REGULATORY CONTROL OF WALLEYE FISHERIES IN ONTARIO

Percid Community Synthesis Harvest Control Working Group
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REGULATORY CONTROL OF WALLEYE (*Stizostedion vitreum* [Mitchill, 1818]) SPORTS FISHERIES IN ONTARIO

Report of the Harvest Control Working Group of the Percid Community Synthesis, 1999

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Table of contents

Executive Summary

This report summarizes the deliberations of the Harvest Control Working Group of the provincial Percid Community Synthesis exercise. Our analysis is based on current science and a review of the experience of both the Ontario Ministry of Natural Resources (OMNR) and other resource management agencies across North America. We present a series of conclusions and recommendations for regulatory control of harvest of walleye (*Stizostedion vitreum* [Mitchill 1818]) populations in Ontario.

Walleye are one of the most popular sport fish in Ontario and the subject of intense fishing pressure. A large portion of the tourism business in northern Ontario relies on the provision of quality walleye angling opportunities, especially to non-residents. Walleye are also eagerly sought by Ontario anglers, with the result that fishing pressure for this species often exceeds sustainable limits in some water bodies.

Walleye are vulnerable to recreational angling, especially in smaller lakes where new technology and new knowledge of their behaviour have substantially increased angler efficiency. Productivity in walleye lakes is related to the length of the growing season, so that southern lakes are more productive and can sustain a higher fishing pressure than northern lakes.

Walleye are a popular species for tournament angling, but are not as suitable for this type of recreation as other popular sports species, such as largemouth bass (*Micropterus salmoides*). Both warm temperature and wave action substantially increase the mortality of walleye held in live wells during tournaments. Better management of tournaments may minimize some of these concerns.

Harvest regulations in Ontario are complex, and generally ineffective in controlling harvest in this open access, common property fishery. Clients generally have not been part of the regulatory process, and often resist change that limits their opportunity to fish. Regulations need to be developed with clear goals and objectives, and with the full and open participation of clients.

Size based regulations (minimum, maximum, slot) show some promise, but may be considered inappropriate for a fishery that values fish as food more than the total angling experience. Nevertheless, there is some indication that size-based regulations are effective in reducing harvest.

The working group suggests a review of the current regulatory structure, with a view to simplifying and rationalizing where possible, and eliminating regulations that have been shown to be ineffective. This review should be undertaken with the full and open participation of the major client groups.

Abstract

Rietveld, H.J., E.W. Armstrong, D. A. Baccante, R. M Korver, R Leith, R. A. S. Mathers, T E. Mosindy, D. M. Reid, B. J. Ritchie, J. Seyler and R.L. Wepruk. 2000. Regulatory control of walleye (*Stizostedion vitreum* [Mitchill, 1818]) sport fisheries in Ontario. Percid Community Synthesis. Harvest Control Working Group. Ontario Ministry of Natural Resources, Peterborough, Ontario. 56 p.

Walleye (*Stizostedion vitreum* [Mitchill, 1818]) are avidly sought by sports anglers in Ontario, both resident and non-resident. Its popularity has resulted in extensive overexploitation in recent years in some areas of the province. The growth of population, improved access to the resource and greater knowledge about angling techniques has exacerbated this problem. As a result, fishing quality for walleye in many areas has declined to unacceptable levels. We describe the response of walleye dominated fish communities to angling exploitation. We examine some techniques used by other fisheries management agencies to control exploitation. Recreational angling harvest in Ontario has traditionally been controlled by means of regulations defining seasons, catch limits, terminal gear restrictions, and sanctuaries. We found that while some of the traditional management strategies still have value, others are largely ineffective in controlling harvest, and that economic and social considerations need to be considered in developing new management strategies for the future. We make recommendations for future directions in the regulatory control of walleye harvest.

Terms of Reference

In 1992, the Ontario Ministry of Natural Resources (OMNR) initiated an exercise to assemble information relating to fish communities dominated by walleye as the top predator. The Percid Community Synthesis which emerged consisted of a number of working groups charged with examining different aspects of walleye biology, exploring current issues, and developing recommendations for the future management of these fish communities.

The Harvest Control Working Group was charged with the tasks of

- providing the rationale for controlling sport harvest;
- describing harvest methods and the development of walleye sport fisheries;
- evaluating the effectiveness of various harvest control regulations;
- determining which techniques are most effective;
- reviewing the impacts of tournaments and catch-release practices on walleye populations , and;
- developing a decision support system to assist in the evaluation of proposed harvest control options

The working group initially focused on management priorities, namely the identification of walleye overharvest and its regulatory control in sport fishing. We did not consider commercial fisheries, which are regulated by a separate set of regulations, nor aboriginal subsistence fisheries.

This report will review the characteristics of a typical walleye population exploited by angling, and will address issues associated with the control of exploitation in recreational fisheries. It will examine changes in population structure, the behaviour of population variables when subjected to angling stress, and describe the response of walleye population parameters such as relative abundance, age and length distributions, and age of recruitment to the fishery, to exploitation. We review commonly used harvest control strategies and evaluate their effectiveness in controlling exploitation pressure. We assess the effect of catch and release mortality in fisheries that are managed by size-based regulations. We examine case histories of collapsed or overexploited populations to determine if there are common biological reference points that might serve as indicators of early warning signals of population stress or overharvest. We propose processes and innovative strategies to control exploitation in a range of walleye fisheries across the province of Ontario.

Introduction

Ontario's walleye are highly prized as food fish by anglers. Recreational angling fisheries are open access fisheries, controlled by seasons, daily catch and possession limits, fish sanctuaries, and size limits. Liberal catch and possession limits, combined with reasonably good catchability, have resulted in a heavy demand for walleye in most areas of the province. The 1985 Survey of Recreational Fishing in Ontario (Department of Fisheries and Oceans, Communications Directorate and Ontario Ministry of Natural Resources 1988) estimated that walleye comprise almost one-third of the non-resident catch of fish in the province, and one sixth of the resident catch. These proportions changed little in subsequent surveys, with the non-resident walleye catch increasing to 38% of the total non-resident catch of all species by 1995. The resident catch remained stable at around 15-16% of the total resident catch of all species (Ontario Ministry of Natural Resources 1993; Department of Fisheries and Oceans, Economic and Policy Analysis Directorate 1997). Non-residents catch more walleye than any of the other species sought. It is the third most frequently kept species after rainbow smelt (*Osmerus mordax*) and yellow perch (*Perca flavescens*) for residents. In northwestern Ontario, half of all the fish kept by both residents and non-residents are walleye. Many tourist outfitting enterprises are based on remote or fly-in walleye fisheries. In some more easily accessible lakes, the pressure on walleye populations has resulted in a significant decrease in angling quality, with the resultant complaints of poor fishing from anglers and outfitters alike. For example, Wepruk et al. (1992) reported that the value of the Rainy Lake tourist industry in 1992 was roughly half of what it was in 1980. This decrease in industry performance was strongly correlated with a sharp decline in walleye catch-per-unit-of-effort (CUE) from 0.6 fish per hour to 0.2 fish per hour.

Complaints led to demands for action by OMNR to improve fishing. The demands are usually of two kinds - stock more fish or prevent some fishers from accessing the resource by a variety of means.

Impact of angling on walleye populations

Angling as a form of exploitation has been observed to follow a predictable pattern in its impact on walleye populations. The early stages of angling on previously unexploited populations are characterized by relatively high yields and high angler success rates, largely at the expense of older age and size groups which appear to dominate the population (Mosindy et al. 1987). Relatively little angling pressure can result in large initial decreases in stock in a short period of time (Schneider 1973). Increasing angling pressure further erodes the initial standing stock, resulting in a decline in angling quality, as evidenced by a decline in mean age and size of the catch as well as the number of contributing age groups in the population. Percid populations respond to exploitation stress in predictable ways. The most obvious of these compensatory responses are: increased variability in recruitment; an increase in growth, especially of young fish; and a decrease in the age at first maturity from historic values (Table 1).

Table 1. Common observed responses of walleye populations to exploitation.

Population response	**Reference**
Increased growth rate	Moenig 1975
Increased fecundity	OMNR 1983, Baccante and Reid 1988
Earlier first age at maturity	Spangler et al. 1977
Reduced CUE	Chevalier 1977
Lower mean age and size of the population	Chevalier 1977; Colby and Baccante 1996

A population's ability to compensate for the effects of exploitation mortality ultimately depends on its own productive capability, within the bounds of available habitat and solar energy. Baccante and Colby (1996) have noted that naturally reproducing walleye populations in southern areas of the province have a greater capacity to compensate for exploitation than in northern areas, because they mature earlier than northern stocks. This difference was attributed to the significantly longer growing season in southern Ontario. Harvest at moderate levels can increase production of relatively unexploited walleye populations by reducing adult stock densities and decreasing competition for food and space, thereby allowing the remaining fish to grow faster.

Fishing quality is as much a factor of the perception of the users as of any objective criteria. In many instances, a decline in angling quality, deemed unacceptable by anglers, is in fact a population response to exploitation through the production of more, smaller fish, without any real loss in yield (Baccante and Colby 1991). The quality fishing index (QFI) developed by Baccante and Colby (1991) is an attempt to quantify what is often a relatively subjective opinion on the part of anglers. For example, an angler in northwestern Ontario may expect to be able to catch a daily limit of relatively large fish, while someone fishing in southern Ontario is often satisfied with fewer, smaller fish. Lower daily bag limits in more highly exploited fisheries also reflect this perception. It is generally acknowledged among fisheries professionals that even these lower bag limits (4 fish per day, rather than the traditional 6) are inadequate to control harvest, since possession limits are infrequently realized by the majority of anglers (Goeman et al. 1993).

At excessive levels, angling has the potential to bring about a dramatic change in fish community structure. The selective removal of larger predators such as walleye may allow for the increased abundance of smaller forage species, which are present in the same water body, as either native or introduced species (Spangler et al. 1977; Krishka et al. 1996). The abundance of other top predators with similar niche requirements can also increase. Numbers of northern pike (*Esox lucius*) and smallmouth bass (*Micropterus dolomieu*) have increased in Shoal Lake, Ontario following a collapse in walleye stocks, as the result of commercial and recreational overfishing (T.Mosindy, pers. comm.). However, D. Reid (M. Sc. Thesis 1985) suggests that there was no measurable increase in northern pike and common white sucker (*Catostomus commersoni*) stocks after the collapse of the walleye stocks in Henderson Lake, Ontario. Changes in dominance of fish communities can hinder recovery to the extent that stocks never return to their former abundance, even after the stress causing their collapse or decline has been removed (Colby et al. 1994). There is little documented evidence that angling alone has led to the total collapse or elimination of walleye populations. Nevertheless, angling in combination with other stresses, such as habitat loss, water level fluctuations or the introduction of exotic fauna, has led to long-term declines in stocks throughout Ontario and to fisheries that continue to produce below their potential.

Walleye angling success is variable, both for size and numbers of fish. The migratory behaviour and the availability of natural prey have both been implicated. Forney (1961) observed that winter ice fishing appeared to select for older walleye age groups than summer angling in Oneida Lake, New York. Increased mobility of larger, older walleye in search of food during fall months, as water temperatures decline, has been noted in assessment net catches from Red Lake (Smith and Ney 1973) and Lake of the Woods, Minnesota (Schupp 1972). In the Bay of Quinte of northeastern Lake Ontario, adult walleye migrate out of the bay in summer months, and return in the fall, as is evidenced by creel surveys carried out during these periods (Bowlby et al. 1991). This corresponds to changes in the mean size of walleye in OMNR index netting catches over the year. Lux and Smith (1960) observed considerable variation in angling success during open water although netting surveys did not indicate corresponding changes in fish abundance. They suggested that a mid-summer slump in angling success could be attributed to an increase in available food, making fish less likely to be caught. Forney (1961) found that walleyes in Oneida Lake, New York were most vulnerable to angling when the abundance of yellow perch, the primary prey, was low. Payer et al. (1987) attributed a decline in summer angling success for walleye s, especially larger fish, in

Lake of the Woods, Minnesota, to a seasonal movement offshore where they were less vulnerable to capture by anglers. The opening of the angling season in the spring in relation to the timing of spawning runs can have a pronounced effect on the exploitation of adult fish. High angling catch rates of mature fish have been observed adjacent to major spawning grounds where fish are still concentrated immediately after spawning: in Snake Bay, Lake of the Woods (T.Mosindy, pers. comm.); around Rainy Lake (D.McLeod, pers. comm.); on Lake Simcoe off the Talbot River; and tributary rivers to the Bay of Quinte (A. Mathers, pers. comm.). Osborn and Schupp (1985) observed a much higher catch rate of females in Lake Winnibigoshish, Minnesota, in years when spawning occurred late in the spring.

