Regulatory Guidelines for Managing the Lake Trout Recreational Fishery in Ontario

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Regulatory Guidelines for Managing the Lake Trout Recreational Fishery in Ontario

This report (tool kit) describes the regulatory options for the management of lake trout (*Salvelinus namaycush*) in Ontario. The options are based on a review of current literature on the effectiveness of various regulations for managing lake trout (McShane 2002; Olver et al. 2004), recent scientific knowledge (e.g. Shuter et al. 1998) and recent monitoring and assessment efforts (Rowe and Ingwersen 2003; Selinger et al. in review). The options presented here build on the science and management recommendations from the Lake Trout Synthesis (e.g. Payne et al.1990; Evans et al. 1991; Olver et al. 1991) and other lake trout management plans (e.g. OMNR 1994). The recommendations in this tool kit represent a combination of management strategies designed to protect lake trout populations from over-exploitation while, where possible, minimizing reductions in angling opportunities.

This tool kit was developed to provide a standard suite of regulatory options that could be applied on a provincial, regional or Fisheries Management Zone (FMZ) basis in order to avoid the unnecessary variations that are found in the existing regulations. Specially designated waters (SDW) are lakes or areas of high socio-economic importance that may have different regulations from the FMZ-wide regulations. Exceptions for these special waters or areas are acceptable, but they should be consistent with the direction in the tool kits and will be subject to a more rigorous review and approval process.

These guidelines will contribute to MNR's new Ecological Framework for Fisheries Management by:

- making the fishing regulations in Ontario easier to understand;
- increasing compliance by anglers;
- removing possible barriers to fishing due to complex fishing regulations; and
- providing a more consistent approach to managing fisheries on a broad scale.

The goal of this approach is to ensure that regulations can be rationalized on a sound biological basis to achieve resource sustainability while, at the same time, streamlining and simplifying Ontario's fishing regulations.

In order to provide consistency to the management of lake trout in Ontario, the regulatory options contained herein are the recommended options to be used in the development of new regulations for lake trout in the future. In cases where the existing regulations do not conform to the approach in this tool kit, they should be analyzed using the criteria set out in the Provincial Approvals in Principle process (Goodchild 2001). They should also be examined to ensure they are consistent with achieving the fisheries management objectives established for the FMZ and should be modified as necessary.

The Great Lakes or other border waters that have international or inter-provincial agreements in place should be considered exceptions to the lake trout tool kit. For those areas where agreements are not currently in place, the harmonization of multi-jurisdictional regulations should be sought and, where possible, be compatible with the lake trout tool kit.

Introduction

Lake trout lakes are rare. Only about one percent of Ontario's lakes contain lake trout (Figure 1), but this represents 20-25% of all lake trout lakes in the world. The lake trout is an important fisheries resource in Ontario. It is a preferred species among many anglers, both resident and non-resident, and provides a diversity of fishing opportunities.

In 1990, MNR identified 2318 lake trout waters in the province (OMNR 1990). Recently, as part of its coordinated strategy to protect lake trout lakes, MNR updated its list of inland lake trout waters and formally designated lakes that will be managed as either naturally reproducing lake trout lakes or put-grow-take (P-G-T) lake trout lakes (OMNR 2006) (see: http://www.mnr.gov.on.ca/MNR/EBR/lake_trout/lakes.pdf).

The current list designates 2283 inland Ontario lakes (exclusive of the Great Lakes) for lake trout management, including 2098 lakes that are identified for management of naturally reproducing populations and 185 lakes that are identified for management for put-grow-take stocking. 'Natural' lakes include those lakes that may have lost populations but have been identified for rehabilitation. 'P-G-T' lakes are managed to provide recreational fishing opportunities or to direct angling effort away from 'natural' lakes.

Lake trout are slow growing, exhibit late maturity, low reproductive potential and inhabit unproductive oligotrophic waters (Olver 1988). Lake trout spawn in autumn when water temperatures drop to 10-14°C and disperse after spawning (Scott and Crossman 1973).

It has been demonstrated that, over time, the development and/or creation of new access to lake trout lakes tends to result in habitat degradation, diminished lake trout populations, and a lower quality fishing experience. Approximately 5% of the province's lake trout populations have already become extinct (Lewis et al. 1990). Many other lake trout populations are threatened. There has been a general decline in both the quality of the sport fishery and in lake trout habitat in many lakes.

Excessive exploitation has undeniably played a key role in the decline of lake trout (Olver et al 1991) however there are many other stressors that have had detrimental effects on the lake trout resource. Lake trout and lake trout lakes are particularly vulnerable to the impacts of other human activities including: increased phosphorus inputs from cottage septic systems and other sources of nutrient enrichment, acidification, species introductions, and habitat destruction (Evans et al 1996; Dillon et al 2004; Steedman et al 2004; Vander Zanden et al 2004a, 2004b; Wilton 1985).

MNR is addressing a number of these other stressors on the lake trout resource through its coordinated strategy to protect lake trout populations in Ontario. In addition to this regulatory tool kit, the coordinated strategy consists of these other components:

- a science based, uniform approach to determining shoreline development capacity on lake trout lakes using a standardized dissolved oxygen criterion; and

- consolidation of land management policies for Crown lands adjacent to lake trout lakes, with subsequent amendments to the relevant area-specific land use policies in the Crown Land Use Policy Atlas (see: http://crownlanduseatlas.mnr.gov.on.ca/).

In 2007, the current thirty seven (37) Fishing Divisions (Appendix 1) will be replaced by twenty (20) proposed new Fisheries Management Zones (FMZ) (Appendix 2). The FMZs will become the unit of management for the majority of water bodies. This means that fish populations will be regulated, monitored, and assessed at the zone level (see: http://www.mnr.gov.on.ca/MNR/fishing/fmz/index.html).

The number of lake trout lakes by FMZ is shown in Appendix 3.

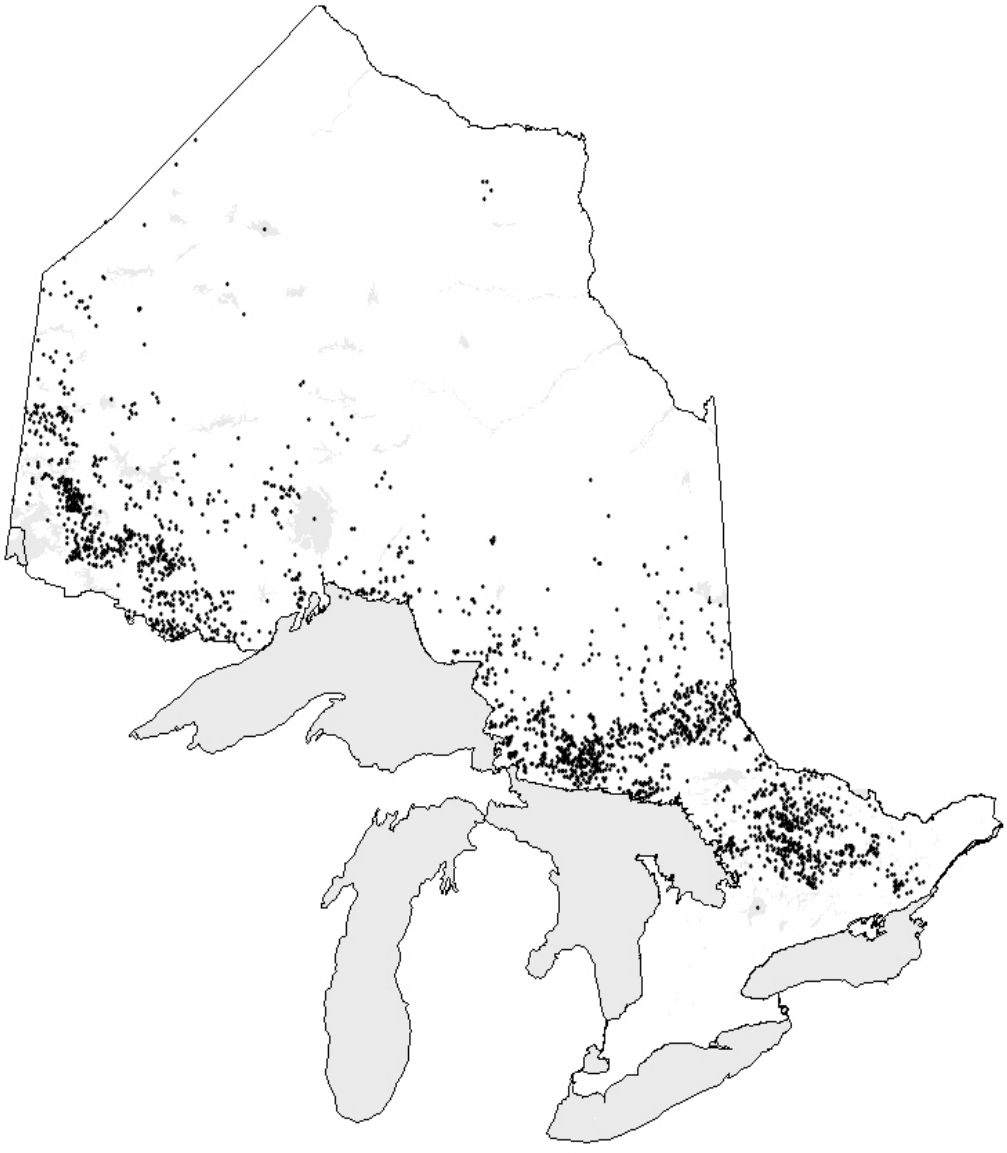

Figure 1. Distribution of lake trout lakes in Ontario (OMNR data).

