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COMMERCIAL FISHING ON THE GREAT LAKES: RESOURCE MANAGEMENT AND TECHNOLOGICAL EFFICIENCY

A. B. McCullough¹

The Great Lakes make up the largest freshwater lake system in the world, and since the middle of the nineteenth century they have supported one of the largest freshwater fisheries in the world. At the time commercial fishing began on the lakes, fish were unbelievably abundant: in 1857 a fisheries superintendent told of 47,000 whitefish being caught in a single haul of the seine off Prince Edward County.² In the face of such abundance a prodigal attitude to the resource would not have been surprising and would indeed have been in the North American tradition. What is surprising is that from an early date Canadian legislators recognized that unrestricted fishing could harm or even destroy the fishery and enacted legislation to preserve it. This paper³ will trace the evolution of major principles embodied in the legislation and will consider how effectively the legislation was enforced.

Early legislation, and much of the legislation which is in force today, attempted to maintain the fishery in three ways: first, by encouraging the reproduction of existing stocks; second, by limiting the total catch; and third, by maintaining the environment. Reproduction was encouraged by protecting spawning grounds, ensuring access by fish to them, limiting fishing during the spawning period and by artificial propagation. Until very recently, no attempt was made to limit the total catch directly by means of catch limits or quotas; instead, catch was limited indirectly by imposing conditions on the use of fishing gear. Basically, these conditions prevented the most efficient use of the available gear. Environmental protection has largely taken the form of regulations preventing obvious pollution. Attempts to restrict more subtle forms of pollution, such as nutrient loading, have only been attempted in recent years.

Indians were fishing the Great Lakes long before white contact and early settlers fished the lakes from the time of their arrival in the area. Although these early fisheries had some commercial aspects, they were primarily subsistence in nature. Large-scale commercial fisheries awaited the growth of a larger local market or a means of transporting fish to a large external market.

1 Research Division, Parks Canada, Ottawa, Ont.

2 Province of Canada, Commissioner of Crown Lands, *Annual Report, 1857* (hereafter cited CCL, 1857), *First Report of the Superintendent of Fisheries for Upper Canada*, 72-92.

3 The research upon which this paper is based was carried out for Parks Canada in preparation of a thematic history of commercial fishing on the Great Lakes.

Commercial fishing probably began on the American side of the lakes at about the time of the War of 1812. Although there is little evidence of commercial fisheries on the Canadian side of the lakes prior to the 1830s, the existence of substantial fisheries, whether commercial, subsistence or sport, may be inferred from the existence of legislation to protect salmon in Lake Ontario (1807), herring in Burlington Bay (1823), whitefish in the Niagara, Detroit and St Clair Rivers (1833) and lake trout in Lake Erie (1843). During the 1830s and 1840s, commercial fisheries were established throughout the Canadian waters of the lakes. The largest fisheries were on Lake Ontario but there were also fisheries at Point Pelee and Rondeau Harbour on Lake Erie, at Fighting Island on the Detroit River, at the Fishing Islands on the Bruce Peninsula, at Sault Ste. Marie and at various Hudson's Bay Company posts on Lake Superior.

The early fisheries were in streams or rivers and in the shallow water along the shores of the lakes. The technology available was not suited to deep water and offshore fishing, and fish were abundant enough in shallow waters that there was no need to fish deeper, less accessible waters. Indian fishermen used hooks, gill nets, weirs, spears, seines and dipnets. Early white fishermen used all of these, but seines operated from the beaches were the most common gear.

By mid-century commercial fishing was well established on the Canadian side of the Great Lakes. The 1851 census reported that 11,886 barrels of fish, probably equal to 2,377,200 pounds, had been cured in Ontario. The census made no mention of fresh fish, although they probably formed a significant part of all fish marketed. In 1857, the fisheries superintendent reported the total value of the fisheries in Lakes Ontario, Huron and Erie as \$117,000; of this almost \$45,000 worth came from the fresh fish fisheries of Port Credit, Port Union and Toronto.⁴

The fishery in the first half of the nineteenth century was small by subsequent standards, but it was large enough to affect fish stocks in areas where it was concentrated. As early as the 1840s salmon were less common in some of their spawning areas than they had been. In 1857 the fisheries superintendent reported that the salmon had long since disappeared from the Moira, Trent and Salmon Rivers and that the salmon fishery at the Ducks Islands on Lake Ontario was greatly reduced.⁵

Although the superintendent implied that the salmon had disappeared as the result of overfishing, it is now accepted that environmental change

⁴ Province of Canada, *Census of the Canadas, 1851-52*, Volume 2 (Quebec: Lovell and Lamoureux, 1855), 65; CCL, 1857, 91-2.