In spite of the historic variability in catches, there is growing evidence to suggest that angling efficiency has greatly improved over the last two decades, and that anglers have become more proficient at catching larger, mature walleyes, as well as more fish generally. Past observations of walleye angling fisheries (Serns 1978, Serns and Kempinger 1981) showed that exploitation rates decreased with increasing fish age and size. Larger walleyes did not appear to be as vulnerable as smaller fish to conventional angling techniques.

In a comparison of catches by anglers and by trap nets set for spawning fish, Osborn and Schupp (1985) found that anglers were catching mature walleyes in greater proportion to their abundance on spawning grounds in the late 1970s than in the late 1950s. The widespread use of electronic gear, especially depth sounders, position locators and underwater viewing devices, downriggers, and devices such as planer boards and glow sticks, along with greater dissemination of knowledge about walleye behaviour and successful angling techniques have increased angler efficiency. On many large walleye lakes, the use of larger, higher quality boats and better hydrographic charts have allowed anglers access to walleye in more open waters, over deep offshore shoals and away from traditional summer angling locations near shorelines and protected bays. As a result, angling impacts are no longer restricted to those segments of a population vulnerable to conventional angling methods. Instead, new technologies have the potential to affect a much higher proportion of a walleye population than in the past, especially fish which inhabit previously unexploited locations (e.g., schools of walleye suspended in mid-water).

With the increased use of new technologies to aid anglers in their pursuit of walleye, there has been a significant increase in the popularity of competitive fishing as a viable form of sporting event. There has been a dramatic increase in the number of competitive fishing tournaments for walleye staged annually throughout North America. Many fisheries managers consider overfishing to be the most significant negative impact of competitive angling (Schramm et al. 1991), although few studies exist to support this perception. A number of studies have documented the effects of hooking and associated handling mortality on walleyes caught during competitive angling tournaments (Fletcher 1987; Goeman 1991). Hooking mortality is generally not an issue in catch and immediate release fisheries. Mortality of tournament caught fish rises dramatically with hooking location (deeper hooked fish have much higher mortality), depth of capture, holding devices and time held, handling and weather (Armstrong 1995). Other potential effects may result from the release of angled fish away from their point of capture, leaving them more vulnerable to recapture and distant from available food sources (Schramm et al. 1987). In a comparison of the biological impacts of competitive fishing on largemouth bass and walleye, Hayes et al. (1995) predicted that walleye could not sustain as high a fishing mortality rate as largemouth bass at the same population growth rate, because walleye tend to mature at a larger size and age relative to minimum size requirements for entry into tournaments. This results in a higher mortality of pre-productive age groups. It has been generally observed that mortality occurring before sexual maturity has a greater impact on population growth than the same level of mortality occurring after maturity (Caswell 1989).

The fact that walleye display schooling behaviour makes them especially vulnerable to being caught at a rate which may be independent of their overall abundance in a water body (Korver et al. 1996). Improvements in angling technologies, such as the widespread use of sonic locators and underwater viewing aids, have increased anglers' abilities to find concentrations of fish, even when relative densities of populations are low. Angling CUE has traditionally been considered to be proportional to population density (Beard et al. 1997): fish were assumed to be caught by anglers in proportion to their abundance. This is known as constant catchability. However, Korver et al. (1996) observed a non-linear relationship such that catchability (the proportion of stock removed per unit of effort) is not constant, but increased as fish density decreased in seven Ontario walleye fisheries. This phenomenon, known as density-dependent catchability challenges our traditional reliance on angling catch-per-unit effort as a measure of walleye population abundance. A high or constant CUE may not indicate a stable population, because increasing catchability could mask other indicators that a population is declining.

Differences in water body characteristics can have a major influence on the degree to which walleye populations are affected by angling. Significant relationships have been noted between lake area and walleye yields (Baccante and Colby 1996), between lake area and population abundance (Hansen 1989), and between Secchi depth and growing degree days (Workshop Proceedings, this synthesis). Larger lakes have more walleye and can sustain higher harvests than smaller lakes although populations tend to be less dense. However, this relationship can be affected by other factors, notably fish community structure, nutrient loading, habitat type and availability, fishing effort characteristics, and harvest method (Baccante and Colby 1996). Between-lake differences in adult walleye densities can be attributed to many of these same factors, especially fish community type, energy input (e.g. growing degree days) and the availability of ideal habitat. The fact that smaller walleye lakes tend to be shallower and have a greater portion of their substrate in productive littoral area supports Rounsefell’s (1946) observation that smaller lakes are capable of producing more fish yield per unit area than larger ones.

Whether walleye populations in smaller lakes are more easily exploited and vulnerable to angling because fish are more concentrated than those in larger lakes needs to be more fully evaluated. Sullivan (pers.comm.) attributed the collapse of the walleye fishery in Wolf Lake, a small shallow mesotrophic lake in central Alberta, to angling. He documented a 600% increase in angling effort for walleye on this lake between 1979-92, along with a significant increase in angling efficiency attributable to the use of such gear as sonic locators and electric trolling motors. As walleye densities decreased, fish were found to concentrate in two small areas of the lake, which increased their vulnerability to anglers.

In southern Ontario, fishing pressure is high and most walleye lakes are thought to be over-exploited. Resource managers in northern Ontario have long observed the rapid decline in angling quality following the construction of access roads into previously unexploited or lightly exploited walleye lakes (Armstrong and Hendry 1995). This decline appears to be most dramatic in smaller lakes where low angling effort can produce high yields in the short term. Mosindy et al (1987) observed that 43% of the estimated annual adult walleye production was removed by relatively low angling effort (1.24 angler-hrs.ha^{-1}) during the initial stages of experimental angling on Savanne Lake, Ontario. Walleye were found to be available to open water angling techniques throughout the day and at locations throughout the lake, owing to its shallow depth and darkly stained waters. Ryder (1977) also found that walleye s fed intermittently during the day in similar low-transparency lakes. Armstrong and Hendry (1995) observed that allowable yields for walleye in four small Clay Belt lakes along the Detour Lake road in Northern Ontario were exceeded 64% of the time when angling pressure reached a minimum of 3 angler-hrs.ha^{-1}. They also attributed high walleye yields from relatively low fishing pressure to the increased vulnerability of walleye to capture in these small (<500 ha), shallow, low transparency waters. Conversely, in the Bay of Quinte, as water clarity has increased in the 1990’s as a result of phosphorus control and the invasion of zebra of mussel (*Dreissena polymorpha*), daytime walleye angling success has declined (A.Mathers, pers. comm.).

Productivity and potential yields of walleye waters vary greatly across the province of Ontario, depending on such factors as transparency, geology and growing degree days. Lakes in the south, with their longer growing seasons and higher productivity can sustain much higher levels of fishing effort (Kerr 1997, 1998 a,b,c; M. Rawson, pers. comm., A. Mathers, pers. comm.). The capability of small, northern walleye lakes to sustain high yields, fishing pressure, and exploitation rates is restricted by their inherent low productivity. Once angling quality declines to less than acceptable levels, many anglers move to other nearby lakes that promise better catch rates. Up until now, the continued availability of newly accessed lakes and alternate angling opportunities has probably saved many small lake walleye fisheries in northern Ontario from the more severe impacts of overfishing. In southern Ontario, where most walleye lakes are readily accessible, and generally heavily developed, there is usually some level of latent fishing pressure from lakeshore residents regardless of the quality of the fishery. As well, the proximity of southern lakes to major population centres makes them more vulnerable to sustained high angling effort, irrespective of angling success rates.

The working group suggests the following rapid assessment criteria for fisheries field managers to use as a quick means to diagnose overexploitation (Table 2). These criteria are by no means rigidly defined, show a high degree of variability when applied to individual cases, and should be used with caution, and then only as a guide to suggest if a problem might exist which demands further study. They are meant to assist managers as early warning flags.

Table 2. Rapid assessment criteria to help diagnose overexploitation

PARAMETER	**CRITERIA**
Effort	$\exists$ 5rod.hr.ha^{-1}(north), $\exists$ 20 rod.hr.ha^{-1} (south)
Actual yield/predicted yield	> 1
Mean age of angler catch	Age at first maturity or less
Number of female spawners	3 or fewer year classes present; mean age < 5
Mortality rate	> 50%
FWIN/NSCIN index	Good – Fair – Poor

Goals, objectives and regulations

The literature on percids suggests that they are resilient species, and respond predictably to stress (Colby 1977). Experience has shown that exploitation is **the** major stress operating in most of the walleye lakes in Ontario, followed by habitat alteration (e.g., shoreline alteration, water level fluctuations) in more developed areas. Walleye lakes vary in their ability to produce fish. Deep clear lakes, tending towards oligotrophy, produce less fish flesh per hectare than more productive, darker, shallower lakes. However, the range in productivity across the province for all practical purposes varies between 1 and 1.75 $kg.ha^{-1}$ (Ontario Ministry of Natural Resources 1983). Within these bounds, individual lake characteristics determine the productivity of their individual communities. This is an important concept. Sustainable yields cannot exceed what the waterbody is capable of producing. Those who see stocking as the panacea to all fisheries management problems poorly understand this seemingly self-evident statement.

The simple fact is that harvest expectations have to be matched to resource capabilities. This is not to say that only one scenario will be successful or sustainable. Many levels of biological sustainability are possible - from a very low rate of harvest of relatively few large fish, to a much higher rate of harvest with many small fish. For example, a 1000-hectare lake might produce a sustainable annual harvestable surplus of 1500 kilograms of walleye. This harvest could be expressed as 3000 0.5 kg (1 pound) fish, which, with a daily limit of 6 fish translates into 500 fishing days, or 1500 1 kg. (2 pound) fish, which, with a daily limit of 6 translates into 250 fishing days. It is clear that in order to provide more fishing days, the harvest of fish by each individual angler must be reduced. The implications of this strategy to those who make a living from the resource are obvious. If resort owners have exclusive access, the decisions become fairly easy, and make it possible for those entrepreneurs to base their marketing strategy on the biological capability of the lakes under their control. However, if the outfitters have to share the harvest with anglers who are not their guests, and who do not have to live by their rules, the problem of sustainability and wise harvest becomes more complicated. The situation can quickly deteriorate into a race to see who can catch the harvestable surplus most quickly. This example illustrates that it is necessary to define what the management objectives of a fishery are within the bounds of biological productivity. It also illustrates that basing a business strictly on the harvest and consumption of fish flesh may be a shortsighted decision, especially if the fishery is multi-use and open-access.

Most recreational fisheries, whether for walleye or for other species, are driven by the expectation of success. That intangible hunger on the part of anglers that they might actually succeed in enticing a fish to take a lure, "fighting" that fish to capture, and obtaining some evidence of their success, be it a photograph, a wall mount, or a shore lunch, continues to be a powerful motivator. The objective of most anglers is clear - they want to have the opportunity to catch a fish. Yet, when surveyed in the past (Department of Fisheries and Oceans, Communications Directorate and Ontario Ministry of Natural Resources 1988, Ontario Ministry of Natural Resources 1993, Department of Fisheries and Oceans, Economic and Policy Analysis Directorate 1997), the actual capture of a fish ranks below several other values related to outdoor recreation such as, clean water, scenery, and solitude. In managing these fisheries, most resource management agencies, including the Ministry of Natural Resources, continue to try to manage the resource, without admitting that they primarily manage people while generally ignoring expectations and values. As a result, they often lack the clear objectives and goals that satisfy the value systems of most anglers (Barber and Taylor 1990). Many of the problems associated with exploitation control reflect this lack of clear objective setting. Demaré (1995) states,

> “The fundamental problem with fisheries regulation, which has been identified repeatedly throughout the ONTARIO MINISTRY OF NATURAL RESOURCES’ internal policy literature, has been the failure to replace open access as the basis for public policy governing use of the

> fisheries with a system which establishes value and limits use in accordance with the public interest. The present system is defensive, reactive and results in an ad hoc application of regulatory techniques. As a result, individual fish stocks across the province are subject to unsuitable harvesting levels, the welfare derived from the resource is below potential, and the system of allocating harvesting opportunities across and amongst user groups is perceived to be unequitable, leading to conflicts over fisheries allocations."

