hours of effort per hectare of all lakes in the zone (Figure 4.4). That level of intensity was 4th highest in the province and highest of all zones located on the low-productivity waters of the Canadian Shield.

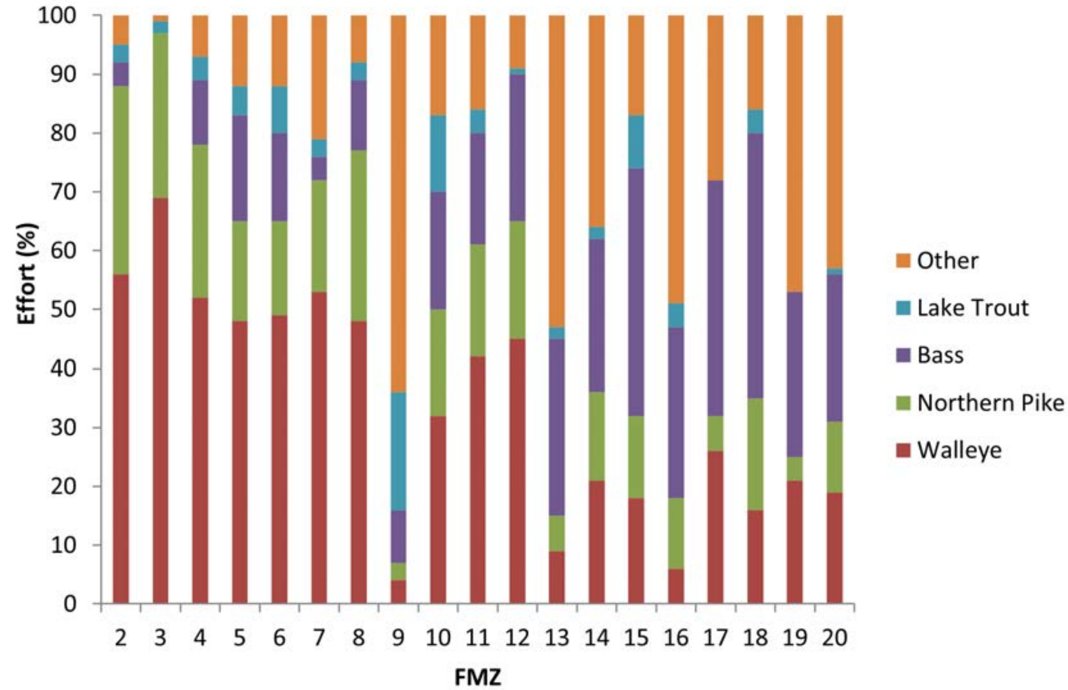


Figure 4.3 Species targeted by anglers, by FMZ, Survey of Recreational Fishing in Canada 2010.

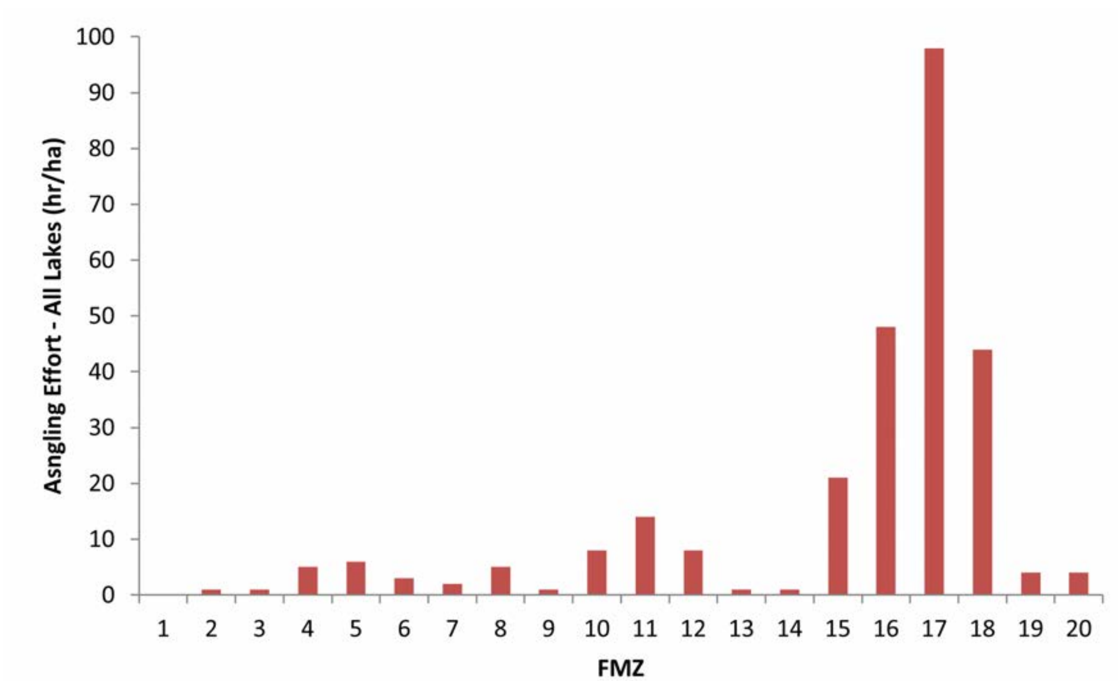


Figure 4.4 Fishing intensity (hr/ha of all lakes), by FMZ, Survey of Recreational Fishing in Canada, 2010.

Smallmouth and Largemouth Bass were the most harvested species (175,755 kg), followed by Northern Pike (107,128 kg), Lake Trout (98,037 kg), Walleye (89,667 kg), Yellow Perch and Panfish (52,412 kg) and Brook Trout (13,512 kg) (Figure 4.5).

The yield of fish from FMZ 15 was among the highest of inland zones, other than the highly productive off-shield waters of FMZ 16, 17 and 18 (Figure 4.6).

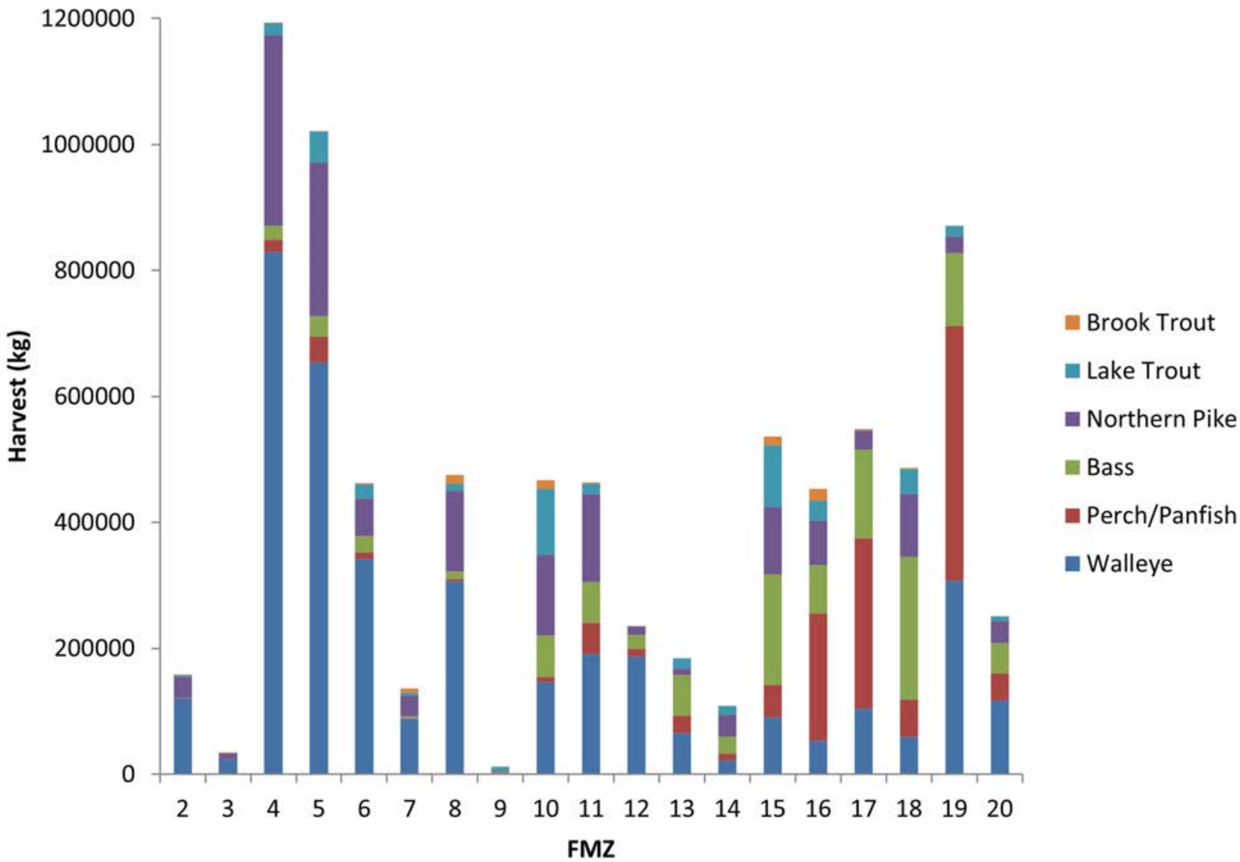


Figure 4.5 Total weight (kg) harvested of selected species, by FMZ, Survey of Recreational Fishing in Canada, 2010.

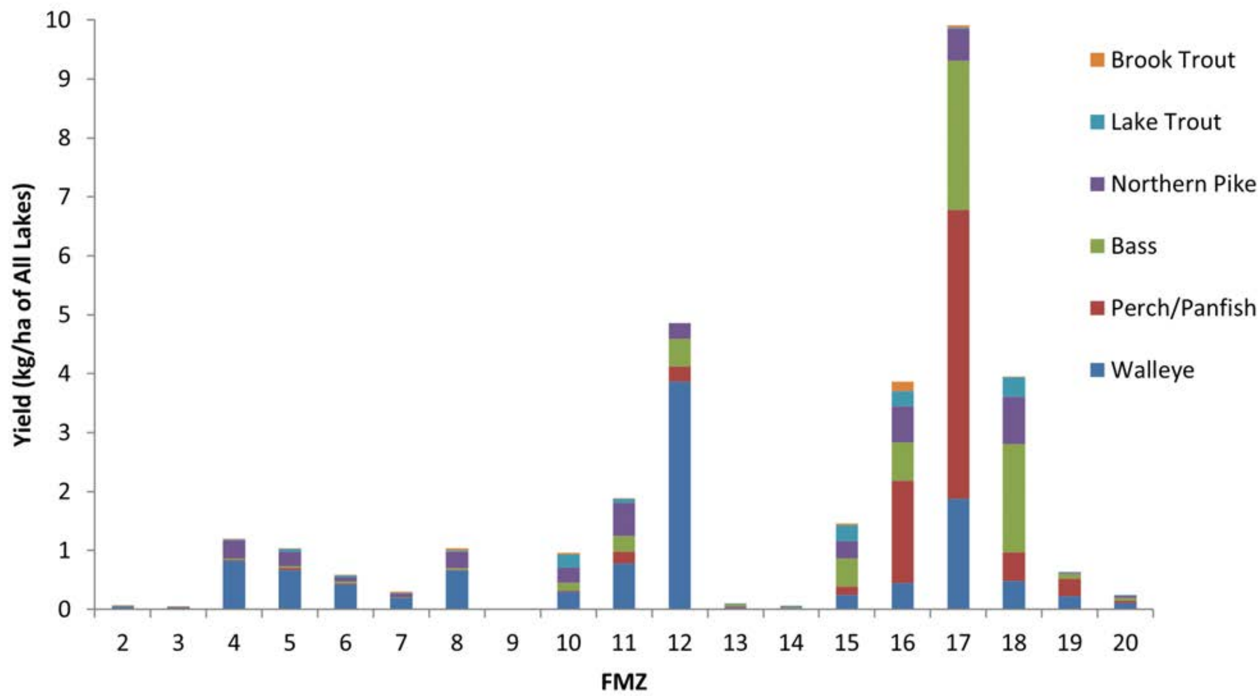


Figure 4.6 Yield of selected sport fish species (kg/ha of all lakes), by FMZ, Survey of Recreational Fishing in Canada, 2010.

Anglers in FMZ 15 spent more money than any other zone by a considerable margin (Figure 4.7). Expenditures include consumable goods and services and investment goods used entirely or partly for angling.

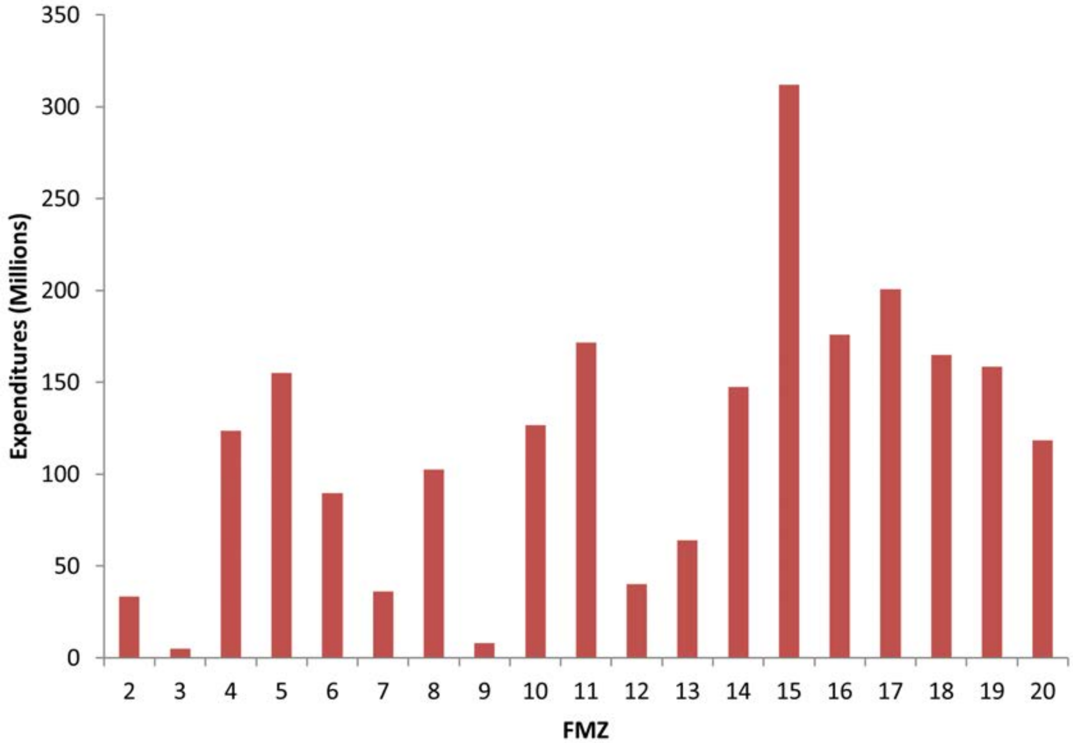


Figure 4.7 Angler expenditures (millions), by FMZ, Survey of Recreational Fishing in Canada, 2010.

4.1.2 Broad-scale Monitoring Program

The BsM program measures fishing effort by counting boats, ice huts and open ice anglers. Midday activity counts are transformed to estimates of fishing effort and intensity (hr/ha) using predictive models. Activity counts are done remotely with no contact with anglers, so the proportion of fishing effort that is directed at different species cannot generally be determined. For lakes that have only one target species, it can be assumed that all effort is directed at that species.

The average summer angling activity on Walleye trend lakes in FMZ 15 during Cycle 1 was 0.27 boats/km^2, whereas angling activity increased in Cycle 2 to 0.4 boats/km^2 (Figure 4.8). Activity was lower than other zones in southern Ontario but higher than the other zones in northern Ontario. In winter, there were an average of 0.9 ice huts/km^2 and 0.16 ice huts/km^2 and 0.1 anglers/km^2 and 0.17 anglers/km^2, from Cycle 1 and 2 respectively, on Walleye lakes in FMZ 15 (Figure 4.9 and Figure 4.10). Compared to other zones, the pattern was different than for summer anglers. The number of ice huts in FMZ 15 was similar to other zones in much of southern and northeastern Ontario. The amount of open ice activity was similar across the province except for FMZ 4 and 7 which were lower and FMZ 16 which was higher than the others.

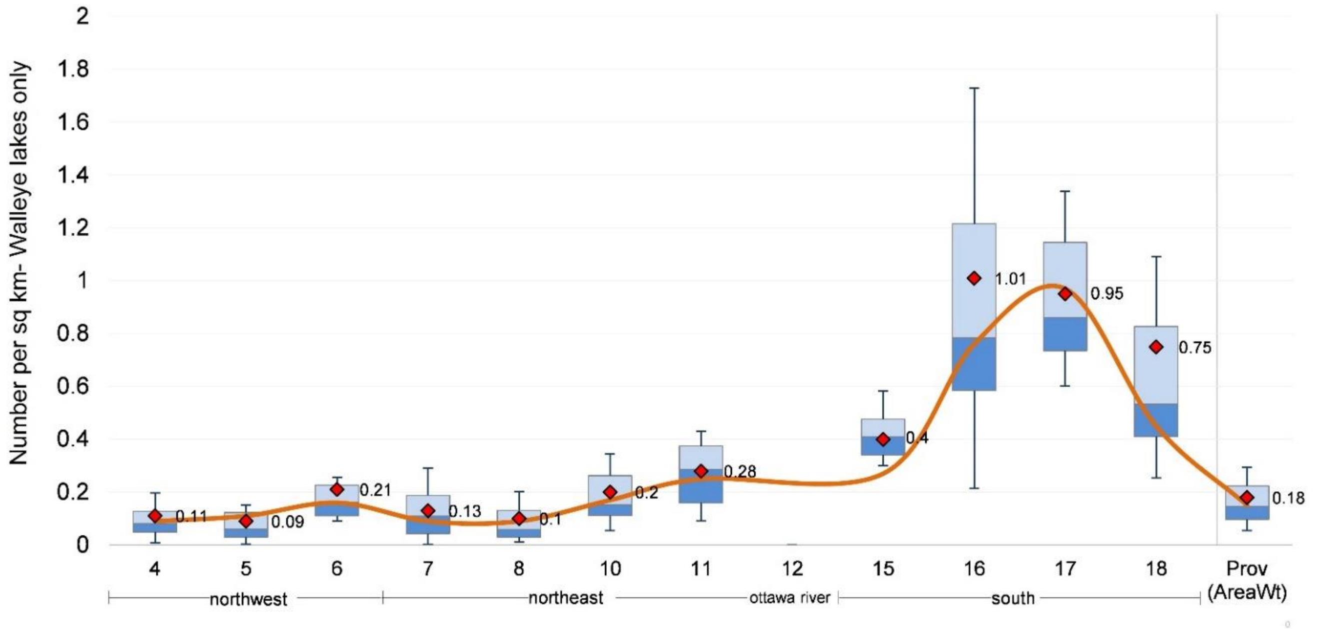


Figure 4.8 Mean summer angling activity (boats/km^2) on Walleye trend lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

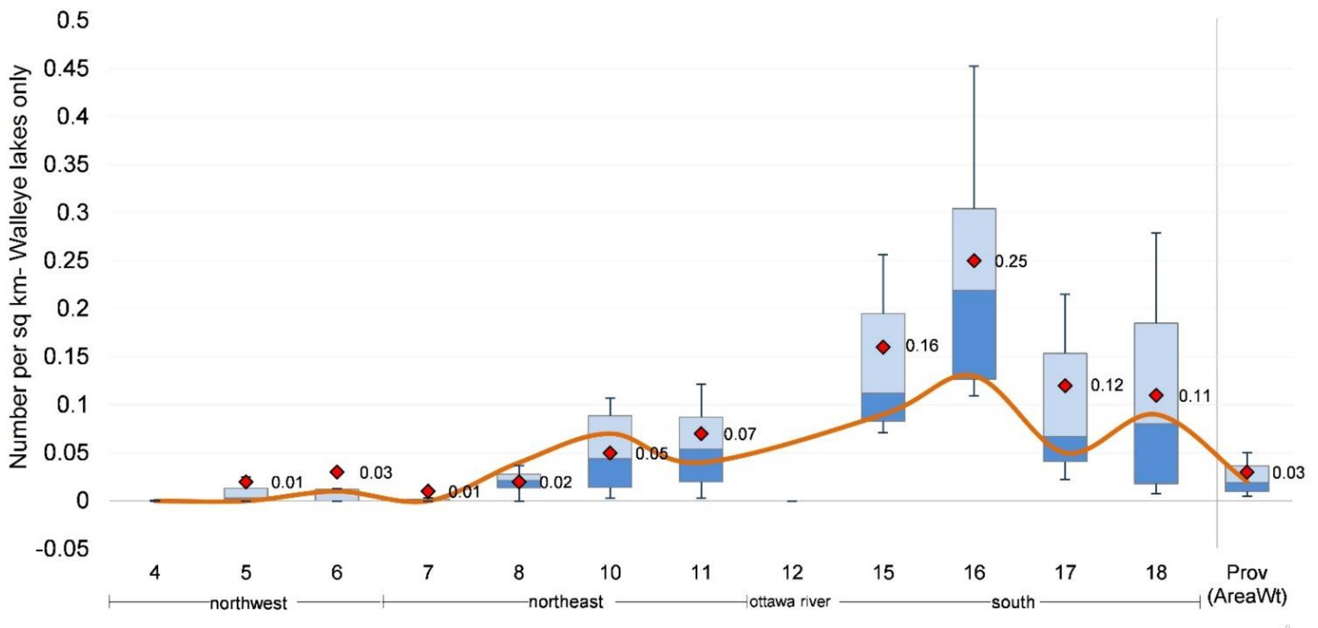


Figure 4.9 Mean number of ice huts (ice huts/km^2) on Walleye trend lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

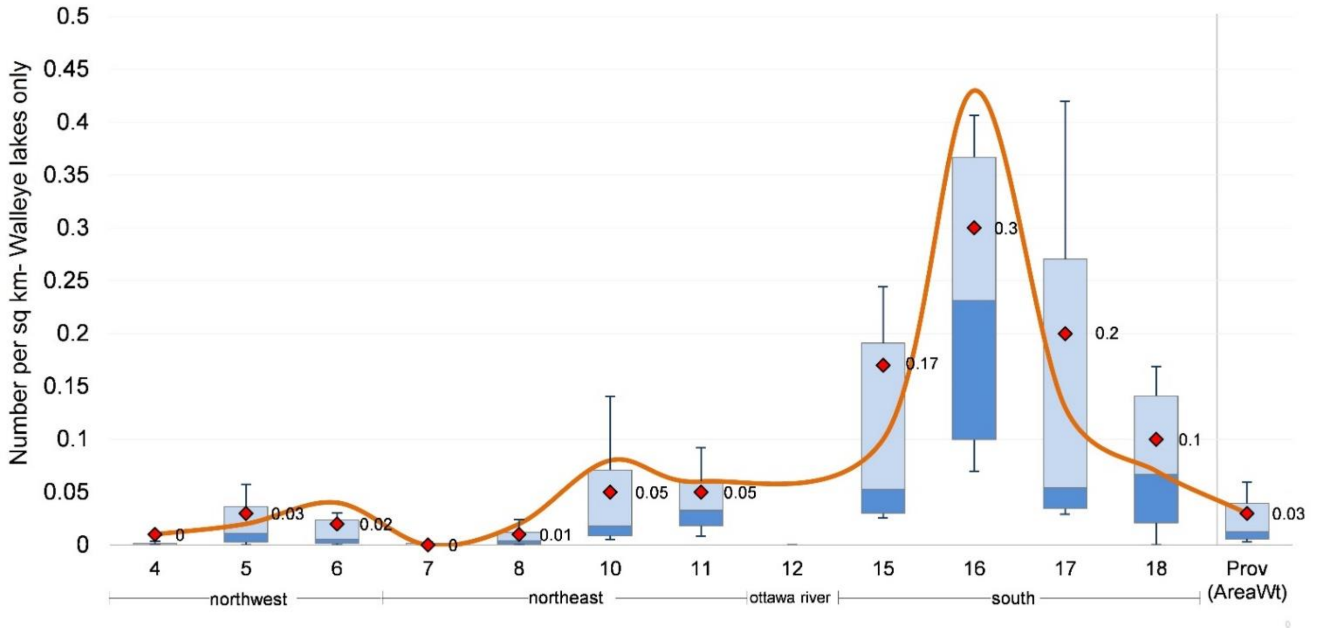


Figure 4.10 Mean number of open ice anglers (anglers/km^2) on Walleye trend lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

The average summer angling activity on Lake Trout lakes in FMZ 15 during Cycle 1 and 2 of BsM is not presented as a large proportion of summer effort in many lakes is probably directed at species other than Lake Trout. In winter, there were an average of 0.21 ice huts/km^2 and 0.18 ice huts/km^2 for Cycle 1 and 2, respectively (Figure 4.11) and 0.21 anglers/km^2 and 0.19 anglers/km^2 on Lake Trout lakes in FMZ 15 (Figure 4.12). FMZ 7 and 15 had the highest density of ice huts, FMZ 8, 10 and 11 in the near north had moderate numbers and other zones with Lake Trout lakes had few ice huts. Like the pattern for Walleye lakes, the amount of open ice effort on Lake Trout lakes was similar across most zones except for zones in the far northwest which were lower and FMZ 11 which was higher.