⁵ W.S. Fox, 'The Literature of the *Salmo Salar* in Lake Ontario and Tributary Streams,' *Transactions of the Royal Society of Canada*, 24 (1930), 50; CCL, 1857, 81, 87.

was as important in the decline of the salmon as was overfishing.⁶ The clearing of forests and damming of streams destroyed many of the salmon's spawning grounds and would probably have driven the salmon to extinction even if there had been no fishing. Environmental changes such as silting, changes in water levels and pollution would also affect other species although none so dramatically as the salmon.

These threats to the fisheries prompted a major revision and consolidation of fisheries protection legislation in 1857-58. Ontario had passed its first fisheries protection legislation, 'An Act for the Preservation of the Salmon', in 1807. The act forbade the taking of salmon with nets or weirs in rivers and creeks in either of the Newcastle or Home Districts. It did not prevent the use of spears or of hook and line. In 1810 the act was amended to prevent the taking of salmon by any means from 25 October to 1 January and to prohibit the taking of salmon within 100 yards of any mill or dam at any time. The amended act established three principles which continued to shape fishery conservation laws on the Great Lakes into the twentieth century. First, the government could regulate the types of gear which could be used. Second, it could regulate where the gear could be used and third, it could establish close seasons during which no fishing could take place. Usually close seasons were designed to protect the fish during their spawning period.⁷

The rationale behind the original legislation is not known but it may be surmised from the justification for later, similar legislation. Fishing during the spawning season was prohibited because fish were particularly vulnerable when they were concentrated on spawning grounds or ascending spawning streams. In addition, both fisheries officials and fishermen believed that the taking of fish during the spawning period had a more serious effect on propagation than taking the same fish at some other time. In fact, there is little rational support for this position because a fish taken at any time of year is prevented from spawning.

The restrictions on the types of gear which could be used and where it could be used were also designed to protect fish when they were on, or approaching, spawning grounds. Not coincidentally, by preventing the use of gear where it could catch the most fish, the legislation limited the total catch. Limitation of catch by restricting the most efficient use of gear was to remain a feature of Canadian fishery regulations on the Great Lakes until at least the 1950s.

6 J.R. Dymond, *Fish and Wildlife: a Memorial to W.J.R. Harkness* (Toronto, 1964), 86.

7 47 George III, 1807, Upper Canada, An Act for the Preservation of the Salmon; 50 George III, 1810, UC, An Act to extend the Provisions of an Act passed in the 47th year of His Majesty's reign intituled 'An Act for the Preservation of the Salmon.'

The prohibition against fishing near mill dams prevented fish from being taken at places where it was particularly easy to take them. Mill dams also posed a serious threat to salmon because they blocked their access to spawning grounds. An act of 1828 required 'aprons' on all mill dams on streams which were frequented by salmon and perch or which were used for running logs.⁸ Although the description of the apron suggests that it was more of a timber slide than a fish ladder, the principle that fish must be allowed access to their spawning grounds was important. The failure to enforce the principle is now considered to have been one of the causes of the extinction of the Lake Ontario salmon.⁹

In 1823 and 1836 the Legislature passed laws for the protection of the herring fishery in Burlington Bay. In 1833 it gave some protection to the whitefish fisheries on the Niagara, St Clair and Detroit Rivers. In 1843 legislation was passed to protect lake trout in Kent and Essex counties on Lake Erie.¹⁰ In each case, the legislation provided for some form of closed season, limited the types of gear which could be used and, except in the case of the trout on Lake Erie, limited where gear could be used. The acts were rudimentary and left the initiative for enforcement to informers; nevertheless, they extended the principles of fisheries management to the three species which formed the backbone of the commercial fisheries until the 1920s.

In 1857 and 1858, the government revised and consolidated fishery legislation in one act, for the first time known by the short title 'The Fishery Act'.¹¹ The new act incorporated the provisions from the earlier acts for the protection of fisheries and introduced four other principles of fishery management.

First, the Act of 1858 declared that the government could licence or lease fisheries for periods of up to eight years. Prior to 1857 the fisheries were treated as a 'public right' vested in the public and not in the crown.¹² Consequently, the government had not leased or licensed fisheries although it had issued leases or licences of occupation to crown lands which fronted on desirable fisheries. In the case of seine net fisheries, such a licence gave effective control of the fishery to the licensee. By declaring its competence to lease

8 9 George IV, 1828, UC, c. 4.

9 Dymond, op. cit., 86.

10 4 George IV, 1823, UC, c. 37; 6 William IV, 1836, UC, c. 15; 3 William IV, 1833, UC, c. 29; 7 Victoria, 1843, Canada, 1843.

11 20 Victoria, 1857, Canada, c. 21; 22 Victoria, 1858, Canada, c. 86.