The first step in the management of exploitation of a walleye population is the setting of clear, tangible goals and objectives for the management of the fishery. Barber and Taylor (1990) suggest that clearly stated tangible goals and objectives set the stage for:

- X identifying conflicting activities and providing a basis for accommodation;
- X guiding all elements of the decision-making process which leads to more effective management;
- X ensuring the accountability of the individuals charged with the management responsibilities; and
- X providing operational milestones for evaluating performance and results.

Intangible goals, on the other hand, while allowing resource management agencies the flexibility to accommodate diverse interests, also allow interest groups to promote their own agendas. This allows for differential interpretations of the actual goals, which usually leads to conflict both within agencies and between agencies and their clients. As well, it tends to lead to a bureaucratic emphasis on process over product.

In the process of setting goals and objectives, managers and clients must recognize the existence of the value systems of all the parties and larger interest groups. Although the term 'value' defies accurate definition, the awakening of one value will usually trigger a whole suite of other values. Conflict intensity is directly related to the differences among the values of the participants. Sashkin and Morris (1984) state that unresolved, value-based conflicts are major organizational problems and a major contributor to goals and objectives not being reached.

The people making the decisions need to have as much information as possible about the status of the walleye community, the fishing effort (real and expected) which will be brought to bear on the fish community, and the predicted effects of any recommended management approaches. Armed with this information, the management group, which should be composed of representatives of interest groups affected by any proposed changes, will then be able to choose a course of action which will fulfil the management objectives, while addressing the values held by the members of the group. In this way, they can choose between a numbers fishery and a trophy fishery, between catch-and-kill and catch-and-release, and between quantity and quality. This process will have the added advantage of educating the users of the resource about its finite nature and the need for trade-offs and compromise in all resource management decisions, and the need to address all the value systems of the affected parties. It puts the decision-making process squarely in the hands of the users, while government agencies act as information providers and facilitators.

Review of Ontario’s Walleye Fishing Regulations

Open season reductions, decreasing bag limits, and restricted size limits have been the most popular methods to reduce angler harvest in the management of Ontario’s walleye resource. The vast increase in the number of specific regulations emphasizes the increased usage of walleye fisheries, the decline in fishing quality in Ontario, and the perceived need by managers to control overharvest.

Season Closures

A review of the historic trends in walleye sportfishing regulations dating back to the 1950s (Appendix 1) reveals open fishing seasons were previously based on much broader geographical areas. Historically a north/south split in walleye fishing seasons was used, with the French River as the boundary. In the 1954 regulations summary, there was no closed season in the Great Lakes and their connecting waterways, with the exception of the Bay of Quinte (April 1 to May 14), Lake St. Francis (November 16 to May 14) and the remainder of the St. Lawrence River (March 2 to April 30). Kenora and Rainy River Districts and border waters between Ontario and Minnesota had a closed season of April 15 to May 14. All other inland waters north of the French and Mattawa Rivers had a protected spring spawning season of April 15 to May 21, while in the south, the season was closed January 1 to May 14. The shorter season in the south was likely indicative of higher fishing pressure due to accessibility of waterbodies, and their proximity to larger urban centres.

Changes in walleye seasons from 1967 to 2000 have generally reduced the duration of the open fishing season and have been used to protect the fish at their vulnerable time of spring spawning. In many areas the closed season has been changed to begin earlier and last longer, thereby protecting the spawning fish even in years with unusually early or late spawning periods. Currently in 2000 there are 34 different walleye seasons in Ontario waters (Table 3).

In spite of efforts to control harvest by regulation, there are still six divisions (Fig. 1) with an all-year open season. Two of those Divisions are in the extreme north of Ontario. Of the remaining all-year seasons, Divisions 1, 2 and 17 are Great Lakes waters or portions thereof, while Division 3 consists of that portion of southwestern Ontario adjacent to Lake St. Clair, the Detroit and St. Clair Rivers, and Lake Erie, all of which have all year seasons on their American sides. The issue of consistency with adjacent jurisdictions is also addressed in Divisions 11 (St. Lawrence River/New York) and 12 (St. Lawrence and Ottawa Rivers/Quebec).

Table 3. Summary of current (2000) walleye open seasons used in Ontario (some apply to entire divisions as noted, while others apply to specific waterbodies).

	Winter	Spring/Summer/Fall	Divisions
1	Open all year	Open all year	1, 2, 3, 14, 17, 24
2		May 13 (2nd Sat.) – September 30	6
3		May 13 – November 15	
4		May 13 – December 31	
5		May 17 – December 31	
6		May 20 – March 30	

7		May 20 – March 31	
8		May 20 (3rd Sat.)– November 30	13
9		May 20 – December 31	
10	January 1 – February 29(last day)		
11	January 1 – February 29(last day)	May 6 (1st Sat.) - December 31	8
12	January 1 – February 29(last day)	May 13 (2nd Sat.) – November 15	10
13	January 1 – February 29(last day)	May 20 – December 31	
14	January 1 – March 7	May 20 (Sat. before Victoria day) – October 15	27
15	January 1 – March 13	May 20 – December 31	
16	January 1 – March 13	June 15 – December 31	
17	January 1 – March 14	May 13 – December 31	
18	January 1 – March 14	May 20 – December 31	
19	January 1 – March 15	May 1 – December 31	16
20	January 1 – March 15	May 6 (1st Sat.) – December 31	11
21	January 1 – March 15	May 13 (2nd Sat.) – December 31	9
22	January 1 – March 15	May 20 – December 31	
23	January 1 – March 15	June 15 – December 31	
24	January 1 – March 31	May 12 (Fri. before 2nd Sat.) – December 31	12
25	January 1 – March 31	May 13 (2nd Sat.)-December 31	4, 5, 7, 12A, 29
26	January 1 – March 31	May 20 (3rd Sat.) – December 31	15, 28
27	January 1 – March 31	June 1 – December 31	
28	January 1 – March 31	June 15 – December 31	
29	January 1 – April 14	May 20 (3rd Sat.) – December 31	18, 19, 20, 21, 22, 22A, 23, 25, 26, 30, 31, 32, 33
30	January 1 – April 14	June 10 – December 31	34
31	January 1 – April 14	June 15 – December 31	
32	January 1 – April 14	July 1 – December 31	
33	January 1 – April 15	May 19 – December 31	
34	February 15 – March 15	May 20 – September 30	

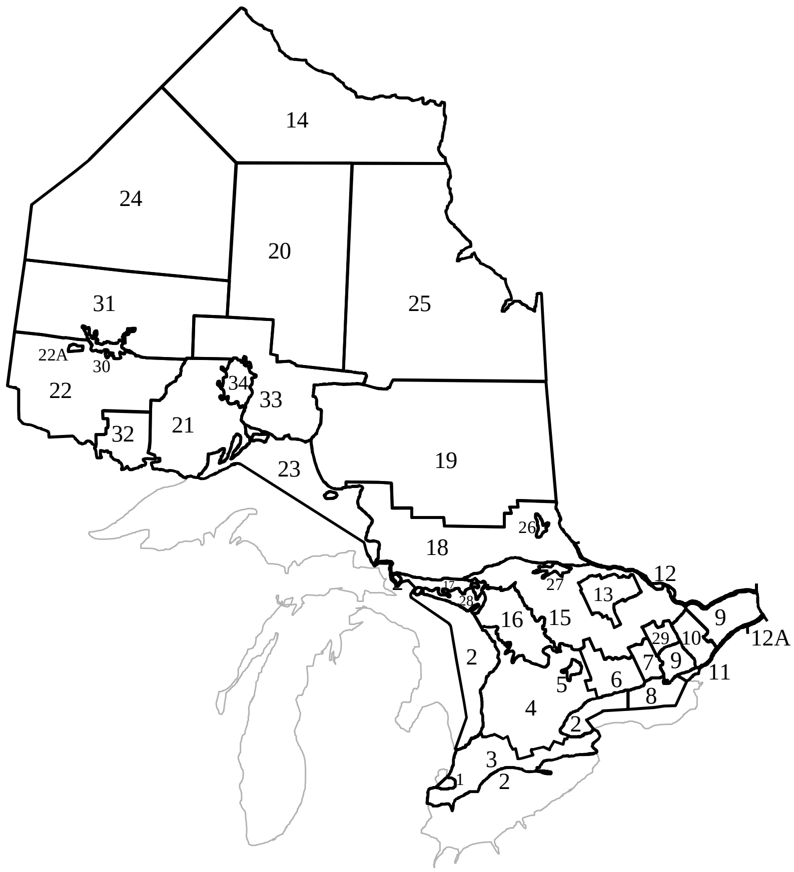

Fig. 1. Fishing divisions in Ontario, 2000.

The liberal walleye seasons on the Great Lakes were probably due to lake size, relatively light fishing pressure, and the perception that overharvest by sportfishing was unlikely. Prior to the 1970s, boats suitable for angling on large waters were relatively unavailable and may have limited the openwater Great Lakes angling fishery during this period. Currently the walleye season is open all year on Lakes Erie, Huron (except Georgian Bay), and the western portion of Ontario. While this is consistent with the United States jurisdictions of Ohio and Michigan, New York state has a first Saturday in May to March

15 season in Lake Ontario. The northeastern portion of Lake Ontario (Division 8; Fig. 1) has a walleye season from the first Saturday in May to the last day in February. The walleye closed season of the first Saturday in May to March 15 in the lower St. Lawrence (Division 11) is the same as in adjacent New York State waters. There is no apparent reason for this inconsistency on the same waterbody, other than tradition.

The remaining inland divisions show some degree of consistency in their closing dates, reflecting a cline from south to north. Two (Divisions 8 and 10) close at the end of February. Both these divisions are located in southeastern Ontario. Three divisions (9, 11,and 16) close on March 15th. These divisions are all in southern Ontario. Six divisions (4, 5, 7, 12A, 15, 28 and 29) close on March 31st. All but Division 28 (Manitoulin Island) are located in southern Ontario. Fourteen divisions (18-23, 22A, 25, 26, 30 - 34) close on April 14th. These divisions are all located north of the French and Mattawa Rivers, and contain the bulk of northern Ontario’s walleye resource. While the consistency in closing dates in northern Ontario is to be commended (seasons are either all-year or end on April 14th), the same cannot be said for the remainder of Ontario. With the exception of a few high profile waters (Lake Nipissing, Bay of Quinte), there appears to be little biological rationale for the current variety of closing dates. There may be some rationalization of the variety of season closing dates, but the matter requires further scrutiny.

The situation with season opening dates is much more complex. For those divisions with a winter season (only Division 13, Algonquin Park and Division 6, Victoria County are closed during the winter season). Division opening dates include: May 1st, the first Saturday in May, the second Saturday in May, the Friday before the second Saturday, the third Saturday in May, the Saturday before Victoria Day, and set dates of May 1 and June 10. In addition, there are six constant opening dates ranging from May 13 to July 1 on individual waterbodies. This confusing situation has dubious biological relevance, however, traditional use patterns make anglers generally resistant to change.

Since the early 1980s there has been a trend to tailor seasons for increasingly smaller geographic areas (Fig. 2; Appendix 1). In many cases individual waterbodies have been totally closed to walleye fishing for a number of years to allow the population to rehabilitate themselves naturally, without the added stress of continued angling pressure (Fig. 2; Appendix 1).

Reductions in open seasons seldom reduce harvest in a meaningful way (Christie 1978). Reducing seasons may not reduce overall fishing effort but only concentrate the same amount of fishing into the shorter seasons. Unless fish are less vulnerable during the shorter seasons, the harvest may not be as effectively reduced as initially predicted if fishing effort were to stable.