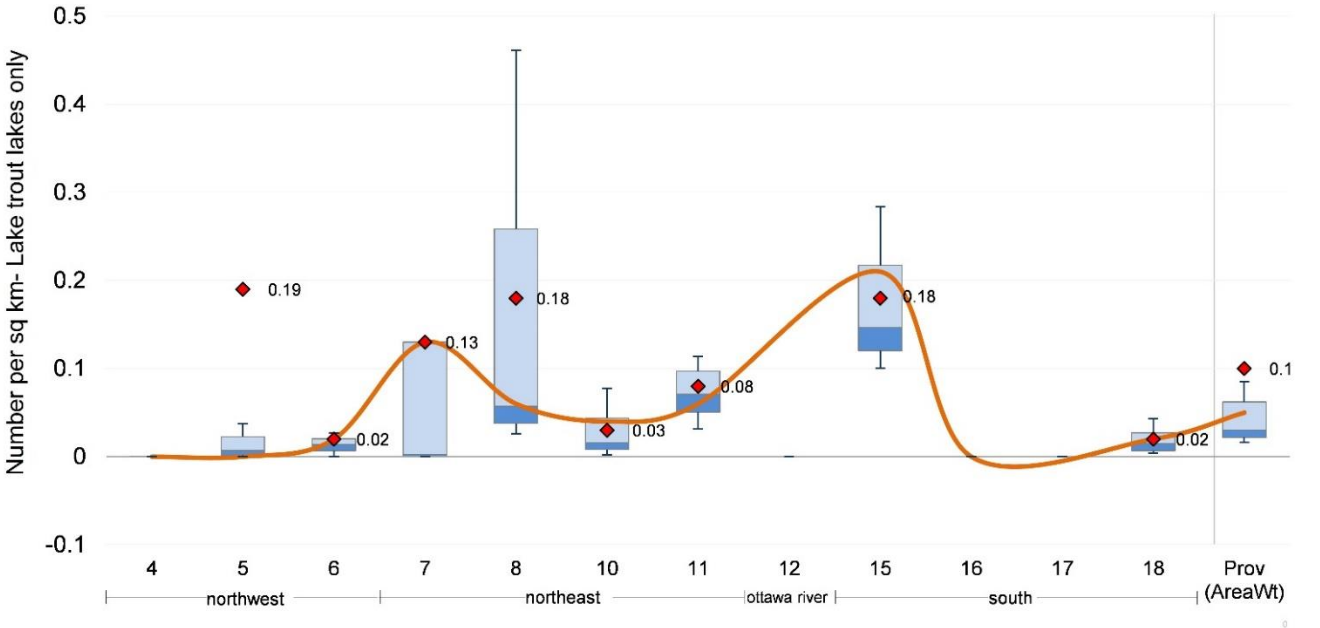


Figure 4.11 Mean number of ice huts (ice huts/km²) on Lake Trout trend lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

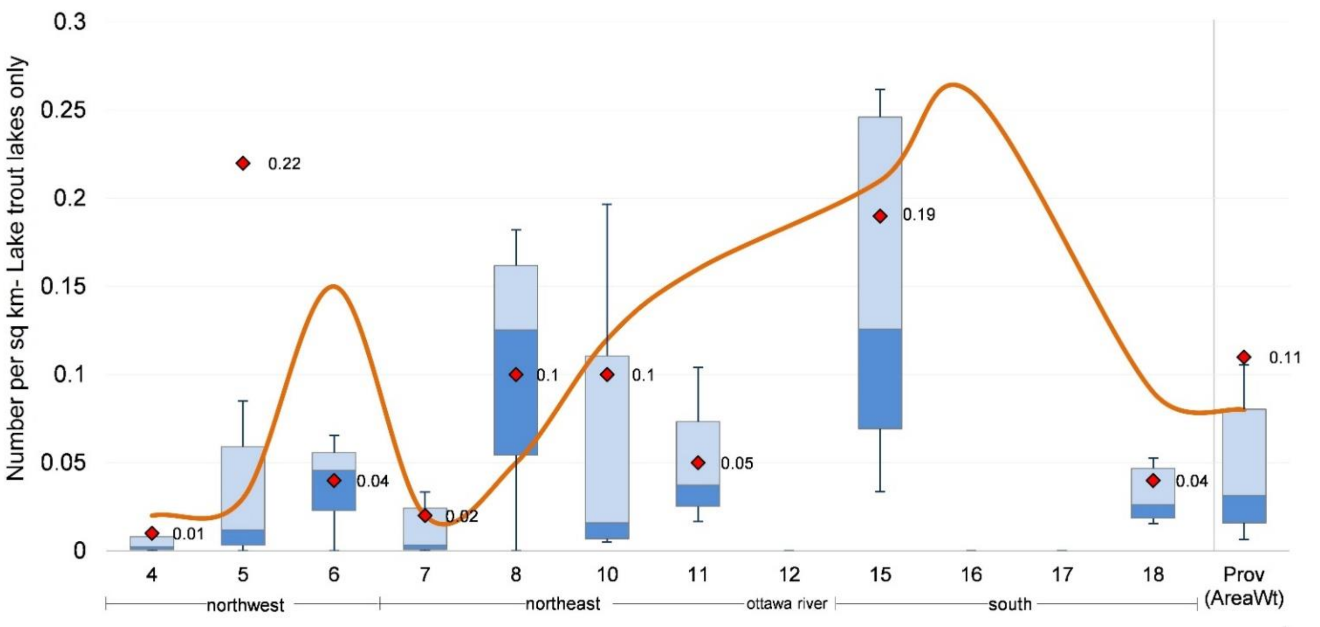


Figure 4.12 Mean number of open ice anglers (anglers/km²) on Lake Trout trend lakes, by FMZ, BsM Cycle 1 (line) and Cycle 2 (box plot).

Angling effort was predicted to be roughly 10 – 12 hrs./ha for Walleye FMSS modeling. In Chu et al. (2016), they applied this formula to covert angling activity to angling pressure (page 538) to estimate zone average ang-hr./ha for different inland FMZs where angler effort was 12.6 hrs./ha for FMZ 15.

Angling effort was predicted to be roughly 6 hrs./ha for Lake Trout FMSS modeling.

A full range of modelling options were run for both Walleye and Lake Trout.

4.1.3 Fisheries Assessment Unit Network

The Muskoka Lakes Fisheries Assessment Unit has conducted monitoring of the fishery on its core lakes (Muskoka, Rosseau, Joseph) from 1988 to the present. Intensive creel surveys were conducted from 1988 to 2005 (Table 4.1). Since 2005, monitoring of fishing activity has been limited to counts of ice huts in late winter when numbers are at their greatest.

Lakes Joseph and Rosseau support the largest natural Lake Trout fisheries in the zone. A rough estimate is that these two lakes yield 60-75% of the harvest from the entire zone, excluding Algonquin Provincial Park (S. Sandstrom pers. comm.). Winter harvest averaged about 10,000 Lake Trout for both lakes. The harvest from Lake Joseph declined modestly over the time series, while the harvest from Lake Rosseau increased. The catch rate increased in both lakes. In the absence of recent creel surveys the only current information on the fishery are effort counts from BsM and local ice hut counts.

Table 4.1 Lake Trout catch, harvest and catch rate from winter creel surveys conducted on Lakes Joseph and Rosseau, 1988-2005 (Sandstrom 2010; Sandstrom 2011).

	Lake Joseph			Lake Rosseau		
Year	**Total Winter Catch**	**Total Winter Harvest**	**Catch per Hour**	**Total Winter Catch**	**Total Winter Harvest**	**Catch per Hour**
1985	7,243	6,412	0.18			
1988	13,047	9,631	0.33	931	890	0.11
1989	8,088	5,769	0.36	3,551	3,247	0.11
1990	10,087	5,785	0.46	3,841	3,372	0.12
1991	7,023	5,050	0.26	6,480	4,621	0.15
1992	8,990	6,464	0.29	8,204	4,717	0.21
1993	9,911	5,843	0.29	8,449	3,762	0.21
1994	9,588	5,832	0.27	10,789	3,979	0.26
1995	6,058	3,466	0.27	5,928	1,515	0.20
1996						
1997	8,972	5,271	0.33	9,218	3,849	0.37
1998	8,973	3,972	0.61	5,256	1,542	0.57
1999	10,778	5,076	0.45	11,397	5,543	0.31
2000	8,618	3,617	0.55	7,769	4,421	0.30

	Lake Joseph			Lake Rosseau		
Year	**Total Winter Catch**	**Total Winter Harvest**	**Catch per Hour**	**Total Winter Catch**	**Total Winter Harvest**	**Catch per Hour**
2001	12,936	6,928	0.41	8,745	5,318	0.26
2002						
2003	5,405	3,590	0.28			
2004						
2005	10,619	7,592	0.24	6,131	3,729	0.19
Average	**9,146**	**5,644**	**0.35**	**6,906**	**3,608**	**0.24**

Ice hut counts are highly variable from year to year. There appears to be a declining trend in the number of huts deployed, particularly since about 2005 (Figure 4.13). There is a relationship between the number of huts and total winter fishing effort on a lake, but the relationship varies between lakes due to differing angler demographics. The relationship for a given lake may also change over time if demographics and angler practices change (e.g., use of portable huts).

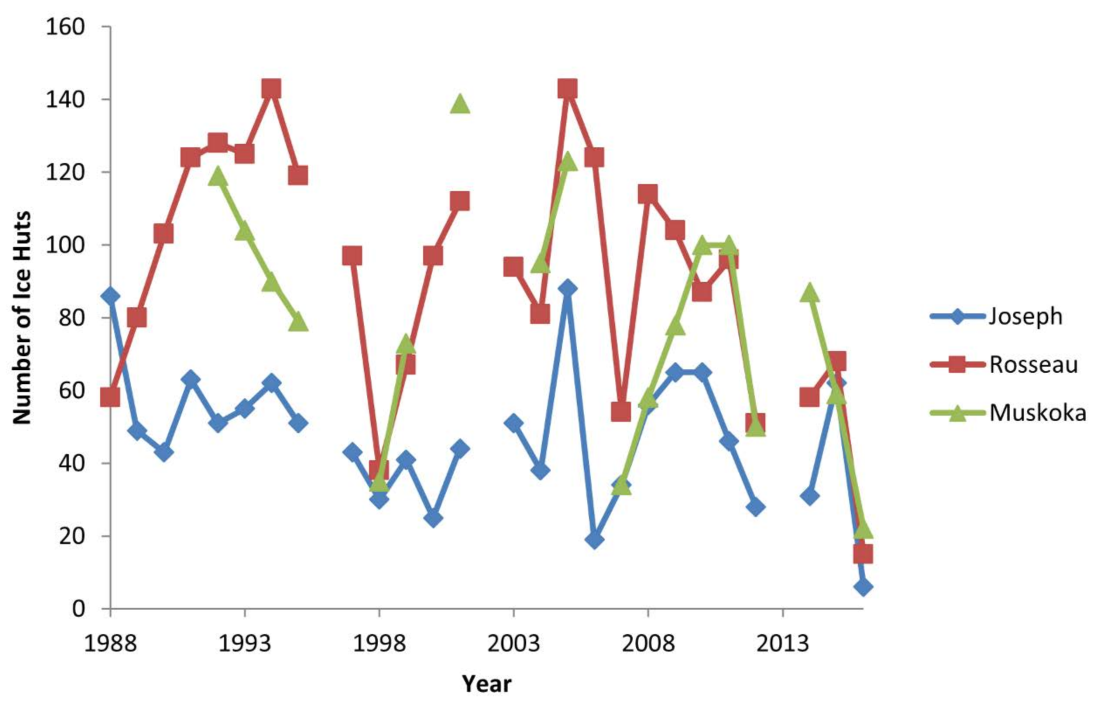


Figure 4.13 Maximum number of ice huts recorded by year, for lakes monitored by the Muskoka Lakes Fisheries Assessment Unit, 1988-2016.

4.1.4 Local Fishery Monitoring

Local offices have conducted creel surveys on individual lakes to provide information to address management needs. The number of surveys conducted has declined greatly due to the high cost and shift away from individual lake management. Relatively few have been conducted since 2000 but several large and/or locally important lakes have had multiple surveys and/or are now monitored through BsM (Table 4.2).

Winter fishing effort on Kawagama Lake and Skeleton Lake declined greatly after the implementation slot size limits in 1996. Effort on Lake of Bays increased greatly in 1996 as angling pressure was diverted from lakes that had size limits. Lake of Bays does not have a size limit.

Winter fishing effort on Bernard Lake was relatively stable from 1993 to 2001, but the amount directed at Lake Trout declined, as Lake Trout abundance decreased after supplemental stocking was suspended. Bernard Lake does not have a size limit for Lake Trout.

Table 4.2 Summary of creel surveys for selected lakes in FMZ 15.

Lake	Area (ha)	Year	Season	Total Effort (ang-hr)	Walleye Effort (ang-hr)	Walleye CUE	Lake Trout Effort (ang-hr)	Lake Trout CUE
Ahmic L.	1,600	1983	Summer	29,647	13,593	0.01		
Ahmic L.	1,600	1993	Summer	12,460	2,123	0.01		
Bernard L.	2,100	1993	Winter	18,362			16,494	0.07
Bernard L.	2,100	2001	Winter	19,796			15,148	0.04
Bernard L.	2,100	2011	Winter	17,816			13,633	0.03
Cecebe L.	780	1983	Summer	24,189	15,579	0.15		
Kawagama L.	3,160	1989	Winter	9,079			8,981	0.14
Kawagama L.	3,160	1994	Winter	8,649			8,605	0.28
Kawagama L.	3,160	2001	Winter	3,171			3,171	0.19
Kawagama L.	3,160	2008	Winter	364			363	0.19
Lake of Bays	6,740	1990	Winter	20,970			20,056	0.05
Lake of Bays	6,740	1996	Winter	44,032			39,134	0.10
Lake of Bays	6,740	2004	Winter	18,899			18,424	0.20
Skeleton L.	2,060	1988	Winter	5,159			3,840	0.11
Skeleton L.	2,060	1994	Winter	9,545			9,443	0.11
Skeleton L.	2,060	2004	Winter	2,370			2,370	0.06

Counts of ice huts give an easy, cheap source of information on the relative amount and distribution of winter fishing effort. The largest number of huts, a simple indicator of the average number of huts and total fishing effort can be collected by a single mid-winter visit or extracted from more intensive surveys. Selected lakes have been monitored since the late 1980's for ice hut numbers (Figure 4.14). The number of huts deployed on many of the lakes displays a declining trend.

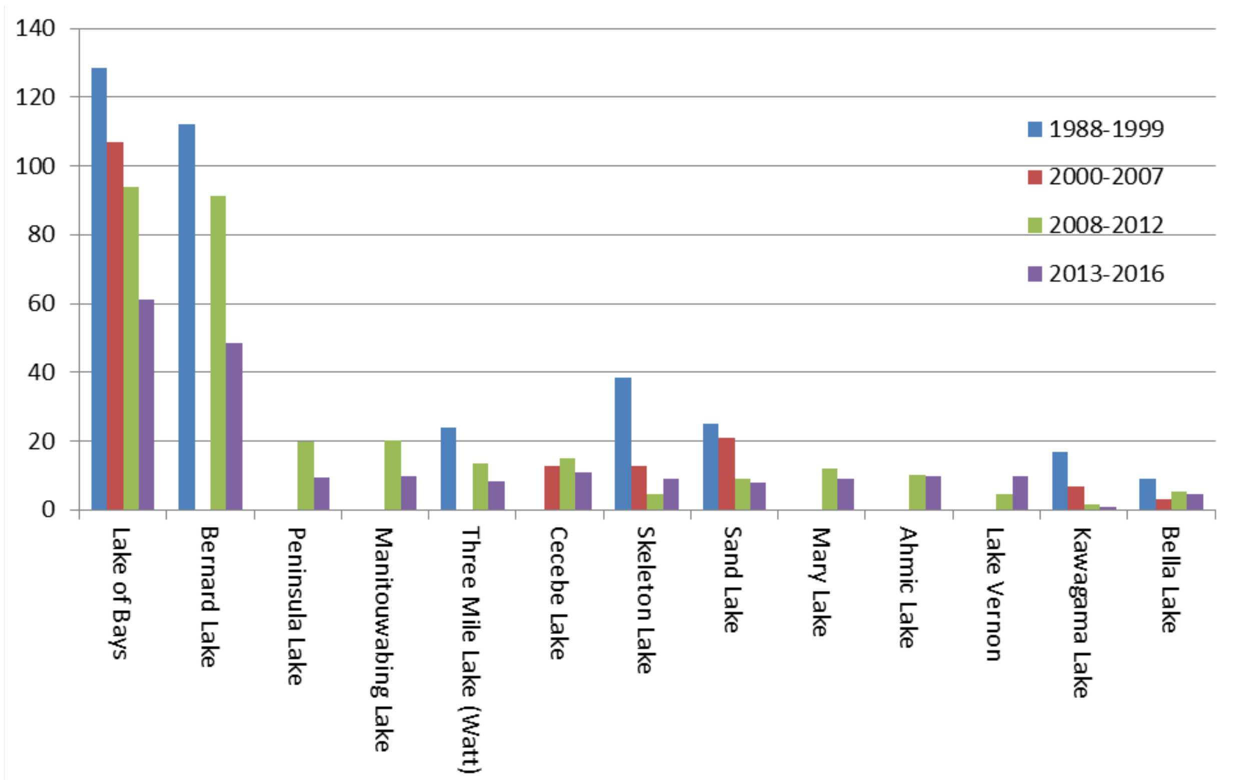


Figure 4.14 Average maximum ice hut counts for selected lakes in FMZ 15, 1988-2016.

The voluntary submission of angling information through formal diary programs or casual reports gives valuable information on individual lakes. This source of information is particularly useful for small, remote access lakes that are not monitored in other ways. The stocking program relies heavily on volunteer angler data.

Muskies Canada Inc. has collected diary information from its members since at least 1979 and is the largest source of information on the Muskellunge fishery in the province. From 1980-2016, reports have been received for 33 waterbodies (Table 4.3). For most waterbodies the number of years with reports and the effort and catch reported are inadequate to be useful for monitoring any changes to fishing quality, but the sizes of fish reported may be useful for estimating growth potential and rationalizing size limits. The greatest amount of effort has been reported on Madawaska, Petawawa and Pickerel Rivers and Jack Lake. Since 2001, reports have been received for an average of 9 waterbodies per year.

Table 4.3 Summary of Muskies Canada angler diary reports, FMZ 15, 1980-2011.

