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HISTORICAL REVIEW OF  
WALLEYE ALLOCATION IN LAKE ERIE:  
AN ONTARIO PERSPECTIVE

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## ABSTRACT

In 1976 agencies in Ontario, Michigan and Ohio, under the auspices of the Great Lakes Fishery Commission, developed a scheme of quota management for the walleye (Stizostedion vitreum vitreum) population of western Lake Erie. This paper outlines the background to this scheme and the scientific knowledge on which it was based. Regional and individual allocation within the province of Ontario and the successes and problems of walleye management are discussed.

## INTRODUCTION

The resources of the Great Lakes have traditionally been conceived by legislators as common property -- to which, in theory at least, all have rights of use (Regier and Grima 1985). Nevertheless, for over a century the protection of these resources (and the occasional perpetuation of special interest groups) have prompted management agencies to devise a range of allocative devices. Licences and permits have been issued to restrict participants, effort, expenditures or grounds within perceived allowable limits. In the early 1900s, management of Canada's Great Lakes fisheries shifted from Federal to Provincial jurisdiction and, for a time, the use of closed seasons and harvest exclusion zones escalated.

Allocative devices employed by early managers continue in use today. However, various conditions have acted to complicate the management process. Decline in the abundances of certain commercially important species has spurred increased legislative intervention and control. The rise of new user-groups in traditionally one-user areas demands increased wisdom in resource partitioning. Increasingly sophisticated assessment of fish movements, stock discreteness, and aquatic community interactions is laying bare the fallacy of large-region, single species management strategies. This and the problems of widespread pollution have demanded enhanced interagency cooperation, in some cases at an international level.

In Ontario quota management has come into vogue among fisheries managers. We examine in this paper an early instance of its application and outline the process by which the quotas were formulated. Walleye management for western Lake Erie affords a unique opportunity for examining allocation at three levels: international, regional and individual.

On the heels of a precipitous decline of the walleye population during the 1960s, those fish remaining were found to contain high concentrations of mercury and commercial fishing in both Canadian and American waters was banned in 1970. During a five-year moratorium (excepting small-scale assessment fishing only), favourable spawning conditions, improved habitat, and a limited recreational fishery permitted rapid recovery. Through the Great Lakes Fishery Commission (GLFC; Appendix 1), in late 1973 an agreement was reached at the international level to re-introduce the fishery at a rate of exploitation commensurate with long term "conservation and enhancement of the walleye resource."

All available biological data was culled from the three jurisdictions of Ontario, Ohio and Michigan, and a model for calculating annual total allowable catches (TAC's) was devised. The TAC's were partitioned among the jurisdictions, which became responsible for allocation within their own territorial waters. The original model was conservative, and in a somewhat modified form continues to be the reigning paradigm of harvest determination. Nevertheless, at various times in the past eight

years different agencies have requested changes in parameters of the model, changes which would (and did) significantly affect TAC estimates. Various people have even recommended a major overhaul, an action for which there is widespread reluctance born of inertia, the lack of a long-term data base, and the lack of viable model alternatives (as outlined below). Kendall et al. (1977) also noted:

"There is a general tendency among Lake Erie Fishery Managers as there is among fishery managers in general, to avoid changes in the prevailing management framework because of anticipated social disruptions..."

This, they add, may have been justified in the past due to lack of socio-economic information and skill at its interpretation.

However,

"...the volume of information that is available now which shows the incorrectness of this attitude suggests that anticipated social disruptions can no longer serve as an excuse for avoiding changes."

Nevertheless, the model and regional allocation methods have on the whole been successful in avoiding major (but not all) user conflicts and in permitting the walleye population of the western Lake Erie basin to recover. In fact, the walleye population appears to have already exceeded restoration objectives and extended its range outside the basin. This situation, along with the desire of the Ontario Ministry of Natural Resources to manage Lake Erie based on a percoid fish community and their desire of extending quota management as part of the so-called "Modernization" initiative (OMNR and OCCF 1982), is hastening a reexamination of the original walleye model paradigm and a reassessment of sampling programs.

## BACKGROUND

Traditionally, the walleye of western Lake Erie have been considered discrete stocks, but within the basin itself many fish move freely over political boundaries (Fig.1). The commercial fishery here has enjoyed a successful history of about 140 years as the best equipped and most productive on the Great Lakes. Ohio's production surpassed Ontario's until 1956, the year harvest of walleye from Lake Erie peaked at 15.4 million pounds and 8.6 million pounds came from Canadian waters (Fig.3). Walleye thus lost the sanctuary of Ontario waters which had once been their resort. In Ohio recreational fishing (although light for a period in the mid-1960s) was very popular; in Ontario the sport has not been significant until recent years.