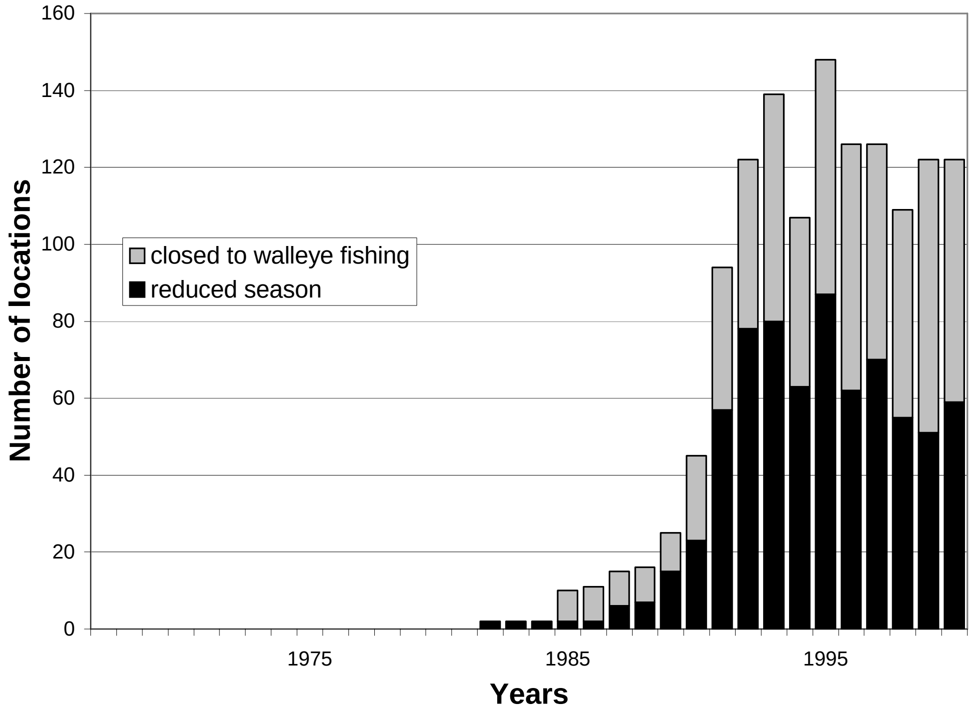

Fig. 2. The number of Ontario lakes with a lake specific walleye season or all year closure, 1967 to 2000.

Reducing fishing season length does restrict angling opportunities and may result in angler resentment.

We conclude that the use of seasons to control harvest (as opposed to protecting fish during vulnerable life history periods) is largely ineffective, even though this has been a traditionally accepted approach. Hence, we suggest that the relatively complex set of opening and closing dates has little if any biological relevance, and should be critically reviewed and simplified.

Catch and Possession Limits

Catch limit is defined as the number of fish an angler is allowed to catch and keep in one day. The possession limit is the number of fish an angler is allowed to legally possessed, on-hand, in cold storage, or in transit. Possession limits are the same as one day's catch limit for walleye in Ontario. The concept behind catch and possession regulations is to limit the overall harvest, to equitably distribute the resource among users and to promote the ethical use of the resource. The harvest limit of six walleye that was in place in the mid-1950s, is still being used in much of Ontario. Although the history is unclear, this regulation does not appear to have a biological basis, but is used mainly as an equitable allocation mechanism. It was not until the early 1980s that bag limits were reduced on some specific waterbodies (Figure 3). More recently (1995), a voluntary 'Conservation Limit' of 2 walleye was offered on a reduced fee licence. Similar limits were imposed for other species, and 'full' limits are only available for those anglers who pay the 'full' licence fee. The effectiveness of this strategy in reducing harvest of the target species has yet to be assessed.

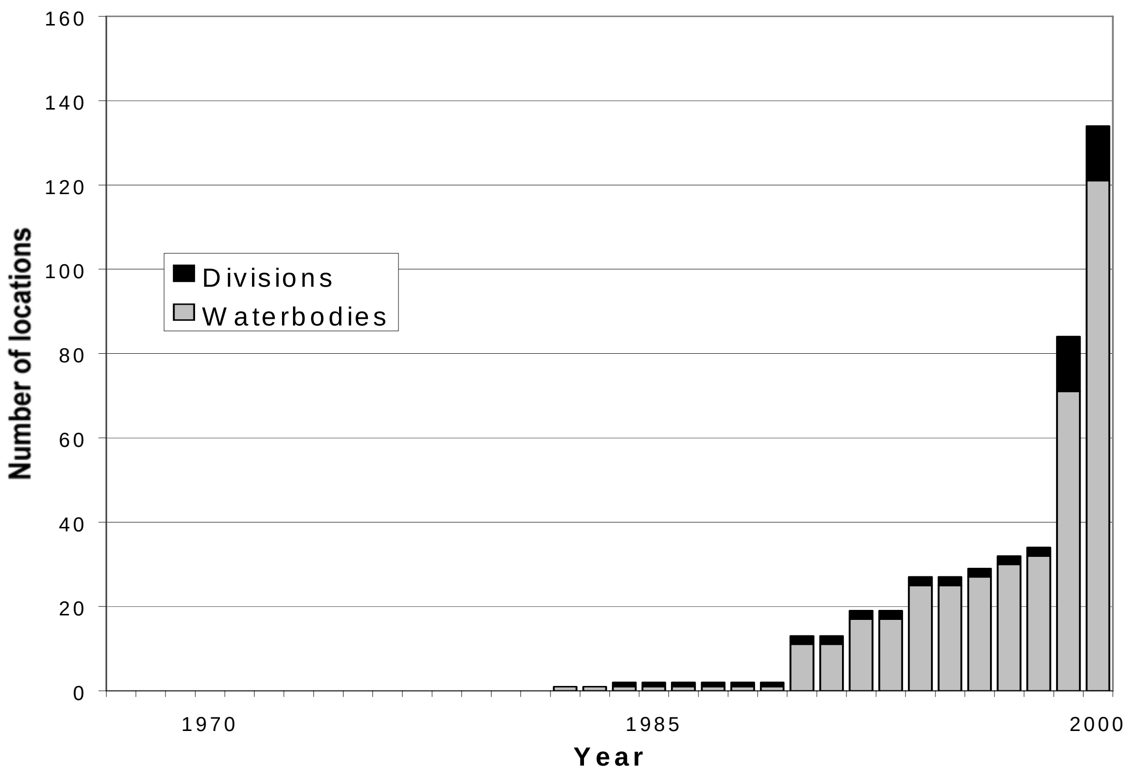

Fig. 3. Number of walleye catch and possession limit reductions (less than six fish) in Ontario, 1967 to 2000.

The number of lakes with lowered bag limits has continued to increase since the early 1980s, and by 2000 , 121 individual lakes and 13 fishing divisions have lower bag limits than the traditional six fish limit. The most common walleye bag limit less than six being used on individual lakes is two (Fig. 4). In 1999, all of northwestern Ontario (Divisions 20-22, 22A, 24, 30-34) and Division 27 of central Ontario reduced the walleye catch and possession limit to four. Division 8 of Lake Ontario has had a limit of four since 1984 and Lake Superior (Division 23) adopted a limit of three walleye in 1999.

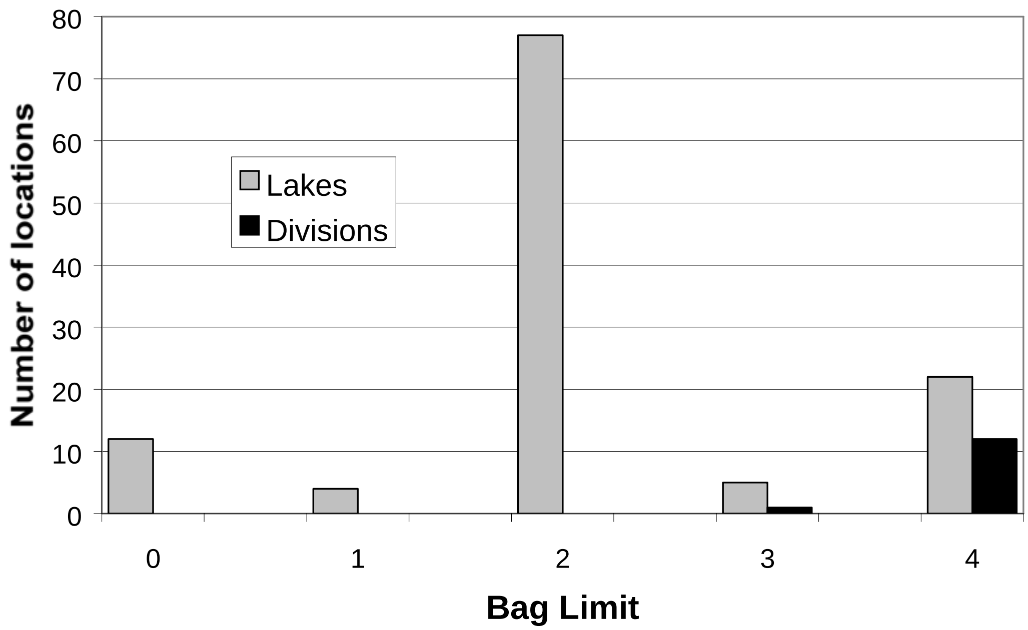

Fig. 4. Frequency of waterbody specific walleye catch and possession limits less than six in Ontario in 2000.

Bag limits are viewed as a goal by many anglers, and unfilled bag limits may increase angler frustration, as well as promote increased fishing effort. Lowering the bag limit thereby allowing more anglers to achieve the goal of filling their limit may increase angler satisfaction.

Although catch and possession limits are often used as an apparent means of reducing harvest, in most cases the majority of anglers catch very few fish (Baccante 1995). Munger and Kraai (1997) concluded that changes in the daily bag limit (increased from 5 fish to 10 fish daily) of walleye from Meredith Reservoir in Texas had no significant impact on angler harvest. Similar conclusions were reached by Quinn (1992). Goeman et al. (1993) found that increasing the bag limit from three to six fish in Minnesota waters was not successful in altering northern pike population size structure. In Ontario Ministry

Of Natural Resources computer simulations (R. Korver, OMNR, pers. comm.) of heavily exploited walleye fisheries, bag limit reductions have no appreciable effect on harvest except when they are very low (e.g. one fish per day). A. Mathers (OMNR, pers.comm.) working on the Bay of Quinte and the Kawartha lakes in Ontario, found that a bag limit reduction to two walleye per day would be required to reduce harvests by 20%. The effect of bag reductions were positively correlated to angling success, measured by CUE, with the greatest reduction in harvest occurring when CUEs were the highest. A. Mathers and L. Deacon (OMNR, unpub.) developed a set of nomograms illustrating this phenomenon. Redmond (1974) and Snow (1982) also found that changes to walleye bag limits had little effect on walleye harvest unless they were set at extremely low levels (e.g. 1-2 fish). This suggests that lower bag limits, while possibly distributing the catch more widely among anglers, actually has little effect in reducing harvest except when set very low (1-2 fish).

The question of bag limits, however, is more complex than simply an effort either to limit harvest or to more equitably distribute the catch of walleye. What is being offered as part of the walleye fishing experience needs to be considered. If the product is pounds of fish flesh then liberal bag limits, even though they are likely unsustainable in most instances, would tend to attract those angler interested in the fishing experience only to “fill the freezer”. We suggest that this exploitation pattern is no longer compatible with modern values and that harvest and consumption should only be a part of the fishing experience. We recommend that a catch and possession limit of four walleye be considered as a provincial limit, with exceptions for even lower limits where sustainability is an issue.

Although this change would likely have limited value in harvest reduction it will likely assist in a more equitable distribution of the resource among users. More importantly it will stress the value of each walleye and attempt to highlight the fishing experience more that the extraction component. Traditionally, the tourist industry has opposed this type of catch and possession limit reduction, since it means that their guests can only possess and take home four fish. We suggest that the “take-home” fish are no longer a major part of the tourist experience, as indicated by the reduced bag limit to four walleye (or less) recently introduced throughout northwestern Ontario. Since this area has long been renowned for excellent walleye fishing, with much higher harvests than southern Ontario, it would seem logical that limits in the south should be at least as restrictive and perhaps more so than the north.