Lake	Number of Years with Reports	Total Effort (hr.)	Number of Fish Caught	Maximum Length (in.)
Baptiste Lake	8	237	12	45
Bass Lake	5	54	28	46
Beech Lake	2	20	1	40
Benoir Lake	1	19	2	
Big Cedar Lake	1	11	7	46
Blackstone Lake	2	27	1	38
Bonnechere River	1	30	2	
Burnt River	4	24	9	41
Canning Lake	3	289	21	47
Chalk River	1	13	1	36
Contau Lake	1	13	0	
Corry Lake	5	103	11	38
Crane Lake	5	142	6	48
Elephant Lake	11	548	47	47
Fishog Lake	2	34	2	32
Gibson Lake	2	135	4	40
Grass Lake	1	6	0	
Green Lake	5	57	4	40
Head Lake	2	33	2	36
Jack Lake	23	2,083	211	49
Kashagawigamog Lake	15	746	78	44
Kasshabog Lake	10	540	34	40
Lake Rosseau	7	63	11	47
Lennon Lake	2	65	3	42
Madawaska Headpond	1	85	3	40
Madawaska Lake	1	30	0	
Madawaska River	21	3,877	340	55
Maple Lake	4	60	7	42
Petawawa River	14	1,302	206	48
Pickerel River	11	3,577	64	54
Pine Lake	2	4	1	45
Salerno Lake	1	11	2	
White Lake	2	14	24	37
Total	**176**	**14,250**	**1144**	**55**

4.1.5 Competitive Fishing Events

Competitive fishing events are not required to be registered or authorized. The number or locations of events or their potential impact on fish populations are not formally monitored. A survey conducted in 2012 documented 1,068 events in Ontario, held on more than 400 waterbodies, with Bass, Walleye, Northern Pike or any species being the primary species targeted (Kerr 2012). This number is believed to be an underestimate due to the absence of a mandatory registry. Competitive fishing events can generate significant social economic benefits to the areas in which they are held and give an opportunity to obtain biological data from the fishes captured.

A significant number of competitive fishing events take place each year in FMZ 15. In 2012, 72 events were held in at least 48 different locations (Kerr 2012). Of those tournaments where target species was known, Bass were the most common target species, followed by Northern Pike, Lake Trout and Walleye. Several Rock Bass derbies were also held. Most events were held in the open water season, with a small proportion (~14%) being held in the winter months, particularly around Ontario Family Fishing Weekend. Refer to Appendix 5 for a summary of events that occurred in 2012 (Kerr 2012).

The following issues or concerns may arise from competitive fishing events:

- Fish mortality
- Hooking/handling injuries
- Number of events per waterbody
- Timing of events
- Displacement of fish
- Organizational procedures (weigh-in locations and type)
- Invasive species
- Disease

Several recommendations were made in the 2004 provincial survey report to resolve these issues. These include promoting techniques to decrease handling and air exposure; encouraging MNRF biologists to use large and long-running events to obtain biological information; working co-operatively with the Ontario Competitive Fishing Council to develop guidelines and best management practices; discouraging Walleye and Northern Pike events during the summer months; and discouraging events which target native Lake Trout and Brook Trout.

In 2007, regulations were revised to permit anglers fishing in a boat to catch, hold, and selectively live release more Walleye, Northern Pike, Smallmouth or Largemouth Bass than the daily limit if specific requirements are met. These rules were intended to improve compliance and advance competitive fishing activities. These requirements include: an operating live well with a mechanical aerator must be on board and operating when fish are present in the live well; fish must follow applicable size limits; daily catch and keep limits for Walleye and Northern Pike are not exceeded; and no more than 6 Largemouth or Smallmouth bass are kept.

4.1.6 Resource-Based Tourism

Resource-based tourism is tourism based on using and enjoying the natural environment and resources on Crown lands and waters. Resource-based tourists hunt, fish, visit provincial parks and conservation reserves, camp, canoe, hike, snowmobile, view wildlife and plants, and enjoy other similar outdoor activities.

Resource-based tourism establishments are no longer required to obtain Resource-Based Tourism Establishment Licences. On December 15, 2009, the Ontario Legislature passed Bill 212, the Good Government Act, 2009. This bill repeals the Tourism Act and revokes Regulation 1037 under the Tourism Act, thereby eliminating the licensing program.

Defining the segment of the Resource-based Tourism industry that is based on fishing in FMZ 15 is not possible because of the elimination of the licencing requirement and the multi-purpose nature of most facilities. Unlike areas of northern Ontario where many lodges, resorts and outposts cater almost exclusively to anglers, many facilities that offer services to anglers in FMZ 15 are mixed with other uses such as provincial park use, cottage ownership and rental, and family campgrounds and resorts. A small number of fly-in camps located in the semi-remote areas at the north end of Parry Sound District and Kawartha Highlands Park are an exception.

4.2 Commercial Fishery

Commercial fishing is the harvest of fish for sale, primarily for food. In Ontario, there are over 500 active commercial fishing licenses.

Ontario's commercial food fishery is part of our heritage and culture and is the largest freshwater fishery in North America. Most commercial food fishing takes place on the Great Lakes, where Rainbow Smelt, Yellow Perch, Walleye and Lake Whitefish make up approximately most of the harvest. Lake Erie accounts for approximately most of that commercial harvest. Large commercial fisheries also exist on several large inland lakes, such as Lake of the Woods, Lake Nipigon and Lake Nipissing, with less significant fisheries on some of the smaller inland lakes in northwestern and eastern Ontario. Most commercial fishing licences are in northwestern Ontario, where fisheries mainly target Lake Whitefish, with smaller harvests of other species. Approximately 10% of the commercial fish harvest is sold in Canada, and 90% is exported primarily to the United States, and a small proportion to Europe.

In 2011, commercial licence holders caught nearly 12,000 metric tonnes (about 12 million kg) of fish. The dockside value of that harvest in 2011 was more than $33 million and, including processing, packaging, and shipping, contributed approximately 1,000 jobs and $234 million to Ontario's economy. Commercial fishing and its industries are significant employers in many smaller Great Lakes communities and are an important economic development initiative for many Aboriginal communities across the province (OMNRF 2015b).

There are, however, no licenced commercial fisheries in FMZ 15.

4.3 Commercial Baitfish Fishery

Baitfish are small fish caught for use as bait by anglers to attract and catch larger sport fish. The harvest and use of live bait have been an important part of Ontario's fishing industry for nearly a century and the commercial bait industry employs many Ontarians. In 2005, it was estimated that the total annual retail value of bait was $23 million for the province (Koenig pers. comm. 2012).

Commercial bait harvest activities are governed by the FWCA (O. Reg 664/98) and Ontario Fishery Regulations (OFR) as well as through conditions on licenses. Conditions on commercial baitfish licences discuss issues including the movement of bait, types of gear used, and the timing of harvest. Bait harvesters must harvest within their assigned bait harvest area(s) and are required to keep a logbook with information on harvest details such as dates, locations and sales, purchases, and quantities. They must also give an annual report to the MNRF.

Both harvesters and dealers must take mandatory training and have an approved Hazard Analysis and Critical Control Point (HACCP) plan to decrease the risk of invasive species and disease transfer (e.g., VHS) before the commercial bait harvest license is issued.

Since the detection of VHS in the Great Lakes in 2005, bait harvesters have been affected via harvest and movement restrictions in VHS management zones. FMZ 15 includes part of the VHS Management Zone.

There are 4 types of commercial baitfish licenses available:

- Regular Harvester: harvest and sell bait to retail outlets, the public and tourist lodges;
- Regular Dealers: sell from their own facility to public or to other dealers;
- Tourist Harvester: assigned a designated water body for harvest and can sell bait only to guests registered at their tourist facility;
- Tourist Dealers: sell bait only to guests registered at their tourist facility.

The species of fish that may be used as baitfish are set out in Schedule 1 of the OFR. There are 48 permitted baitfish species that can be harvested for use as bait. Most baitfish species belong to the Minnow (Cyprinidae) family, but Central Mudminnow, Cisco (Lake Herring) and species of sucker, darter, stickleback and sculpin may also be used. Leeches, crayfish, earthworms and Northern Leopard Frogs are also used by anglers but only baitfish and leeches may be sold in the regulated commercial bait industry in Ontario. In Ontario, anglers may harvest their own bait under the authority of an angling licence or buy bait from a commercial retailer. Anglers are restricted to possessing a limit of 120 baitfish at any time.

In Ontario, most baitfish harvest and sales are made up of about 10-11 species (Kerr 2012). Winter bait sales usually include of species such as Emerald Shiner, Common Shiner, and Spottail Shiner, while summer sales are usually made up of species of dace (*Rhinichthys, Phoxinus and Margariscus* spp.), Fathead Minnow, Common Shiner, suckers (*Catostomus* sp.) and chubs (*Semotilus, Nocomis and Couesius* spp.).

FMZ 15 has 375 bait harvest area blocks entirely or partially within its zone boundaries (Figure 4.15). Sixty-nine (69) BHAs are located within the Bancroft district, 217 are within Parry Sound, 97 are within Pembroke. There is no commercial bait harvest in Algonquin Provincial Park. The use and possession of live baitfish is prohibited.

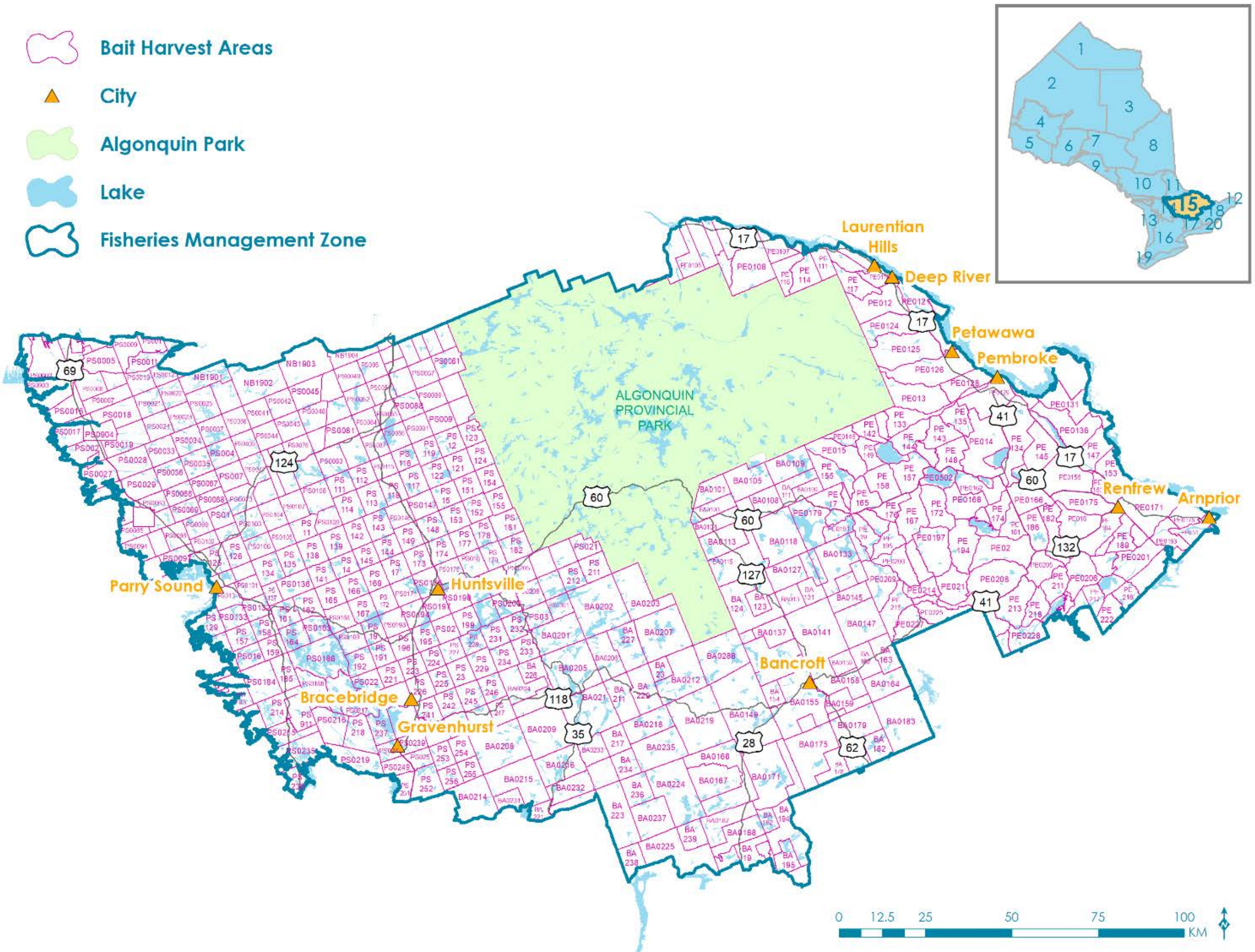


Figure 4.15 Map of commercial bait harvest areas, FMZ 15.

Commercial harvest and sales are reported by MNRF district, not FMZ. Most reports for Parry Sound and Pembroke districts can be attributed to FMZ 15, but a significant portion from Bancroft District and almost all of North Bay District's would have occurred outside the zone. In 2014, commercial licencees in Bancroft, Parry Sound and Pembroke districts reported harvesting and selling almost 116,000 dozen baitfish (Table 4.4). Even though the harvest and sale numbers are similar, a large amount of import and export of baitfish into and out of the zone likely occurs. No Cisco are believed to be harvested commercially within the zone; however, a small quantity is harvested in North Bay District.

Table 4.4 Commercial baitfish harvesting and sale summary, by MNRF District, 2014.

MNRF District	Dozens Harvested (BHA District)	Dozens Harvested (Issuing District)	Dozens Sold	Dozens Exported
Dryden	154,018	231,850	217,285	0
Fort Frances	200,345	192,425	172,129	0
Kenora	99,767	121,259	161,614	0
Nipigon	68,619	53,999	35,653	0
Red Lake	166,601	113,261	118,618	0
Sioux Lookout	138,315	132,645	116,839	0
Thunder Bay	90,305	72,801	91,691	0
Chapleau	32,777	16,015	14,259	0
Cochrane	11,036	10,796	13,632	0
Hearst	21,985	21,985	27,359	0
Kirkland Lake	15,623	11,903	9,318	0
North Bay	85,121	90,931	50,867	0
Sault Ste. Marie	19,960	16,640	37,407	0
Sudbury	95,984	92,396	53,034	0
Timmins	39,723	53,379	58,018	0
Wawa	58,498	66,734	43,709	0
Aurora	49,470	94,260	140,875	575
Aylmer	57,000	23,580	48,806	0
Bancroft	70,419	102,716	32,618	0
Guelph	285,855	54,405	12,260	0
Kemptville	83,098	76,468	71,885	0
Midhurst	94,914	301,434	38,449	0
Parry Sound	19,706	13,364	49,032	0
Pembroke	25,811	39,108	34,167	0
Peterborough	97,066	77,662	71,413	0

As of 2020, Ontario's Sustainable Bait Management Strategy (OMNRF 2020b) provides policy direction for the sustainable use, movement and harvest of bait (i.e., baitfish and leeches). The direction in the policy balances four goals:

1. To protect the health of aquatic ecosystems.
2. To enhance the quality of life for Ontarians by providing recreational, social and economic benefits.
3. To conserve the resource and maintain a viable bait industry; and
4. To create policies that are adaptable, effective, consistent across the province, and simple to implement.

Several parts of this new policy will have major implications for how bait is used in the zone. To implement the direction in the strategy, new regulations or amendments to existing regulations will be needed. These processes will take from one to three years to complete.

The strategy includes actions to minimize the risk around baitfish use including limiting the permitted baitfish species, controlling the movement of baitfish through Bait Management Zones (BMZs), ensuring proper receipts and documentation for compliance purposes, requiring conditions around storage, and limiting the use of bait in native brook trout lakes. Additionally, MNRF will continue to licence Commercial Bait Operators and reduce risks associated with bait use though requiring operators to undertake standardized training, limiting the type of equipment that can be used, by strengthening the required annual reporting and through regular compliance.

Efforts to mitigate the risks of spreading invasive species and disease through the use and movement of bait is a shared responsibility amongst all of those involved in the bait pathway, including harvesters, dealers and anglers. Education and awareness of the risks of invasive species, disease and the movement of non-native species is critical to help ensure the effectiveness of the strategy.

The management of baitfish in FMZ 15 will be carried out through the policies outlined in Ontario's Sustainable Bait Management Strategy. These policies will help to ensure the sustainable use and harvest of Ontario's bait resources while reducing the ecological risks.

4.4 Aquaculture

Aquaculture is the breeding or husbandry of fish. Aquaculture in Ontario is undertaken by MNRF, MNRF partners and privately. MNRF and partner aquaculture is done mainly to raise fish for stocking into public waters. Provincially, the focus of private aquaculture is the production of fish for food, but fish are also reared for stocking and baitfish.

An Aquaculture Licence, issued under authority of the FWCA, is required for non-MNRF entities to culture fish. A suite of policies and procedures gives guidance for the administration of applications and licences.

Before 2013, partner stocking was considered a form of MNRF stocking and Aquaculture Licences were not usually issued to partners. Beginning in 2013, the Community Hatchery Program (CHP) was formed, which resulted in all partner aquaculture operations being required to obtain an Aquaculture Licence. As a result, the distinction between private and partner aquaculture authorization has been lost.

Private aquaculture operations offer alternative and specialized sport fishing opportunities through fee-for-fishing facilities and a portion of the fish used for partner and private stocking. A significant, but unquantified portion of privately stocked fishes originates from facilities outside the zone. In general, potential opportunities for large-scale private aquaculture are limited in the zone by the availability of quality water sources and extensive competing water uses, such as cottage development.

As of 2016, there were 20 active private aquaculture licences in the zone (Table 4.5). Almost half (9) were in Bancroft district, with smaller numbers in Parry Sound (7) and Pembroke (4). Three (3) facilities are primarily partner-based and rear fish for stocking public waters; 8 facilities are strictly Fee-for-Fishing operations, 3 raise fish primarily for sale as food and the remainder offer a mix of uses including baitfish and fish for private and public stocking. The species most commonly reared include Brook Trout, Rainbow Trout and Walleye with fewer operations rearing Lake Trout, Brown Trout, bass and other sunfishes, Tilapia, and baitfish species. All the operations are relatively small and service a local market. Limited information is available on production or economic value of the private aquaculture industry.

Table 4.5 List of private aquaculture operations, FMZ 15, 2016.

District	Name	Purpose	Primary Species
Bancroft	Haliburton Highlands Outdoors Assoc.	Public Stocking	Trout, Walleye,
Bancroft	Irondale Fish Farm	Bait; sport fish for food and rec	Trout, Walleye, Baitfish
Bancroft	Kinmount Fish Farm	Private Stocking	Trout, Walleye, Bass, Baitfish
Bancroft	Lochaven Fish Farm	Bait; sport fish for food and rec	Trout, Walleye, Bass, Baitfish
Bancroft	North Hastings Community Hatchery	Public Stocking	Trout
Bancroft	Private	Bait; sport fish for food and rec	Trout, Bass, Baitfish
Bancroft	Private	Bait; sport fish for food and rec	Trout, Baitfish
Bancroft	Private	Fee For Fishing	Trout
Bancroft	Speckled Creek Trout Farm	Fee For Fishing	Trout, Bass
Parry Sound	Almaguin Fish Improvement Association	Public Stocking	Walleye
Parry Sound	Aquatic Growers	Food Fish	Trout, Bass, Baitfish, Tilapia
Parry Sound	Deer Lake Trout Farm & Archery	Fee For Fishing	Trout
Parry Sound	Hekkla Valley Farm	Food Fish	Tilapia
Parry Sound	Limberlost Corporation	Fee For Fishing	Trout
Parry Sound	Milford Bay Trout Farm	Fee For Fishing	Trout
Parry Sound	Private	Food Fish	Trout

District	Name	Purpose	Primary Species
Pembroke	Highlands Fish and Game Club		Trout
Pembroke	Natural Waters Trout Farm	Fee For Fishing, Private Stocking	Trout
Pembroke	Opeongo Trout Farm	Fee For Fishing	Trout
Pembroke	Red Wolf Retreat	Fee For Fishing	Trout

5 Current Fish Management

Historically, fisheries management in Ontario was focused on stocking fish to introduce new populations to waters where they did not occur naturally and to mitigate the recognized impacts of early human settlement and development. During the 1850s to 1900s, in response to negative impacts of land clearing, agriculture, development, pollution, overexploitation, and damming of waterways, the first laws were enacted in Ontario to prevent overfishing, while artificial fish propagation and stocking programs were developed, in the widely held belief that fish stocking could counterbalance the negative impacts (Kerr 2010).

During the early 1900s, the spread of invasive species was facilitated through development of roads, railways and canal systems. Deliberate introductions of non-native species, such as Smallmouth and Largemouth Bass, Walleye, Muskellunge, Rainbow Trout, Brown Trout and Rainbow Smelt was widespread. For example, in FMZ 15 historic stocking records for Baptiste Lake included annual stocking of Lake Trout, Cisco, Smallmouth Bass, Largemouth Bass, Brook Trout, Walleye and Muskellunge through the 1920s to 1960s. Other common fisheries management actions throughout this time included coarse fish removals (Burbot, Bullhead, Whitefish and Cisco) in the hopes that removing the “undesirable” species would improve angling for sport fish species.

By the 1970s, fisheries management began to evolve to a more ecosystem, science-based approach. There was a great deal of inventory and advances in fisheries science. The Strategic Plan for Ontario Fisheries (SPOF) was published in 1978, which set up principles of managing fisheries on an ecosystem basis for the benefits of all society. In 1992, the Government of Ontario released the updated Strategic Plan for Ontario Fisheries II (SPOF II) (OMNR 1992), with the goal of shifting site-specific management to a more comprehensive, aquatic ecosystem-based approach. The SPOF II also included the notion of sustainable development (OMNR 1992).

In 2005, the province recognized the need for a landscape level management of fisheries and introduced the Ecological Framework for Recreational Fisheries Management in Ontario (EFFM). The EFFM is discussed in more detail below.

MNRF updated and revised the SPOF II in 2015 through the development of Ontario’s Provincial Fish Strategy: Fish for the Future (OMNRF 2015b). The strategy includes a new overarching strategic plan that guides the immediate and long-term management of fisheries resources in Ontario based on the most recent available science (OMNRF 2015b). The strategy is the current guiding document for managing fisheries resources in Ontario and it identifies provincial fisheries goals, objectives and tactics to achieve them.

Fisheries Assessment Units

Recommendations from SPOF included the establishment of Fisheries Assessment Units (FAU) to monitor suites of lakes on a regular basis to assess populations and effects of management actions. Within FMZ 15, three fisheries assessment units were established including Muskoka Lakes, Haliburton Highlands and Algonquin Fisheries Assessment Units. The FAUs were active from the late 1980's until recently. Since the initiation of BsM the FAUs have gradually become inactive or transitioned to supporting BsM. A fourth unit, the Acidification Study Group (ASG), a joint program of MNRF and MECP was established to study the effects of acid rain on aquatic systems, with study lakes occurring mostly in Algonquin Provincial Park, the Frost Centre and Parry Sound district. The ASG was active in the 1980's.