By 1960 commercial harvest had fallen to 614,000 pounds and the collapse was evident to all. The walleye were beset by several problems coincident in time; limnological changes in the Central Basin, population explosions of smelt and, perhaps overridingly, an increase of fishing mortality caused by a technologically more efficient fishery (Regier et al. 1969, Nepszy 1977, Schneider & Leach 1979).

By the time commercial fishing was halted, Lake Erie seemingly possessed two discrete stocks; an eastern basin stock of stable but small abundance and low yield, and a western basin stock dominated by one or two year classes and displaying classic signs of an overstressed population.

## INTERNATIONAL INVOLVEMENT

The Great Lakes Fishery Commission was created in 1955 and designed as an international forum and advisory board through which fisheries biologists and managers could exchange information, monitor changes in the fisheries and, hopefully, coordinate their efforts at effecting improvements. The Commission has been most successful in controlling sea lamprey predation within the Great Lakes. It appears to have been slower in mobilizing action to protect Lake Erie's walleyes, even though the impending crisis was perceived in the early 1960s (relevant extracts from the Commission's annual reports are summarized in Appendix 2).

Finally in March 1973, with the commercial fishing ban still in effect, the GLFC Commission called a meeting of representatives from the Bureau of Sport Fisheries and Wildlife, Great Lakes Fishery Commission, and Ontario, Ohio, Michigan, New York and Pennsylvania:

"This seems to be a singularly auspicious time to forge an international and interstate consensus on how to break out of the open-access, laissez-fair approach to fishery resource exploitation. An integrated international management program would provide a fair sharing of the resource and would allow the walleye resource in western Lake Erie to recover to higher levels. If such management goals were achieved for the walleye, a similar approach could be extended to other species (such as yellow perch) or even sets of species."  
(GLFC, Annual Meeting Minutes, June 19-21, 1973 App.IX).

In consequence, a Walleye Scientific Protocol Committee (SPC) was formed and charged with:

- ". outlining procedures for resolving such technical matters as measuring the standing stock, projecting its surplus

- production, etc.;
- . identifying basic data requirements...;
- . deriving methods for apportioning surplus yields and allocating the harvestable fraction; and
- . formulating the mechanism (or criteria) by which said management plan will be implemented and administered." (SPC Meeting Minutes, November 14, 1973, Ann Arbor, Michigan).

Seminal to any allocation scheme were to be the concepts of joint surveillance, equitable distribution and equal sacrifice. Any recommendations made to the GLFC required the prior approval of all agencies. Furthermore, the SPC made no reference to individual user-groups nor to means of quota implementation or enforcement: such was the domain of its member agencies.

Philosophically, the SPC almost from its inception opted for a conservative approach, necessary it was felt for rapid and long-term restoration of the walleye stock. In addition, because of the potential social and economic consequences of major quota readjustments, these were to be considered with care and instituted only when absolutely necessary -- it is, of course, difficult to take away what has been given in haste.

The SPC technical report and addenda was formally accepted by the Lake Erie Committee (LEC) of the GLFC on July 21, 1976 (GLFC SPC 1976). Development of TAC figures, it noted, was "traditional" in manner. Data from the different agencies were collated, mortality parameters estimated, mean annual biomass and surplus production calculated, and finally, adjusting for annual recruitment, total allowable catches for the coming year and projected allowable catches for the succeeding year were determined. The TAC was divided on an areal basis (using the



42-foot contour) among Ohio (52.4%), Michigan (8.8%) and Ontario (38.8%).

As outlined in the next section, the initial quotas were established on the basis of the best available, albeit incomplete data. Subsequent adjustments were made as data gaps were filled. Other adjustments occurred as responses to problems which arose. All were made, and continue to be made under the umbrella of the original surplus production model; the original benchmark population estimates have been maintained. However, the adjustment iterations continue, and the model has gained in sophistication. Other models, such as that of Shuter and Koonce (1977: see also Shuter, Koonce and Regier 1979), have been reviewed, but none have gained widespread support nor have the quota committees chosen to devote much time to their development.

In their turn, the Great Lakes Fishery Commission agencies responsible for allocation have also changed. Early in 1977 the SPC, its mandate completed, was disbanded and replaced by a Standing Technical Committee (STC) charged with developing quota recommendations and (in 1979) reviewing the original model. STC membership included Lake Erie Committee members and their designees. Further to the STC, a Walleye Task Group (WTG) was formed with terms of reference:

- ". to review the existing model for predicting allowable catch of walleye and determine if it remains the most appropriate;
- . to prepare for managements' consideration, an estimate of the ultimate level of walleye stock biologically appropriate to the Western Basin;

- . to develop a basis for partitioning surplus production of walleye into components of yield and enhancement."  
(STC, Meeting Minutes, October 22, 1980, Sandusky, Ohio)

Complementary to the WTG, there has also been established the Perch Task Group and Lake Trout Task Group. The onward thrust is one of integrating the efforts of these groups, although this has occurred more slowly than was conceived by the WTG when they recommended that:

"...a joint Percid Community Task Force be appointed to explore the possibility of developing a community related model..." (WTG, Meeting Minutes, October 8-9/81, Sandusky, Ohio).