Critical Levels of Effort and Harvest

Exploitation is a critical stress affecting lake trout populations (Olver et al. 1991; Olver et al. 2004). Angling effort on lake trout lakes varies across the province. A recent inland fisheries state of the resource pilot study on four tertiary watersheds (2HF, 2DC, 4LA, 5PB) found that mean total angling effort (21.1, 7.8, 5.2, 4.2 angler–hrs/ha respectively) generally decreased from south-central to northwestern Ontario (OMNR 2004). Effort can be extremely high on individual lakes (Evans et al. 1991; Rowe and Ingwersen 2003; Lester & Dunlop in press; Selinger et al. in review) especially for those lakes close to urban areas or those easily accessible by anglers (Lewis et al. 1991; Olver et al. 2004; Selinger et al. in review). In extreme cases, especially on small lakes, improved access can lead to harvests well in excess of sustainable levels in a matter of weeks (Gunn & Sein 2000).

Shuter et al. (1998) used an age-structured equilibrium yield model to predict Maximum Sustainable Yield (MSY) for lake trout lakes, determine the relationship between yield and fishing mortality, and the implications for fishing effort in no release fisheries (i.e. no size limits). They found that MSY ranged from less than 1.5 kg/ha/yr for 100 ha lakes to approximately 0.5 kg/ha/yr for 10,000 ha lakes. As lake area increases from 100 ha to 10,000 ha, effort associated with MSY shrinks from around 6 angler-hr/ha to values less than 4 angler-hr/ha.

Lester and Dunlop (2004) proposed that these could be used as critical values to evaluate fishing stress. It should be noted, however, that these values should be viewed as thresholds and not targets, and that ‘safe’ effort and harvest levels are likely much lower. To accommodate effort levels in excess of this range, fishing practices that reduce harvest by encouraging the release of a portion of the catch would be necessary.

For restoration of a remnant lake trout stock in Parry Sound, Georgian Bay, Reid et al. (2001) found that once supplemental stocking was terminated, yields as low as 0.3 kg/ha/yr could be necessary for long term sustainability of the population. Even lower yields would be required if mortality from sea lamprey increased (Reid et al. 2001).

Lower levels of critical effort and harvest would be expected with a loss of lake trout habitat or changes to fish community structure (Lester and Dunlop 2004). Recent predictions based on climate warming scenarios indicate that losses in fisheries yields could be expected with relatively small changes in lake trout habitat (Evans 2005; Mackenzie-Grieve and Post 2006). Direct effects of climate warming coupled with other indirect factors such as increased water demand would result in reductions in sustainable harvest levels and sustainable levels of fishing effort and mortality (Shuter and Lester 2004). Precautionary harvest regulations should be a component of future management strategies to mitigate or adapt to impacts of climate change on the lake trout resource (Evans 2005).

Open/Closed Seasons

In 1988, there were 10 division-wide lake trout open seasons in Ontario and over 50% of the lakes had the same season (Olver 1988). Currently there are twelve division-wide open seasons for lake trout, ranging from all-year openings to all year closures; in addition, there are ten open season exceptions (Table 1).

Fall closures are intended to protect aggregations of pre-spawning and spawning fish while spring closures are used when lake trout are vulnerable to capture during the ice-out period (Olver et al. 2004).

Spring and winter (partial and complete) closures are common exceptions in Ontario (Table 1) and the norm in Quebec (Olver et al. 2004). For the Great Lakes, the open season is Jan. 1-Sep. 30 & Dec. 1-Dec. 31.

Table 1. Division wide lake trout open seasons and exceptions in Ontario. (OMNR 2002).

Open Season	**Division (s)**
Open all year except December 24	14, 25, 24
January 1 - March 7 & May 20 - September 30	27
January 1 - September 30 & December 1 - December 31	1, 2, 8, 11, 16, 17, 23
January 1 - September 30	3, 4, 7,12A, 15, 28, 18, 19, 20, 22/22A, 30, 31, 32, 33
January 1 - March 15 & May 11 (2nd Saturday) - September 30	5
February 15 - March 15 & May 18 (3rd Saturday) - September 30	26
February 15 - March 15 & May 25 (4th Saturday) - September 30	21
March 9 (2nd Saturday) - September 8	29
March 1- September 30	34
April 26 (last Friday) - September 30	12
April 27 (last Saturday) - September 30	6, 13
June 1 (1st Saturday) - September 8	9, 10

Exceptions
Closed all year
April 27 - September 30
Closed January 1 - May 17 (Friday before 3rd Saturday) & September 9-December 31
January 1 - September 30
May 18 (3rd Saturday)- September 30
January 1 - March 15 & May 18 (Saturday before Victoria Day) – September 30
February 15 - March 15 & May 18 (3rd Saturday) - September 14
February 15- March 15 & May 18 (3rd Saturday) - September 30
June 15 (3rd Saturday) – June 21 (Friday before 4th Saturday)
January 1 - June 30

Regulating the length of the winter fishing season for lake trout can be a contentious issue. Many studies have found higher effort, success and harvest in winter lake trout fisheries and that the winter harvest has higher percentages of small, young, immature fish (Olver et al. 2004). Reducing the biological impacts on lake trout populations has been seen as a legitimate justification for limiting the winter season for lake trout (Olver 1988, Olver et al. 2004). A reduction in the length of the winter season, however, doesn't necessarily reduce angling effort or harvest in proportion to the season length

reduction (Amtstaetter 2006), nor does it ensure an effort reduction in the long run, as anglers will adapt their fishing activity to regulation changes (Rowe and Ingwersen 2003, Olver et al. 2004).

Olver et al. (2004) point out that, because season closures may impact different segments of the angling population disproportionately (eg. local residents versus tourists), allocating the resource among winter versus summer anglers is a social, rather than a biological issue. Despite the need to balance biological and socio-economic concerns, season reductions or closures remain a legitimate fisheries management tool.

Recommended Season Dates

Season close dates should reflect the timing of spawning activity to provide protection during this critical period. Due to wide geographic and climatic differences, lake trout spawning dates can vary somewhat across the province (MacKay and Hicks 1995), therefore we recommend that fisheries managers select the appropriate season from one of the following zone-wide open season standards.

RECOMMENDATION: Establish two open season standards:

- **January 1 to September 30; or**
- **January 1 to Labour Day**

Olver et al (1991) recommended that lake trout lakes of 100 ha and less should be closed to winter fishing, and that the winter lake trout season should be reduced to one month (February 15-March 15) on all lake trout lakes < 1000 ha. These seasons have been applied previously in some Divisions and as lake specific exceptions (Table 1).

Fisheries managers who employ reduced seasons should be aware that the relationship between season length, effort and harvest will not necessarily be linear. Amstaetter (2006) found that a 68% reduction in winter season length from a three month to a one month season (February 15-March 15) on Greenwater Lake in northwestern Ontario resulted in an effort reduction of 26%. Average yield (kg/ha) did not appear to decline in proportion to the effort reduction however; although the power of the statistical test to detect change was low (Amstaetter 2006).

In situations where a reduced winter fishing season is deemed an appropriate tool in order to reduce angler effort and harvest, fisheries managers should apply one of the following exception standards to maintain consistency in season length.

RECOMMENDATION: Establish standard exceptions for reduced winter lake trout seasons:

- **Winter Closure: If the desired outcome is a complete winter closure select one of the two (i or ii) open seasons below, with a closing date that coincides with the zone-wide open season standard (above):**

    i) Fourth Saturday in April to September 30 (or Labour Day); or

    ii) 3rd Sat. in May – Sept. 30 (or Labour Day)

- **Split season:**

  February 15 - March 15 & 3rd Saturday in May to September 30 (or Labour Day)

- **Closed all year (research lakes, lakes under rehabilitation or brood stocks requiring protection)**

Where season reductions are being considered for lake trout fisheries in areas which also support natural brook trout fisheries, some fisheries managers have expressed concerns about redirecting effort to these fisheries (e.g. Selinger et al. in review).

RECOMMENDATION: **In order to avoid redirecting angling effort, fisheries managers should consider, where possible, similar open season dates for brook trout and lake trout fisheries in zones with both of these fisheries.**

Seasons for Put-Grow-Take (P-G-T) Fisheries

In some cases, lake trout lakes are managed for P-G-T fisheries in order to deflect fishing effort away from vulnerable naturally reproducing (natural) lakes. This is a legitimate management strategy ("protection stocking"). In these cases, it may be desirable to have open season dates coincide with those for natural lake trout lakes within the same FMZ. This eliminates the potential shift of angling effort from the P-G-T lakes to the natural lakes once the season on the natural lakes opens.

In other situations, where the objective is to provide additional fishing opportunities and there are no nearby natural lakes, or sustainability on nearby natural lakes is not a concern, an extended season may be appropriate on put-grow-take lakes.

RECOMMENDATION: **Where it is consistent with the fisheries management objectives for the FMZ, establish a "standard" exception for put-grow-take fisheries:**

- **Year- round open season**.