District Fisheries Management Plans

The SPOF also guided the provincial exercise to develop Fisheries Management Plans. Fisheries Management Plans were prepared in the 1980s by each administrative district. Plans followed a somewhat consistent format following provincial guidelines. The terms of the final plans were generally from 1986-1988 to 2000. The plans give both short-term (5 year) and long-term direction for management of the fisheries resource within each district.

At the time, there were 6 districts within the current FMZ 15 boundaries including Algonquin Provincial Park, Bancroft, Bracebridge, Parry Sound, Minden, and Pembroke. Each plan contained a district fisheries perspective (resource description, use and projections, resource concerns and problems), management direction (objectives, targets, strategies and tactics), and an action plan. The targets were heavily based on providing angling opportunities for greatest social and economic benefit and providing for the greatest allowable harvest for both cold and warmwater species (Table 5.1). The targets were derived from the provincial average angler success rates of 0.2 kg of coldwater fish harvest per opportunity (defined as 4-person hours of fishing) and 0.5 kg of fish harvested per warmwater fish harvest per opportunity. The intent was to "maximize" production of lakes and rivers to meet the angler demand for opportunities to harvest fish.

Table 5.1 Summary of sport fishing targets from District Fisheries Management Plans.

	Coldwater Fishing Target		Warmwater Fishing Target		Total Fishing Target	
District	**Angling Opportunities (4-person hrs)**	**Harvest (kg/yr.)**	**Angling Opportunities (4-person hrs)**	**Harvest (kg/yr.)**	**Angling Opportunities (4-person hrs)**	**Harvest (kg/yr.)**
Bancroft	86,500	17,300	138,700	69,300	256,800	86,600
Bracebridge	187,000	37,500	109,600	54,800	297,100	92,000
Minden	207,250	41,450	204,750	82,320	412,000	123,770
Parry Sound					165,100	57,300
Pembroke	104,640	20,816	727,535	364,888	832,175	385,704
Algonquin Provincial Park	143,800	57,800	39,200	20,100	183,000	77,900
Total					**2,146,175**	**823,274**

There were many common themes amongst the six plans, and all are still relevant today (Table 5.2). The protection and conservation of natural trout populations was emphasized throughout the plans. There was a general recognition that demand exceeds supply in most cases and that specific issues needed to be addressed to increase the supply. Issues such as overharvest, habitat loss and degradation, “under-producing” waters, lack of public awareness and unrealistic resource demands, loss of valuable fisheries, dependency on hatchery fish, need for more inventory and scientific knowledge, lack of public education and awareness, acid rain and contaminants, water level fluctuations, limited access to resources, invasive species and fish introductions, illegal harvest, user conflicts and resource development were the main issues discussed in these plans.

Table 5.2 Summary of problems and issues identified in District Fisheries Management Plans.

	Algonquin	Bancroft	Bracebridge	Minden	Parry Sound	Pembroke	Sub-categories
Overharvest	X	X	X		X		Localized overexploitation (AP), inadequate supply in high demand areas (AP), overharvest of Lake Trout (MI), Limited coldwater fishery (PE), illegal harvest (BR,PE)
Fish Introductions	X		X	X	X	X	
Loss of Habitat	X		X	X		X	Water level fluctuations (BR, MI), shoreline development (BR, PS)), resource development (AP)
Contaminants	X		X	X			Acid precipitation (AP, MI)
Restricted Access			X	X		X	
Under-producing Waters		X		X	X		Lack of desirable fish community (MI, PS), loss of whitefish fisheries (BA), loss of valuable fisheries (BA), projected high demand for bass (MI), under-utilized species (BA)
Dependence on Hatchery Fish		X		X	X		Inability of hatchery fish to meet demand (PS)
Lack of Adequate Knowledge		X	X	X	X	X	
Public Awareness and Expectations	X	X	X	X	X	X	
Conflicting Use			X	X	X	X	

Common strategies and tactics to address such issues included the protection, maintenance and rehabilitation of fish habitat, promotion and protection of naturally reproducing fish populations (conservative regulations, redirection of angling effort, promoting alternate species angling), providing artificial coldwater fishing opportunities through stocking, controlling and preventing stresses on fisheries (controlling overharvest, education and regulation to control invasive species, removal of "unwanted or introduced species", monitoring contaminants, working with water control agencies), increase inventory, monitoring and assessment of the results of fisheries management actions, increased enforcement presence and actively involving and educating the public in fisheries management.

It is unclear how the targets, strategies and tactics were to be evaluated to determine whether they were successful at providing for the angler opportunities and harvest targets identified in the Fisheries Management Plans. The only measure given was the target number of opportunities and total harvest in kg, but those measures were not being monitored at the district level.

The Survey of Recreational Fishing in Canada has been completed every five years since 1975 but it was reported on a provincial scale and not analyzed by FMZ within the province of Ontario until the 2005 report (published in 2010), or by species thermal guild. As a coarse evaluation, fishing effort was reported as 7.5 million hours in FMZ 15 (OMNRF 2015a) including Algonquin Provincial Park, which would equate to 1.9 million "opportunities" (as defined in the Fisheries Management Plans, an opportunity is considered to be 4-person hours of fishing). This figure is not greatly different from the district targets of 2.15 million opportunities by the year 2000. Also, estimated harvest from FMZ 15 in 2010 was about 536,515 kg (OMNRF 2015a) which is much less than the target harvest of 823,274 kg by the year 2000.

Overall, the district Fisheries Management Plans were strongly focused on individual lakes and included a range of projects and activities such as harvest control through regulation, inventory and assessment, stocking and habitat enhancement. Action plans were spurred by funding available from the newly established fishing licence system. Many projects and management actions were undertaken. A summary and evaluation of the plans as a whole and many individual lake actions has not been done.

Ecological Framework for Recreational Fisheries Management in Ontario

The Ecological Framework for Recreational Fisheries Management in Ontario (EFFM), introduced in 2006, introduced the next generation of fisheries management in the province. The key pillars of the framework were shifting management to a broader landscape level, the development of regulatory "toolkits" to guide the development of regulations across the broader landscape and enhancing stewardship (OMNR 2005b). As part of this shift, the 37 existing fishing "divisions" were replaced with 20 FMZs, based on biological, climatic and social considerations (OMNRF 2015b). FMZs have become the primary geographic basis for setting fishing regulations and will be the units for fisheries management planning. Enhanced public involvement was to be achieved by the formation of a Fisheries Advisory Councils, which provide advice to MNRF on various aspects of fisheries management (OMNR 2005b).

Species-specific "toolkits" provide a suite of regulatory options that should be considered when determining fisheries regulations. The toolkits are intended to provide effective science-based management strategies to ensure sustainability of each species while providing optimal angling opportunities, providing a standard suite of regulations when considering changes, and simplifying and streamlining current regulations. The regulatory options are meant to be applied on a zone-wide basis, with some allowance for exceptions where they are consistent with the tool kit direction and subject to more rigorous review and approval.

Regulation Streamlining

The transformation of old Fishing Divisions into FMZs based on ecological and social boundaries necessitated a comprehensive review of existing regulations to align them with the new FMZs and rationalize and standardize where possible. The regulatory toolkits were used to guide the streamlining process.

The streamlining process occurred from 2005 to 2008. The regulation changes proposed for FMZ 15 were relatively minor in nature. New zone-wide regulations included:

- Reduced Walleye quota from 6 to 4 with only one allowed over 46cm;
- Change in Walleye season (March 15 closure);
- Implementation of a quota for Yellow Perch, Crappie, Sunfishes, Whitefish and Channel Catfish following provincial standards;
- Year-round open season for PGT stocked Lake Trout, Brook Trout, Brown Trout, Splake, and Rainbow Trout lakes to provide more angling opportunities;
- New closed season for Atlantic Salmon to aid the recovery strategy for this species;
- Change in Lake Sturgeon season to give more protection for this species.

Of the 524 existing exceptions in FMZ 15, 75 were removed mainly due to recent changes in management intent for the lake or redundancy with new regulations, 30 were changed (winter sanctuaries changed to winter closed seasons), and 419 stayed as they were (mainly Lake Trout and Brook Trout exceptions rationalized as part of the Management Plan for Naturally Reproducing Populations of Brook Trout and Lake Trout in South Central Ontario, implemented in 1996). Nineteen (19) new exceptions were added (primarily shorter Brook Trout seasons) as well as 87 new exceptions with the addition of the "open year-round" list of stocked Brook Trout lakes. The result of the regulation streamlining and simplification exercise was 555 exceptions in FMZ 15; a net gain of 31 new exceptions.

In the years since the regulation streamlining several regulation changes have been proposed but their implementation has been deferred pending the preparation of the new Fisheries Management Plan.

5.1 Brook Trout

Before 1996, management of Brook Trout was generally done at a local level, with direction given by district Fisheries Management Plans. Before 1990, open seasons for Brook Trout were typically 9 months (January 1 to September 30) across central Ontario, with a catch and possession limit of 5 fish.

Natural Trout Strategy

The Management Plan for Naturally Reproducing Populations of Brook Trout and Lake Trout in South Central Ontario (Natural Trout Strategy) is the current landscape direction for managing Brook Trout in the zone. Unlike the Lake Trout section, which obtained strong direction from the provincial synthesis exercise, the Brook Trout strategy was built more on local and regional experience evolving from the district Fisheries Management Plans. At the time of initial implementation, the plan applied to Bancroft, Pembroke and the southeast corner of Parry Sound district.

The strategies for Brook Trout include:

- A minimum size limit will be imposed on natural Brook Trout lakes whereby all fish under 28 cm (11 in.) total length must be released;
- Only artificial lures will be permitted in natural Brook Trout lakes;
- In lakes with suitable habitat, which do not support a naturally reproducing population of Brook Trout, management efforts will be directed at establishing naturally reproducing populations.

Like the Lake Trout part of the plan, implementation was inconsistent and incomplete:

- The strategies did not apply to lakes in the Almaguin and Kawagama Areas of Parry Sound district due to lack of information on the lake status in those areas;
- Pre-existing non-standard exceptions were kept (e.g., Winter closures);
- The artificial lures regulation was not implemented but many individual lakes kept or had bans on live bait fish;
- Not all lakes with natural populations have been identified/recognized.

At the time, over 200 lakes and a smaller number of stream populations of Brook Trout were identified; but many were dependant on stocking of hatchery fish. Of those, only 20 were identified as having a level of natural reproduction, with another 3 thought to have potential for natural reproduction. At the time of the report, there were 70 more Brook Trout lakes in Parry Sound district that were pending assessment of reproductive potential. Reports from long-time inhabitants of the area show there were many more natural Brook Trout lakes in the past, but a variety of human activities had contributed to the decline (OMNR 1995). The introduction of species such as Smallmouth and Largemouth Bass, Yellow Perch and Rock Bass made many lakes and stream unsuitable for Brook Trout. The combination of habitat alteration, fish community changes and over-harvest contributed to the decline of natural Brook Trout populations. Due to the relative rarity of natural Brook Trout populations and their sensitivity to stresses, conservative management strategies were proposed, though the strategy was not fully implemented.

Overall, the strategy was only partially implemented. Regulation changes were made in 1997 with minimum size limits imposed on 10 natural Brook Trout lakes, with 10 more changes to reduce season lengths or to put sanctuaries in place. More regulation changes were put in place in 1998 to restrict live bait on Brook Trout lakes. Exceptions for minimum size, no live bait and shortened seasons continued to be added until approximately 2013. As with the Lake Trout exceptions, many of these individual Brook Trout exceptions are still in place. Other management actions, such as the identification and protection of nursery creeks, protection from the introduction of competitive species, and reserves for resource development projects and rehabilitation stocking were recommended.

Regulations

The current angling regulations for Brook Trout in FMZ 15 are:

- Season: Open Jan. 1 to Sept. 30
- Catch and Possession Limit: Sport: 5, Conservation: 2

There are many lake-specific exceptions that target Brook Trout. A total of 162 waterbodies have 1 or more of 7 regulation variations (Table 5.3). A total of 90 stocked lakes are open to fishing all year. Nineteen (19) of them also have a ban on live baitfish. Forty-six (46) lakes have only a ban on live bait fish. Twenty-one (21) more of those lakes also have a combination of winter closure and/or sanctuary and size limit. Four (4) lakes have only a season and/or size limit variation but no bait regulation.

The zone-wide regulation and most exceptions are consistent with available choices in the Guidelines for Managing the Recreational Fishery for Brook Trout in Ontario but the application across lakes has been inconsistent, including:

- Not all stocked Brook Trout waters are open all year;
- Some stocked lakes have bans on live bait fish;

- Most lakes with natural populations do not have the standard exceptions from the Management Plan for Naturally Reproducing Populations of Brook Trout and Lake Trout in South Central Ontario applied (size limit);
- Some known natural lakes do not have the live baitfish ban applied;
- Some lakes with known natural population have no exceptions applied.

Finally, as the occurrence and/or status of many Brook Trout lakes is not known, there may potentially be more lakes that support Brook Trout that may be eligible for regulation exceptions.

Table 5.3 Summary of waterbody-specific regulations that apply to Brook Trout, FMZ 15, 2016.

Regulation Description	Number of Lakes with Indicated Combination of Regulations											Number of Lakes with Individual Regulation
Brook Trout Open All Year	X	X										90
Live fish may not be used as bait or possessed for use as bait		X	X	X	X	X	X					86
Fish sanctuary - no fishing from Jan. 1 - Fri. before 3rd Sat. in May & Dec. 1 - Dec. 31 OR Fish sanctuary - no fishing from Jan. 1 - Fri. before 4th Sat. in Apr.				X		X		X	X			9
4th Sat. in Apr. - Sept. 30					X		X					14
Must be greater than 28 cm (11 in.)						X	X		X	X		17
Fish sanctuary - closed all year											X	2
Lakes with Combination of Regulations	71	19	46	5	1	2	13	1	1	1	2	162

Lake Reclamation

Lake reclamation is the extermination of fish from a lake in order to eliminate undesirable species. Following the extermination, desired species are re-introduced. Chemical reclamation using Rotenone or Toxaphene has been the most commonly used method in FMZ 15. An active lake reclamation program occurred in the past in the zone, primarily in the 1970s. A Class Environmental Assessment (Class EA) specific to reclamation was in place at one time which facilitated projects being completed. Reclamations were done on natural and stocked Brook Trout lakes. A ban on the use of live bait fish was often put in place after the reclamation to protect the lakes from re-introduction of species that are incompatible with management of natural or stocked Brook Trout.

The expiry of the Class EA, changing requirements for training and licencing for use of chemicals and declining capacity to undertake projects have resulted in no reclamations being done in the zone many years.

Monitoring

Brook Trout are a target species of the BsM program. Trend and state lakes are selected, monitored and reported on through the program.

The former Haliburton-Hastings Fisheries Assessment Unit conducted intensive monitoring on Meach and Little Meach Lakes from approximately 1980 to 2000. Since that time monitoring has become less intense, with some being done as local monitoring by Bancroft district staff. Information on these lakes is an excellent case study of what are probably the best natural Brook Trout lakes in the zone.

Extensive local monitoring of lakes has occurred. The focus of the monitoring has been the identification of the presence of natural reproduction in both stocked and un-stocked lakes. Surveys are done on a locally ranked basis.

Local monitoring of streams occurs through the values collection program for Forest Management Planning. Small amounts of data are also received from private sources via mandatory reports from Licences to Collect Fish for Scientific Purposes. Most of those licences are issued in connection with development proposals, in particular road work. Most surveys are done to determine species presence or absence only. Very little population status or trend data is available.

5.2 Lake Trout

Lake Trout Synthesis

The provincial Lake Trout Science Synthesis exercise was completed in 1991. The synthesis was an exhaustive compilation and analysis of data concerning Lake Trout biology and management. The product was a series of working group reports with recommendations on a broad suite of Lake Trout management topics including exploitation, habitat, stocking, species interactions and assessment of stocks.

Before 1990, the Lake Trout season in FMZ 15 was January 1 to September 30 (with 7 exceptions for shorter seasons and several sanctuaries) with a catch and possession limit of 2. A history of Lake Trout regulations is available in the Background Document of the Harvest Control Options for the Proposed Management Strategy for Naturally Reproducing Populations of Brook Trout and Lake Trout in South Central Ontario (OMNR 1995).

Natural Trout Strategy

The Management Plan for Naturally Reproducing Populations of Brook Trout and Lake Trout in South Central Ontario (Natural Trout Strategy) was developed as a natural progression of the Lake Trout Synthesis. It began in 1996 across what is now FMZ 15. The west and north part of Parry Sound district was not included in the original strategy, but parts of it were eventually implemented on most lakes.

The reproductive status (natural versus artificial/supplemental stocking), body size (small bodied versus large bodied), and level of exploitation stress was for each Lake Trout lake and a management objective was defined. At the time, 140 Lake Trout populations were found to support natural reproduction or significant potential for natural reproduction, 55 lakes were undetermined status due to lack of information, and 30 lakes were identified as having no natural reproduction and no potential for natural reproduction. Of the 195 populations with some level of natural reproduction, it was found that 59% of them were experiencing stress from over-exploitation. The plan recommended conservative regulations to control harvest on natural Lake Trout lakes.

The key parts of the plan are:

- Lakes less than 100 ha (250 ac.) and lakes with small-bodied Lake Trout populations will have an open Lake Trout season from the 3rd Saturday in May until September 30th;
- Lakes greater than 100 ha (250 ac.) which have large-bodied Lake Trout populations will have a protected slot size limit (40 cm to 55 cm) imposed also to existing seasons;
- The slot limit will be accompanied by a one-line only restriction and a ban on live baitfish during the winter fishing season (i.e., through the ice);
- Supplemental stocking into lakes which can sustain naturally reproducing populations for Lake Trout will be stopped;
- Stocking can occur in lakes which have no natural reproduction or for which reproductive status is undetermined.

During implementation an option from an earlier draft was included. Instead of all lakes with small-bodied population being closed to winter fishing, some lakes larger than 100 ha had a small slot size applied (33-40 cm).

Most of these regulations were applied for the 1997 fishing season (slot sizes, shortened seasons, sanctuaries, gear restrictions), greatly increasing the number of regulation exceptions. The regulation changes to open PGT Lake Trout lakes year-round occurred in 2000. Individual lake exceptions for Lake Trout lakes continued to be added or altered to the fishing regulations until about 2004 as lakes not originally included were brought into compliance with the plan and the status of lakes changed or became known.

A monitoring plan was drafted to study the effectiveness of the new Lake Trout regulations. Most, if not all, lakes had prior assessments which were considered "pre-treatment" assessments. A standardized netting protocol (Spring Littoral Index Netting) was to occur every 3 years, starting in 1998-1999, on a selection of Lake Trout lakes where the slot regulations or winter closures began. It was estimated it would take 10 to 15 years for the regulations to show an effect due to the late maturity and slow growth of Lake Trout. This would be considered "post-treatment" assessment, which would occur in 2008-2009 when a final report was to be written on the effectiveness of the regulations. The monitoring plan was not put into action and little coordinated assessment of the regulations has occurred, but many local assessments were completed that give information on the status of individual populations.

A research plan was also developed. Four (4) lakes in Haliburton County were chosen to test the effectiveness of the slot size limit. Detailed studies of the fish populations and fishery were conducted. Results have not been published to date but progress reports are available.

Regulations

The current angling regulations for Lake Trout in FMZ 15 are:

- Season: Open Jan. 1 to Sept. 30
- Catch and Possession Limit: Sport: 2, Conservation: 1

There are also many lake-specific exceptions that target Lake Trout (Table 5.4, Figure 5.1).

Table 5.4 Summary of regulations applied to natural Lake Trout lakes, by BsM lake size class, FMZ 15, 2016.

		BsM Lake Size Class (ha)					
Season/Sanctuary	**Size Limit**	**5-50**	**50-500**	**500-1500**	**1500-5000**	**5000-250000**	**Total**
Jan. 1 - Sep. 30 (zone standard)	None	3	20	8	1	3	35
	Small Slot	1	5				6
	Large Slot	1	38	12	5		56
Fish sanctuary - no fishing from Jan. 1 - Fri. before Family Day	None					1	1
Lake Trout open from Jan. 1 - June 30.	None	1	3				4

Season/Sanctuary	Size Limit	BsM Lake Size Class (ha) 5-50	50-500	500-1500	1500-5000	5000-250000	Total
Fish sanctuary - no fishing from Jan. 1 - Fri. before 3rd Sat. in May & Dec. 1 - Dec. 31.	None	2	11	3			16
	Large Slot	3	5	1	2		11
Fish sanctuary - no fishing from Jan. 1 - Fri. before 4th Sat. in April & Dec. 1 - Dec 31.	Large Slot		1				1
Lake Trout open from 3rd Sat. in May - Sept. 30	None	6	27				33
	Large Slot	1	5	1	2		9
Fish sanctuary - no fishing from Jan. 1 - Fri. before 4th Sat. in May & Dec. 1 - Dec. 31.	Large Slot	1					1
Fish sanctuary - closed all year	None		1				1
Total		**19**	**116**	**25**	**10**	**4**	**174**
Number of Exceptions		16	96	17	9	1	

Also, most (66/71) PGT lakes have an extended season (Open All Year).

Inconsistencies with the suite of exceptions that are in place include:

- Inconsistent dates of winter closures and sanctuaries;
- Application of slot size limits that are not appropriate for the observed growth potential of populations (e.g., large slot on lake with small-bodied population);
- Application of slot size to lake less than 100 ha;
- Application of winter closures to lakes greater than 100 ha.