Sanctuaries

Fish sanctuaries are areas that exclude any angling activity. Some sanctuaries are seasonal in nature while others are year-round closures. Seasonal fish sanctuaries are extensively used in Ontario to reduce harvest in both specific spawning areas (to protect adult fish and eggs) and “gathering areas”, (bays or reaches where fish form pre-spawning aggregations) while still allowing angling outside the protected area. Enforcement of sanctuaries can be difficult, since illegal activity has to be “found committing” in order to be effectively enforced. Once an illegally angled fish has been taken out of the sanctuary area, the onus of proof that the fish was taken illegally lies with the Conservation Officer. If the entire lake is declared a sanctuary, this onus of proof is much easier, but the net result is almost invariably a loss of fishing opportunities. The working group felt that this is an effective regulatory tool; however Christie (1978) concluded that, from an enforcement perspective, seasonal restrictions were more desirable than area limitations (fish sanctuaries) where closure was necessary to protect spawning fish.

In spite of the conclusions of Christie (1978) we recommend that sanctuaries continue to be used as a tool to fine tune harvest control regulations which protect walleye at vulnerable times of their life histories.

Size-Based Regulations

Few changes in the sportfishing regulations for walleye were implemented in the 1960s and 1970s (Appendix 1). With the 1980s increased emphasis was being placed on the nature of lakes and their relative classification to types based on size, depth, water chemistry, and fish communities types. Several international symposia (Loftus and Regier,1972; Colby, 1977; Christie and Spangler, 1987) and the articulation of a strategic philosophy for the management of fisheries in Ontario (OMNR 1976, OMNR 1992) undoubtedly influenced the burgeoning regulation changes ushered in through the late 1980s and the 1990s.

During this period increases in human population, available leisure time, and improved fishing technology resulted in much higher fishing pressure and harvest of fish especially in Southern Ontario and near the larger urban centres in the North. In addition, through the 1980s a change in angler attitudes began to focus more attention on angling as a form of recreation and sport rather than a method of harvesting fish for consumption.

These changes led to a management philosophy of trying to restrict harvest while maintaining fishing opportunities. Hence the attractiveness of size based regulations. Size based regulations allow anglers to continue to enjoy the benefits of the angling experience while reducing the impact of high harvest levels on fish populations.

Size limits have been used by fisheries managers across North America for many years (Table 4). Some of the objectives of size limits include increasing the size of fish caught, maximizing yield, protecting brood stock, maintaining desirable population structure, and maintaining angling quality. Any size limit regulation requires that the managers have sufficient age, length and maturity data for the effects of size limit regulations to be accurately modeled before their inception. As well, subsequent monitoring will be required to document and adjust to expected changes in population structure.

Table 4. A synopsis of selected walleye size limit applications in North America.

TYPE OF REGULATION	LOCATION	REFERENCE
Length and bag limits	Texas	Munger and Kraai (1997)
Minimum size	Wisconsin	Serns (1978, 1981)
Minimum size	Michigan	Schneider (1978)
Slot size	N. Ontario	Armstrong and Hendry (1995)
Size limits (slot, min, max)	Ontario	Brousseau and Armstrong (1987)
Slot limits	N. Ontario	Acres International (1997)
Slot, minimum size	S. Ontario	Kerr (1997, 1998a, b, c)
Slot size	N. Ontario	Seyler (1991)
Length limits	N. Ontario	Colby and Baccante (1996)
Length limits	Minnesota	Willis (1989)

The variety of different size based regulations in use in North America, includes minimum, protected (i.e. no harvest of fish in the slot) and open (i.e. release of fish in the slot) slots, maximum and one over maximum size limits.

Minimum size limit.

Minimum size limit regulations are those which require that fish shorter than a designated length be released. Minimum size regulations are recommended for populations:

- with low reproduction,
- that have good growth, especially of small fish,
- with low natural mortality,
- with high angling mortality.

(Brousseau and Armstrong 1987)

A minimum size limit, where all harvested fish had to be greater than 15” total length (38.1 cm), was in place for all waters in Ontario from 1941 to 1954. The only exception was Lake Erie where a minimum size limit of 14” total length (35.6 cm) was in effect.

During the 1950s, several good natural year-classes produced an abundance of fish in the range of 12 to 13 inches (30.5 to 33.0 cm). Fish of this size were caught by the thousands while the number of larger legal sized walleye declined rapidly. These smaller sized fish became stunted, and high natural mortality resulted in few of them surviving to reach legal size. This situation led to increased public pressure for change and the size limit was removed in 1954. It was hoped that by removing the minimum size limit, fishing mortality could be substituted for natural mortality and a thinning of the younger fish would reduce stunting and ensure the survival of more fish to larger, more desirable sizes (Brousseau 1985).

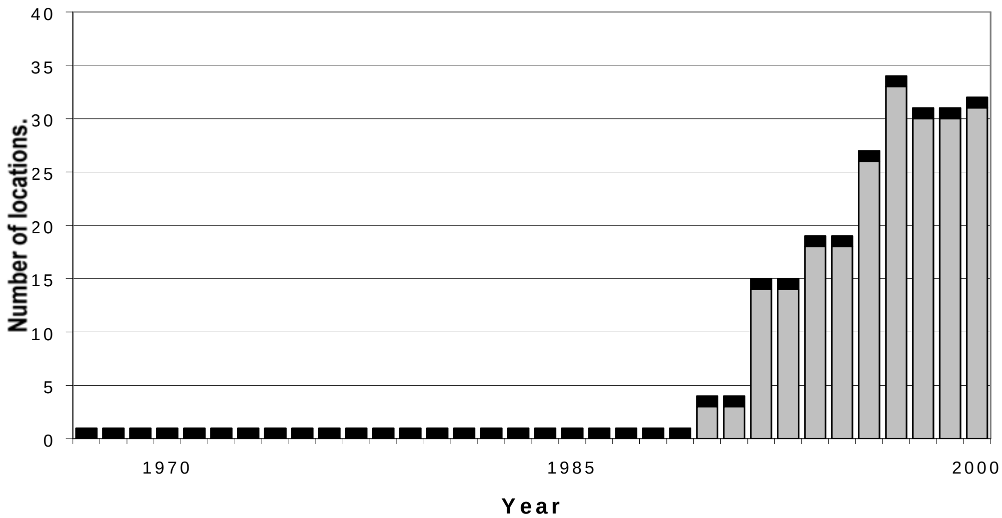

Figure 5. Number of divisions and waters with minimum size limits in Ontario, 1967-2000.

In the early 1960s a minimum size limit of 14 inches (35.6 cm) was established in Division 10 (Lanark and Leeds counties of eastern Ontario) and has remained in effect to the present. This particular regulation does not appear to have been established on any sound biological basis, and has been largely ineffective in increasing the size of fish caught (S. Kerr, OMNR, pers. comm.). Since 1990, the use of minimum and modified minimum size limits (i.e. those in combination with slot size and maximum size limits) has increased. Currently minimum size limits are the least popular of the size limit regulations. In 2000, 31 individual waterbodies and one division had some form of minimum size limit.

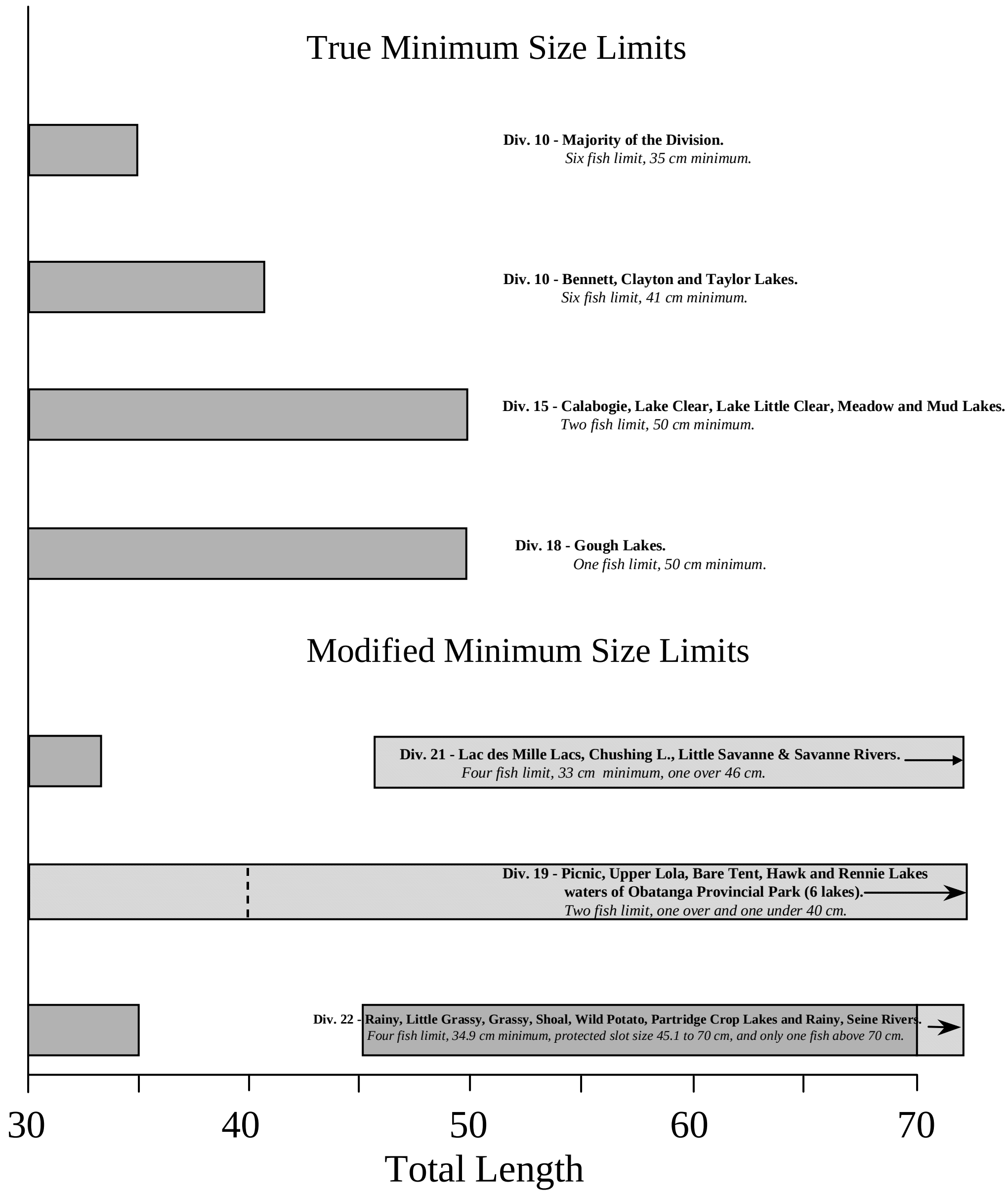

Fig. 6. Walleye minimum size limits currently being used in Ontario waters in 2000.

Currently, there are three different minimum size limits being used in Ontario, 35, 41 and 50 cm (Fig. 6). The waterbodies with these regulations are in southern and central Ontario (Div. 10, 15 and 18). In both the Lac des Mille Lacs (Div. 21) and Rainy Lake areas (Div. 22) of northern Ontario, a modified minimum size limit is being used in combination with a slot size limit. In Division 19 a modified minimum size limit is being used where only one fish greater and one less than 40 cm can be harvested. In most instances, minimum size limits are used in an attempt to protect young fish, thereby allowing increases in recruitment to fish of a more desired size. Success has been mixed in the use of minimum size limits. Stunting can result from excessively low minimum size limits. In Big Crooked Lake, Wisconsin, a 15 inch minimum size limit resulted in a decreased catch of larger fish (greater than 15 inches), and a decline in walleye growth rates (Willis 1989). While in nearby Wolf Lake, Wisconsin, the same minimum size limit increased the number of larger fish in both the population and the catch, with minimal decreases in growth rates (Serns 1981). These observations suggest that the application of a minimum size on an area, rather than a lake basis, should be done with caution. Selecting an overly high minimum size limit can result in a *de facto* maximum size limit or a total catch-and-release (no harvest) fishery. Modeling lake specific growth and maturation information can help determine the most appropriate minimum size regulation. Minimum size limits are most appropriate in lakes with low recruitment and thus are not appropriate to control exploitation where low recruitment is not a problem.