For a list of inland waters that have been formally designated for management as Put-Grow-Take lake trout lakes (OMNR 2006) (see: http://www.mnr.gov.on.ca/MNR/EBR/lake_trout/lakes.pdf).

Alternate Open Seasons

Summer season closures have been rarely applied (Table 1), or evaluated, in Ontario and have been infrequently used in other North American jurisdictions (McShane 2003, Olver et al. 2004). One exception is a January 1 - June 30 open season on four lakes in Haliburton County, south-central Ontario. This season was put in place in response to evidence that a disproportionate number of large mature females were being harvested later in the summer (Casselman 2004).

Selinger et al. (in review) found reduced numbers of older females in their recent surveys of lake trout populations in north-eastern Ontario. They propose a similar mid to late summer season closure in order to reduce potential selective harvest of mature females and improve reproductive potential.

RECOMMENDATION: **Fisheries managers should explore, on an adaptive management basis, alternate open seasons for lake trout fisheries across a broad geographic scale (on a FMZ basis, for example).**

Catch and Possession Limits

Catch limit is defined as the number of fish an angler is allowed to catch and keep in one day. Fish which are caught and eaten that day as a shore lunch are counted as part of the daily catch limit. The possession limit is the number of fish an angler is allowed to legally possess at any time, whether on-hand, in cold storage, or in transit. In most cases the daily catch and possession limit are the same.

The concept behind catch and possession regulations is to limit the harvest, to equitably distribute the resource among users, promote an ethical use of the resource, attribute value to the resource and to convey a realistic expectation regarding capacity of the lake trout resource. However, Lester and Dunlop (in press) believe that historical (and current) fishing regulations have promoted unrealistic expectations of lake trout abundance and harvest potential. Also, daily catch limits alone, without entry or effort restrictions are not very effective at limiting total harvest (Olver et al. 2004).

Despite these limitations, catch limits are the most common restriction used to manage lake trout populations (Olver at al. 2004). In 1956, the daily catch limit for lake trout in Ontario was 5 fish. The limit gradually decreased in various regions of the province until, in 1974, a provincial standard limit of 3 fish was established. Olver (1988) felt this regulation would have little impact in low yield, low catchability lakes, but that it could have a large impact on high yield, high catchability lakes. Subsequently, catch and possession limits were reduced to 2 fish in many fishing divisions (Table 2).

Catch and release regulations for lake trout can have positive results, especially when hooking mortality is low (Burr 1991). Mortality can vary seasonally, however, and can be influenced by fishing method, bait type, and hooking location (Powell & Hawkins 1994).

There are currently two division-wide catch and possession limits for lake trout in the province of Ontario and nine exceptions by waterbody (Table 2).

Catch and possession limits for trout and salmon are considered in aggregate.

Table 2. Division-wide lake trout catch and possession limits and exceptions (OMNR 2002).

Division (s)	Catch Limit by License Type		Possession Limit by License Type	
	Sport	Conservation	Sport	Conservation
1, 2, 8, 11, 16, 17, 14, 18, 19, 25, 26, 23, 28	3	1	3	1
3, 4, 5, 6, 7, 9, 10, 12, 12A, 29, 13, 15, 27, 20, 21, 22/22A, 24, 30, 31, 32, 33, 34	2	1	2	1
Exceptions				
	3	3	3	3
	5	1	5	1
	0	0	0	0
	1	1	1	1
	2	2	2	2
	1	0	1	0
	2	1	2	1
	1	1	1	1
	1	1	2	2

Recommended Catch and Possession Limits

Currently, standard catch and possession limits for lake trout are either three (3) or two (2) for holders of a sport fishing licence and one (1) for a conservation licence. There are also numerous exceptions (Table 2). The majority of North American jurisdictions, including Canadian (Appendix 4) have standard catch and possession limits in this range (McShane 2003). As a general principle, conservation limits should not be equal to sport fishing licence limits, however, there are some areas where this occurs (Table 2).

In general, catch and possession limits are applied equally to resident and non-resident anglers alike, however in some cases differential catch and possession limits (i.e. lower daily catch limits for non-residents) are applied as a method of dealing with an allocation decision. There are currently differential catch and possession limit regulations for non-resident lake trout anglers in the Northwestern Ontario Border Waters area (OMNR 2002). If these regulations are meeting fisheries management objectives for this broad geographic area, they should be retained and considered exceptions to the tool kit.

Catch and possession limits for trout and salmon are considered in aggregate and should remain so. In order to maintain consistency with other salmonine species tool kits, we recommend the following.

RECOMMENDATION: Fisheries managers should adhere to the following principle:

- **Lake trout catch and possession limits should remain part of trout and salmon aggregate limits.**

Evidence suggests that a three (3) fish catch and possession limit is likely too liberal for the long term sustainability of inland lake trout fisheries (Selinger et al. in review).

RECOMMENDATION: **Establish a provincial catch and possession limit standard:**

- **Two (2) fish for holders of a sport fishing licence and one (1) fish for holders of a conservation fishing licence.**

As a minimum, those undertaking regulation reviews in the future should be encouraged to use this standard. Lester and Dunlop (in press) contend that even a two (2) fish limit (without additional measures to reduce overall harvest) is unsustainable in heavily fished regions of the province and may promote unrealistic expectations of lake trout abundance and harvest potential with anglers.

Size limit regulations along with gear and bait restrictions are often used as additional measures to reduce the harvest of lake trout while minimizing the restrictions on angling opportunities. The application of appropriate size limit regulations ideally requires a detailed knowledge of growth rates, maturation schedules and recruitment for an individual population or group of populations. In addition, gear and bait restrictions are often necessary to reduce post-release mortality associated with size limit regulations.

All of this tends to add further layers of complexity onto the regulatory regime (see Size Limits, next section).

Some of this complexity could be reduced with a catch limit of one fish, rather than size based regulations.

RECOMMENDATION: **Where additional conservation measures are required, fisheries managers should give serious consideration to the effectiveness of the following catch and possession limit standard:**

- **One (1) fish for sport fishing licence holders and zero (0) fish for conservation fishing licence holders.**

Walters and Cox (1999) point out, however, that in open access fisheries total angling effort is not limited and, therefore, individual daily catch and possession limits will only ensure a sustainable fishery as long as angling effort doesn't increase to a level that allows for excessive harvest.

In some situations, it has been determined that catch and release fishing for lake trout is consistent with local fisheries management objectives (eg. Clearwater Bay, Lake of the Woods; Parry Sound, Georgian Bay).

RECOMMENDATION: **Where fisheries managers wish to implement catch and release fishing for lake trout, they should use the following standard exception:**

- **Zero (0) fish for holders of either a sport fishing licence or a conservation fishing licence.**

More liberal catch limits may be appropriate for some Great Lakes fisheries where lake trout are less vulnerable to angling or where angler harvest is a small proportion of the total harvest.

RECOMMENDATION: **For Great Lakes waters that have a commercial lake trout quota, or where lake trout rehabilitation has been successful (eg. Lake Superior), establish a standard exception:**

- **Three (3) fish for sport fishing licence holders and one (1) fish for conservation fishing licence holders.**

Size Limits

Size-based regulations are intended to reduce the biological impacts of angling without restricting angling opportunities. Size limit regulations are usually intended to maximize yield and protect the spawning stock while maintaining angling quality at often intense levels of effort. There are three basic types of size limits:

- minimum size limit, whereby all fish below a designated size must be released;
- slot size limit, under which fish within a designated size range must either be released (protected slot) or retained (harvest slot); and
- maximum size limit, where all fish above a designated size must be released.

Ideally, the appropriate application of size based regulations requires a thorough knowledge of the life history for an individual population or class of lakes.

In the past 12-15 years, the number of different size limit regulations has increased to the point where these regulations have become exceedingly complex. Some size limit regulations are not based on adequate information and should be reevaluated.

The following guidelines are provided for evaluating a potential size limit regulation:

- Select the most appropriate type of size limit based on characteristics of the population (or population of lakes) and the objectives of the regulation.
- Ensure that biological information is collected and utilized to rationalize the use of size limit regulations.
- Only one type of size limit regulation should be used on an individual waterbody.
- Only one size regulation should be used over the course of the angling season.
- Evaluate the success/failure of size limit regulations based on the original goals and objectives.

Minimum length limits for lake trout are set to allow females to spawn at least once before they are harvested (Olver 1988); Burr (1991) proposed that minimum size limits should be set to allow lake trout two spawning occasions before being harvested. A minimum size limit may increase the yield of fish in the following circumstances:

- limited natural reproduction,
- good growth,

- low natural mortality,
- high exploitation (Burr 1991).

Minimum length limits for lake trout are generally avoided in most jurisdictions (Olver et al. 2004). Olver et al. (2004) report that most authors examining the utility of minimum size limits indicate that limits have generally been set too low to allow sufficient spawning escapement. The variability in lake trout growth and size at first maturity makes the application of a minimum size limit over a broad geographic range impractical. In addition, the tendency to catch smaller lake trout during winter ice fisheries than in open water fisheries further complicates the application of a minimum size limit (Olver et al 2004). When they are used effectively however, the result is an increase in the spawning stock, an increase in the catch rate and an increase in the minimum size of fish (Olver 1988).