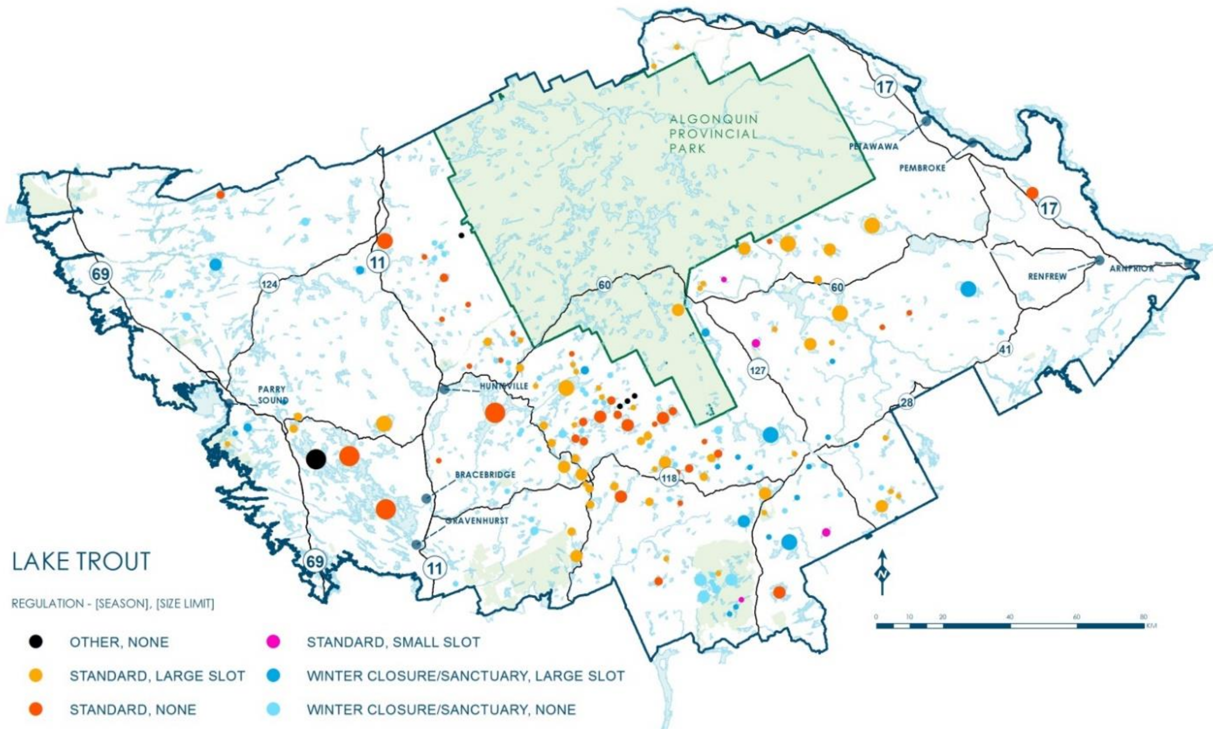


Figure 5.1 Natural Lake Trout lakes, showing open season and size regulations, FMZ 15, excluding Algonguin Park.

Habitat

More active habitat management has occurred for Lake Trout than any other species in the zone. Deep water habitat may be altered through oxygen depletion caused by nutrient enrichment from shoreline and watershed development (Section 3.5.2.3). Efforts to control the impact through input to the municipal planning process began in the 1980s. The science and management evolved, culminating in a suite of complementary documents being released in the mid-2000s, including:

- Lakeshore Capacity Assessment Handbook (MOE 2010);
- Inland Ontario Lakes Designated for Lake Trout Management (OMNR 2006, updated 2015);
- Dissolved Oxygen Criterion for the Protection of Lake Trout Habitat (OMNR 2006);
- revisions to the Provincial Policy Statement (2005, updated 2020).

Together these documents give guidance and tools for managing shoreline development to support dissolved oxygen levels. Since their release, the science and technology pertaining to the phosphorus retention capabilities of soils and septic systems have continued to evolve.

Considerable effort has also been spent on finding, mapping, monitoring and enhancing Lake Trout spawning habitat. Kerr (1998) reviewed selected projects that had been conducted until that time, a large proportion of which occurred in FMZ 15. There is not a summary or database of projects that have been completed but the number has declined in recent years. There has not been adequate post-project evaluation to determine if Lake Trout recruitment has been improved despite the amount of effort Lake Trout spawning habitat manipulation (Kerr 1998). Recent projects have tended to be rationalized on the grounds of improving habitat resilience instead of direct population benefits that are difficult to quantify.

Monitoring

Lake Trout are a target species of the BsM program. Trend and state lakes are selected, monitored and reported on through the program.

The former Muskoka Lakes and Haliburton-Hastings Fisheries Assessment Units conducted intensive monitoring on selected lakes from approximately 1980 to 2000. Since that time monitoring has become less intense. Information on these lakes is critical as they represent what are probably the best natural Lake Trout lakes in the zone.

Extensive local monitoring of lakes has occurred. The focus of the monitoring has been the identification of the presence of natural reproduction in both stocked and un-stocked lakes and assessing the abundance and population structure of natural populations. Surveys are done on a locally ranked basis.

Extensive local monitoring of spawning habitat has also occurred. Identification and mapping of spawning locations has been done for a large number of lakes in order to facilitate protection, such as through municipal planning, and to inform habitat enhancement projects.

5.3 Lake Whitefish

Minimal active management has occurred for Lake Whitefish in the zone. The daily catch and possession limits were reduced as part of the regulation streamlining exercise implemented in 2008. Fall dip netting was also restricted to named waters only.

In Parry Sound district, an attempt to re-introduce Lake Whitefish to Mary Lake was initiated in 2009. To date, no evidence of natural reproduction has been documented.

Regulations

The current angling regulations for Lake Whitefish in FMZ 15 are:

- Season: Open all year
- Catch and Possession Limit: Sport: 12, Conservation: 6

Also, fall dip-netting (Oct. 1 to Dec. 15) is permitted in 18 lakes in Bancroft and Pembroke districts.

Monitoring

Targeted broad-scale monitoring of Lake Whitefish has not occurred. Whitefish occur in some lakes that are monitored for other species during BsM, but they may not be representative of the entire Lake Whitefish resource.

Local monitoring of important Whitefish fisheries, including Lake of Bays and Bernard Lake, has occurred periodically, primarily in the form of angler surveys.

5.4 Northern Pike

There has been minimal active management of Northern Pike in FMZ 15. Most of the historic and ongoing range expansion of this species has occurred through unauthorized introductions and natural dispersal.

Regulations

The current angling regulations for Northern Pike in FMZ 15 are:

- Season: Open Jan. 1 to Mar. 31 and 3rd Sat. in May to Dec. 31.
- Catch and Possession Limit: Sport: 6, Conservation: 2

No lake-specific exceptions, sanctuaries or gear limitations are in place that specifically target pike.

Monitoring

The occurrence of new pike populations is documented as they are encountered.

Generally, no targeted species monitoring has occurred. Monitoring has occurred incidental to surveys that target other species, especially Walleye. The primary survey types in which pike are caught are BsM and the trap net protocols; Nearshore Community Index Netting (NSCIN) and End of Spring Trap Netting (ESTN).

Northern Pike statistics are reported on by BsM because they occur in many selected Walleye and Lake Trout lakes. However, they also occur in many lakes that do not support these species; therefore, the information collected may not provide reliable status information for Northern Pike in the FMZ.

Pike sampling has occurred occasionally at some competitive fishing events.

5.5 Muskellunge

The primary historic management activity for Muskellunge has been range expansion through stocking. Stocking is no longer occurring, though range expansion through natural dispersal and illegal stocking continues to occur, primarily in the south-central part of the zone.

Provincially, Muskellunge are managed by a standard suite of minimum size regulations which are applied to most FMZs, and some individual lakes based on the demonstrated growth potential of fish in each population.

Regulations

The current angling regulations for Muskellunge in FMZ 15 are:

- Season: Open 1st Sat. in June to Dec. 15
- Catch and Possession Limit: Sport: 1, Conservation: 0
- Size Limit: must be greater than 91 cm (36 in.)

Two waterbody-specific exceptions:

- Pickerel River: Must be greater than 122 cm (48 in.) (intended to be harmonized with French River in FMZ 10)
- Nogies Creek: Fish sanctuary - closed all year (research study area)

The minimum size limits which are recommended in the Regulatory Guidelines for Managing the Muskellunge Sport Fishery in Ontario have not been applied on other water bodies, primarily due to the absence of enough data on the growth potential of individual populations.

Monitoring

The occurrence of new Muskellunge populations is documented as they are encountered.

Generally, no targeted species monitoring by MNRF has occurred. Monitoring has occurred incidental to surveys that target other species, especially Walleye. The primary survey types in which muskellunge are caught are the trap net protocols; NSCIN and ESTN. Few Muskellunge are caught in any type of survey.

No reporting of Muskellunge data is done through BsM as very few are caught.

Muskies Canada Inc. manages a volunteer angler diary program and provides data to MNRF. The diary program is ongoing and is the primary source of information on Muskellunge at both the FMZ and provincial scales.

5.6 Walleye

Percid Community Synthesis

The Percid Community Synthesis project began in the mid-1990s and was completed in 2004. The project followed the model of the Lake Trout Synthesis, with working groups producing a series of reports examining a wide range of aspects of Walleye science and management. The project culminated in the release of Strategies for Managing Walleye in Ontario (Kerr et al. 2004) which contained key highlights such as reviewing Walleye regulations to simplify and apply "benchmark" standards across broader areas, reducing catch and possession limits, spring sanctuaries to protect Walleye spawning periods, and adherence to provincial stocking guidelines for Walleye including no supplemental stocking. Other management recommendations included habitat protection and enhancement and controlling the spread of invasive and non-native species.

Southern Region Walleye Review

From 1993-2001, a provincial exercise was conducted to collect information on Walleye populations through a Fall Walleye Index Netting (FWIN) program. A report summarizing regional Walleye life history characteristics was published in 2003 (Morgan et al. 2003). A total of 34 different lakes had FWIN assessments completed in FMZ 15 as part of this project. The results show that southern region Walleye populations were stressed when compared to northern populations. Amongst southern region walleye lakes, the waters located within the future FMZ 15 boundary had the lowest relative abundance of Walleye.

In 2005, MNRF conducted a Southern Region Walleye Management Review. The exercise was founded on the results of the 2001 FWIN project which documented for the first time the regional status of the Walleye resource and the management recommendations produced by the recently completed Percid Community Synthesis.

A suite of regulation options was developed and presented to the public in a series of Open Houses in 2006. Following consultation, it was decided that an interim approach would be adopted until FMZ planning was done (the EFFM was just being implemented at that time). The catch and possession limit was to be reduced from 6 to 4 (2 for a conservation license) with only 1 Walleye permitted over 46cm (18.1 inches), and the winter season would be reduced by two weeks, ending March 15. These interim changes began in 2007 in FMZ 15 and continue to be in place in 2018, with exceptions as described below.

Regulations

The current angling regulations for Walleye in FMZ 15 are:

- Season: Open Jan. 1 to Mar. 15 & 3rd Sat. in May to Dec. 31
- Catch and Possession Limit: Sport: 4, Conservation: 2

- Size Limit: not more than 1 greater than 46 cm (18.1in.)

There are also waterbody specific exceptions:

- 11 lakes in Pembroke district have reduced catch (S:2, C:1) and different size limit (must be greater than 50 cm (19.7 in.)
- 2 lakes (one in Pembroke and one in Bancroft district) have reduced open season: 3rd Sat. in May to Dec. 31
- 26 water bodies with spring sanctuaries (Table 5.5).

Table 5.5 Spring sanctuaries for Walleye spawning and staging, FMZ 15, 2016.

Regulation	Number
Fish sanctuary - no fishing from Apr. 1 to Fri. before 3rd Sat. in May	10
Fish sanctuary - no fishing from Apr. 1 to June 15	1
Fish sanctuary - no fishing from Mar. 1 to Fri. before 3rd Sat. in May	11
Fish sanctuary - no fishing from Mar. 16 to Fri. before 3rd Sat. in May	3
Fish sanctuary - no fishing from May 1 to June 15	1

Habitat

Many physical enhancement projects have been conducted. In 1996, it was reported that 58 projects had been conducted in the zone (Bancroft: 35, Parry Sound: 20, Pembroke: 3) (Kerr 1996). In general, goals have often been poorly defined and pre- and post-project monitoring are either not done or done on a casual basis making it difficult to gauge the success of projects. Furthermore, when monitoring was done, it was generally not possible to draw direct cause-effect conclusions due to the many other factors influencing Walleye populations. The number of projects done has declined greatly since 1996.

Monitoring

Walleye are a target species of the BsM program. Trend and state lakes are selected, monitored and reported on through the program.

The provincial FWIN initiative (1993-2001) provided the first zone-wide assessment of the Walleye resource.

Some local monitoring of Walleye lakes has occurred, though not as extensive as that for Brook and Lake Trout. The focus of the monitoring has been on monitoring the abundance and population characteristics of the major fisheries using a variety of trap-netting procedures.

Local monitoring of spawning habitat has also occurred. Identification and mapping of spawning locations has been done for many lakes in order to facilitate protection, such as through the establishment of spring sanctuaries, municipal planning, and to inform habitat enhancement projects.

Because of the ongoing range expansion of Walleye in the zone, many lakes that now support Walleye have not been recently assessed nor had critical habitat identified.

5.7 Smallmouth and Largemouth Bass

The primary management action that has been undertaken for bass in FMZ 15 is the introduction of the species to waters where they did not occur naturally. Stocking of bass in the zone by the Ontario Government began in the early 1900s. At that time the purpose of stocking was not usually recorded so it is not clear in early records which were introductions, and which were supplemental. Extensive bass stocking occurred until about the 1960s. Few intentional, authorized introductions have occurred recently. As an exception, Parry Sound district had a Largemouth Bass adult transfer program that ended in 1988.

Despite the end of planned range expansion by MNRF, the ranges of both species have continued to expand due to illegal introductions. In recent years the introduction of bass into new waters has been discouraged through education programs aimed at illegal introductions, with clearly little effect as new populations continued to be discovered on a disturbingly frequent basis.

Regulations

The current angling regulations for Bass in FMZ 15 are:

- Season: Open 4th Sat. in June to Nov. 30.
- Catch and Possession Limit: Sport: 6, Conservation: 2

There are no lake-specific exceptions, sanctuaries or gear limitations in place that specifically target Bass.

The regulations are consistent with the Regulatory Guidelines for Managing the Recreational Fishery for Largemouth and Smallmouth Bass in Ontario.

Monitoring

The occurrence of new Bass populations is documented as encountered.

Generally, no targeted species monitoring has occurred. Monitoring has occurred incidental to surveys that target other species, especially Walleye. The primary survey types in which Bass are caught are BsM and the trap net protocols; NSCIN and ESTN.

Smallmouth Bass statistics are reported on through BsM when they occur in selected Walleye, Lake Trout and even Brook Trout lakes. They occur in many lakes that do not support these species; therefore, the lakes being monitored cannot be considered a random sample of lakes.

Largemouth Bass are not caught in adequate numbers in BsM surveys to allow reporting.

Bass sampling has occurred occasionally at some competitive fishing events. This data has been used for public information and education purposes.

Long term research on the ecology of Smallmouth Bass is ongoing on Lake Opeongo in Algonquin Provincial Park. The location of this work is very convenient as it is directly applicable to FMZ 15.

5.8 Black Crappie

Little active management of Black Crappie has occurred. Most of the range expansion that has occurred is due to illegal introductions. Parry Sound district conducted one adult transfer to Dinner Lake. A second environmental assessment was started to introduce them to three more lakes but was not completed due to unresolved concerns. One of the three lakes was later found to have crappie through an illegal introduction.

The current angling regulations for Crappie in FMZ 15 are:

- Season: Open all year
- Catch and Possession Limit: Sport: 30, Conservation: 10

Monitoring

No targeted monitoring of Crappie has occurred. Black Crappie have a low vulnerability to gill nets and so are not effectively sampled by BsM.

Sampling has occurred incidental to surveys that target Walleye, primarily in NSCIN and ESTN trap net surveys. Crappie occur in many lakes that do not support Walleye or Lake Trout, so available sampling may not be representative of the entire crappie resource.

5.9 Panfish (Yellow Perch, Pumpkinseed, Bluegill and Rock Bass)

Panfish species are not actively managed in the zone.

The current angling regulations for Panfish in FMZ 15 are:

- Season: Open all Year
- Catch and Possession Limit: Sport: 50, Conservation: 10

The primary management concern with Panfish is their introduction of into lakes that support other sport fish species. Specifically, the introduction of any species, most commonly Yellow Perch and Rock Bass, into Brook Trout lakes (natural or stocked) has had severe impacts on that species. Before 1980, some lakes in the zone were chemically reclaimed to kill species that compete with Brook Trout, primarily Yellow Perch. Rotenone and Toxaphene were the chemicals used. Changes to the regulations, Environmental Assessment requirements and lack of public support have made it difficult to obtain approval to conduct these projects and none have been done in recent years.

5.10 Rainbow Trout and Kokanee Salmon

Naturalized populations of Rainbow Trout and Kokanee Salmon, resulting from historic stocking, occur in three lakes:

- Bernard Lake – Rainbow Trout
- Sand Lake – Rainbow Trout
- Boulter Lake - Kokanee Salmon

The current angling regulations for Rainbow Trout in FMZ 15 are:

- Season: Open All Year
- Catch and Possession Limit: Sport: 5, Conservation: 2

There is no closed season or catch limit for Kokanee.

Two waterbody-specific exceptions that apply to the Rainbow Trout spawning streams of naturalized populations in Bernard Lake and Sand Lake:

- Joly Creek: Fish sanctuary - no fishing from Apr. 1 to May 31
- Cashman Creek: Fish sanctuary - no fishing from Apr. 1 to May 31

Similarly, all of Boulter Lake is a sanctuary during the spawning season:

- No fishing October 1 to December 31

PGT stocking is the primary historic and ongoing management activity for Rainbow Trout (see Section 5.13). The zone-wide regulation is designed for PGT fisheries. The Regulatory Options for Managing Rainbow Trout Recreational Fisheries in Ontario recommend different regulations for self-sustaining populations, but they are not currently applied to Bernard and Sand Lake. No management of Kokanee, other than the original stocking, has occurred.

Monitoring

No monitoring of the naturalized populations or their spawning streams have occurred other than occasional incidental catches in assessments that target other species.

5.11 Species at Risk

Recovery strategies have been prepared for Lake Sturgeon (GLSL) and American Eel in accordance with requirements of the Endangered Species Act (ESA), 2007 and as part of sound ecological management objectives.

Several recovery actions to address these goals are ongoing, including installation and monitoring of eel ladders, translocation, and increasing escapement.

As of April 1, 2019, the ESA, 2007 is no longer the responsibility of MNRF, and is now administered by MECP.

5.12 Fish Habitat Management

Fish habitat management is a joint responsibility of DFO and MNRF (DFO 2000). Development projects that may impact fish habitat are referred to DFO for review and, if required, regulatory authorization. MNRF retains review responsibility in some circumstances, for example Environmental Assessments where MNRF is the proponent such as Forest Management Planning. MNRF provides data and direction to municipalities on the protection of fish habitat during municipal planning via the Natural Heritage Policies in the PPS.

MNRF keeps databases of fish habitat information that is available for planning and protection purposes.

MNRF and MECP jointly administer the Dissolved Oxygen Policy for the Protection of Lake Trout Habitat and makes recommendations to municipalities on shoreline development capacity. MNRF and MECP collect late summer dissolved oxygen levels in designated Lake Trout lakes in support of the application of the policy.

Government agencies administer funding programs which private entities can access to fund habitat creation, rehabilitation and enhancement projects (Table 5.6).

Table 5.6 Government agencies and their funding programs related to fish habitat.

Agency	Program
MNRF	Community Fish and Wildlife Involvement Program (CFWIP) (discontinued)
MNRF	Land Stewardship and Habitat Restoration Program
MECP	Species at Risk Stewardship Fund
MECP	Great Lakes Guardian Community Fun
DFO	Recreational Fisheries Conservation Partnerships Program
Environment Canada	Environmental Damages Fund

BsM monitors water quality aspects of fish habitat, including water temperature, dissolved oxygen, water clarity and phosphorus.

MECP administers the Lake Partner Program whereby volunteers, primarily lakes association representatives, collect water samples which are analyzed by MECP. Water Management Plans developed under the Lakes and Rivers Improvement Act for watershed that have commercial waterpower generation facilities may have fish habitat protection provisions, in particular flow requirements.

District offices undertake local habitat mapping, monitoring and enhancement projects, often in concert with local partners. A large number of spawning habitat enhancement projects targeting primarily Walleye and Lake Trout have been undertaken. Monitoring has typically been limited to short term success measures such as stability and evidence of use. Monitoring of population level benefits has been limited due to the cost and complexity.

5.13 Fish Stocking

Stocking is a significant fisheries management action undertaken in FMZ 15. The planning, implementation, monitoring and communicating of stocking by MNRF requires a large amount of staff time and funding. A considerable amount of rearing and stocking is also done by private and partner groups which receive their stocking direction from MNRF.

The "Guidelines for Stocking Fish in Inland Waters in Ontario" is the main document that MNRF uses for direction on stocking fish (OMNR 2002b).

Stocking may occur for several reasons:

- Introduction: to create a new population;
- Put-grow-take (PGT): to offer artificial angling opportunities;
- Rehabilitation: to rehabilitate/restore a population;

- Supplemental: to increase the abundance of a population that is sustained by natural reproduction;
- Research and Assessment.

Introductions of fish species to create new populations are done where species do not occur naturally, usually due to natural range limitations or occasionally to reintroduce populations that have been lost. Generally, an Environmental Assessment (EA), under MNRF's Class EA for Resource Stewardship and Facility Development must be completed. Few new introductions are occurring but a large proportion of Northern Pike, Bass, Crappie and Walleye populations in the zone originated from introductions, some authorized and some unauthorized.

PGT stocking creates artificial angling opportunities by supplying a waterbody with stocked fish on an ongoing basis. This type of stocking typically occurs on waterbodies where there is no known natural reproduction, usually due to natural limitations in the habitat for early life history stages (spawning and nursery). PGT stocking is most successful in water where the habitat for older life stages is good, and the fish community is relatively simple. Waters stocked on a PGT basis must be accessible to the public. PGT stocking can divert fishing pressure away from stressed lakes, with naturally reproducing fisheries.

Rehabilitative stocking is used to restore depleted naturally-reproducing populations that are unable to respond when the stressor that caused the decline is removed. Rehabilitative stocking is intended to be a short-term strategy that relies on the existence of naturally reproducing populations for long-term recovery. Rehabilitative stocking considers conservation of the genetic diversity of the established populations.

Supplemental stocking occurs when some natural reproduction is occurring for the species being stocked. It is generally done to enhance fishing opportunities. Supplemental stocking is generally discouraged if the management objective is to support natural reproduction because stocked fish may compete with natural fish, reduce genetic fitness and increase exploitation by attracting anglers. MNRF policy recommends that as a rule, supplemental stocking be discouraged when waters contain a viable population of native or naturalized fish of the same species. Occasionally, supplemental stocking may be done to meet specific local objectives, such as supporting a regionally important fishery.