12 National Archives of Canada (NAC), RGL, E1, Volume 64, p. 628, 23 October 1845, Reel C-111.

fisheries or licence fishermen the government put itself in a position to limit the number of fishermen and thus limit overfishing. In fact, the government continued to issue licences almost on demand until the 1890s; nevertheless, recognition of the principle that the government could control access to the fisheries was essential to any programme of fisheries conservation.

Second, the Fishery Act provided for the encouragement of artificial propagation of fish. It was to be ten years before a government fish hatchery was established but by the end of the century, hatcheries were a major element in Canada's fishery policy.

Third, the Act recognized the danger of pollution and prohibited the dumping of fish offal or ballast into fishing waters and prohibited the throwing of lime or chemical substances into water inhabited by fish. The federal fishery act passed in 1868 included a provision which prohibited the dumping of sawdust or mill rubbish into any stream.¹³

Perhaps the most important provision of the provincial Fishery Act of 1858 was the one which shifted responsibility for enforcement of fishery laws from informers or municipal governments to the provincial government and gave the government authority to appoint fishery overseers. A superintendent was appointed in 1857; by 1866, Upper Canada had a fisheries superintendent, eighteen fishery overseers and a number of guardians who were appointed on a seasonal basis to supervise spawning grounds.¹⁴

Although the staff was small, poorly paid and often poorly motivated, it made some progress towards implementing the fisheries law. It began a systematic collection of statistics which made subsequent scientific investigations of the fishery possible. It began enforcing the law requiring fish ladders around mill dams and had some success in limiting the dumping of sawdust. The staff was essential to the introduction of the licence system. Many fishermen assumed that they had, through long occupation, acquired a title to the fisheries which they were accustomed to exploit and resisted the imposition of licences and leases.¹⁵ By the 1870s this resistance had been overcome and fishermen accepted that licences and fishery officials were a part of the fishery.

The last half of the nineteenth century was a period of rapid growth in the fisheries. In 1850 the annual catch was in excess of two million pounds; by the early twentieth century annual catches of thirty million

13 31 Victoria, 1868, c. 60, s. 14.2.

14 CCL, 1866, 52.

15 Ibid., 1859, Appendix 30.

pounds were not unusual.¹⁶ The growth was achieved by increasing the manpower and gear employed, by exploiting new areas and by introducing new technology.

The early fisheries were primarily inshore and river fisheries; the abundance of fish made it unnecessary to pursue fish in the deeper and more remote parts of the lakes. Commercial fisheries used seine nets, spears, dip nets, hoop nets, gill nets and hooks. The seine was preferred because it was cheap, safe to use, required little skill and, when fish were abundant, it was very efficient. However, the seine was not selective in the fish it caught; it had a small mesh, usually two inches, extension measure, and it caught all fish which it enclosed including many immature fish which were unsaleable and were wasted. In addition, because the best seining grounds were also spawning grounds, seines fell into disfavour among fisheries officials and in the 1890s the government began to restrict their use.¹⁷ Practical considerations also limited the use of the seine. It could only be used in shallow waters where the bottom was smooth and when these areas were fished out it was not adaptable to other parts of the lakes.

By the 1850s many of the best seining grounds on the lower lakes were occupied and, in some cases, were showing signs of being overfished. Fishermen began to move to unexploited areas such as northern Lake Huron and Lake Superior and to fish deeper waters which were unsuited to seines. To exploit these waters they made increasing use of gill nets and pound nets.

Gill nets had been used in the Hudson's Bay Company fishery on Lake Superior in the 1830s and in the fishery off Prince Edward County as early as 1840. They became increasingly common during the 1860s; by 1881 there were more than one million yards of gill net licensed for use on the lakes. By the mid-1890s, more than twelve million yards were licensed. Fishermen regularly fished more net than they were licensed for and the amount actually in use may have been double the licenced amount.¹⁸

At the same time as the gill net came into widespread use, the pound net was introduced on Lake Erie. Pound nets consisted of a series of stationary nets hung on stakes driven into the lake bottom. The nets were arranged so as to lead fish into a net trap or pot from which they could not escape. They were first used on Lake Erie about 1850 and

¹⁶ N.S. Baldwin, R.W. Saalfeld, M.A. Ross and H.J. Buettner, *Commercial Fish Production in the Great Lakes, 1867-1977*, Great Lakes Fishery Commission, Technical Report No. 3 (Ann Arbor, 1979).

¹⁷ Canada, *Hansard*, 6 April 1894, 843 and 9 April 1894, 951.

¹⁸ The amount of gear licensed was reported in the annual reports of the Department of Marine and Fisheries. Canada, Department of Marine and Fisheries, *Annual Report*, 1888, 195-205.

spread slowly to the upper lakes. They were almost never used on the Canadian side of Lake Ontario but by 1890 they were the dominant net on Lake Erie and had become common on lower Lake Huron, around Manitoulin Island and on some parts of Lake Superior. By the mid 1890s there were 285 pound nets in use on the lakes and they continued to increase in popularity until the 1930s when there were more than 1100 in use.