In order to protect spawning size lake trout or to control harvest of "trophy" sized fish, a maximum or modified maximum size limit can be imposed, most commonly allowing anglers one fish over the maximum limit (Burr 1991). Maximum size limits can be applied to increase the density of mature fish where the stock has good growth potential or to maintain the population structure of unexploited stocks in lakes where a large body size can be attained (Olver et al. 2004). Reid et al. (2001) successfully rehabilitated a remnant lake trout population in Parry Sound, Georgian Bay by using a 61cm maximum size limit (along with a number of other management actions) in order to increase survival of spawning fish. Preliminary analysis of recent spawning stock assessment (2005) indicates increased numbers of large individuals on the spawning shoals (D. Reid, personal communication).

The objective of slot limits is to protect spawning age fish (Burr 1991). Theoretically, protected slot limits protect spawners but still allow the angler to harvest smaller fish and trophy fish (Olver 1988). In the Flaming Gorge Reservoir, Utah-Wyoming, a slot limit was implemented in response to decreased harvest. The result of the slot limit was a moderate increase in trophy catch with minimal reductions in yield and minimal increases in forage fish consumption (Luecke 1991).

In order to increase the number of large individuals in a lake trout population, a "window size limit" (with a minimum and maximum – i.e. a "harvestable slot") was once thought to be an appropriate management tool, however wild populations of trout often show decreases in the number of larger individuals after such a regulation (Jensen 1980). No jurisdictions are currently applying harvestable slots to lake trout fisheries (Olver et al. 2004).

Different management tools are sometimes required to achieve the objective of a trophy fishery. If the trophy catch is increased, then generally, total catch is decreased. Slot limits have been used in this situation in an attempt to increase the trophy catch without reducing the overall catch – i.e. by also allowing the harvest of smaller fish below the slot (Favro 1980).

Table 3. Division-wide and exception size limit regulations used for lake trout in Ontario. (OMNR 2002).

Size limit	Division
Division-wide	
40-55 cm protected slot	12
One over 56 cm (from September 1- September 30)	20, 21, 22/22A, 24, 30, 31, 32, 33
One over 70 cm	34
Exceptions	
Maximum Size Limit	
51 cm maximum (must have a healed fin clip)	
56 cm maximum (1 fish limit)	
55 cm maximum (1 fish limit)	
61 cm maximum (1 fish limit) (date restriction applied)	
Modified Maximum Size Limit	
One fish over 40 cm (2 fish limit)	
One fish over 56 cm (3 fish limit)	
One fish over 56 cm	
One fish over 65 1 fish limit, 2 fish possession	
One fish over 40 cm, one fish under 40 cm (2 fish limit)	
Slot Size Limit	
40 - 55 cm protected slot	
33 - 40 cm protected slot	

Recommended Size Limit Regulations

Currently there are three division-wide size limit regulations (one protected slot and two maximum size limits) and eleven exceptions by waterbody (Table 3). Ontario size limits are in total length.

Setting size limit regulations for inland lake trout fisheries is complicated by differences in growth potential among populations (e.g., large bodied – generally piscivorous vs. small bodied – generally planktivorous lake trout). One size limit is usually not appropriate for both types of populations, making the application of standard size limit regulations across broad geographic areas difficult.

Ideally, information about the life history characteristics of individual lakes would be desirable in order to select an appropriate size limit. According to Payne et al. (1990), in south-central Ontario, lake trout start to mature at age 5, achieve 50% maturity at age 6-7 and 90-100% maturity at age 7-9. They found a great deal of variability in growth parameters across the province but failed to find any clear regional differences, implying that such differences may be small relative to differences among individual lakes (Payne et al. 1990). In south central Ontario, a 33-40 cm and a 40-55 cm slot limit have been applied to small and large bodied populations of lake trout, respectively in order to protect spawning size (primarily 6 & 7 year old) fish (OMNR 1994).

In order to determine if various size limits would be effective on small bodied lake trout populations in northwestern Ontario, a preliminary examination of harvest data from Squeers Lake indicated that if a 33-40 cm protected slot limit were implemented on that lake, approximately 43% of harvested fish would fall within the slot and have to be released. This would result in a 28% reduction in harvest by weight (from 1.8 kg/ha/yr to 1.3 kg/ha/yr) (F. Amtstaetter, unpublished data).

Hicks (1994) found that a 40-56 cm protected slot size regulation in Smoke Lake, Algonquin Park has been effective at reducing angler harvest and increasing numbers of fish on the spawning shoals. That lake trout population is piscivorous, fast growing and late maturing. Early results from an adaptive management experiment on four small (220-360 ha) lakes in Haliburton County in south central Ontario indicate that a 40-55 cm protected slot regulation effectively protects lake trout of spawning age 6-12 yrs (D.O. Evans, unpublished data) providing for good natural recruitment even though winter fishing rates are relatively high (5-10 angler hours/ ha/yr) in the slot-protected lakes.

In Quebec, in order to avoid complexity, a single 30-50 cm (Fork Length) protected slot size limit was applied to over 300 lakes with varying growth rates, across a broad geographic area. The regulation proved effective in reducing exploitation for fast growing populations, but not for slow growing populations, especially in areas of high angling pressure (Legault et al. 2001). Quebec has since adopted a 40 cm (Fork Length) minimum size limit for slow growing populations and a 48 cm (Fork Length) minimum size limit for fast growing populations, despite the reported success of the slot limit (Legault et al. 2001). These minimum size limits are similar to the upper bounds of slot limits applied in south-central Ontario.

In order to reduce the harvest of large mature adult lake trout in northwestern Ontario, Trippel (1993) recommended either a “one over 55 cm” or “one over 60 cm” size limit for low or high conductivity lakes, respectively. He based his recommendations on differences in growth rates, maturity and fecundity and a concern that simple daily catch limits are not sensitive to differences in growth rates between lakes. NW Region implemented a seasonal size limit in 1999 – one over 56 cm from Sept 1 – Sept 30.

In a recent effort to reduce the harvest of the large bodied lake trout population of Big Vermilion Lake in northwestern Ontario by 50%, a modeling exercise indicated that a 45-60 cm protected slot rather than a “one over limit” may be an acceptable approach. It is too soon to evaluate the efficacy of this action; however anecdotal information indicates that after instituting the regulation, anglers are releasing a large portion of their catch (T. Marshall, personal communication).

As discussed earlier, a single protected slot limit may not be appropriate for both small and large bodied lake trout populations and life history information from individual lakes would be ideal in order to select effective size limits. Fisheries managers should be cognizant however, that tailoring size limits to classes of lakes based on lake trout growth characteristics could lead to increased numbers of exception regulations, depending on the distribution of each population type across a Fisheries Management Zone. In these situations, the zone standard should reflect the most commonly occurring population type, if known.

RECOMMENDATION: **Establish and continue to evaluate standard size limit regulations for classes of lake trout populations as follows:**

- **33 - 40 cm protected slot for small bodied populations**
- **40 - 55 cm protected slot for large bodied southern populations**
- **45 - 60 cm protected slot for large bodied northern populations; or**
- **1 > 56 cm for large bodied northern populations**

Selinger et al. (in review) propose that the selective protection of mature fish above 40 to 50 cm should be further evaluated in northeastern Ontario. They feel that a "**1 > 40 cm**", "**1 > 45 cm**", or "**1 > 50 cm**" regulation could offer more vulnerable larger bodied (piscivorous) populations a higher level of protection. A preliminary examination of data from Squeers Lake in northwestern Ontario indicates that a 1> 40 cm and a 1 > 45 cm regulation could reduce annual fishing mortality from 12.5% to 10.5% and from 12.5% to 11.9%, respectively on this small bodied population (F. Amtstaetter, personal communication). Application of a "one over" limit may, therefore, have utility in protecting both small and large bodied populations while reducing the need for exception regulations for specific waterbodies. Olver et al. (2004) recommend that experimental (i.e. adaptive) management projects should evaluate alternate size limit regulations (among other management approaches).

RECOMMENDATION: **Slot limits, maximum, and modified maximum size limits to protect mature fish or to manage for quality (trophy) fisheries should continue to be evaluated using an adaptive management approach.**

Size limit regulations are based on the assumption that lake trout can be caught and then released with no significant mortality. When considering size limit regulations, fisheries managers should determine if additional gear & bait restrictions are also required in order to reduce post-release mortality.

Fisheries managers should also promote guidelines for proper fish handling techniques, as outlined in Casselman (2005), to maximize survival of released fish (see: http://www.mnr.gov.on.ca/mnr/pubs/fishing/catch_and_release_review_and_guidelines.pdf).

A summary of catch and release tips can also be found on the OMNR website, here: http://www.mnr.gov.on.ca/MNR/fishing/catrel.html

Gear and Bait Restrictions

Gear and bait restrictions have been instituted in association with other regulations that are designed to reduce all or a portion of angler harvest (e.g., slot limits, catch-and-release only) in order to reduce mortality of released fish (OMNR 1994). These regulations are usually implemented in heavily fished waters to prevent overexploitation or in circumstances where fisheries management objectives are based on a measure of angling quality (e.g. high catch rates, trophy fishery).

Wording for gear and bait restrictions and exceptions should be consistent with wording recommended in *Regulatory Guidelines for Bait and Gear Restrictions* (OMNR 2005).

Recommended Gear and Bait Restrictions

Gear restrictions for lake trout should be standardized on a province-wide basis. The standardization of additional gear and/or bait restrictions should also be addressed.