Maximum size limit

Maximum size limits require that all fish above a designated length range be released. This is an attempt to protect spawning-sized fish to increase spawning potential, recruitment, and year-class strength. This technique has also been used in an attempt to provide a fishery catering to those anglers seeking trophy-sized fish. These trophy-based fisheries can be managed either as a catch and harvest, or strictly catch-and-release situation.

Brousseau and Armstrong (1987), stated that maximum size limits are generally most effective where:

- there is a need to protect a brood stock,
- there is low density of mature fish,
- recruitment may be low,
- there is a highly exploited population.
- managing for a quality trophy fishery is a stated objective.

No maximum size limits were in use in Ontario prior to 1990. In recent years the regulation has been introduced to some divisions and individual lakes in northern Ontario. In 2000, 75 individual waterbodies and 10 divisions had some form of maximum size limit (Figure 7).

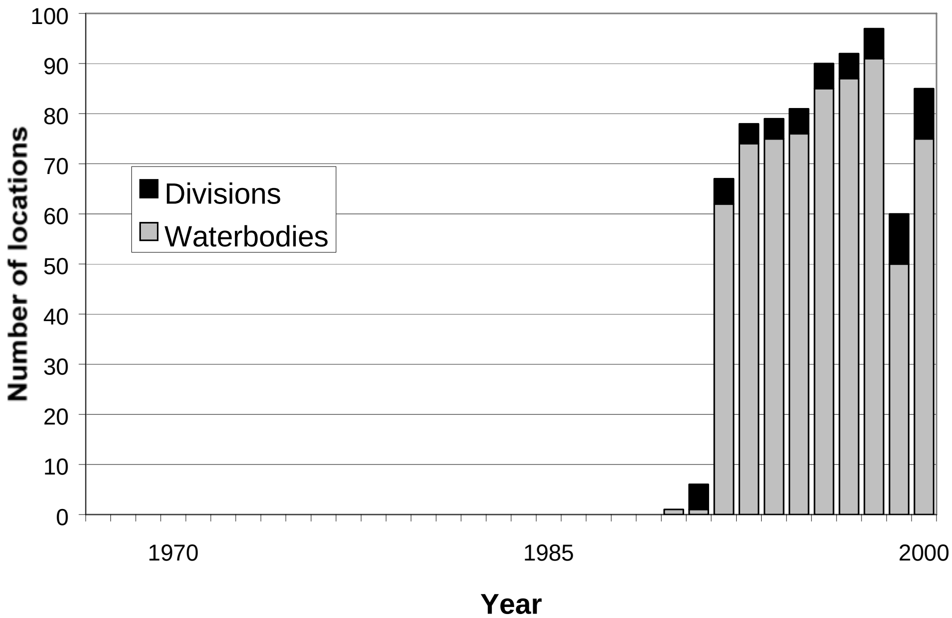

Fig. 7. Number of waterbodies and divisions with walleye maximum size limits in Ontario, 1967-2000.

In 2000, only two true (not in combination with other size based or allowing one fish over a maximum size) maximum size limits were in use in Ontario (Fig. 8). These were a two walleye limit none larger than 35.6 cm on two lakes in central Ontario, and a six fish limit none greater than 46 cm in the St. Marys River area between Lakes Superior and Huron. In some cases combining a maximum size limit with low bag limits may increase it's effectiveness. The most common modified maximum size limit in Ontario allows the harvest of one fish above the maximum size in an individual's bag limit. Maximum size limits are sometimes used in combination with slot size limits as a method to reduce the harvest of intermediate and large walleye. Although maximum size limits are currently being used Division wide in many cases, it has been recommended that this type of regulation be used only on a lake specific basis (Brousseau and Armstrong 1987). Since maximum size limits have only been used in Ontario since 1990 their suitability and long-term effectiveness is unknown and needs to be closely monitored.

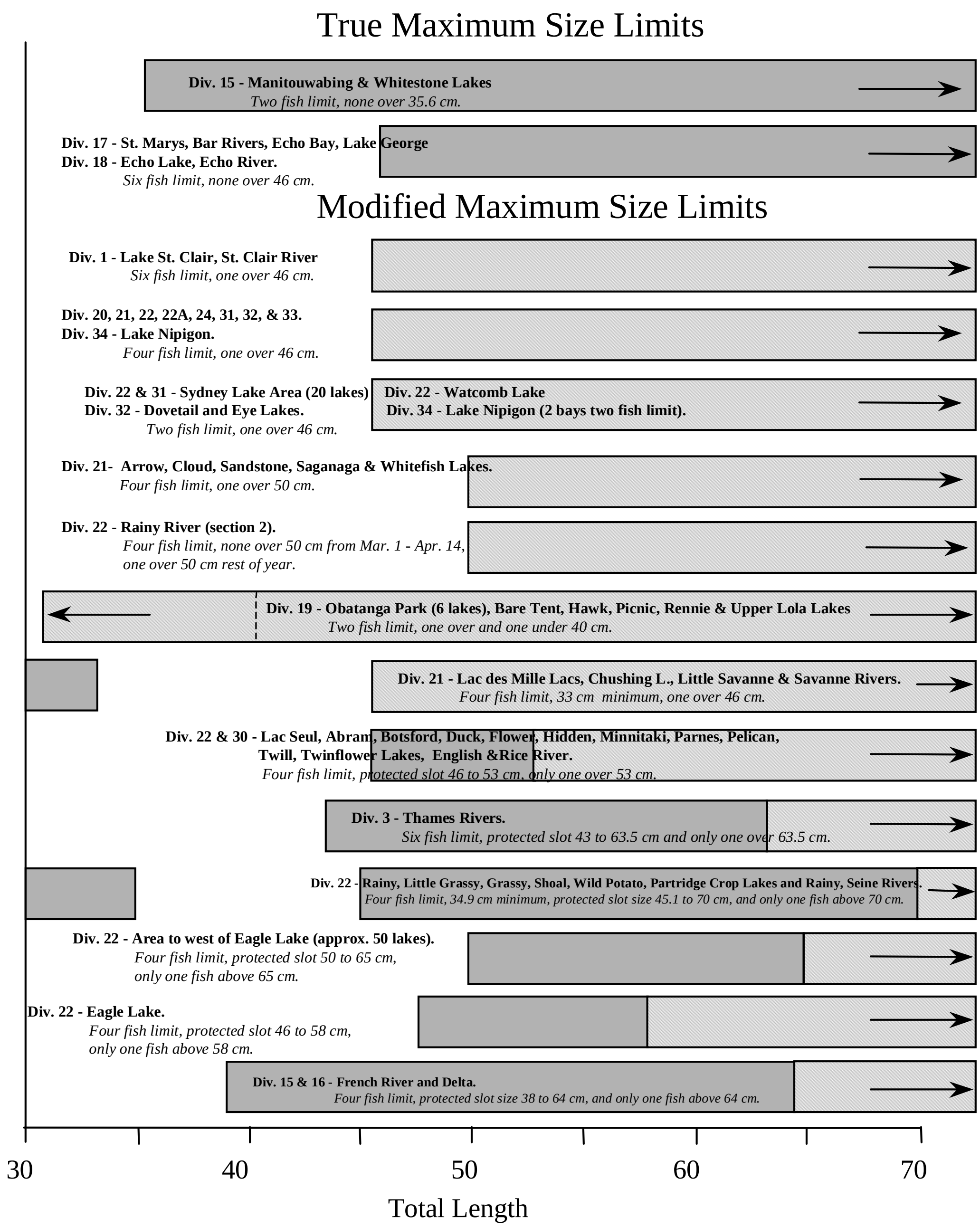

Fig. 8. Walleye maximum size limits currently being used in Ontario waters in 2000.

Slot size limit

The most common type of slot limit is the protected method where fish within a designated length range must be released. This designated length range is usually chosen to protect the broodstock, allowing fish the opportunity to spawn once or twice before being vulnerable to angling. The harvest of smaller, more numerous fish is permitted as well as the opportunity to catch and harvest a trophy size fish. Since growth rates and maturation schedules vary geographically, slot size lengths differ across the province. Although minimum and maximum size limits have been used on a limited basis in Ontario, slot size limits have become the size-based regulation most often chosen for walleye management over the past decade. Fishable slot limits, where only fish between a certain range of lengths can be harvested have been used in other jurisdictions and for other species but only protected slots are currently used in Ontario waters.

Brousseau and Armstrong (1987) recommend protected slots in waters that have:

- good natural reproduction,
- slow growth, especially of small fish,
- high natural mortality of small fish, and
- high angling effort.

The first slot-size regulation for walleye in Ontario was established in 1985. By 2000, there were 114 lakes and one Division (30) with a walleye slot size limit in Ontario (Fig. 9). A second Division (27) has a seasonal only slot size limit.

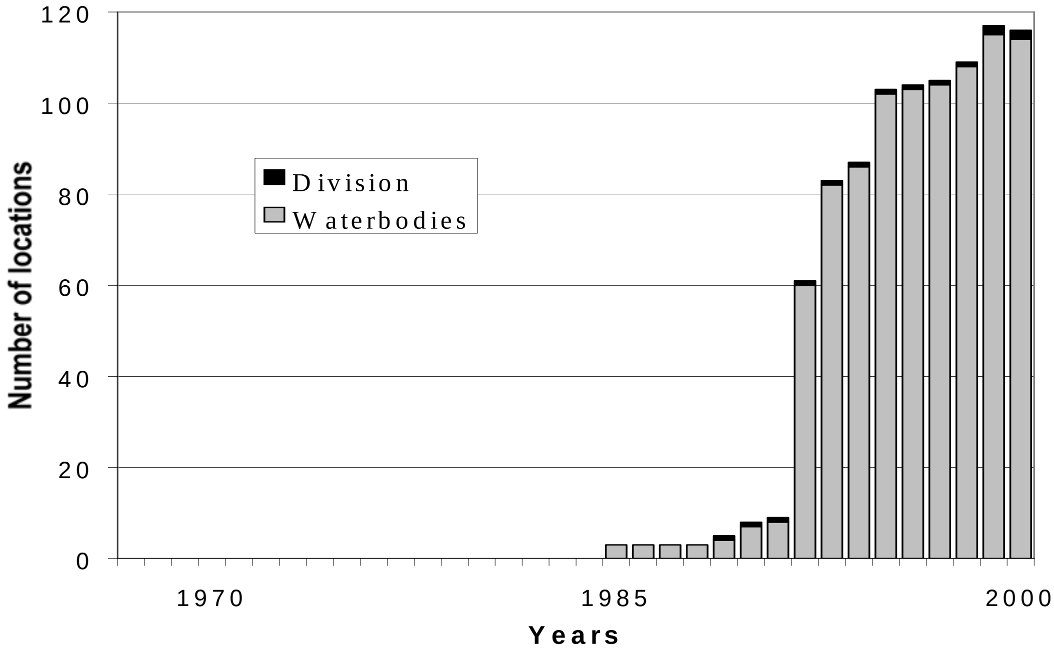

Fig. 9. Number of lakes with slot size limits in Ontario, 1967-2000.

Eight different true walleye slot size limits are currently being used in Ontario (Fig. 10). In addition seven modified slot size limits are being used in combination with minimum and/or maximum size limits and/or reduced bag limits (Fig. 10).