By 1870 gill and pound nets had replaced seines as the commonest nets on the lakes. Gill nets were more flexible than either seines or pounds in that they could be set almost anywhere and could be moved to follow the fish. They were relatively cheap and could be used by small scale fishermen. They could be fished over a longer season than pound nets because they were less susceptible to damage from storms and ice. They were also relatively selective in that, by varying the mesh size and the location and depth at which they were set, they would catch particular types of fish. Whitefish and lake trout were usually caught with a 4.5- or 5-inch mesh and herring with a 2.5- or 3-inch mesh. The principal disadvantage of gill nets was that fish caught in them drowned after several hours and their quality declined.

The major advantages of pound nets was that fish were alive when they were taken from the nets. Because fish from pound nets were usually in better condition than those from gill nets, dealers were often willing to pay a premium for pound net fish. The nets' principal disadvantage was that they could be used only in relatively shallow water and on sandy or muddy bottoms; where conditions favoured their use, on western and central Lake Erie and southern Lake Huron, pound nets were the most popular nets.

In addition to adopting new means of capture, fishermen improved their boats and equipment so that they could handle more gear and exploit new areas. The early fishermen had used canoes, rowboats and small sailboats; about 1870 they began to use steam-powered tugs. The tugs made it possible to fish in worse weather and in more exposed areas than had been possible before their introduction; consequently, they opened new areas to fishing. With tugs, fishermen could reach the fishing grounds more quickly than formerly and spend more time in actual fishing. All of these factors increased total fishing effort. One estimate was that three men using sails or oars could handle 6,000 yards of gill net or two pound nets while six men with a tug could handle 60,000 yards of net or ten pound nets.¹⁹ This advantage was increased about 1900 when powered net lifters were developed. Net lifters doubled the amount of net which a tug's crew could handle.²⁰ Shortly after 1900, small gasoline engines began to replace sails and oars as the motive power in the smaller boats; on a smaller scale, the gas engine gave the fishermen many of the advantages of the steam tugs.

19 G.C. Toner, 'The Great Lakes Fisheries: Unheeded Depletion,' Canadian Forum 19 (September 1939), 178.

20 NAC, RG23, Volume 139, File 317, Post to Gordon, 27 February 1923.

Between 1870 and 1890 the number of licensed fishermen increased from about 1900 to more than 2800 and the total catch increased from 6.7 million pounds to almost 29 million pounds per year. The catch per man increased from about 3500 pounds per man to more than 10,000 pounds per man. It remained at this level until about the First World War and then began to decline slowly until the 1940s. The trend was reversed in the 1950s when substantial reductions in the number of licensed fishermen and the introduction of new technology, most notably trawl nets which made the capture of large volumes of low value smelt economical, increased the catch per fisherman.

The growth of the industry after 1850 put increasing pressure on the fishery resources of the lakes. The Lake Ontario salmon, which had been a major commercial fish in the first half of the nineteenth century, became extinct shortly after 1900 and the sturgeon was reduced to commercial insignificance. The effect on the fish which formed the backbone of the fishery -- lake trout, whitefish and herring -- was less dramatic, but by the end of the century lake trout and whitefish were depleted in some of the local fisheries.

In spite of the extinction of the salmon and the decline in the populations of other key commercial fish, the total commercial catch remained within a range of 25 to 35 million pounds per year from the 1890s until the early 1950s. The catch was maintained by exploiting new areas, increasing fishing effort and exploiting new species. By the turn of the century, fishermen were relying increasingly on fish such as yellow perch, walleye, northern pike and sauger which, in the early years of the fishery, had been considered coarse fish. These fish became even more important after the Lake Erie herring fishery failed in 1925 and whitefish and lake trout fisheries failed in the 1930s and 1940s. Today, many of the substitute fish are under pressure and smelt, an introduced species, is the mainstay of the fisheries on the lakes.²¹

At Confederation the federal government took responsibility for the fisheries. The principles of the provincial fisheries act of 1858, including the guarantee of access by the fish to their spawning grounds, the regulation of the time, methods and place of fishing, the limitation of access to the fishery, the control of pollution and the encouragement of artificial propagation were incorporated into the Fishery Act of 1868. These principles remained at the core of fisheries protection legislation until the turn of the century when primary responsibility for the fisheries was transferred to Ontario. Most of them remain a part of fisheries legislation today; however, there has been a gradual evolution in the way in which they are enforced and interpreted.

²¹ These changes are clearly evident from the catch reports in *Commercial Fish Production*.