Two lines have traditionally been used for angling through ice during the winter in Ontario. Most North American jurisdictions allow two lines in winter (Olver et al. 2004) although some Canadian jurisdictions allow as many as 5 or 10 (Appendix 4).

RECOMMENDATION: **Establish the following standard gear restrictions for lake trout fisheries:**

- **Two lines may be used when angling through the ice.**
- **Only one line may be used while angling in open water.**
- **Two lines may be used while angling in open water from a boat in Great Lakes FMZs 9, 13, 19, 20 (each FMZ may attach specific conditions under which two (2) lines may be used by boat anglers)**

Several studies have found that post release hooking mortality is influenced by hook placement. Deep hooking in critical areas (e.g. gills or gut) increases short-term mortality in released lake trout (Dextrase and Ball 1991; Powell and Hawkins 1994).

Some angling techniques specialize in allowing LT to swallow the hook (e.g. “beer canning”; using dead herring in the winter, etc). Any technique which allows the fish to swallow the bait before hooking and thus jeopardize post release survival needs to be regulated, particularly when protected slot size limit regulations are in effect.

Olver at al (2004) identified that species specific bait bans (eg. no herring) cannot be totally effective if alternative bait of a similar size is permitted. We recommend, therefore, that an appropriate standard bait restriction be applied in these situations.

RECOMMENDATION: **Fisheries managers concerned about excessive post release mortality from the use of large (live or dead) baits & deep hooking, should use one of the following standard bait restrictions for lake trout:**

- **The use or possession of live or dead fish exceeding 13 cm (5.1 inches) in length, as bait is prohibited.**
- **Only artificial lures (no organic bait) may be used while angling.**

For some lake trout fisheries, where there is a size limit regulation which necessitates the release of large numbers of captured fish (e.g. protected slot limit), there may be concerns about handling stress and increased post-release mortality, particularly in winter due to deep hooking.

Persons and Hirsch (1994) found that higher mortalities of winter caught lake trout were associated with set-lining (as opposed to jigging). This was primarily due to the deeper hooking associated with set lines. They recommended that set-lining should be restricted when regulations that require release of winter caught lake trout are in effect.

In these circumstances, managers may wish to consider additional gear restrictions.

Barbless hooks are easier to remove and can therefore reduce handling time and subsequent stress and potential post-release mortality of released fish (Casselman 2005). Anglers in British Columbia seem to readily accept and comply with barbless hook regulations (D.O. Evans, personal communication).

RECOMMENDATION: **Fisheries managers concerned about excessive handling stress and subsequent post-release mortality, should apply one or both of the following additional standard gear restrictions:**

- **Only one line may be used when angling through the ice.**
- **Only one barbless hook (single, double or treble) may be used while angling.**

In a review by Cooke and Suski (2005), they conclude that use of barbless hooks and a reduced use of organic baits will, in general, lead to minimal injuries, reduced handling time, and a lower chance of mortality.

In some situations a lake trout fishery may be designated for rehabilitation, however angling for lake trout (with harvest restrictions) is still permitted. In these situations, or others, where the levels of post-release mortality may be detrimental to successful rehabilitation or harvest reduction, additional measures may be required. Some jurisdictions prevent culling or "trading up" by requiring anglers to either immediately release live fish or immediately kill them to include in their daily limit (Olver et al. 2004).

RECOMMENDATION: **Fisheries managers should consider eliminating the possession of live lake trout. This prevents culling of the catch and greatly reduces mortality due to handling associated with delayed release of angled fish.**

Introduced Aquatic Organisms and Lake Trout Lakes

There is growing concern about the impacts of introduced aquatic organisms (particularly centrarchids) to lake trout lakes and subsequent reductions in growth and productivity and loss of biodiversity (Vander Zanden et al. 1999; Weidel et al. 2000; Jackson 2002; Pazzia et al. 2002; Vander Zanden et al. 2004a, 2004b; Lepak et al. 2006). Recent surveys by OMNR in northeastern Ontario have documented numerous unauthorized species introductions into lake trout lakes (Selinger et al. in review).

Due to the demonstrated impact of introduced fish on native brook trout populations, Olver et al. (2004) felt that a live bait ban would be appropriate where lake trout and

brook trout have co-evolved. There is currently a live bait ban in Algonquin Park, primarily to protect native brook trout populations.

RECOMMENDATION: **We recommend that, in order to protect the integrity of native lake trout and brook trout populations:**

- **Fisheries managers should continue to educate anglers about the impacts of bait bucket dumping and unauthorized introductions of sport and forage fish.**

- **Further restrictions on the use of live bait fish to conserve aquatic biodiversity may be appropriate on landscapes such as parks, protected areas and within some Fisheries Management Zones.**

Sanctuaries

Sanctuaries are designated areas, either an entire water body or portion, where fishing is prohibited. Some sanctuaries are seasonal in nature while others are year-round closures. In Ontario, sanctuaries for most species are instituted to protect spawning fish or pre- and post-spawning aggregations, when fish are potentially more vulnerable to harvest. Sanctuaries have also been used to prohibit all fishing for lakes that have a fishery that has been designated for rehabilitation.

In most cases, sanctuaries should not be used to close a fishery for an extended period of time for rehabilitation purposes. Season closures are a more appropriate option for rehabilitation or where short-term protection is required to establish a new population (i.e. introductions and transfers), since sanctuaries limit angling opportunities for other species.

Management recommendations from the Lake Trout Synthesis exercise (Olver et al 1991) included closing winter fishing for lake trout on lakes less than 100ha, due to the vulnerability of these fisheries. Selinger et al (in review) found that, in general a higher proportion of angling effort occurred during the open water season, except for small remote lake trout lakes which had higher angling effort in winter, primarily due to snowmobile access. In some situations it may be appropriate to institute a winter sanctuary rather than a closed season where other angling opportunities will not be lost.

RECOMMENDATION: **We recommend that, if fisheries managers wish to institute a winter sanctuary on a lake trout lake, the following sanctuary standard could be used <u>for lakes which do not support a fishery for other species</u>:**

- **Sanctuary from January 1 to 3rd Saturday in May**

There may be other legitimate reasons for instituting a sanctuary on a lake trout lake. In some cases, where there is a concern about post release mortality of incidentally caught lake trout while angling for other species, or a concern about the introduction of invasive species, a sanctuary may be more appropriate than a year round season closure.

RECOMMENDATION: **Where it may be appropriate to exclude all fishing activity in order to meet fisheries conservation objectives (e.g.**

research lakes, lakes under rehabilitation, Wilderness Class Parks or zones), we recommend the following sanctuary standard for lake trout lakes:

- **Year- round Sanctuary**

Limited Entry Fisheries

Olver et al (2004) contend that the open access, common property nature of lake trout management in Ontario is an inherent constraint to effective harvest control. Lester et al. (2003) feel that the assumption that recreational fisheries in Ontario will always be managed as open-access systems has greatly constrained the choice of management options (i.e. mainly creel and size limits).

Reid et al. (2001) found that when strict harvest control regulations were effective in restoring a remnant lake trout stock in Parry Sound, Lake Huron, anglers soon responded to improved fishing quality and harvests increased despite the controls. They felt that a more direct control of harvest (eg. a tag system) may be necessary to control harvest in the face of increased future angling effort.

Only two lake trout lakes in Ontario are currently managed as limited-entry systems. In Clearwater Bay (Lake of the Woods), a tag system is used to regulate an annual quota for lake trout harvest. Catch-and-release fishing only is permitted for those not successful in the tag draw (Lester et al. 2003). A recent evaluation of the effectiveness of the lake trout winter closure and limited entry tag system on Clearwater Bay found that, even though effort has increased dramatically in recent years, overall harvest has been reduced and maintained at sustainable levels (T. Marshall, personal communication). On Squeers Lake, total annual fishing effort is regulated through a draw that allows anglers 1 day of lake trout fishing during a 10 day period in the winter. The lake is closed to fishing for the rest of the year (Lester et al. 2003).

These have been useful experiments, but their applicability to zone-wide management should be tested across a broader landscape (Lester et al. 2003; Olver et al. 2004).

Anglers are often initially opposed to the idea of limited entry fisheries, but this opposition dies quickly when the benefits of improved fishing quality become evident (Walters and Cox 1999). Limited entry fisheries may be an appropriate option to consider in situations where a fishery is currently closed and is being considered for re-opening (after rehabilitation, for example) thus creating new angling opportunities.

It should be recognized, however, that while limited entry fisheries or tag systems can be effective in reducing harvest or managing a trophy fishery, they can be a complicated system to administer (B. Corbett, personal communication). Cost recovery through limited entry fees may be one way to cover the extra administrative costs.

RECOMMENDATION: **We recommend that Limited Entry Fisheries should be explored further as an option to control angler harvest for lake trout fisheries in Ontario.**

A "Fair Share" Quota

Olver et al. (2004) identified a number of lake trout management options that they felt should be implemented, reviewed, or evaluated through an experimental approach. The following is one option that we feel could be pursued.

Lester and Dunlop (in press) believe that fishing regulations have traditionally promoted unrealistic expectations of lake trout abundance and harvest potential.

They compared the difference between an angler's perspective of a "fair share" of the resource, based on fishing regulations that dictate a maximum allowable daily harvest (i.e. catch limit), with a perspective based on models that predict maximum sustainable annual harvest (Shuter et al. 1998) along with surveys that estimated annual fishing effort. Their analysis revealed a large mismatch between what anglers might perceive as their fair share of annual lake trout harvest and what might be sustainable, based on the level of fishing effort.