#### THE MODEL - SCIENTIFIC BASIS

The SPC, at the outset of their study, were aware of certain major data limitations (Table 1; GLFC SPC 1976):

1. Although faced with a multigear industry, data came mainly from the U.S. trap net fishery; thus, a standardized unit of effort for the various gear types could not be calculated.
  - . Consequently, the trap/poundnet was considered to be the relative non-selective gear. Efficiency factors for gill nets were based on catch data for the year 1954 in district OE-2 (further bias may have been introduced by the fact that multifilament nylon gillnets were a relatively new innovation at that time).
2. Changes in fishing methods during the reference period (1963-1969) were significant.

3. Significant variations in the quality, distribution and amount of walleye age-composition data presented a "troublesome statistical problem". Data, of course, was especially scarce from the moratorium period.
  - . It was necessary to group data into yearly and national totals.
4. Natural walleye mortality was unknown.
  - . Based on literature values it was assumed to be .20 (Instantaneous natural mortality,  $M = .218$ ). This today remains a problem, and evidence suggests that the model has consequently been incorporating too many older year classes. (WTG, Meeting Minutes, October 8 - 9, 1981, Sandusky, Ohio).
5. Angling pressure was unknown in Ontario.
  - . Recreational fishing mortality (the only component of fishing mortality prior to 1976) was assumed to be no greater than 33 percent. In 1975 the Ontario Lake Erie Fisheries Assessment Unit began to conduct annual creel censuses and surveys in the Point Pelee area.
6. Incidental commercial catch was also unknown.
  - . This continues to be a problem in both Ontario and Ohio (where walleye is incidental in the catch of other species).
7. No basis for assessing sub-population discreteness and interaction with walleye stocks outside the western basin existed.

- . This necessitated the selection of the 42-foot contour as an arbitrary definition of walleye habitat. As yet no adequate mapping of stocks exists. As noted in the 1978 - 79 Walleye Catch Quota Recommendations, stock diversity might account for "the variations in year-class strengths reported by different agencies from different areas of the western basin."

Despite the data limitations, estimates of abundance and mortality revealed a high level of exploitation during the 1960s.

On the basis of the derived population parameters, western Lake Erie's walleye standing stock was "provisionally" estimated at 1 to 1.5 million fish of age 1.5 years or older during the reference period 1963 - 1969: the "benchmark" population. Each year quotas have been calculated by a process of sequential projection from this benchmark population (Fig.3, Table 2)<sup>1</sup>.

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<sup>1</sup> Standing stock of each successive age group are obtained by multiplying the survival rate by their standing stock in the previous year. To these are added estimates of the survivors of the non-vulnerable youngest age class of the previous year. New recruitment of the first age group is derived as follows:

$$A_1 = \frac{A_B}{YOY_B} > YOY_1$$

where  $A_1, A_B$  = abundance of the young of the year and benchmark standing stock respectively

$YOY_1, YOY_B$  = Young of the year index for the previous year and during the period 1963 - 69

Fishing mortality was calculated according to the formula

$$F = \text{catch/mean standing stock}$$

Total numbers are converted to biomass on the basis of the average weight of each age group and summed.

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A relationship between sustained yield and virginal biomass (for semi-tropical populations) derived by Gulland (1970, 1971) was adopted in calculating a TAC for 1976 of 1.6 million lb. of walleyes 2-year and older (defined as fish 16.5" and longer).<sup>1</sup> The strategy of Gulland's formula involves substituting as much as possible fishing mortality for natural mortality. Although it presupposes an unfished stock at carrying capacity (definitely not the case with western Lake Erie walleyes which have continued to swell in numbers since 1976), it was considered the best formula available at the time.

Lending credence to the initial TAC estimate of 1976, application of a Ricker-type surplus production model (a different approach, although one still forced to use Gulland's formula) generated a higher but comparable TAC of 2.2 million pounds.

#### ADJUSTMENTS AND MODEL REVIEW

After 1976 there followed a series of fine-tuning and error adjustments to the model:

- On the basis of recently collected age-at-length data, X of Gulland's formula was recalculated at 0.4 which

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<sup>1</sup>TAC = X x M x B

where X = .5 (estimated from parameters of the Bertalanffy growth equation)

M = .218, natural mortality (or total mortality for the unexploited population)

B = maximum biomass (of the unexploited fishable stock)

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produced a more conservative TAC (GLFC SPC First Technical Report, App. Note 4, Dec. 2/76).