Research or assessment stocking is generally done for a short, fixed period to investigate a scientific question, often to improve stocking program. Examples include trials of different genetic strains or stocking densities to determine which offers the best results for a particular purpose.

5.13.1 Stocking in FMZ 15, 2001-2015

The following summary is based on records approved in the provincial Fish Stocking Information System (FSIS), between 2001 and 2015. To simplify summarizing the data, the stocking purposes, which have several choices and many combinations, were grouped into broad categories of assessment and research, PGT, rehabilitation, introduction and reintroduction, and supplemental.

From 2001 to 2015, MNRF stocked about 500 different lakes, with about 300 lakes stocked each year. Partners and private groups stocked about 150 different water bodies in total and 50 lakes each year.

5.13.1.1 MNRF Stocking

Brook Trout

Brook Trout is the most stocked species by MNRF in FMZ 15. On average 144 lakes were stocked each year with 157,000 fish between 2001 and 2015 (Table 5.7, Figure 5.2). A total of 229 different waters have been stocked between during that time. The vast majority are stocked on a PGT basis, with small numbers stocked for rehabilitation or supplemental purposes. Brook Trout stocking is restricted primarily to small lakes on Crown Land that do not support competing spiny-rayed species (e.g., Yellow Perch) and significant natural reproduction does not occur due to the absence of suitable spawning habitat. Waters suitable for Brook Trout stocking occur throughout Bancroft district, the northern and western parts of Pembroke and the far eastern side of Parry Sound district. The number of waters and number of fish stocked has stayed consistent since 2001.

Table 5.7 Brook trout stocking summary including number of waterbodies stocked annually (count) and number of fish stocked annually (number), FMZ 15, 2001-2015.

	Assessment-Research		Put-Grow-Take		Rehab-Intro-Reintro		Supplemental		Total	
Year	Count	Number	Count	Number	Count	Number	Count	Number	Count	Number
2001			147	132,795			4	3,801	151	136,596
2002			127	156,006					127	156,006
2003			160	186,300			10	8,325	170	194,625
2004			168	233,047	1	3,400			169	236,447
2005			149	214,420			5	5,542	154	219,962
2006			143	189,417	3	2,934	2	1,700	148	194,051
2007			136	128,965					136	128,965
2008			151	149,791			4	3,425	155	153,216

	Assessment-Research		Put-Grow-Take		Rehab-Intro-Reintro		Supplemental		Total	
Year	**Count**	**Number**	**Count**	**Number**	**Count**	**Number**	**Count**	**Number**	**Count**	**Number**
2009			133	120,114			1	10,000	134	130,114
2010			145	125,378	1	950			146	126,328
2011			135	139,773	1	950			136	140,723
2012			142	124,950					142	124,950
2013			116	115,915	1	700			117	116,615
2014			155	171,783					155	171,783
2015			152	165,188					152	165,188

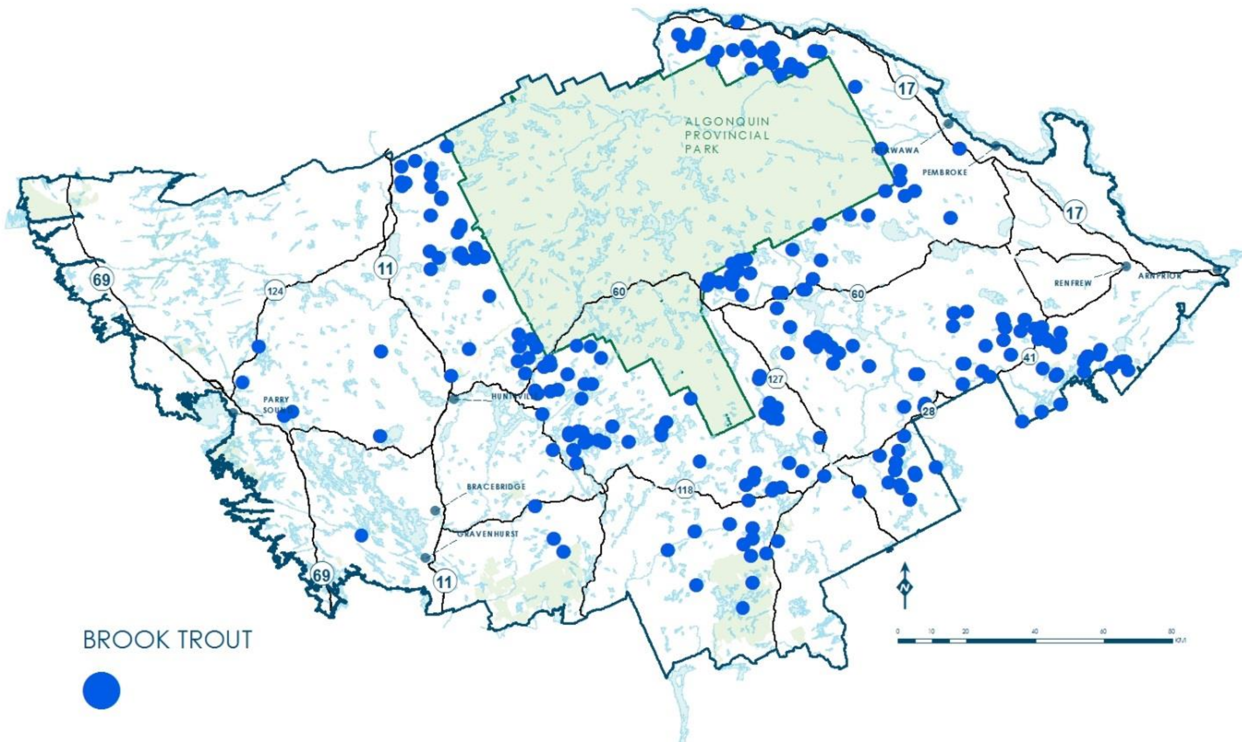


Figure 5.2 Water bodies stocked with Brook Trout by MNRF, 2001-2015, FMZ 15.

Lake Trout

Lake Trout is the third most commonly stocked species in the zone. The number of fish stocked is similar to that for Splake, but the number of water bodies is fewer. Unlike the other Trout species, the purpose of Lake Trout stocking is varied. On average, each year, about 33 lakes have been stocked with 61,000 fish on a PGT basis and 6 lakes with 25,000 fish for rehabilitation or re-introduction. Prior to 2006, about 12 lakes were stocked annually with 26,000 fish on a supplemental basis (Table 5.8, Figure 5.3). This practice was largely stopped following the recommendations of the Lake Trout Synthesis project. A total of 90 different waters have been stocked since 2001. The number of lakes and fish being stocked for rehabilitation and supplementation has declined greatly since 2001, but PGT stocking has been relatively stable.

The recorded purpose of stocking has varied for a few lakes over time. Of the 90 different lakes stocked, 52 had two different stocking purposes (PGT and supplemental most commonly) and 7 lakes had three stocking purposes. The reason is probably two-fold; that the stocking purpose has changed but also that there may be inconsistency in how the terms are used based on the understanding of how much reproduction occurs in a lake.

Stocked Lake Trout lakes occur throughout Bancroft district, in the north and southwest section of Pembroke and in the east part and around the Town of Parry Sound in Parry Sound district. Lake Trout are stocked in lakes of a wide range of size and physical and biological characteristics where reproduction is poor or absent due to one or more factors such as limited deep-water nursery habitat, introduced species such as Smelt or water quality (dissolved oxygen or clarity).

Table 5.8 Lake Trout stocking summary including number of waterbodies stocked annually (count) and number of fish stocked annually (number), FMZ 15, 2001-2015.

	Assessment-Research		Put-Grow-Take		Rehab-Intro-Reintro		Supplemental		Total	
Year	**Count**	**Number**	**Count**	**Number**	**Count**	**Number**	**Count**	**Number**	**Count**	**Number**
2001			35	72,550	11	126,301	19	32,925	65	231,776
2002			2	3,000	10	54,452	35	81,379	47	138,831
2003			39	118,152	10	8,090	11	13,750	60	139,992
2004			37	94,787	8	16,885	25	32,623	70	144,295
2005			39	62,146	9	9,535	23	83,679	71	155,360
2006			38	82,772	9	15,496			47	98,268
2007			38	85,687	6	9,686	2	2,700	46	98,073

	Assessment-Research		Put-Grow-Take		Rehab-Intro-Reintro		Supplemental		Total	
Year	Count	Number	Count	Number	Count	Number	Count	Number	Count	Number
2008			29	65,044	4	8,128	1	1,000	34	74,172
2009			35	62,354	5	13,601			40	75,955
2010	4	3,140	32	38,382	4	7,778			40	49,300
2011			43	37,225	8	35,438			51	72,663
2012			33	41,977	6	13,501			39	55,478
2013			32	44,300	5	35,030	2	4,500	39	83,830
2014			31	55,351	2	8,700	1	3,000	34	67,051
2015			35	57,062	1	6,797	3	6,500	39	70,359

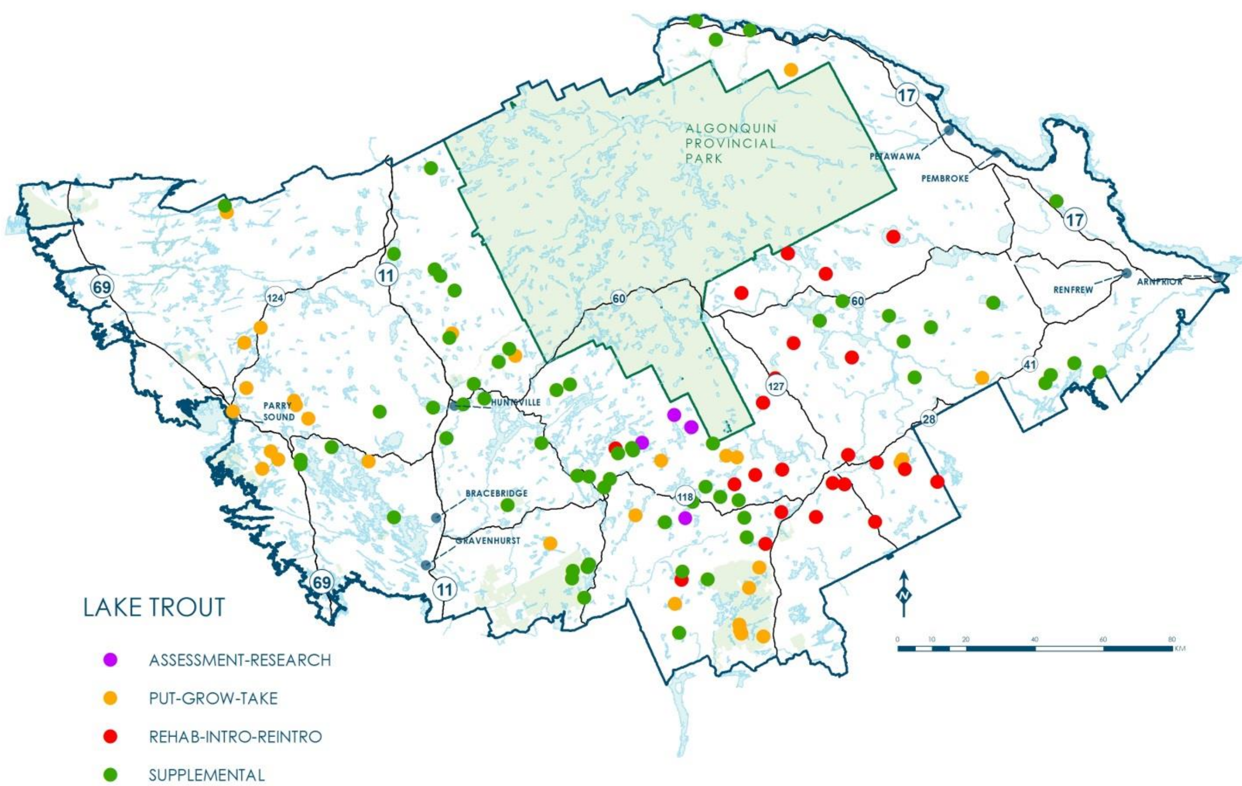


Figure 5.3 Water bodies stocked with Lake Trout by MNRF, 2001-2015, FMZ 15. Some lakes had more than one stocking purpose, which is not shown on map.

Splake

Splake is the second most commonly stocked species in the zone. An average of 110,000 fish is stocked into 66 lakes annually (Table 5.9, Figure 5.4). A total of 126 different water bodies were stocked between 2001 and 2015. Splake are an artificial hybrid produced exclusively for PGT stocking. They are typically stocked into transition lakes that have complex fish communities and are unsuitable for Brook Trout but do not have adequate deep-water habitat for Lake Trout. The distribution of lakes within the zone is similar to that of Brook Trout lakes.

Since 2001, the number of lakes stocked annually has stayed relatively stable but between 2001 and 2006 the total number of fish stocked declined. Since 2006, the proportion of Splake lakes stocked in the fall instead of the spring has increased from about 5 to 25%. The stocking of fish in the fall at a larger size, particularly in lakes that support predators such as Bass, has improved returns in some lakes. The larger size allows for stocking of fewer fish.

Table 5.9 Splake stocking summary including number of waterbodies stocked annually (count) and number of fish stocked annually (number), FMZ 15, 2001-2015.

	Assessment-Research		Put-Grow-Take		Rehab-Intro-Reintro		Supplemental		Total	
Year	**Count**	**Number**	**Count**	**Number**	**Count**	**Number**	**Count**	**Number**	**Count**	**Number**
2001			76	161,911					76	161,911
2002			73	149,393					73	149,393
2003			69	155,265					69	155,265
2004			54	114,250					54	114,250
2005			65	123,555					65	123,555
2006			64	117,196					64	117,196
2007			62	86,200					62	86,200
2008			62	113,883					62	113,883
2009			68	82,054					68	82,054
2010			73	112,400					73	112,400
2011			70	90,270					70	90,270
2012			62	111,592					62	111,592
2013			68	83,152					68	83,152
2014			62	107,650					62	107,650
2015			79	90,370					79	90,370

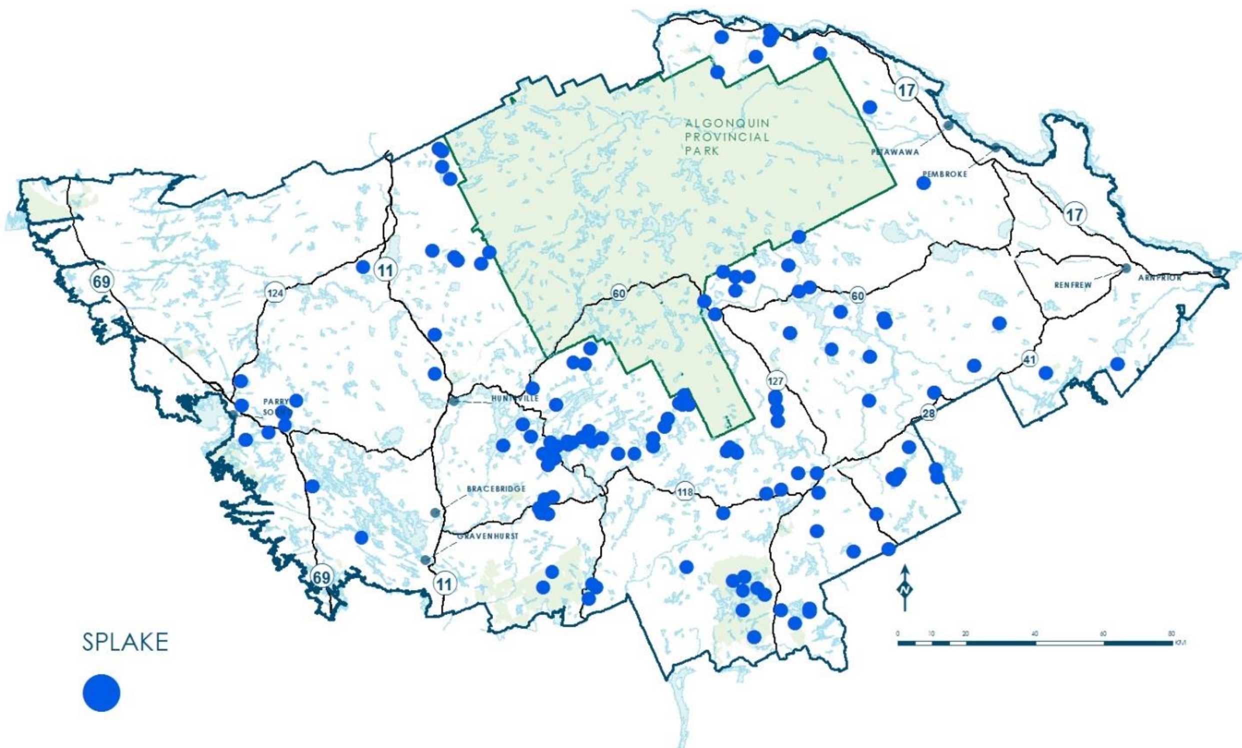


Figure 5.4 Water bodies stocked with Splake by MNRF, 2001-2015, FMZ 15.

Rainbow Trout

Rainbow Trout, which are non-native to Ontario, are stocked strictly on a PGT basis. On average 38 waters were stocked with about 58,000 fish per year between 2001 and 2015 (Table 5.10, Figure 5.5). A total of 84 waters have been stocked since 2001. The numbers have been relatively stable since 2001. Rainbow Trout are stocked into lakes with a variety of characteristics ranging from small lakes with simple fish communities to medium-sized lakes with more diverse fish communities. The greatest proportion of Rainbow Trout waters are in the central part of the zone in Bancroft district, less are distributed through Parry Sound and they are least common in Pembroke district.

Table 5.10 Rainbow Trout stocking summary including number of waterbodies stocked annually (count) and number of fish stocked annually (number), FMZ 15, 2001-2015.

	Assessment-Research		Put-Grow-Take		Rehab-Intro-Reintro		Supplemental		Total	
Year	**Count**	**Number**	**Count**	**Number**	**Count**	**Number**	**Count**	**Number**	**Count**	**Number**
2001			32	53,632					32	53,632
2002			39	54,291					39	54,291
2003			46	71,774					46	71,774
2004			28	28,495					28	28,495
2005			57	97,450					57	97,450
2006			30	51,250					30	51,250
2007			31	38,880					31	38,880
2008			40	45,783					40	45,783
2009			34	50,030					34	50,030
2010			51	81,448					51	81,448
2011			40	64,550					40	64,550
2012			41	59,146					41	59,146
2013			37	56,010					37	56,010
2014			32	53,950					32	53,950
2015			39	70,300					39	70,300

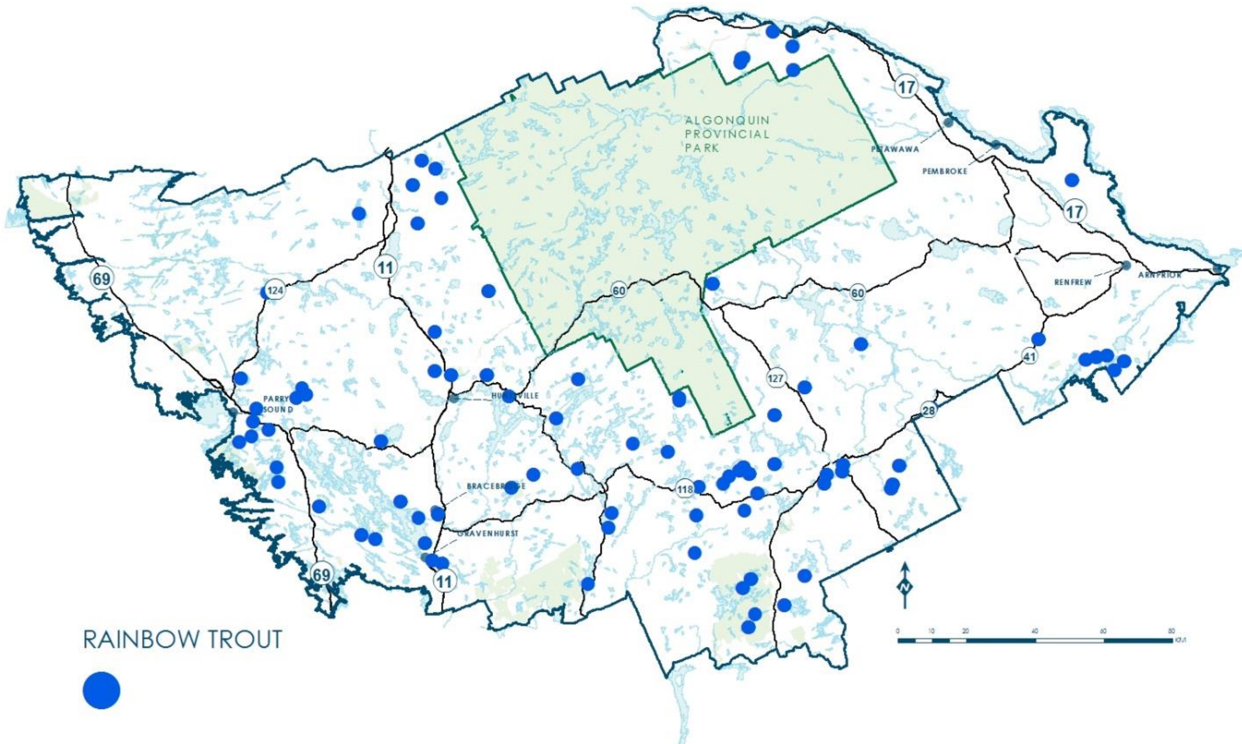


Figure 5.5 Waterbodies stocked with Rainbow Trout by MNRF, 2001-2015, FMZ 15.

Brown Trout

Brown Trout are stocked on a limited basis in the zone. About 5 waterbodies were stocked each year with about 8,000 fish between 2001 and 2015 (Table 5.11, Figure 5.6). A total of 6 different waters have been stocked between 2001 and 2015, 5 of them were rivers or streams. Brown Trout are not native to Ontario and are stocked strictly on a PGT basis in FMZ 15. There appears to be a decreasing trend in the number of waters stocked with Brown Trout.

Table 5.11 Brown Trout stocking summary including number of waterbodies stocked annually (count) and number of fish stocked annually (number), FMZ 15, 2001-2015.