Olver et al. (2004) recommended that seasonal or annual catch quotas should be evaluated as alternate methods of regulatory control. Lester and Dunlop (in press) suggest that issuing a license with a stated "fair share" quota that is tailored to changes in the demand and supply of lake trout in different management zones might be a useful option.

Information supplied when issuing a license could state that anglers should not harvest more than *x* lake trout per year, where *x* would vary depending on the level of fishing effort. In less-populated Fisheries Management Zones, where fishing effort is lower, a higher annual "quota" (per angler) could be offered. The "quota" could be modified through time as changes in the level and spatial distribution of fishing effort occurred. Its value would provide a direct signal to anglers about changing demands on the resource (Lester and Dunlop in press). This approach implies monitoring of angling effort at the Fisheries Management Zone scale.

Ideally, the quota should be enforced, but if the required enforcement mechanisms and resources are not available, this explicit tactic (i.e., advertising fair share) still serves better than the current management approach which offers few clues and can result in unrealistic angler expectations of fair share (Lester and Dunlop in press).

<u>RECOMMENDATION:</u> **We recommend that efforts should be undertaken to educate anglers about the limited productive capacity of lake trout populations and the popularity of lake trout fishing:**

- **The use of a "fair share" quota, tailored to changes in the demand and supply of lake trout in different management zones, should be explored.**

References

Amtstaetter, F. 2006. Changes in the winter fishery of Greenwater Lake following a reduction in fishing season length. Aquatics Update 2006-1. Quetico-Mille Lacs Fisheries Assessment Unit. Northwest Science and Information. Ministry of Natural Resources. Thunder Bay, Ontario. 2 p.

Burr, J.M. 1991. Length limit regulations as applied to Alaskan lake trout fisheries, a synthesis of available data with recommendations. Alaska Department of Fish and Game. 23p.

Casselman, S.J. 2005. Catch-and-release angling: a review with guidelines for proper fish handling practices. Fish & Wildlife Branch. Ontario Ministry of Natural Resources. Peterborough, Ontario. 26 p.

Casselman, J.M. 2004. The lake trout (*Salvelinus namaycush*): An important northern freshwater keystone predator and valuable fish resource (Effects of temperature, global extremes and climate warming on year-class production of warmwater, coolwater and coldwater fishes in the Great Lakes Basin), p. 17-26. *In* L. McKee and S. Thompson (eds.) Symposium proceedings. Symposium on the ecology, habitat and management of lake trout in North America. Whitehorse, Yukon, August 14-16, 2002. 164 p. + appendices.

Cooke S.J. and C.D. Suski. 2005. Do we need species-specific guidelines for catch-and-release recreational angling to effectively conserve diverse fishery resources? Biodiversity and Conservation 14: 1195–1209.

Dextrase, A.J. and H.E. Ball. 1991. Hooking mortality of lake trout angled through the ice. North American Journal of Fisheries Management 11: 477-479.

Dillon, P.J., B.J. Clark and H.E Evans. 2004. The effects of phosphorus and nitrogen on lake trout (*Salvelinus namaycush*) production and habitat. *In* Boreal Shield Watersheds: Lake Trout Ecosystems in a Changing Environment (*eds*. J.M. Gunn, R.A. Ryder, R.J. Steedman). Lewis/CRC Press, pp. 119-131.

Evans, D.O. 2005. Vulnerability of lake trout populations and fisheries in eastern Canada to climate change: Ecological linkages, adaptation and management options. *In* Abstracts for Climate Change Effects on Fisheries and Aquatic Resources: Exploring the Reality of Adaptation in the Great Lakes Basin. Great Lakes Symposium-Workshop Windsor, January 10-11, 2005. http://www.fishclimate.ca/workshop-2005-abstracts.htm

Evans, D.O., K.H. Nicholls, Y.C. Allen and M.J. McMurtry. 1996. Historical land use, phosphorus loading, and loss of fish habitat in Lake Simcoe, Canada, Canadian Journal of Fisheries and Aquatic Sciences 53(Suppl. 1):194-218.

Evans, D.O., J.M. Casselman and C.C. Willox. 1991. Effects of exploitation, loss of nursery habitat, and stocking on the dynamics and productivity of lake trout populations in Ontario lakes, Ontario Ministry of Natural Resources, Lake Trout Synthesis, Toronto.

Favro, L.D., P.K. Kwo and F.J. MacDonald. 1980. Effects of unconventional size limits on the growth rate of trout. Canadian Journal of Fisheries and Aquatic Science. 37: 873-876.

Goodchild, C. 2001. Instructions for Ontario Fishery Regulation changes, variation orders and amendments. Fisheries Section, Fish and Wildlife Branch. Ontario Ministry of Natural Resources. Peterborough 11 p.

Gunn, J.M. and R. Sein. 2000. Effects of forestry roads on reproductive habitat and exploitation of lake trout (*Salvelinus namaycush*) in three experimental lakes. Canadian Journal of Fisheries and Aquatic Sciences 57: 97-104.

Hamilton, R. 1979. Lake trout management in Thunder Bay District. Ontario Ministry of Natural Resources, Thunder Bay District. M.S. Report- 2 parts. 18p.

Hicks, F. 1994. Early response of lake trout to a slot size limit. FAU Update No. 94-3. Algonquin Fisheries Assessment Unit. Ministry of Natural Resources. Whitney, Ontario. 2 p.

Jackson, D.A. 2002. Ecological effects of *Micropterus* introductions: the dark side of black bass. American Fisheries Society Symposium 31:221–232.

Jensen, A.L. 1981. Optimum size limits for trout fisheries. Canadian Journal of Fisheries and Aquatic Sciences. 38: 657-661.

Legault, M., H. Fournier, D. Nadeau and J. Benoit. 2001. Report on the protected slot limit for lake trout, 1993-1997: Status in Quebec. Societe de la faune et des parcs du Québec, Direction de la recherche sur la faune, Direction de l'aménagement de la faune. 76 p. (English translation).

Lepak, J.M., C.E. Kraft and B.C. Weidel. 2006. Rapid food web recovery in response to removal of an introduced apex predator. Can. J. Fish. Aquat. Sci. 63(3): 569-575.

Lester, N. and W. Dunlop. (in press). Contrasting views of fair share in lake trout fisheries. Extended abstract in: Proceedings of the 2nd North American Lake Trout Conference. Yellowknife, NWT. August 2005.

Lester, N.P. and W.I. Dunlop. 2004. Monitoring the state of the lake trout resource: a landscape approach. *In* Boreal watersheds: lake trout ecosystems in a changing environment. (*eds*. J.M. Gunn, R.A. Ryder, R.J. Steedman). Lewis/CRC Press. 293-328 pp.

Lester, N.P., T.R. Marshall, K. Armstrong, W.I. Dunlop and B. Ritchie. 2003. A broad-scale approach to management of Ontario's recreational fisheries. North American Journal of Fisheries Management 23:1312-1328.

Lewis, C.A., G.L. Cunningham and T. Chen. 1990. Analysis of Questionnaire on Stresses Acting on Lake Trout Lakes, Ontario Ministry of Natural Resources, Lake Trout Synthesis, Toronto.

Luecke, C., T.C. Edwards Jr., M.W. Wengert Jr., S. Brayton and R. Schneidervin. 1994. Simulated changes in lake trout yield, trophies and forage consumption under various slot limits. North American Journal of Fisheries Management. 14: 14-21.

MacKay, L. and F. Hicks. 1995. Spawning and emergence times for lake trout and brook trout. Ontario Ministry of Natural Resources. Muskoka Lakes FAU Manuscript Report. 9p.

Mackenzie-Grieve, J.L. and J.R. Post. 2006. Projected impacts of climate warming on production of lake trout (*Salvelinus namaycush*) in southern Yukon lakes. Can. J. Fish. Aquat. Sci. 63:788-797.

McShane, L. 2003. A literature review of lake trout regulations in North America. Ontario Ministry of Natural Resources, Fisheries Section, Peterborough 108p.

Olver, C.H. 1988. The regulation of harvest in lake trout sport fisheries: a review and appraisal. Ontario Ministry of Natural Resources. 67 p.

Olver, C.H., R.L. Desjardine, C.I. Goddard, M.J. Powell, H.J. Reitveld and P.D. Waring. 1991. Lake trout in Ontario: management strategies. Ontario Ministry of Natural Resources, Lake Trout Synthesis, Toronto. 90 p.

Olver, C.H., D. J. Nadeau and H. Fournier. 2004. The control of harvest in lake trout sport fisheries on Precambrian Shield lakes. *In* Boreal watersheds: lake trout ecosystems in a changing environment. (*eds*. J.M. Gunn, R.A. Ryder, R.J. Steedman). Lewis/CRC Press. 23 pp.

Ontario Ministry of Natural Resources (OMNR). 2006. Inland Ontario Lakes Designated for Lake Trout Management, May 2006. Ontario Ministry of Natural Resources, Fisheries Section, Peterborough 52p.

Ontario Ministry of Natural Resources (OMNR). 2005. Regulatory Guidelines for Bait and Gear Restrictions. Fisheries Section, Fish and Wildlife Branch, Peterborough. 6p.