The most dramatic innovation in fisheries management after Confederation was the emphasis on artificial propagation. In 1868 the Department of Marine and Fisheries leased a small hatchery at Newcastle, Ontario and began a programme of building hatcheries across the country. The programme was based on a faith in the efficiency of artificial, as opposed to natural, propagation. It was believed that under natural conditions only a very small proportion of whitefish eggs, perhaps 1%, were fertilized and that only a fraction of fertilized eggs were hatched. Hatcheries were able to fertilize 75% of the eggs which they received and to raise a large proportion to the stage at which they were released. Given the advantage of artificial over natural propagation, it was argued that hatcheries could counterbalance the effects of pollution, overfishing and the loss of spawning grounds.²²

Although there was widespread support for the hatchery system from both commercial fishermen and fishery officials, scientists were unable to prove that large numbers of the planted fish actually grew to maturity and increased the commercial catch. In fact, subsequent investigations found that there was usually an immense mortality among the extremely small fish or eyed eggs which hatcheries planted.²³ As early as 1883 the Commissioner of Fisheries, W.F. Whitcher, expressed doubts about the practical value of planting fish.²⁴ In spite of these doubts, the hatchery system was expanded rapidly. By 1927 there were fifteen hatcheries in Ontario and 714 million fry were planted. Of these, 448 million were whitefish, a species only pursued by commercial fishermen. Planting continued on the same scale for thirty years and it was not until the 1960s that the planting of whitefish was stopped and the entire hatchery programme was greatly scaled down and directed almost entirely to the support of sport fishing.²⁵

In addition to stocking indigenous but depleted species such as whitefish, both Canadian and American fisheries officials introduced new species. Only two species of planted exotics, carp and smelt, have played a role in the commercial fishery. Carp were planted in the

22 S.W. Downing, 'A Plan for Promoting the Whitefish Production of the Great Lakes,' *Bulletin of the US Bureau of Fisheries* (1908), 630-2; P.R. Reighard, 'A Plan for Promoting the Whitefish Production of the Great Lakes,' *ibid.*, 682-3.

23 A.G. Huntsman, 'Fishery Management and Research,' *Great Lakes Fisheries Symposium* (1952), App. C.8.; J.R. Dymond, 'Artificial Propagation in the Management of the Great Lakes Fisheries,' *Transactions of the American Fishery Society* 86 (1957), 384-91.

24 W.F. Whitcher, 'Practical Results of Fish Culture in the Dominion of Canada,' *Forest and Stream* 20:21 (21 June 1883), 408.

25 See Ontario, Department of Fish and Game, *Annual Reports*, for figures on plantings.

1870s and 1880s and quickly spread throughout the lakes. Although they were a popular foodfish in Europe, they were not accepted by North American consumers and the market for carp remained small. In addition carp were thought to compete with commercially more desirable fish. By 1896 fishery officials heartily regretted their introduction.²⁶ Smelt were introduced into Lake Michigan in 1912 and gradually spread throughout the lakes. By the 1940s they were common but because of their low unit value, they were not actively pursued until the early 1960s when the development of trawling made smelt fishing commercially viable. Smelt is now the mainstay of the Lake Erie fishery.

Although it was not deliberately introduced, the lamprey is an exotic species which has had a dramatic effect on Great Lakes fisheries. Lamprey were indigenous to Lake Ontario. They apparently made their way to upper lakes via the Welland Canal. In the 1940s and 1950s they attacked, and virtually destroyed, the lake trout populations on Lakes Huron, Michigan and Superior. Joint action by the Canadian and American governments has since brought the lamprey under control but has failed to restore trout populations.

In addition to artificial propagation, the federal government encouraged natural reproduction by means of close seasons. The 1868 Act provided close seasons on whitefish and lake trout in November and December; however, enforcement of the Act was uneven and weak. In part, the failure to enforce the Act rigorously was the result of poorly paid officials, patronage appointments and inadequate equipment. In many cases, the major problem was a lack of political will to enforce the regulations.

Prior to 1890, the close season on whitefish was never enforced on the Detroit River system where Canadian fishermen fished within sight of American fishermen who were not required to observe a close season. When officials began to enforce the Act in 1890, area fishermen complained that the regulations were ruining them. They had support of local politicians and after 1896 the Minister of Marine and Fisheries usually agreed, over the objection of his officials, to suspend the regulations.²⁷ In 1903 the close season was abandoned on the Detroit River and on much of Lake Erie. Twelve years later, the close season for trout and whitefish was abandoned on all of the lakes so far as commercial fishing was concerned although a close season was kept in sport fishing areas.²⁸

²⁶ Canada, Department of Marine and Fisheries, *Annual Report*, 1896, Supp. No. 1, 29.

²⁷ Canada, *Hansard*, 27 March 1893, 3204; NAC, RG 23, Volume 224, File 1241.