	Assessment-Research		Put-Grow-Take		Rehab-Intro-Reintro		Supplemental		Total	
Year	Count	Number	Count	Number	Count	Number	Count	Number	Count	Number
2001			8	14,854					8	14,854
2002			3	11,984					3	11,984
2003			9	19,481					9	19,481
2004			6	16,233					6	16,233

	Assessment-Research		Put-Grow-Take		Rehab-Intro-Reintro		Supplemental		Total	
Year	**Count**	**Number**	**Count**	**Number**	**Count**	**Number**	**Count**	**Number**	**Count**	**Number**
2005			9	16,995					9	16,995
2006			4	3,100					4	3,100
2007			5	4,372					5	4,372
2008			4	3,896					4	3,896
2009			5	4,000					5	4,000
2010			4	3,000					4	3,000
2011			3	1,034					3	1,034
2012			5	4,107					5	4,107
2013										
2014			6	1,324					6	1,324
2015			4	6,000					4	6,000

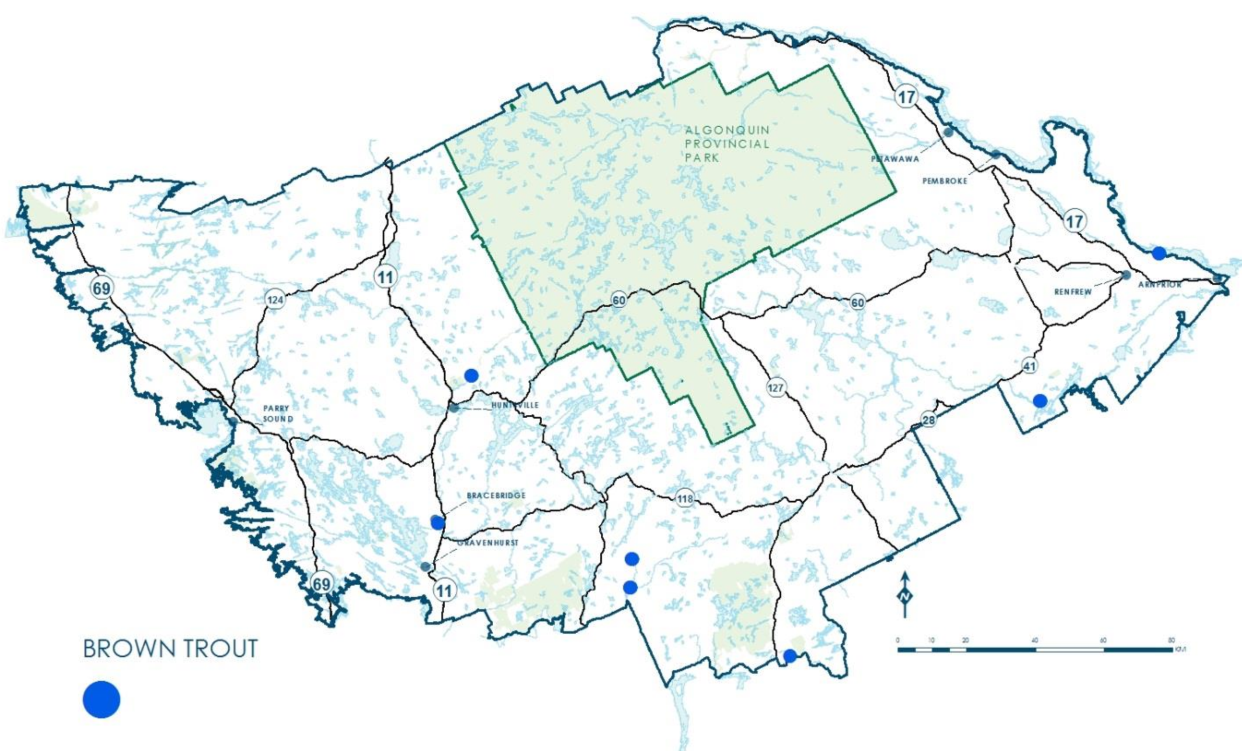


Figure 5.6 Water bodies stocked with Brown Trout, by MNRF, 2001-2015, FMZ 15.

Walleye

Fewer Walleye are stocked in the zone than the other major species. Also, most Walleye are stocked at a smaller size and earlier life stage than most trout due to a combination of limited supply and the challenges of culturing Walleye. On average, only 3 lakes, but a relatively large number of 37,000 fish per lake, were stocked annually between 2001 and 2015 (Table 5.12, Figure 5.7). Fifteen (15) different waters have been stocked during this period. From 2001 to 2006 most stocking was classified as rehabilitation stocking and fry were being stocked each year (Table 5.13). After 2006, following the Southern Region Walleye Review, the emphasis, or at least the classification, changed to PGT stocking and fry stocking was largely abandoned. Lack of clear criteria for what is PGT and supplemental stocking and consistency in their application have confounded the classification of some Walleye stocking. Also, the life stage at which Walleye have been reported to be stocked can be misleading; as the terms sac fry, fry and fingerlings may be used inconsistently. The number of Walleye stocked annually varies greatly due, in part, to the vagaries of Walleye culture success.

Table 5.12 Walleye stocking summary including number of waterbodies stocked annually (count) and number of fish stocked annually (number), FMZ 15, 2001-2015.

	Assessment-Research		Put-Grow-Take		Rehab-Intro-Reintro		Supplemental		Total	
Year	**Count**	**Number**	**Count**	**Number**	**Count**	**Number**	**Count**	**Number**	**Count**	**Number**
Walleye	2	19,165	8	71,331	24	355,137	8	68,186	42	513,819
2001					3	78,543			3	78,543
2002					5	34,579			5	34,579
2003					4	100,520	1	1,275	5	101,795
2004					4	25,218			4	25,218
2005					2	90,000			2	90,000
2006	2	19,165			3	21,860			5	41,025
2007										
2008							1	4,000	1	4,000
2009			1	405					1	405
2010			1	10,000					1	10,000
2011							5	57,411	5	57,411
2012			1	400	1	300			2	700
2013			2	20,000	1	2,117			3	22,117
2014			2	9,972	1	2,000			3	11,972
2015			1	30,554			1	5,500	2	36,054

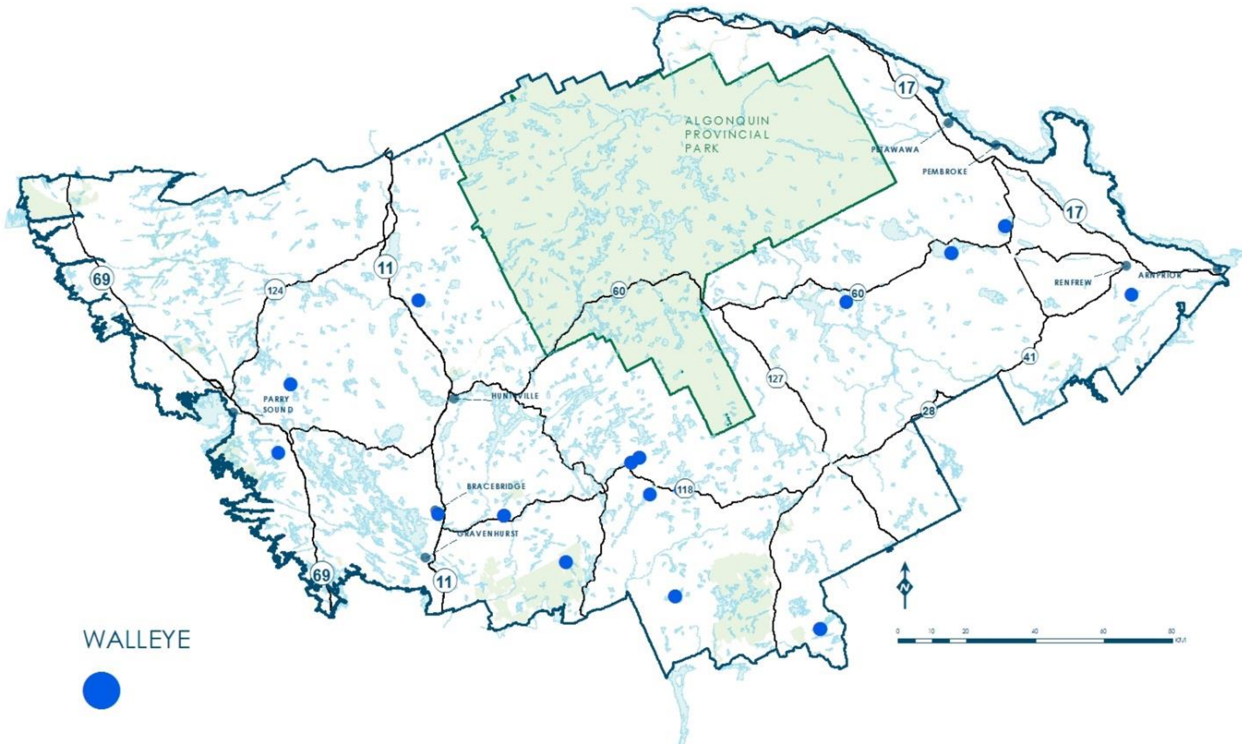


Figure 5.7 Water bodies stocked with Walleye by MNRF in FMZ 15, 2001-2015.

Table 5.13 Number of Walleye stocked, by year and life stage, FMZ 15, 2001-2015.

Year	Fry	Summer Fingerling	Yearling and Older
2001	38,543	40,000	
2002	6,722	27,857	
2003	40,000	61,795	
2004	7,291	17,927	
2005	62,492	27,508	
2006		30,675	10,350
2008		4,000	
2009			405
2010		10,000	
2011		57,411	
2012			700
2013		22,117	
2014		11,972	
2015		36,054	

Other Species

Lake Whitefish were stocked for several years into Mary Lake, in Parry Sound district, as part of a re-introduction project. No other Whitefish stocking has occurred in the zone recently.

Private and Partner Stocking

Private stocking is stocking done by individuals or groups under the authority of the Licence to Stock Fish. The waterbodies stocked are a combination of private lakes and ponds that do not have public access and accessible lakes that MNRF does not stock.

Partner stocking is generally done by private groups with the support of MNRF into publicly accessible waters. Support can be in the form of financial or advisory. Partner stocking is typically done by Fish and Game Clubs. It was formerly authorized as MNRF stocking but is now authorized by licence under the auspices of the Community Hatchery Program which is administered by the Ontario Federation of Anglers and Hunters.

Since 2001, stocking has been undertaken by about 40 individuals or organizations into 157 different waterbodies (Figure 5.8). It is difficult to determine the exact number of organizations that have stocked because member names may change from time to time (e.g., Cottage Association presidents) and data entry has not been entirely consistent.

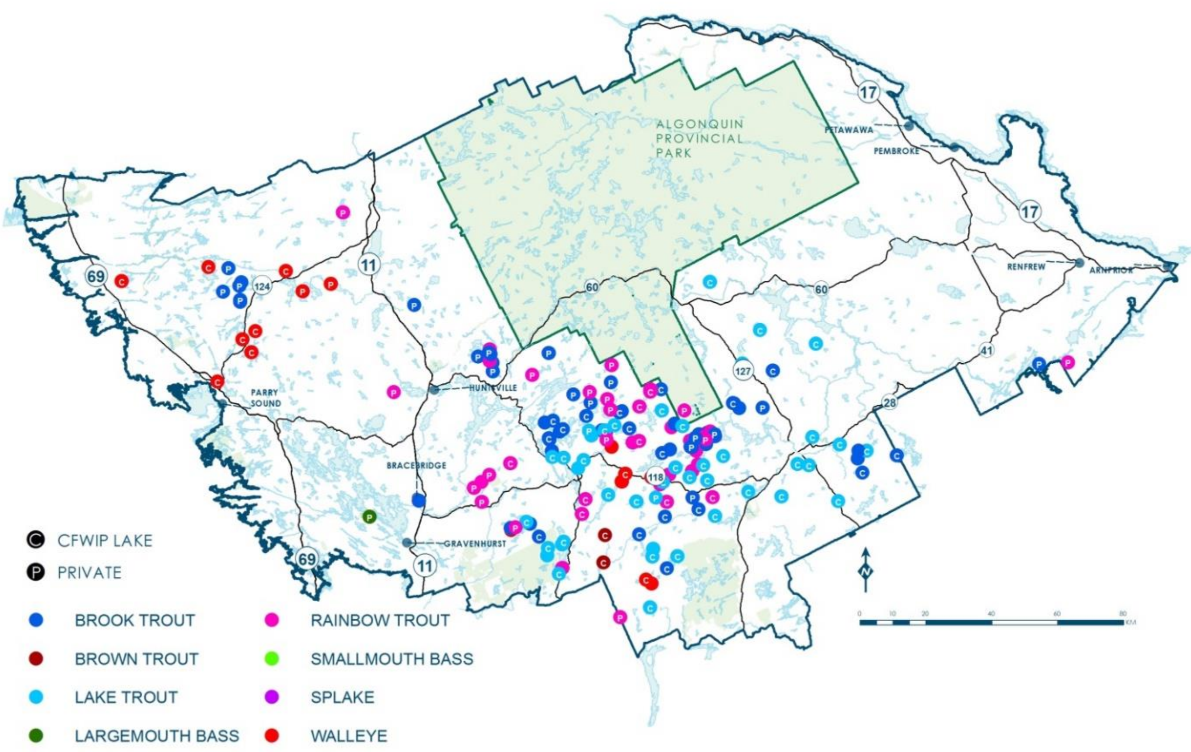


Figure 5.8 Waterbodies stocked privately and by partners, FMZ 15, 2001-2015.

Rainbow Trout has been the most popular species for private and partner stocking. On average, about 20,000 fish are stocked into 20 waterbodies annually and 51 different waterbodies have been stocked (Table 5.14). A large majority has been done as private, as opposed to partner stocking. Major proponents of private Rainbow Trout stocking include Harcourt Park, the Haliburton Reserve and some Cottage Associations. The Haliburton Highlands Outdoors Association (HHOA) is the only partner group to have stocked Rainbow Trout. Like MNRF stocking, virtually all private Rainbow Trout stocking is done on a PGT basis. The number of Rainbow Trout stocked annually has stayed relatively constant since 2001.

Lake Trout has been the second most common species that has been stocked privately or by partners. About 15,000 fish have been stocked into 15 different lakes annually. A total of 47 different lakes have been stocked. Unlike Rainbow Trout, most non-MNRF Lake Trout stocking has been done by partner groups, mainly the HHOA and North Hastings Community Fish Hatchery (NHCFH). Private stocking has been done primarily by Harcourt Park. Compared to MNRF Lake Trout stocking, a larger proportion of partner stocking is classified as rehabilitation. Lake Trout stocking increasing from 2001 to a peak in 2010 and has declined greatly since then.

Brook Trout are also commonly stocked privately or by partners. Almost 8,000 fish have been stocked into 15 waterbodies annually. A total of 65 different waterbodies have been stocked. About 2/3 of Brook Trout stocking has been private and 1/3 by partners. PGT is the dominant purpose for both groups; only about 10% has been done for rehabilitation. Other than 2001, the number of Brook Trout stocked has stayed steady, but the number of lakes varies greatly from year to year.

A small number of Splake were stocked into 4 different lakes from 2002 to 2006 by 1 private group. This stocking has stopped.

Finally, an average of over 600,000 Walleye was stocked privately or by partners into 4 lakes annually between 2001 and 2015. A total of 16 different water bodies were stocked but the number stocked has declined over time with only 6 different lakes stocked by 2 groups (HHOA and Almaguin Community Hatchery Program (ACHP) since 2011. Unlike MNRF Walleye stocking, which is mainly of fingerlings, most partner and private stocking is of newly hatched sac fry. Virtually all was classified as supplemental stocking (the HHOA stocks several lakes with fingerlings on a PGT basis). The number of Walleye stocked annually varies greatly, in large part due to variation in egg collection success.

Small numbers of Brown Trout, and Smallmouth and Largemouth Bass have been stocked privately in the zone as well.

The greatest concentration of private and partner stocking activity has occurred in the central part of the zone in Bancroft district due to the presence of the two largest community hatcheries and the most active private stocking groups (Harcourt Park and

Haliburton Forest). A smaller number of lakes have been stocked in Parry Sound district and few in Pembroke.

Table 5.14 Summary of private and partner stocking including number of waterbodies stocked annually (count) and number of fish stocked annually (number), FMZ 15, 2001-2015*.

	Brook Trout		Lake Trout		Rainbow Trout		Splake		Walleye	
Year	Count	Number	Count	Number	Count	Number	Count	Number	Count	Number
2001	30	34,535	3	6,728	11	6,000				
2002	10	3,150	7	16,105	13	7,350	2	1,500		
2003	11	7,950	6	11,807	21	20,201	2	2,000	9	1,534,250
2004	9	4,150	7	11,591	19	18,920	2	2,000	5	417,850
2005	13	5,850	10	9,800	16	11,524	3	1,700	9	1,883,048
2006	9	4,000	5	7,184	29	27,876	3	2,800	5	88,200
2007	15	9,200	19	7,918	20	20,895			2	440,360
2008	9	3,775	16	12,351	20	26,680			1	20,000
2009	20	6,858	32	23,275	33	23,465			5	333,976
2010	22	7,625	24	28,648	37	30,112			3	111,700
2011	9	4,100	21	20,060	30	23,972			1	380,000
2012	21	7,485	22	18,510	27	29,100			5	1,179,000
2013	17	7,180	22	19,625	24	23,200			2	128,000
2014	19	7,845	20	15,317	21	21,800			3	188,000
2015	6	3,557	17	11,000	9	19,000			3	1,521,500

* Note: other stocking: Brown Trout (1,000 fish in 3 events in 2013) Smallmouth Bass (180 fish in 2 events in 2012 and 2014) and Largemouth Bass (55 fish in 2 events in 2014)

Unauthorized Stocking

Unauthorized stocking is illegal, but it has played an important role in the evolution of the fisheries of the zone. Generally discovered incidentally by the presence of new populations well after the fact, little is known about this form of stocking. Most introductions of sport fish species are believed to be intentional, rather than accidental (e.g., bait bucket releases). Most introductions are of cool and warmwater species including Smallmouth and Largemouth Bass, Northern Pike, Walleye and Black Crappie. Control of unauthorized stocking is virtually impossible due to the dispersed, intermittent and difficult to detect nature of the activity.

Stocking Assessment

Despite the importance of the stocking program, assessing it remains a challenge due to the large number of lakes (many of which are small), dispersed angling effort and the remote location of many lakes. Lakes stocked on a PGT basis are generally not sampled by BsM unless another target species is present; therefore, local assessments are the primary source of information for stocked lakes. Many surveys have been conducted using a wide variety of techniques ranging from standard protocols to informal volunteer reporting. Efforts have focused on gathering information to make decisions on individual lakes such as whether to continue stocking, species and genetic strain to stock and stocking density and not to assess the program as a whole.

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7 Appendices

Appendix 1 List of common and scientific names of fishes.

Common Name	*Scientific Name*	MNR Code
American Brook Lamprey	*Lampetra appendix*	11
Northern Brook Lamprey	*Ichthyomyzon fossor*	12
Silver Lamprey	*Ichthyomyzon unicuspis*	13
Lake Sturgeon	*Acipenser fulvescens*	31
Longnose Gar	*Lepisosteus osseus*	41
Bowfin	*Amia calva*	51
Alewife	*Alosa pseudoharengus*	61
Rainbow Trout	*Oncorhynchus mykiss*	76
Brown Trout	*Salmo trutta*	78
Brook trout	*Salvelinus fontinalis*	80
Lake Trout	*Salvelinus namaycush*	81
Splake	*Salvelinus fontinalis x Salvelinus namaycush*	82
Lake Whitefish	*Coregonus clupeaformis*	91
Longjaw Cisco	*Coregonus alpenae*	92
Cisco (Lake Herring)	*Coregonus artedi*	93
Deepwater Cisco	*Coregonus johannae*	95
Kiyi	*Coregonus kiyi*	96
Blackfin Cisco	*Coregonus nigripinnis*	97
Shortnose Cisco	*Coregonus reighardi*	99
Shortjaw Cisco	*Coregonus zenithicus*	100
Round Whitefish	*Prosopium cylindraceum*	102
Rainbow Smelt	*Osmerus mordax*	121
Northern pike	*Esox lucius*	131
Muskellunge	*Esox masquinongy*	132
Grass Pickerel	*Esox americanus vermiculatus*	133
Central Mudminnow	*Umbra limi*	141
Longnose Sucker	*Catostomus*	162
White Sucker	*Catostomus commersoni*	163
Silver Redhorse	*Moxostoma anisurum*	168
Black Redhorse	*Moxostoma duquesnei*	169
Golden Redhorse	*Moxostoma erythrurum*	170
Shorthead Redhorse	*Moxostoma macrolepidotum*	171
Greater Redhorse	*Moxostoma valenciennesi*	172
River Redhorse	*Moxostoma carinatum*	173

Common Name	*Scientific Name*	MNR Code
Goldfish	*Carassius auratus*	181
Northern Redbelly Dace	*Phoxinus eos*	182
Finescale Dace	*Phoxinus neogaeus*	183
Redside Dace	*Clinostomus elongatus*	184
Lake Chub	*Couesius plumbeus*	185
Common Carp	*Cyprinus carpio*	186
Cutlips Minnow	*Exoglossum maxillingua*	188
Brassy Minnow	*Hybognathus hankinsoni*	189
Eastern Silvery Minnow	*Hybognathus regius*	190
Silver Chub	*Macrhybopsis storeriana*	191
Hornyhead Chub	*Nocomis biguttatus*	192
River Chub	*Nocomis micropogon*	193
Golden Shiner	*Notemigonus crysoleucas*	194
Pugnose Shiner	*Notropis anogenus*	195
Emerald Shiner	*Notropis atherinoides*	196
Bridle Shiner	*Notropis bifrenatus*	197
Common Shiner	*Luxilus cornutus*	198
Blackchin Shiner	*Notropis heterodon*	199
Blacknose Shiner	*Notropis heterolepis*	200
Spottail Shiner	*Notropis hudsonius*	201
Rosyface Shiner	*Notropis rubellus*	202
Spotfin Shiner	*Cyprinella spiloptera*	203
Sand Shiner	*Notropis stramineus*	204
Redfin Shiner	*Lythrurus umbratilis*	205
Mimic Shiner	*Notropis volucellus*	206
Pugnose Minnow	*Opsopoeodus emiliae*	207
Bluntnose Minnow	*Pimephales notatus*	208
Fathead Minnow	*Pimephales promelas*	209
Blacknose Dace	*Rhinichthys atratulus*	210
Longnose Dace	*Rhinichthys cataractae*	211
Creek Chub	*Semotilus atromaculatus*	212
Fallfish	*Semotilus corporalis*	213
Pearl Dace	*Margariscus margarita*	214
Silver Shiner	*Notropis photogenis*	215
Central Stoneroller	*Campostoma anomalum*	216
Striped Shiner	*Luxilus chrysocephalus*	217
Ghost Shiner	*Notropis buchanani*	218
Grass Carp	*Ctenopharyngodon idella*	219
Brown Bullhead	*Ameiurus nebulosus*	233

Common Name	*Scientific Name*	MNR Code
Channel Catfish	*Ictalurus punctatus*	234
Margined Madtom	*Noturus insignis*	238
American Eel	*Anguilla rostrata*	251
Banded Killifish	*Fundulus diaphanus*	261
Burbot	*Lota*	271
Brook Stickleback	*Culaea inconstans*	281
Threespine Stickleback	*Gasterosteus aculeatus*	282
Ninespine Stickleback	*Pungitius*	283
Trout-Perch	*Percopsis omiscomaycus*	291
Rock Bass	*Ambloplites rupestris*	311
Green Sunfish	*Lepomis cyanellus*	312
Pumpkinseed	*Lepomis gibbosus*	313
Blue Gill	*Lepomis macrochirus*	314
Longear Sunfish	*Lepomis megalotis*	315
Smallmouth bass	*Micropterus dolomieu*	316
Largemouth bass	*Micropterus salmoides*	317
Black crappie	*Pomoxis nigromaculatus*	319
Yellow perch	*Perca flavescens*	331
Sauger	*Stizostedion canadense*	332
Walleye (Yellow Pickerel)	*Sander vitreus*	334
Eastern Sand Darter	*Ammocrypta pellucida*	335
Greenside Darter	*Etheostoma blennioides*	336
Iowa Darter	*Etheostoma exile*	338
Johnny Darter	*Etheostoma nigrum*	341
Logperch	*Percina caprodes*	342
Blackside Darter	*Percina maculata*	344
Tessellated Darter	*Etheostoma olmstedi*	346
Brook Silverside	*Labidesthes sicculus*	361
Round Goby	*Neogobius melanostomus*	366
Mottled Sculpin	*Cottus bairdi*	381
Slimy Sculpin	*Cottus cognatus*	382
Spoonhead Sculpin	*Cottus ricei*	383
Deepwater Sculpin	*Myoxocephalus thompsoni*	384
Fourhorn Sculpin	*Myoxocephalus quadricornis*	387

Appendix 2 Hydro-electric generating stations in FMZ 15, 2016.