Ontario Ministry of Natural Resources (OMNR). 2004. Monitoring the state of Ontario's inland lakes fisheries resources: a pilot study. Fisheries Section, Fish and Wildlife Branch, Peterborough. 55p.

Ontario Ministry of Natural Resources (OMNR). 2002. 2002 Recreational Fishing Regulations Summary. 96 p.

Ontario Ministry of Natural Resources (OMNR). 1994. Proposed management for naturally reproducing populations of brook trout and lake trout in south central Ontario. Brook Trout/Lake Trout Management Committee. Toronto, Ontario. 38p.

Ontario Ministry of Natural Resources (OMNR). 1990. Lake Trout Lakes in Ontario, June 1990. Ontario Ministry of Natural Resources. Peterborough. 67p.

Payne, N.R., R.M. Korver, D.S. MacLennan, S.J. Nepszy, B.J. Shuter, T.J. Stewart and E.R. Thomas. 1990. The harvest potential and dynamics of lake trout

populations in Ontario. Lake Trout Synthesis Population Dynamics Working Group Report. Ontario Ministry of Natural Resources, Toronto, Ont. 72p.

Pazzia, I., M. Trudel, M. Ridgway and J.B. Rasmussen. 2002. Influence of food web structure on the growth and bioenergetics of lake trout (*Salvelinus namaycush*). Can. J. Fish. Aquat. Sci. 59: 1593–1605.

Persons, S.E. and S.A. Hirsch. 1994. Hooking mortality of lake trout angled through ice by jigging and set-lining. North American Journal of Fisheries Management 14 (3) pp. 664–668.

Powell, M.J. and R. Hawkins. 1994. A review of the mortality of caught-and-released fish. Ontario Ministry of Natural Resources. Toronto, Ontario. 11p.

Reid, D.M., D.M. Anderson and B.A. Henderson. 2001. Restoration of Lake Trout in Parry Sound, Lake Huron. North American Journal of Fisheries Management 21:156–169.

Rowe, R. and T. Ingwersen. 2003. Highway 805 Lake Trout Lakes: State-of-the-Resource Report. Ontario Ministry of Natural Resources. North Bay. 32p.

Scott, W.B. and E.J. Crossman. 1973. Freshwater Fishes of Canada. Fisheries Research Board of Canada. Ottawa. 966 p.

Selinger, W., D. Lowman, S. Kaufman and M. Malette. (in review). The status of lake trout populations in Northeastern Ontario (2000-2005) NE Regional Planning Unit, Ontario Ministry of Natural Resources, South Porcupine. Xxp.

Shuter, B.J. and N.P. Lester. 2004, Climate change and sustainable lake trout exploitation: predictions from a regional life history model, *In* Boreal Shield Watersheds: Lake Trout Ecosystems in a Changing Environment (*eds*. J.M. Gunn, R.A. Ryder, R.J. Steedman). Lewis/CRC Press, pp.281-291.

Shuter, B.J., M.L. Jones, R.M. Korver and N.P. Lester. 1998. A general, life history based model for regional management of fish stocks: the inland lake trout (*Salvelinus namaycush*) fisheries of Ontario. Canadian Journal of Fisheries and Aquatic Sciences 55:2161-2177.

Steedman, R.J., C.J. Allan, R.L. France and R.S. Kushneriuk. 2004. Land, water and human activity on Boreal watersheds. *In* Boreal Shield Watersheds: Lake Trout Ecosystems in a Changing Environment (*eds*. J.M. Gunn, R.A. Ryder, R.J. Steedman). Lewis/CRC Press, pp. 59-85.

Trippel, E.A. 1993. Relations of fecundity, maturation, and body size of lake trout and implications for management in northwestern Ontario lakes. North American Journal of Fisheries Management 13: 64-72.

Vander Zanden M.J., J.M. Casselman and J.B. Rasmussen. 1999. Stable isotope evidence for the food web consequences of species invasions in lakes. Nature. 401(30): 464-467.

Vander Zanden, M.J., J.D. Olden, J.H. Thorne and N.E. Mandrak. 2004a. Predicting occurrences and impacts of smallmouth bass introductions in north temperate lakes. Ecological Applications. 14(1), pp. 132–148.

Vander Zanden, M.J., K.A. Wilson, J.M. Casselman and N.D. Yan. 2004b. Species introductions and their impacts in North American Shield Lakes. *In* Boreal Shield Watersheds: Lake Trout Ecosystems in a Changing Environment (*eds*. J.M. Gunn, R.A. Ryder, R.J. Steedman). Lewis/CRC Press, pp. 239-263.

Walters, C. and S. Cox. 1999. Maintaining quality in recreational fisheries: how success breeds failure in the management of open-access sport fisheries. Pages 22–29 *in* T. J. Pitcher, editor. Evaluating the benefits of recreational fishing. Fisheries Centre, University of British Columbia, Vancouver.

Weidel, B.C., D.C. Josephson and C.C. Krueger. 2000. Diet and prey selection of naturalized smallmouth bass in an oligotrophic Adirondack lake. J. Freshwat. Ecol. Vol. 15, no. 3, pp. 411-20.

Wilton, M.L. 1985. Water drawdown and its effects on lake trout (*Salvelinus namaycush*) reproduction in three south-central Ontario lakes, Ontario Fisheries Technical Report Series no. 20, Ontario Ministry of Natural resources, Toronto, Ontario.

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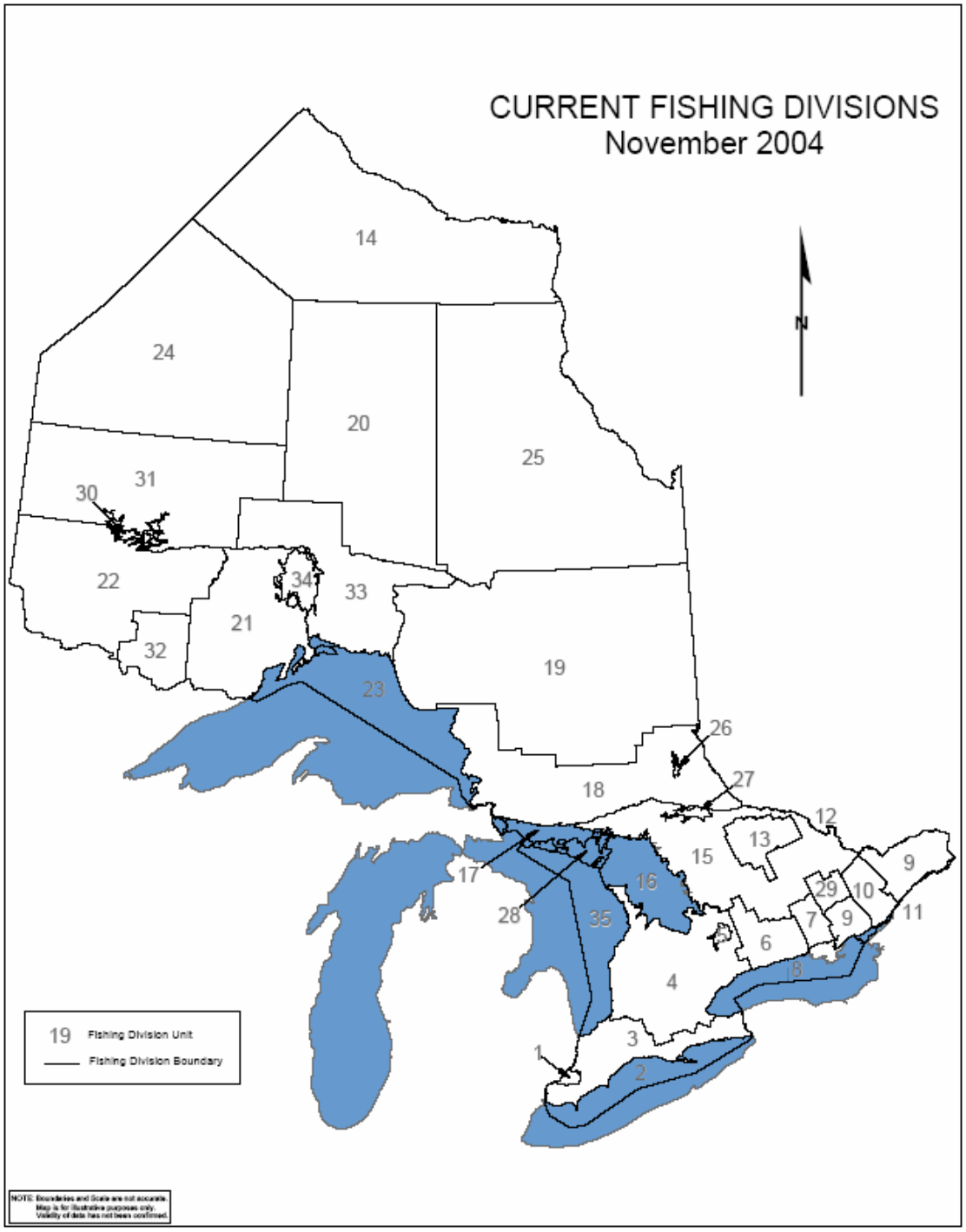
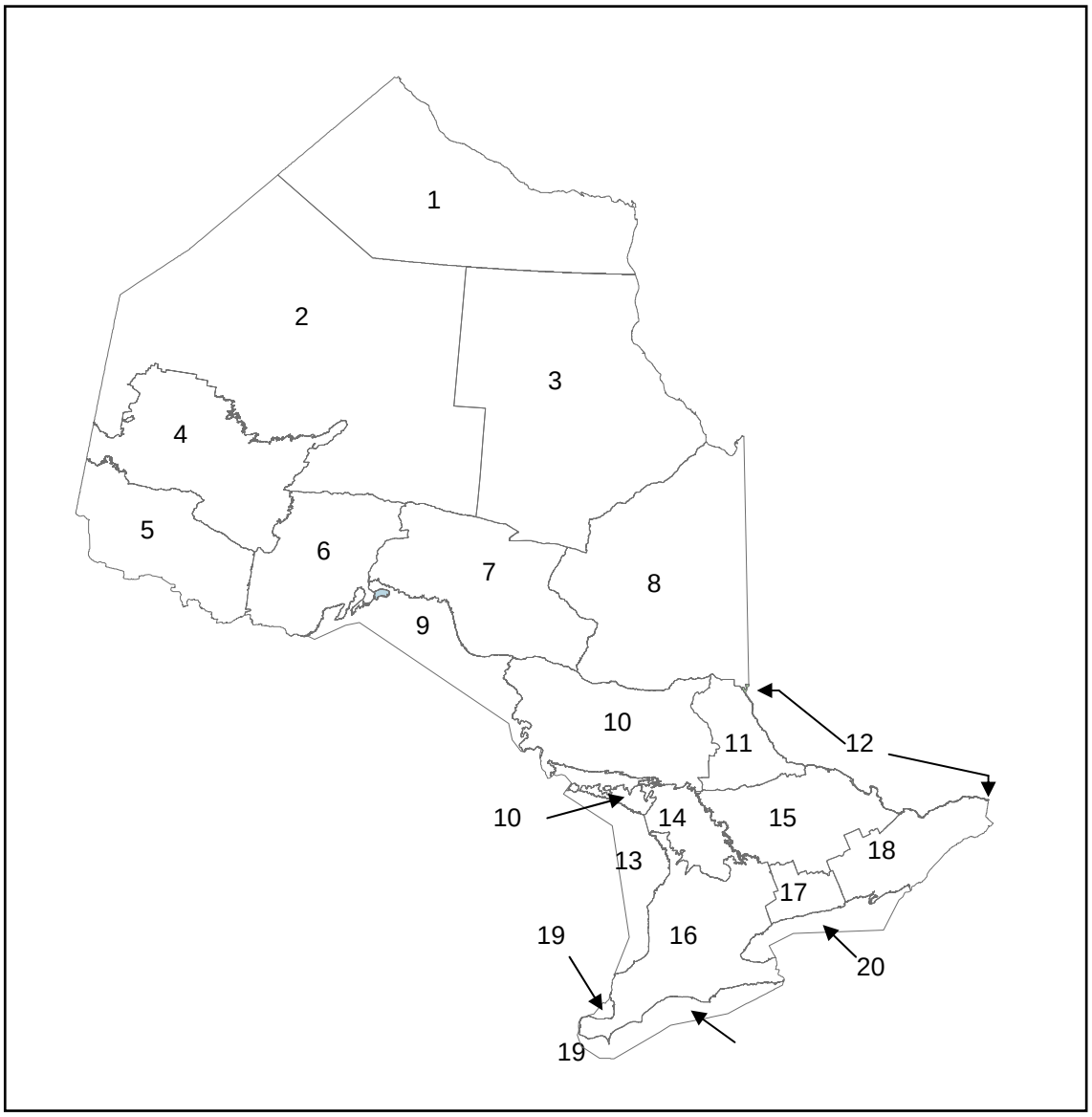
Appendix I. Current Fishing Divisions for Ontario's Recreational Fisheries.