²⁸ NAC, RG23, Volume 139, File 137, Copy of Order in Council of 13 August 1903; *ibid.*, Volume 926, 721-4-5(1), memorandum of 12 June 1915.

The abolition of the close season for trout and whitefish and subsequently for other commercial fish involved a major change in fishery policy, but the only rationale given for the change was that huge plantings of fry made a close season unnecessary. The explanation is unconvincing given that at least some fishery officials had doubts as to the value of fish plantings. The final abolition of the close season in 1915 was also a response to demands for increased production during World War I; once the close season was abandoned, pressure from fishermen would have made it difficult to re-impose. Fishery officials may also have come to believe that the close seasons were largely ineffective and that the effort it took to enforce them could be put to better use enforcing other regulations.

Natural reproduction was also encouraged by preventing the capture of immature fish. Until early in the twentieth century, there was no direct control over the size of fish which could be taken. The 1868 fishery act provided that gill nets for whitefish and lake trout should have a minimum mesh of 5 inches, extension measure. This was intended to ensure that only larger, mature fish which had spawned at least once would be caught. Like many of the other regulations established by the act, this one went largely unenforced. In the 1880s and 1890s most gill net fishermen used 4.5-inch mesh or less for whitefish and trout and a 2.5-inch net for herring. Pound net fishermen commonly used a 2-inch mesh in the pot. As a result, tons of immature fish were caught; the fish were largely unmarketable and were wasted.²⁹ Early in the century the Ontario government began to require, as a condition of obtaining a licence, that whitefish and trout of less than two pounds be returned to the water. In 1922 the condition was incorporated into the federal fishery regulations, but it is impossible to estimate how effectively these regulations were enforced.³⁰ Between 1915 and 1925 there also seems to have been a major effort to enforce regulations on gill net mesh size. With minor variations these sizes, 4.5 inches for whitefish and trout nets and 2.5 to 3 inches for herring nets, are in force today.

Protection of selected spawning areas and limitations on the concentration of fishing effort were other means used to aid natural propagation. Regulations restricted the setting of nets in or near streams. In the 1890s areas such as the Lizard Islands on Lake Superior, parts of the Bay of Quinte and the eastern shore of Georgian Bay were set aside as fish sanctuaries and no fishing was allowed in them. Excessive concentration of fishing effort was avoided by assigning pound nets to specific locations and by limiting gill net

²⁹ Canada, Department of Fisheries, Annual Report, 1888, 195-205; testimony before the Wilmot Commission. Samuel Wilmot and Edward Harris, Report of the Dominion Fishery Commission on the Fisheries of the Province of Ontario (Ottawa, 1894).

³⁰ NAC, RG49, 1904, No. 58, fishing licence; Canada Gazette, 29 April 1922, 43-6, Special fishing regulations--Ontario, S.12.

licences to specific areas; usually boats were licensed to fish in the vicinity of their home port. After 1915 the rule was abandoned, at least on Lake Erie, and gill net fishermen were allowed to fish anywhere on the lake. As a result, the entire fleet was able to concentrate in parts of the lake where the fishing was good and greatly increase its efficiency. Some fisheries scientists have related the intense concentration of effort which this allowed to the collapse of the herring fishery on Lake Erie in 1925.³¹ In the 1930s, the province reintroduced the concept of licence zones and continues to use it today. Although boats can be licensed to fish in more than one zone, most are not.

Between 1850 and 1950 there were major changes in the boats which Canadian fishermen used and the methods used in processing and distributing fish but only minor modifications in the nets used. This technological stagnation was in contrast to important innovations in net technology in the United States. Towards the end of the nineteenth century American fishermen developed the trap net. A trap net was similar in design to a pound net except that the trap net was held in place by floats and anchors instead of by stakes. In addition the pot was completely enclosed and consequently could be submerged. Because they did not require stakes, trap nets could be used in areas where pound nets could not. They could also be moved more easily than pound nets and were cheaper. They were widely used in the United States but were not permitted in Canada although many were used illegally. The nets were prohibited in Canada because, being totally submersible, they were more difficult to regulate than were pound nets. In addition, because the nets were extremely efficient, many fishermen feared that they would result in overfishing and opposed them as a conservation measure.³²

About 1915 American fishermen on Lake Erie developed bull nets. The bull net was simply a very deep gill net. A standard gill net was 36 mesh or six feet deep; a bull net was as much as 100 mesh or eighteen feet deep. For reasons which are not known, the nets caught many more fish than equivalent amounts of gill net. In fact, they were so efficient that the Ontario government banned their use in 1922 and most states had banned their use by 1934.³³

31 Ibid., Volume 327, File 721-4-5(6), P.G. Robinson to Director of Naval Services, 12 November 1920; Frank Egerton, *Overfishing or Pollution? Case History of a Controversy on the Great Lakes*, Michigan, Great Lakes Fishery Commission, Technical Report No. 41 (Ann Arbor, 1985), 12-13.