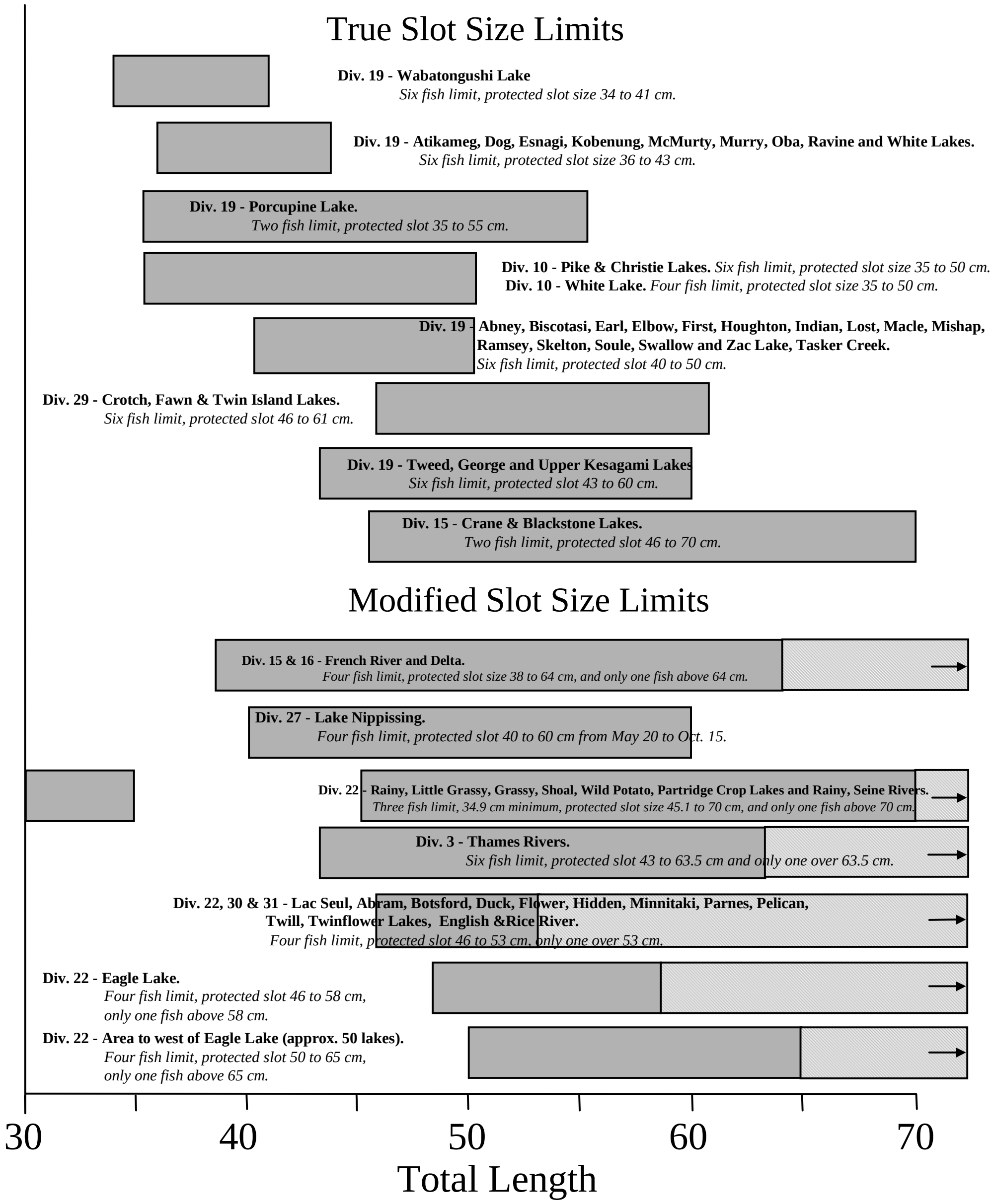

Fig. 10. Walleye slot limits currently in use in Ontario waters in 2000.

Slot size limits have been used on largemouth bass since the mid-1970s in the United States (Anderson 1976, Eder 1984, Sollen 1984). Slot sizes have also been used for other species such as brown trout (*Salmo trutta*) and rainbow trout (*O. mykiss*), and one was implemented for walleye on a lake in Wisconsin in 1984, but was removed due to objections by the public (Brousseau and Armstrong 1987). The attractiveness of slot size limits for walleye is in the ability to protect the majority of breeding fish, while directing most harvest pressure to the younger, more plentiful members of the population. In theory, a protected length range for walleye should provide sustainable angling yields while allowing increases in fishing effort without adversely affecting the quality in terms of catch rates and size of fish, even though the number of harvested (i.e., killed and kept) fish will be reduced. As long as reproduction and recruitment are satisfactory, younger fish can satisfy the angler fishing mainly for food. The premise is that harvesting walleye smaller than the slot “thins out” larger year-classes at relatively small sizes, reducing intraspecific competition for food. This maintains growth and recruitment into and through the protected slot, and should sustain the availability of some large fish above the slot (Brousseau and Armstrong 1987). The slot-size concept also provides the attraction of allowing anglers to potentially catch and keep a trophy-sized fish.

It was anticipated that an increase in fishing mortality of smaller sized fish would be offset by a reduction in natural mortality. Although this hypothesis has gained wide acceptance over the years, there have been no studies to support this conclusion. In one study a walleye population monitored before and after extensive exploitation showed no evidence of a reduction in natural mortality, despite much elevated fishing mortality (Reid 1985).

Actual lake-specific slot sizes are chosen most often by using information on the size and age of spawning fish; the amount that harvest needs to be reduced to achieve sustainable levels; and population fecundity and reproductive potential. Part of the thinking behind the slot size concept is that the eggs of older fish may not be as viable as younger fish. Therefore protecting a brood stock of smaller fish produces more viable eggs. Although this idea is often accepted as fact one study found that walleye hatching success was best from eggs of older, slower growing females (Johnston 1997). The exploitation of older walleye, above the protected slot limit, could both reduce their number and accelerate compensatory growth thereby limiting the proportion of the highest quality eggs in any given year class. Any increased longer-term (beyond the hatching stage) benefits of offspring from older, slower growing walleye has yet to be clarified (T. Johnston, Queens University, pers. comm.)

Not all anglers have been receptive to slot size limits. Many oppose the concept of releasing fish that make up the majority of their catch. Acceptance of this approach appears to be more likely where: 1. the health of the fishery so poor that anglers are supportive of any regulation changes that might help or 2. where the fishery is healthy enough that anglers are less reluctance to release protected fish since the probability of catching a fish outside the protected slot is high.

The most serious biological concerns with this management technique are: 1. that the potential heavy harvest of young fish will prevent adequate continued recruitment to the protected slot, 2. stunting of fish could occur within the slot due to a high abundance of similar-sized fish, and 3. possible invoking of negative population feedback mechanisms reducing the productivity of the population due to the high numbers of fish in the slot (Colby pers. comm.).

The problems of enforcing the release of fish within the slot size, and the skepticism that released fish will survive, are commonly voiced concerns of the angling public. Diligent enforcement efforts and numerous catch and release studies have countered most of these arguments, though unacceptable mortality rates under adverse environmental or fishing conditions (e.g. tournaments, live wells, holding pens, stringers) continue to be a concern (Armstrong 1995).

Initially, slot sizes were intended to be an experimental management technique in Ontario. A pressing need for a timely and effective harvest control option, and the initial relative acceptance of slot sizes by the general public over other harvest control options, have resulted in the escalation of their use. However, there is a lack of sufficient assessment of the technique and subsequently no evaluation of the long-term effectiveness of slot limit application on either a lake-specific or regional level. Brousseau and Armstrong (1987) cautioned that slot size limits should be used under controlled conditions until more is known about their effects on fish, fishing, and yield.

Although slot size limits seem to make intuitive sense, support among the angling public is mixed. Walleye are prized more for their qualities as excellent table fare than for their fighting qualities. This view brings into question the validity of assuming that the angling **experience** alone (as suggested by the national surveys) is sufficient motivation for anglers to fish for walleye. Managers need to ask themselves and their clients what it is they expect to achieve by the use of size limit regulations. The need for articulation of clear objectives cannot be over-emphasized, especially since anecdotal evidence of the success of slot limits in actual usage has been mixed. Nevertheless, the few documented studies suggest some walleye populations have responded favourably to slot size limit regulations. In Esnagi Lake, slot size limits maintained fishing effort but resulted in increased size of the catch, a 15% increase in the mean age of the walleye catch, and increased catch rates but reduced harvests (Acres International Limited 1997). In Christie Lake in eastern Ontario, Kerr (1998b) reported that fishing effort declined immediately after the implementation of the slot size limit but soon rebounded to historic levels. Other changes noted were a significant increase in the mean age of the walleye catch and a large decrease in the harvest. In nearby Pike Lake, a similar slot-size limit resulted in an increase in the mean age of the walleye catch (Kerr 1998c). We recommend that the use of slot limits be carefully assessed for the intended objectives, recognizing that the use of slot limits is not a panacea to control high angling pressure and harvest. It should also be recognized that the parameters used in assigning slot limits should be tailored to different areas of the province.

Conclusions

The suite of regulations in use in Ontario has grown rapidly, especially evident in the past decade. No coordinated approach to regulatory management across Ontario has occurred in recent times. The current situation is a plethora of regulations, often with relatively small differences between them. This has created confusion among clients, a suspicion of dubious effectiveness for many of the regulations, and is some cases a limited potential for any serious impact on the control of harvest. There are currently 34 different seasons, six different bag limits, 15 different slot sizes, seven different minimum sizes and 15 different maximum sizes. Each one of these separate regulations originally had a rationale for its implementation. We suggest that it is time to review the entire suite of regulations, and develop “benchmark” standards. This would include simplifying and standardizing regulatory approaches for walleye harvest control by: standardizing opening and closing dates based on the number of growing degree days in similar geographical areas; using sanctuaries where appropriate to fine tune harvest control; and reducing the number of different size based standards to two or three.

Other regulations

Other methods of harvest control used in Ontario include no night fishing, barbless hooks only (to increase catch and release survival) and banning the use of stringers (where all fish need to be either released or killed immediately). The banning of night fishing has generally been used in areas where a perceived problem of high levels of night harvest is occurring. There is the perception that either anglers are conducting unethical activities under the cover of darkness or that walleye are more vulnerable to night fishing. Due to the nature of the fishery accurate creel or enforcement estimates make assessment of the level of the problem difficult to quantify. We know of no studies that either document the problem or assess the effectiveness of this regulation in reducing walleye harvest. Although barbless hook regulations have been enacted to enhance the probability of successful catch and release there is no evidence that barbless hooks are more effective than barbed hooks at increasing walleye catch and release survival (Armstrong 1995). The banning of live bait has a scientific basis by potentially increasing catch and release survival since studies suggests that artificial lures may cause lower hooking mortality than live bait (Payer et al. 1989; Santucci and Wahl 1993). The practice of holding walleye on stringers and later exchanging them for larger fish has been shown to result in high mortality rates (Ryan and Tost 1987) which supports banning the use of stringers. Generally the longer and more roughly walleye are handled reduces the probability of successful survival upon release (Armstrong 1995). The practice of tournaments that include a central weigh-in facilitate should be strongly discouraged. Any regulations that reduce either the time that walleye are handled or retained should be encouraged since they enhance survival rates.

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Appendix 1. A Summary of Significant Changes to the Ontario Fishing Regulations for Walleye, 1941 to 2000.

<u>1941-1954</u>

- minimum size limit for walleye of 15" total length (38.1 cm) for the majority of Ontario's waters.

<u>1967</u>

- No closed season for walleye on the Great Lakes.
- Harvest of 6 walleye allowed per day.
- Division 10 - Two counties had a minimum size limit of 14 inches.
- There was no fishing license required except for Algonquin and Quetico Provincial Parks $3.50 per year.
- Of a total of 25 fishing Divisions, 9 were open to walleye fishing all year.

<u>1969</u>

- Fishing licence for males 19 years and older, $3.00 per year

<u>1972</u>

- No fishing license for Ontario residents.

<u>1981</u>

- Division 2 – Lake Erie, any boat with non-residents can have not more than 18 walleye on board taken by non-residents.
- Division 10 – walleye minimum size limit from 14 inches to 35 cm.
- Division 22 – Lake of the Woods, any boat with non-residents can have not more than 18 walleye on board taken by non-residents.

<u>1982</u>

- Division 8 – possession limit of 4 walleye for Bay of Quinte, Lake Ontario.

1984

- Division 29 – only one winter fishing line allowed.
- Division 8 – walleye possession limit of 4 initiated.

1985

- Division 19 – Tweed, George, Upper Kesagami Lakes walleye protected slot size of 43 to 60 cm.

1987

- Resident sportfishing license initiated, $10.00 per year or $5.00 for a 4 day license.

1989

- Division 30 – Lac Seul protected walleye slot size of 46 to 53 cm initiated.