Appendix 2. Proposed New (2007) Fisheries Management Zones for Ontario's Recreational Fisheries.



Appendix 3. **Inland Ontario lakes designated for lake trout management**.

MNR has recently confirmed 2283 inland Ontario lakes (exclusive of the Great Lakes) that have been designated for lake trout management, including 2098 lakes that are identified for management of naturally reproducing populations and 185 lakes that are identified for management for put-grow-take stocking.

'Natural' lakes are those lakes that have been identified as being managed for naturally reproducing populations (including lakes that have been identified for rehabilitation). Put-Grow-Take ('P-G-T') lakes are those lakes that have been identified as being managed for put-grow-take stocking to support recreational angling opportunities. A complete list of lakes can be found in OMNR (2006). Appendix Table 3.1 shows the distribution of lake trout lakes by proposed Fisheries Management Zones.

Appendix Table 3.1. Number of Inland Ontario lakes that MNR has designated for lake trout management for each proposed Fisheries Management Zone (FMZ), exclusive of the Great lakes.

Fisheries Management Zone	Lake Trout Lakes	
	'Natural'	'P-G-T'
1	4	-
2	103	-
3	-	1
4	123	-
5	490	-
6	153	-
7	108	8
8	17	50
10	603	26
11	125	12
12	1	1
15	326	71
16	2	-
18	43	16
All FMZs	2098	185

Appendix 4. Lake Trout Limits & General Gear Regulations in Canadian Jurisdictions.

Jurisdiction	*Daily Catch & Possession Limits*	*Gear Restrictions*	*Barbless Hooks*	*Notes*
Newfoundland & Labrador	2 (4 possession)	1 line summer 3 lines in winter	Barbless only on some waters. Promotes barbless.	
Nova Scotia	5 (of any species or aggregate of brook, brown, lake or rainbow) (Possession same as daily)	1 line - 3 separate hooks[1/] no gaffs allowed		[1/] non-tidal waters Lake trout in only 3 lakes
Prince Edward Island	N/A[2/]	1 line summer – 3 hooks/line	Promotes barbless.	[2/]No lake trout
New Brunswick	2 (over 45cm TL) (included in aggregate limits of 5 & 10)[3/] (Possession same as daily)	1 line summer – 3 hooks/line 5 lines winter – 1 hook/line no gaffs allowed	Barbless only on some waters. Recommend barbless.	[3/]additional aggregate weight limits apply on border waters
Quebec	2 (8 zones & most parks) [4/] Three standard size limits: 35 – 50 cm FL slot over 40cm FL over 50cm FL (Possession same as daily)	1 line in summer – 3 hooks/line (generally) 5 or 10 lines in winter spring gaff not allowed	Recommend barbless.	[4/] limit exceptions: 3 (3 zones) 4 (1 zone) 1 (some zecs)
Ontario	3/1, 2/1 most common[5/] regular/conservation licence numerous size limits (with numerous exceptions) (Possession same as daily)	1 line summer – 4 hooks/line 2 lines winter[6/] spring gaff not allowed	Barbless only on some waters.	[5/]Bag limits dependent on water body. [6/]Some waters with size limits also limit to 1 line in winter.
Manitoba	2/1 (1 over 65cmTL) [7/] regular/conservation licence 1 on High Quality Management Lakes (Possession same as daily)	1 line summer – 2 hooks/line 2 lines winter – 2 hooks/line	Barbless only.	[7/]Some individual lake exceptions.
Saskatchewan	4 (1 over 65cmTL) Catch & Release Limits: Type 1 - 2 (1 over 65cm) Type 2 - 2 (0 over 65cm) Type 3 - 1 (0 over 65cm)	1 line summer 2 lines winter 4 hooks/line gaffs < 1.5m winter	Barbless only on Catch & Release waters.	Exceptions to bag limits listed by lake (usually 2).

	(Possession same as daily)	spring gaffs not allowed		
Alberta	3 (included in aggregate limit of 5) (Possession same as daily)	1 line summer 2 lines winter 3 hooks/line no gaffs allowed	Barbless hooks **not** promoted	Exceptions to bag limits listed by lake
British Columbia	3 combined lake trout & bull trout/Dolly Varden (lake trout over 30cmFL) (as part of aggregate of 5 char/trout, 1 over 50cmFL, 2 from streams) – most common regulation (possession twice daily)	1 line summer[8/] 1 line winter 1 hook or lure/line	Barbless only on some waters. Barbless recommended.	[8/] a person alone in a boat on a lake may use 2 lines Exceptions to bag and size limits listed by lake.
Yukon	3(one over 65cmTL) Minimum size (20cmTL) applies to all species. (6 possession, one over 65cm)	1 line summer 2 lines winter No gaff in possession while fishing	Barbless only on some waters.	Reduced bag (2) and slot limits (65-100cm) in "High Quality Waters"
Northwest Territories	3 (5 possession) 1(2) for Great Bear 2(3)(one over 70cm TL) for Great Slave & Stark	1 line summer – 2 hooks/line 2 lines winter – 2 hooks/line No gaff in possession while fishing	Promotes use of barbless. Proposed new regulation - barbless only.	
Nunavut	3 (5 possession)	1 line summer – 2 hooks/line 2 lines winter – 2 hooks/line No gaff in possession while fishing	Promotes use of barbless.	
National Parks	3, 2, 1, or 0	1 line – 2 hooks/line no lead sinker	Barbless only on some waterbodies	Park dependant bag & size limits

From 2002 Angling Regulations of each Jurisdiction.

Compiled by Warren Dunlop, 2002.09.30