32 John Peters, 'Commercial Fishing in Lake Huron, 1880-1915: the Exploitation and Decline of the Whitefish and Lake Trout,' (MA thesis, University of Western Ontario, 1981), 107.

33 H.A. Regier and W.L. Hartman, 'Lake Erie's Fish Community: 150 Years of Cultural Stresses,' *Science* 180, 1251.

By 1950, the traditional fisheries -- whitefish, trout and herring-- had almost completely collapsed. Conservation through the restriction of technological innovation had failed and was abandoned. It was clear that if the fishery was to survive, radical technological changes would have to be permitted. The use of trap nets was permitted in 1950 and within a few years they completely replaced pound nets.³⁴ In the late 1940s nylon replaced linen and cotton in gill nets and increased their efficiency by a factor of two or three.³⁵ Trawling, which was essential to the efficient exploitation of smelt, was the most radical innovation; it is significant of the change in attitude to technological change that the government actively supported the introduction of trawling.

The Federal Fisheries act of 1868 required fishermen to be licensed and consequently gave the government a means of reducing fishing pressure by reducing the number of fishermen. This tool was not used until the 1890s when the federal government began to restrict the number of licences in areas which it considered overfished.³⁶ The policy was unpopular and after 1900 the provincial government seems to have abandoned it. The number of licensed fishermen increased from about 2400 in 1900 to more than 3200 in 1920. In spite of the depressed state of the fisheries during the 1930s and 1940s, the number of fishermen remained about 2400 until the mid-1950s when the crisis in the fishery forced the government to resist issuing new licences and to cancel inactive ones. Although the number of licensed fishermen has been reduced to about 1500, some authorities contend that, given the efficiency of modern fishing methods, the number is still too high.³⁷

Throughout the period when it administered the fisheries, the federal government sought to limit the total catch through indirect means such as limiting times and places of fishing and limiting the types of gear which could be used. Until recently the provincial government has also relied on indirect methods of limiting catch. The most probable reason why indirect methods of limiting catch were preferred to direct methods is that direct limitation of the catch would have required a much

34 Ontario, Department of Lands and Forests, Annual Report, 1951, Division of Fish and Wildlife, 38.

35 H.C. Mersereau, 'Some Aspects of the Use of Nylon Fishing Gear,' Fisheries Council of Canada, Annual Meeting, April 1954, 25-7.

36 NAC, RG23, Volume 121, File 141, Deputy Minister to L. Wigle, 30 December 1893.

37 Fikret Bezkes and Dorothy Pocock, *Issues and Conflicts in Fisheries Management in Lake Erie* (Brock University, Institute of Urban and Environmental Studies, June 1980), 10-11; W.J. Christie, *A Study of Freshwater Fishery Regulations based on North American Experience*, FAO Fisheries Technical Report Paper No. 180 (Rome, 1978), 12.

larger and more efficient enforcement agency than was available until recently. It is also possible that direct controls would have conflicted with a continuing popular -- although not legal-- perception of the fishery as a public right to which all citizens had a right of access.

The first attempts to limit catch directly were made by Canadian and American fishermen on Lake Erie who agreed to a daily limit 6000 pounds per tug in 1925.³⁸ Whether the quota was intended purely as a conservation measure or whether it was an attempt to maintain prices is not known. Although the quota was subsequently included in Ontario fishery regulations, there is no evidence that it was ever enforced. The concept of a quota re-emerged in the 1960s when a weekly catch limit of twenty tons was established for the Lake Erie smelt fishery. Although the official smelt quota has not been enforced by the government, the dominant smelt processor on the lake has successfully imposed a smelt quota on the fishermen.³⁹ More recently, an international quota system has been established for walleye in western Lake Erie and the Ontario government has established quotas for various fish in other lakes. Although fishermen have not opposed quotas in principle, there has been serious disagreement as to how quotas should be assigned to individual fishermen and as to the level of fishing which individual fisheries can support.

Although nineteenth-century fisheries officials concentrated on the prevention of overfishing and on guaranteeing the reproduction of existing stocks of fish, they were aware that pollution posed serious threats to fish populations. Unfortunately they often had neither the knowledge nor the authority to combat these threats. Prohibitions against the dumping of sawmill wastes -- principally sawdust and bark-- into streams were included in legislation in the 1840s and prohibitions against dumping fish offal, ballast and chemical pollutants in waters frequented by fish were included in the 1858 fishery act. All of these prohibitions were incorporated into the 1868 federal Fishery Act.