1990

- Resident sportfishing licence increased to $11.50 per year or $6.50 per day.
- Division 10 – Bennett, Clayton, and Taylor Lakes a walleye minimum size limit of 41 cm.
- Division 10 – Pike, Christie and White Lakes a protected walleye slot size of 35 to 50 cm.
- Division 10 – all waters other than Robertson Lake (no size limit) a 35 cm walleye minimum size limit.
- Division 23 – Harvest of three walleye allowed in one day.
- Division 18 – Magpie, Michipicoten, Goulais and Montreal Rivers harvest of three walleye allowed in one day.
- Division 18 – Schembri, Scriven, Way-White, Wlasy, Bracci, and Tupper Twps. harvest of three walleye allowed in one day.
- Divisions 22, 24, 31 & 32 – a harvest of six walleye allowed in one day but only 1 can be greater than 50 cm.
- Division 21 – Saganaga Lake a harvest of six walleye allowed in one day but only 1 can be greater than 50 cm.

- Division 22 – Eagle Lake a protected walleye slot size limit of 48 to 58 cm, no night fish allowed.

1992

- Division 29 – Crotch Lake a walleye protected slot size of 46 to 61 cm.
- Divisions 19 – Picnic, Upper Lola, Bare Tent, Hawk and Rennie Lakes and the waters of Obatanga Provincial Park, harvest limit of two walleye in one day, one fish must be greater than 40 cm and one less than 40 cm.
- Division 19 – Wabatongushi Lake a protected walleye slot size of 34 to 41 cm.
- Division 22 – Waters within boundaries of Hwy. 17 on the north, west shore of Eagle and Teggau Lakes, Highwind Lake Road and junction of Hwys. 17 and 71, a harvest of six walleye in a day, a protect walleye slot size of 50 to 65 cm and only one fish allowed over 65 cm. Includes Winnage, Hawk, Dogtooth and Highwind Lakes, about 50 lakes altogether (D. Wilson, pers. com.)

1993

- Resident sportfishing licence $15.00 per year, plus an outdoors card required ($6.00 valid for three years), conservation license $7.50.
- Division 22 – Minnitaki, Abram, Pelican and Botsford Lakes, a harvest of six walleye per day allowed, a protected slot of 46 to 53 cm, and only one fish allowed greater than 53 cm.

1994

- Resident one day fishing licence $10.00
- Division 15 – Lake Clear, Little Lake Clear, Meadow and Mud Lakes, a harvest of two walleye in one day, 50 cm minimum size.
- Division 19 – Abney, Biscotasi, First, Houghton, Indian, Lost, Macle, Mishap, Ramsey, Skelton, Soule, Swallow, Zac Lakes, and Tasker Creek, a protected walleye slot size of 40 to 50 cm.

- Division 19 – Dog, Esnagi, McMurty, Murray, Ravine, White Lakes, a protected walleye slot size of 36 to 43 cm.
- Division 19 – Three Finger Lake, zero possession limit, catch and release only.
- Division 21 – Arrow, Cloud, Sandstone and Whitefish Lakes, a harvest of six walleye in one day, only one greater than 50 cm.
- Division 22 – Rainy, Little Grassy, Grassy, Shoal, Wild Potato, Partridge Crop Lakes and Rainy (downstream to Fort Frances Dam) and Seine Rivers (upstream to the Crilly Dam), a harvest of three walleye in one day, all must be greater than 34.9 cm, a protected slot size from 45.1 cm to 70 cm, and only one can be greater than 70 cm.
- Division 22 – Rainy River (from Wheeler's Point upstream to Fort Frances Dam), a harvest of six walleye in one day, none may be greater than 50 cm during the period of Mar. 1 to Apr. 14 and at other times no more than one greater than 50 cm.
- Division 29 – Fawn and Twin Island Lakes, a walleye protected slot size of 46 to 61 cm.
- Division 30 – Lac Seul, a harvest of six walleye per day allowed, a protected slot of 46 to 53 cm, and only one fish allowed greater than 53 cm.

<u>1996</u>

- Division 15 – French River, a harvest of four walleye in one day, a protected slot size of 38 to 64 cm, and only one fish greater than 64 cm.
- Division 16 – Shebeshekong Bay, a zero possession limit of walleye, catch and release only.
- Division 15 – Blackstone Lake, a harvest of one walleye in one day.

<u>1997</u>

- Division 1 – Lake St. Clair & St. Clair River, a harvest of six in one day, a minimum size limit of 38.1 cm (15 inches).
- Division 3 – Thames River, a harvest of six in one day, a minimum size limit of 38.1 cm (15 inches), closed to walleye fishing on December 24.
- Division 15 – Meadow Lake, a harvest of two in one day, a minimum size limit of 50 cm.

- Division 32 – Dovetail and Eye Lakes, a harvest of two in one day, only one can be above 50 cm.
- Division 21 – Lac des Mille Lacs, Cushing Lake and Savanne, Little Savanne Rivers, walleye minimum size limit of 33 cm.

1998

- Division 1 – Lake St. Clair & St. Clair River, a harvest of six in one day, a protected walleye slot size of 43 to 63.5 cm, only one may be greater than 63.5 cm.
- Division 3 – Thames River, a harvest of six in one day, a protected walleye slot size of 43 to 63.5 cm, only one
- Division 3 – Thames River, a harvest of six in one day, a protected walleye slot size of 43 to 63.5 cm, only one may be greater than 63.5 cm, closed to walleye fishing on Dec. 24.
- Division 16 – French River Delta (Georgian Bay) a harvest of four walleye in one day, a protected slot size of 38 to 64 cm, and only one fish greater than 64 cm.
- Division 15 – Pickerel River, a harvest of four in one day.
- Division 34 – Lake Nipigon (Ombabika and Wabinosh Bays), a harvest of two in one day.

1999

- Division 2 – Two Tree River, St. Joseph Island, catch limit of zero in one day from April 15 to May 14 (Friday before 3rd Saturday).
- Division 15 – Blackstone and Crane Lakes, a harvest of two in one day, (one for a conservation licence) a protected walleye slot size of 46 to 70 cm.
  – Lake Clear, catch limit of two in one day, a minimum size limit of 50 cm.

– Manitouwabing and Whitestone Lake, catch limit of two in one day, maximum size limit of 35.6 cm.

- Division 17 – Echo Bay, catch limit of zero from April 15 to May 14 (Friday before 3rd Saturday)

  – St. Marys River & Lake George, catch limit of six in one day, maximum size limit of 46 cm. Catch limit of zero from April 15 to May 14 (Friday before 3rd Saturday).

- Division 18 – Bar River, catch limit of six in one day, maximum size limit of 46 cm.

  – Buddy, Daisy, Dave, Dickie, Fulcher, Halfway, Loam, Roderic, Scow Lakes, Shasta Lake & Creek, and Tikamaganda Lake & River, catch limit of two in one day.

  – Curry Lake, Finn, Hunter, Kasog lakes, walleye closed all year.

  – Echo Lake and Echo River, catch limit of six in one day, maximum size limit of 46 cm.

- Division 18 & 19 – Bukwaskeagog Lake, walleye closed all year.
- Division 19 – Atigameg and Kabenung Lakes, catch limit of six in one day, protected slot size between 36 to 43 cm.

  – Cheesehead, Crescent, Dibben, Ermine, Kawaweagama, Medhurst, and Upper Kawageagama Lakes, catch limit of two in one day.

  – Cradle, Dreany, Gale, Goudreau, McPhail, and Wabenung Lakes, walleye closed all year.

  – Earl and Elbow Lakes, catch limit of six in one day, protected slot size between 40 to 50 cm.

- Division 20 – Entire Division catch limit of four in one day, only one over 46 cm. Catch limit of two in one day, only one over 46 cm for conservation licence.
- Division 21 – Entire Division catch limit of four in one day, only one over 46 cm. Catch limit of two in one day, only one over 46 cm for conservation licence.

– Black Sturgeon River, walleye closed all year.

- Division 22 – Entire Division catch limit of four in one day, only one over 46 cm.

  Catch limit of two in one day, only one over 46 cm for conservation licence.

  – Border water regulations for non-residents

  – Lake of the Woods, daily catch limit of 2, possession limit of 4, only one greater than 46 cm.

  – Rainy Lake, daily catch limit of 1, greater than 35 cm, less than 45 cm or greater than 70 cm, possession limit of 4, same size restrictions, only one over 70 cm.

  – Rainy River, daily catch limit of 2, possession limit of 4, only one greater than 46 cm. From March 1 to April 14 catch and possession limit of 2, zero greater than 46 cm.

  – Remaining lakes in Fort Frances District, daily catch limit of 2, possession limit of 4, only one greater than 46 cm.

  – Eagle Lake, catch limit of six in one day, protected slot size limit changed to 46 to 58 cm, not more than one over 58 cm.

  – Elva, Whiterock and Young Lakes, catch limit of zero in one day.

  – Watcomb Lake, catch limit two in one day.

- Division 22A – Entire Division catch limit of four in one day, only one over 46 cm.

  Catch limit of two in one day, only one over 46 cm for conservation licence.

- Division 22 & 32 – Moose Lake, walleye closed all year.

- Division 23 – Black and Nipigon Bays, Lake Superior, walleye closed all year.

  – Lake Superior, catch limit of three in one day

- Division 24 – Entire Division catch limit of four in one day, only one over 46 cm. Catch limit of two in one day, only one over 46 cm for conservation licence.
- Division 27 – Entire Division catch limit of four in one day, zero between 40 and 60 cm may be kept from Saturday before Victoria Day (in May) to October 15.
- Division 30 – Entire Division catch limit of four in one day, only one over 46 cm. Catch limit of two in one day, only one over 46 cm for conservation licence.
- Division 31 – Entire Division catch limit of four in one day, only one over 46 cm. Catch limit of two in one day, only one over 46 cm for conservation licence.
- Division 32 – Entire Division catch limit of four in one day, only one over 46 cm. Catch limit of two in one day, only one over 46 cm for conservation licence.

  – Abie,Coldwell, Dashwa, Icy, Lower Marmion, and Lower Twin Lakes, walleye closed all year.
- Division 33 – Entire Division catch limit of four in one day, only one over 46 cm. Catch limit of two in one day, only one over 46 cm for conservation licence.

  – Onaman Lake, catch limit of four in one day.
- Division 34 – Entire Division catch limit of four in one day, only one over 46 cm. Catch limit of two in one day, only one over 46 cm for conservation licence.

<u>2000</u>

- Resident sportfishing licence $20.00 per year, plus an outdoors card required ($6.00 valid for three years), conservation licence $12.00.
- Division 1 – Lake St. Clair & St. Clair River, catch limit of six per day only one greater than 46 cm, catch limit of two per day only one greater than 46 cm for a conservation licence.
- Division 3 – Grand River, catch limit of four in one day.
- Division 15 – Calabogie Lake, catch limit of two which must be great than 50 cm, catch limit of one which must be greater than 50 cm for conservation licence.
- Division 15 & 16 – Key River, catch limit of two in one day, catch limit of one in one day for conservation licence.
- Division 18 – Gough Lake, minimum size limit of 50 cm, catch limit of one fish in one day, catch limit of zero fish for conservation licence.
- Division 19 – Crouch, Magure, Kapimchigama, Radford, Lund, Lost Sky Pilot, Pashoskoota, Rainbow, Reynolds Lakes, catch limit of two in one day, catch limit of one in one day for conservation licence.

  – Elbow and Scully Lakes, walleye closed all year.

  – Margaret and Wildgoose Lakes, catch limit of one in one day.

  – Porcupine Lake, catch limit of two in one day, a protected slot of 35 cm to 55 cm.
- Division 21 – Lac des Mille Lacs and Savanne River, catch limit of four in one day, minimum size limit of 33 cm and only one may be greater than 46 cm.

- Division 22 – Little Grassy, Partridge Crop, Rainy Lakes, Seine River System Shoal Lake, Wild Potato Lake, catch limit of four in one day, not more than one over 70 cm, none under 35 cm, and none between 45 to 70 cm.

  – Rainy River, catch limit of four in one day, between March 1 to April 14 none can be greater than 46 cm and at other times no more than one over 46 cm.

  – Watcomb Lake, catch limit of two in one day, only one greater than 46 cm.

- Division 22 & 31 – Sydney Lake Area (North Kenora Pilot Project Area), catch limit of two in one day all great than 46 cm (approximately 20 walleye lakes).

- Division 32 – North Twin Lake, walleye closed all year.

- Division 34 – Ombabika and Wabinosh Bays, Lake Nipigon, catch limit of two in one day, only one greater than 46 cm.