Site Ident	Site Name	Waterbody Name	Owner/Operator	Operation Type	Installed Capacity
2DD05	Truisler Chute	South River	OPG	Base Load	0.6
2DD16	South River	South River	OPG	Run-of-River	0.8
2EA29	Burks' Fall's	Magnetawan River	Bracebridge Generation	Base Load	1.1
2EA50	Cascade Street	Seguin River	Bracebridge Generation	Run-of-River	1.2
2EB03	Wilson's Fall's	North Muskoka River	Bracebridge Generation	Base Load	2.9
2EB04	Burgess	Muskoka River	Algonquin Power	Base Load	0.1
2EB07	Bracebridge Falls	North Muskoka River	Bracebridge Generation	Base Load	2.6
2EB08	South Falls	South Muskoka River	OPG	Run-of-River	5.0
2EB15	Trethewey Falls	South Muskoka River	OPG	Run-of-River	2.0
2EB17	Ragged Rapids	Musqash River	OPG	Run-of-River	8.0
2EB18	Big Eddy	Musqash River	OPG	Run-of-River	8.0
2EB22	High Falls	North Muskoka River	Bracebridge Generation	Base Load	0.8
2EB42	Hanna Chute	South Muskoka River	OPG	Run-of-River	1.5
2EB43	Matthias	South Muskoka River	Orillia Power	Base Load	3.0
2HB59	Devil's Gap	Irondale River		Run-of-River	0.1
2HF02	Elliott Falls	Gull River		Base Load	0.7
2HF11	Drag Lake Dam	Drag River		Base Load	0.3
2HF36	Minden Dam	Gull River		Base Load	4.0
2KC04	Douglas	Bonnechere River	Multistream Power Corp.	Run-of-River	1.8
2KC12	Eganville	Bonnechere River	Town of Eganville	Run-of-River	0.8

Site Ident	Site Name	Waterbody Name	Owner/Operator	Operation Type	Installed Capacity
2KC21	Renfrew #1	Bonnechere River	Renfrew Power Generation	Run-of-River	1.0
2KC22	Renfrew #2	Bonnechere River	Renfrew Power Generation	Run-of-River	1.0
2KC25	Thomas Low	Bonnechere River	Renfrew Power Generation	Run-of-River	3.5
2KC5	Killaloa Mill Site	Brennans Creek	Vornweg Waterpower	Run-of-River	0.1
2KD14	Bancroft	York River		Base Load	0.6
2KD53	Algonquin Eco-Lodge	Moffat Pond		Run-of-River	0.0
2KE08	Fraser	Waba Creek	Private Individual	Run-of-River	0.1
2KE10	Mountain Chute	Madawaska River	OPG	Peak Load	170.0
2KE13	Barrett Chute	Madawaska River	OPG	Peak Load	178.0
2KE16	Calabogie	Madawaska River	OPG	Base Load	5.0
2KE17	Stewartville	Madawaska River	OPG	Peak Load	182.0
2KE18	Arnprior	Madawaska River	OPG	Peak Load	84.0
2KE21	Stewart	Waba Creek	Private Individual	Run-of-River	0.2
2KE22	Barrie	Waba Creek	Private Individual	Run-of-River	0.1

Appendix 3 Lakes sampled by the BsM program, FMZ 15, Cycle 1 and 2.

Lake Name	Lake Size Class	Cycle	Target Species	Lake Selection	Surface Area (ha)	Mean Depth (m)	Max Depth (m)
Ahmic L.	1500-5000	2	Walleye	Trend	1598	7	24
Alder L.	5-50	1	Walleye	Trend	27	7	18
Aylen L.	1500-5000	1 & 2	Lake Trout	Trend	2105	23	67
Baptiste L.	1500-5000	1 & 2	Walleye	Trend	2233	5	32
Bark L.	1500-5000	1 & 2	Walleye	Trend & State	4024	24	88
Bella L.	50-500	1	Brook trout	Trend	357	13	37
Bernard L.	1500-5000	1 & 2	Lake Trout	Trend & State	2089	15	48
Big Deer L.	50-500	1	Walleye	Trend	160	3	18
Bigwind L.	50-500	1 & 2	Brook trout	Trend & State	108	10	36
Black Donald L.	1500-5000	1 & 2	Walleye	Trend	1500	16	43
Buck L.	50-500	1	Brook trout	Trend	264	10	24
Calabogie L.	500-1500	1 & 2	Walleye	Trend & State	1353	5	24
Catchacoma L.	500-1500	1 & 2	Lake Trout	Trend	707	19	44
Cecebe, L.	500-1500	1 & 2	Walleye	Trend & State	802	5	20
Clear, L.	1500-5000	1 & 2	Lake Trout, Walleye	Trend	1737	8	36
Cripple L.	5-50	1 & 2	Brook trout	Trend	38	2	9
Doe L.	500-1500	1 & 2	Walleye	Trend	862	6	23
Dore, L.	1500-5000	1 & 2	Walleye	Trend & State	1513	8	20

Lake Name	Lake Size Class	Cycle	Target Species	Lake Selection	Surface Area (ha)	Mean Depth (m)	Max Depth (m)
Dotty L.	50-500	1 & 2	Brook trout	Trend & State	159	7	27
Eagle L.	500-1500	1	Brook trout	Trend	941	6	22
Eels L.	500-1500	1	Lake Trout	Trend	942	7	30
Fletcher L.	50-500	1	Brook trout	Trend	269	7	21
Fosters L.	50-500	1 & 2	Walleye	Trend	68	5	13
Giroux L.	50-500	1 & 2	Walleye	Trend	119	3	6
Golden L.	1500-5000	1 & 2	Walleye	Trend & State	3613	9	24
Goodwin L.	50-500	1 & 2	Lake Trout	Trend	56	8	25
Gurd L.	50-500	1 & 2	Walleye	Trend	97	2	6
Jack L.	500-1500	1 & 2	Walleye	Trend & State	1343	7	37
Joseph, L.	5000-250000	1 & 2	Lake Trout	Trend	5167	27	92
Kamaniskeg L.	1500-5000	1 & 2	Walleye	Trend	2211	9	40
Kelly L.	50-500	1 & 2	Walleye	Trend	57	12	28
Kimball L.	50-500	1	Brook trout	Trend	217	23	67
Lake of B.s	5000-250000	1 & 2	Lake Trout	Trend	6763	22	70
Mary Lake	500-1500	2		State	1061	24	56
McKellar L.	50-500	1 & 2	Walleye	Trend	88	5	10
McKenzie L.	50-500	1 & 2	Lake Trout	Trend	314	8	27
Meach L.	5-50	1 & 2	Brook trout	Trend	44	4	12
Mink L.	500-1500	1 & 2	Walleye	Trend & State	553	6	13
Murphys L.	50-500	1 & 2	Brook trout	Trend	77	8	21

Lake Name	Lake Size Class	Cycle	Target Species	Lake Selection	Surface Area (ha)	Mean Depth (m)	Max Depth (m)
Muskoka, L.	5000-250000	1 & 2	Lake Trout, Walleye	Trend & State	12036	15	67
Muskrat L.	500-1500	1 & 2	Walleye	Trend	1215	18	64
North L.	50-500	1	Brook trout	Trend	54	15	41
Norway L.	50-500	1	Walleye	Trend & State	283	9	38
Paudash L.	500-1500	1 & 2	Lake Trout, Walleye	Trend & State	1200	12	49
Peyton L.	5-50	1 & 2	Brook trout	Trend	39	4	14
Pickerel L.	500-1500	1	Brook trout	Trend	519	9	38
Red Pine L.	50-500	1 & 2	Lake Trout	Trend	395	11	40
Redstone L.	500-1500	1 & 2	Lake Trout	Trend	1178	21	81
Rosseau, L.	5000-250000	1 & 2	Lake Trout	Trend	6297	24	89
Round L.	1500-5000	1 & 2	Lake Trout	Trend	2970	13	55
Salmon Trout L.	50-500	1 & 2	Walleye	Trend	101	6	13
Smoky L.	50-500	1	Walleye	Trend	193	5	25
Tallan L.	5-50	1	Lake Trout	Trend	46	9	26
Twelve Mile L.	50-500	1 & 2	Lake Trout	Trend	355	12	28
Wolf L.	Unk	2		State			

Appendix 4 List of fish species recorded in FMZ 15, showing frequency of occurrence in MNRF databases and origin.

Species	ARA Polygon	ARA Line	ARA Survey Point	BsM Cycle 1	BsM Cycle 2	Origin
Yellow Perch	1240	64	66	57	22	N
White Sucker	1181	161	128	53	18	N
Smallmouth Bass	1100	83	45	48	20	N
Pumpkinseed	1040	78	92	50	19	N
Brown Bullhead	756	48	63	41	16	N
Brook Trout	748	1150	145	7	2	N
Largemouth Bass	712	28	31	24	14	N
Northern Pike	485	77	19	36	13	N
Creek Chub	471	243	346	5		N
Rock Bass	461	56	47	45	21	N
Golden Shiner	405	41	42	32	9	N
Northern Redbelly Dace	395	175	167	4		N
Walleye	338	78	16	31	13	N
Common Shiner	316	159	153	16	4	N
Bluntnose Minnow	291	60	41	29	13	N
Cisco	281	3	1	23	15	N
Lake Trout	273	6	4	29	14	N
Rainbow Trout	248	23	14			I
Fathead Minnow	220	71	58	3		N
Pearl Dace	166	56	66	1		N
Brook Stickleback	159	139	177	1		N
Burbot	159	3	7	23	11	N
Finescale Dace	154	55	91			N
Blacknose Shiner	148	30	29	4		N
Muskellunge	125	11		2	1	N
Iowa Darter	123	28	29	2		N
Lake Whitefish	123	1	3	19	12	N
Lake Chub	115	7	7	1	1	N
Rainbow Smelt	94	3	2	21	12	I
Splake	92					I
Fallfish	83	39	17	4	2	N
Central Mudminnow	78	114	108	2		N
Black Crappie	73	1		12	4	N

Species	ARA Polygon	ARA Line	ARA Survey Point	BsM Cycle 1	BsM Cycle 2	Origin
Johnny Darter/Tesselated Darter	82	37	18			N
Logperch	66	27	16	10	2	N
Longnose Sucker	65	4	2	6	1	N
Spottail Shiner	60	14	7	13	7	N
Trout-Perch	45	13	8	9	8	N
Longnose Dace	44	53	44			N
Mimic Shiner	40	8	4			N
Brassy Minnow	38	15	19			N
Eastern/Western Blacknose Dace	41	42	92			N
Shorthead Redhorse	36	5	4	1		N
Blackchin Shiner	34	6	7	1		N
Emerald Shiner	29	13	5	1	3	N
Channel Catfish	28	2	1	1		N
Rosyface Shiner	26	6	5			N
Bowfin	24					N
Banded Killifish	22	4	3	1	1	N
Mottled Sculpin	22	28	10	2	1	N
Bluegill	19	5	2	7	2	I
Round Whitefish	18			1		N
Silver Redhorse	15	1	1	2		N
Longnose Gar	13		2	1		N
Slimy Sculpin	13	11	5	4	8	N
Hornyhead Chub	11		8			I
American Eel	10	1				N
Brown Trout	10	9	2			I
Ninespine Stickleback	9			1		N
River Redhorse	9	1	2			N
Yellow Bullhead	9	2	1	1	1	N
Greater Redhorse	8			1		N
Lake Sturgeon	8	1		1		N
Common Carp	7	1				I
Mooneye	7	1				N
Brook Silverside	6					N
Grass Pickerel	6		5			?

Species	ARA Polygon	ARA Line	ARA Survey Point	BsM Cycle 1	BsM Cycle 2	Origin
Spotfin Shiner	6	2	1			I
Alewife	5			1		I
Black Bullhead	5	1				?
Margined Madtom	5	1	1	2		?
Sauger	5		2	1	2	N
Fantail Darter	4	4				I
River Chub	4	1				I
Stonecat	4					N
Threespine Stickleback	4	2	1			N
Longear Sunfish	3					?
Atlantic Salmon	2					I
Gizzard Shad	2					N
Northern Hog Sucker	2	1				I
Pugnose Shiner	2					I
Quillback	2					N
Rainbow Darter	2	1	1			I
Spoonhead Sculpin	2				3	N
Tadpole Madtom	2	1				?
Central Stoneroller	1	1	2			I
Chinook Salmon	1					I
Freshwater Drum	1					N
Golden Redhorse	1					?
Goldeye	1					?
Lake Chubsucker	1					?
Redside Dace	1					?
Sand Shiner	1	2				?
Silver Lamprey	1					N
Sockeye Salmon	1					I
Spotted Gar	1					?
Tiger Muskellunge	1					?
White Bass	1					?
Eastern Silvery Minnow		1	1			?
Goldfish		1				I
Northern Brook Lamprey		1				N
Total	98	72	62	52	34	

Appendix 5 List of competitive fishing events, FMZ 15, 2012 (Kerr 2012).

District	Event Name	Location(s)	Fish Species
Bancroft/ Pembroke	2012 Timberfest Fishing Derby	Bark, Aylen and Kaminiskeg Lakes	Lake Trout, Walleye, Northern pike
Bancroft/ Pembroke	Ice Fishing Derby	Kaminiskeg & Bark Lakes	Lake Trout, Northern pike, Walleye
Bancroft	6th Annual Kids Pike Derby	Baptiste Lake	Northern pike
Parry Sound	Lake Bernard Fishing Derby	Bernard Lake	Unknown
Pembroke	Petawawa Bassmasters Open Event	Black Donald Lake	Bass
Pembroke	Super City Bass Tournament	Black Donald Lake	Bass
Bancroft	Canning Lake Rock Bass Derby	Canning Lake	Rock Bass
Bancroft	2012 CBAF Qualifier	Catchacoma Lake	Bass
Bancroft	Kawartha Lakes Fishing Club Event	Catchacoma Lake	Unknown
Pembroke	Ottawa Region Walleye League # 5	Centennial Lake	Walleye
Bancroft	15th Annual Pike Tournament	Chandos Lake	Northern pike
Bancroft	Bancroft Bass Tournament Series Tournament	Chandos Lake	Bass
Pembroke	Bonnechere Valley Fire Department Bass Tournament	Clear Lake (Bonnechere)	Bass
Pembroke	Opeongo Open Fishing Derby	Clear Lake (Bonnechere)	Walleye, Bass, Northern pike
Pembroke	Fall Bass Challenge	Clear Lake	Bass
Bancroft	Earle Beer and Sean Baumhour Memorial Fishing Derby	Elephant Lake	Northern pike, Bass, Panfish
Bancroft	The Homestead Fishing Derby	Eels Lake	Unknown

District	Event Name	Location(s)	Fish Species
Parry Sound	Top 50 Pike Series Event	Fairy Lake (Huntsville)	Northern pike
Parry Sound	Annual Pike Challenge	Fairy Lake (Huntsville)	Northern pike
Bancroft District	Family Fishing Day	Galeairy Lake	All species.
Pembroke	Fall Bass Challenge	Golden Lake	Bass
Bancroft	8th Annual Murray Scott Memorial Ice Fishing Derby	Grass, Head, Syers and Canning Lakes	Unknown.
Pembroke	Ice Fishing Derby	Griffith area waters	Unknown
Pembroke	Madawaska Valley Pike and Walleye Derby	Griffith area – York Madawaska and Kaminiskeg Lake	Northern pike Walleye
Bancroft	Lindsay Bassmasters Event	Gull Lake	Bass
Bancroft	Rock Bass Fishing Derby	Gull River	Rock Bass
Bancroft	Lake Trout Ice Fishing Derby	Halls Lake	Lake Trout
Bancroft	Haliburton Highlands Outdoors Association Children's Fishing Derby	Head Lake	Unknown
Bancroft	Gals n' Pals Tournament	Head Lake	Bass
Bancroft	Kids, Cops and Canadian Tire Fishing Derby	Jack Lake	All species.
Bancroft	Bancroft Bass Tournament Series Event	Jack Lake	Bass
Bancroft	Kawartha Lakes Fishing Club Event	Jack Lake	Bass
Parry Sound	2012 Kermit Long Fishing Derby	Kahshe Lake	Unknown
Bancroft/ Pembroke	Petawawa Bassmasters Open Event	Kaminiskeg Lake	Bass
Bancroft	Gals n' Pals Tournament	Kashagawigamog Lake	Bass

District	Event Name	Location(s)	Fish Species
Bancroft	Kash Fishing Derby	Kashagawigamog Lake	Unknown
Bancroft	Rock Bass Tournament	Kennisis Lake	Rock Bass
Bancroft	12th Annual Rock Bass Derby	Koshlong Lake	Rock Bass
Bancroft	Children's Fishing Derby	Limerick Lake	All species.
Bancroft	Bancroft Bass Tournament Series	Limerick Lake	Bass
Bancroft	Bass Tournament	Limerick Lake	Bass
Pembroke	OBFN Event	Madawaska Headpond	Bass
Bancroft	1st Annual Fishing Derby	Mink Lake	Unknown
Parry Sound	2012 Muskoka Big Trout Ice Fishing Derby	Lake Muskoka	Lake Trout
Parry Sound	Father and Son Ice Fishing Day	Lake Muskoka	Unknown
Parry Sound	Lake Muskoka Pike Open	Lake Muskoka	Northern pike
Parry Sound	Mississauga Bassmasters Event	Lake Muskoka	Bass
Parry Sound	West Toronto Bassmasters	Lake Muskoka	Bass
Parry Sound	Family Fishing Day	Lake Muskoka	All species.
Parry Sound	West Toronto Bassmasters Event	Lake Muskoka	Bass
Parry Sound	Bassmania Western Tour	Lake Muskoka	Bass
Parry Sound	Festival Fishing Derby	Lake Muskoka	Unknown
Parry Sound	Barrie Bassmasters Event	Lake Muskoka	Bass
Parry Sound	York Bassmasters Event #7	Lake Muskoka	Bass
Parry Sound	Aurora Bassmasters Club Event	Lake Muskoka	Bass
Pembroke	Civitan Ice Fishing Derby	Muskrat Lake	All species.
Pembroke	Bass Anglers Association Event	Muskrat Lake	Bass

District	Event Name	Location(s)	Fish Species
Pembroke	Bass Anglers of Ottawa Tournament Series	Muskrat Lake	Bass
Pembroke	South Eastern Bass Open	Muskrat Lake	Bass
Pembroke	Renegade Bass 2012 Classic XVII	Muskrat Lake	Bass
Pembroke	OBFN Event	Muskrat Lake	Bass
Pembroke	Fall Bass Challenge	Muskrat Lake	Bass
Bancroft	MVFGC Annual Pike Tournament	Negeek Lake	Northern pike
Parry Sound	Oxtongue Lake Fishing Derby	Oxtongue Lake	All species.
Pembroke	Family Fishing Tournament	Palmer Rapids area	Unknown.
Bancroft	Palmerston Lake Bass Derby	Palmerston Lake	Bass
Parry Sound	6th Annual Ice Fishing Derby	Parry Sound area	Northern pike, Yellow perch, Black crappie, Lake Whitefish Lake Herring
Bancroft	Equine Assisted Living and Learning's 3rd Annual Ice Fishing Derby	Paudash Lake	Unknown
Bancroft	Percy Lake Ratepayers Association Fishing Contest	Percy Lake	Lake Trout Smallmouth bass
Bancroft	Bancroft Bass Tournament Series Event	Weslemkoon Lake	Bass
Algonquin Provincial Park	Family Fishing Day	Whitefish Lake	Rock Bass
Bancroft	Wollaston Lake Home and Cottage Association's Kids Fishing Derby	Wollaston Lake	All species.