During the period of federal administration of fisheries, pollution was largely a local problem which affected spawning streams and grounds and fisheries within the vicinity of large cities. Dumping of sawmill wastes was the most obvious form of pollution. Officials attempted to stop it, but the political power of the lumber industry was able to

38 'News and Notes from Inland Waters,' *Canadian Fisherman* (April 1925), 92-3; 'Around the Great Lakes,' *ibid.* (September 1925), 283-4.

39 John Jacob Van West, 'The Independent Fisherman in the Port Dover Fishing Industry: A Case Study of their Production and Market Relations,' (PhD thesis, University of Toronto, 1983), 155-62.

resist any effective reforms until at least the turn of the century.⁴⁰ The failure was prophetic of the fate of later attempts to control chemical pollution; in general, polluting industries have been economically and politically much more important than the fishery and have been able to delay attempts to reduce pollution.

Other forms of pollution which may generally be classed as environmental change or degradation were more subtle and often accepted as unavoidable by-products of industrial and agricultural development. For example, in the 1870s Samuel Wilmot, the proponent of the hatchery system recognized that deforestation and agricultural development was ruining salmon spawning streams.⁴¹ He and other officials apparently accepted the loss of the streams as inevitable; this acceptance may explain why artificial propagation was embraced so enthusiastically.

The attitude that environmental degradation was inevitable was not challenged until the middle of the twentieth century when the widely-proclaimed 'death' of Lake Erie as a result of eutrophication prompted a major effort on the part of both Canadian and American governments to reduce pollution. As a result of the implementation of the Great Lakes Water Quality Agreement, eutrophication has been reversed or, at least, the process has been greatly slowed.

In the nineteenth century the most serious chemical polluters were tanneries and early oil refineries. They were small, few in number and their effect was localized. Moreover, they posed a threat to fish and not to the consumers of fish. During the last twenty years governments have become aware that toxic chemicals such as mercury, PCBs and myrex are concentrated in fish and pose direct threats to human health. The Great Lakes Water Quality Agreements (1972 and 1978) were directed at solving the problem of pollution by toxic chemicals as well as other forms of pollution. To some extent, they have been successful; most of the fisheries in the upper lakes are open, but there are still restrictions on several species of fish in Lake Ontario.

The record of fisheries management on the Great Lakes prompts several observations which may have a general application to resource management in North America:

First, it cannot be too strongly emphasized that fisheries management on the lakes was designed for the benefit of the fishing industry, not for the benefit of the fish. There was never any question of maintaining the fish population of the lakes inviolate; fish were

40 R.P. Gillis, 'Early Regulatory Records and the History of Science and Technology: the Case of the Sawdust Pollution Files, 1866-1902,' in R.A. Jarrell and N.R. Ball, eds., *Science, Technology and Canadian History* (Waterloo, 1980), 60-72.

41 Canada, Department of Marine and Fisheries, *Annual Report*, 1881, Supplement 2, 11-12.

protected so that they could be exploited in an orderly manner over the long term. The point is a fundamental one, but it can easily be overlooked and must be emphasized if fisheries protection laws are to be understood.

Second, until recently the fishery has been managed so as to maximize employment with little regard for the income level of those employed. The decision to follow this policy was almost certainly made by default, but it was consistent with a minimal intervention philosophy of government. Early attempts to restrict entry to the fishery conflicted with a strong North American belief in a public right to exploit natural resources with a minimum of government interference. Later attempts to reduce the number of fishermen met with strong opposition from vested interests. It is only within the past three decades when the fishery faced total collapse and when the state had become more interventionist that the number of fishermen has been reduced.

Third, the state has been unwilling to restrict access to the fishery and has been unwilling or unable to limit the total catch of fish by direct means such as a quota system. It has relied on indirect means of limiting the catch. It prevented the most efficient -- in an economic sense -- use of fishing gear and, although it allowed the modification of existing gear, it prohibited the introduction of new, more efficient gear. Like the attitude toward access to the fishery, this attitude only changed in the 1950s when then fisheries were near collapse.

Fourth, the hatchery system was adopted enthusiastically because it offered a straightforward and simple solution to the problem of fishery depletion which would not conflict with vested interests. It also had the glamour of a new scientific technique. It was continued long after most fishery scientists had come to the conclusion that it had little effect on commercial catches; the reasons for the continuation were probably inertia, vested interests and the need to appear to be doing something.

Fifth, the necessity of combining traditional fisheries management practices with environmental controls is clear. Unfortunately, the causes of pollution often lie beyond the jurisdiction of fisheries officials and can only be dealt with in the context of the entire society.

Sixth, the difficulties of resource management in an expanding society with a strong tradition of public access to resources are also clear. On the basis of experience in the fishery of the Great Lakes it seems probable that the difficulties will only be faced when the industry based on the resource is on the brink of disaster.