- . Early in 1979, the Ohio Department of Natural Resources discovered that they had been significantly under-estimating sport-fishing mortality; it became necessary to recalculate all quota values from 1976 to 1979. Also the basic assumption of realized walleye carrying capacity was again challenged, for despite higher fishing effort, biomass had continued to increase.
- . The YOY index generated by Ohio's annual survey appeared inflated in 1977. In calculating the 1980 quota, U.S. Fish and Wildlife Service figures were employed in generating a formula for adjusting Ohio's index. The sequential projection was again recalculated from 1976 and the adjusting formula used in each succeeding year. This could not, however, alleviate problems of YOY data variability:

"Catches of YOY walleye at 6 stations over a ten year period are not consistent between stations within a given year, nor are they consistent at any given station from year to year." (STC, Meeting Minutes November 29-30/79, Windsor, Ontario).
- . In 1980 a cooperative Ohio and Ontario YOY sampling program was instituted. It was anticipated that 5 years of data were required before the new indices could be used (STC, Meeting Minutes, September 5-6/79, Put-In-Bay, Ohio).

- . Gulland's method was abandoned in 1979. In its place a formula employing "allowable" fishing mortality was applied.<sup>1</sup>
- . The original model ignored yearling mortality, which nevertheless formed a component of both the recreational and commercial fisheries. The 1980 quota procedure was redefined to include some yearling fish, originally set at 10%, but conceived as a floating index linked to yearling (fish 14.5" or greater in the fall) abundance estimates.
- . The STC in 1982 expressed reservations concerning recruitment rates used in the model, noting that these were based on year-class conditions of the early 1960s which might no longer be extant. This portion of the model has to date been unchanged.
- . In preparing the 1984 quota, the sequential projection model was again recalculated, incorporating inferred catches for the period 1970-75. (WTG, Meeting Minutes, Sept. 20-21/83, Sandusky, Ohio). Resulting changes in the standing stock were not great (Table 2).
- . The original definition of walleye habitat (42 feet or shallower) is currently under review, but no decision is expected before 1986.

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<sup>1</sup> TAC = abundance of fishable stock/allowable exploitation rate.

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By the end of 1978, several researchers were advocating a thorough review of the basic model, leading perhaps to a liberalization of TAC. Without condemning the entrenched policy of educated "conservatism", they stressed that current data indicated high abundance levels, decline in growth rate, and delayed maturation of the basin's walleye (see Muth and Wolfert 1985 for data summary):

"Is management willing to trade-off good growth for increased walleye abundance or is the current walleye abundance and growth acceptable and should TACs be adjusted to maintain these levels?" (STC Report, Nov. 1978).

The Ohio Department of Natural Resources especially, while accepting quota management in principle, complained that quotas did not reflect the true condition of the walleye population. Scholl (1979) argued for a significant increase in allowable fishing mortality ( $F = .35$ ) from the existing value of  $.10$ . As compromise the STC permitted a level of  $.20$  in 1980 and, following a harvest that again exceeded the allocated quota,  $.236$  in 1981. However at the 1981 LEC Meeting (March 17-18, Windsor, Ont.) Chairman Holder noted:

"... the walleye quota continues to be controversial from a management and scientific perspective."

Allowable mortality for that year's quota was nudged to  $.285$ , pending a further review of methodology.

Such problems had arisen from an inability to define at the outset of quota management the "best" walleye population size and its associated fishing rate. This is a difficult problem and, as



noted above, one of the original terms of reference for the WTG.

In 1982 the STC moved to declare the western basin stock "rehabilitated" and presented a somewhat arbitrary "surplus methodology" for annually adjusting allowable fishing mortality. This was grafted onto the existing surplus production model.<sup>1</sup> By 1983, arguments that the model should be integrated more fully with the extending range of the western walleye population, and with the Lake Erie fish community in general, had become pressing.

#### MULTI-SPECIES MANAGEMENT

Criticism was raised at the 1983 STC meeting:

"The reality of an interacting community of stocks and species with very dynamic properties has received dangerously weak consideration by management so far ... if major changes are made ... there remains the difficult question of what might be the effects upon one or more species in this community that are biologically linked with the walleye stock..."

It was recognized that unrestrained walleye density increase could place undue pressure on forage species with resultant

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<sup>1</sup> "A. When the two-year mean fishable stock size exceeds 25 million fish, the F value will be adjusted up from .285 by appropriating 1/2 of the surplus in either year (above 25 million) to the first year TAC and the remaining 1/2 to the following year's TAC.  
B. When the two-year mean fishable stock size falls between 20 and 25 million walleye, the assigned F for the next 2 years TAC computations will be the prevailing F = .285.  
C. When any one of the fishable stock sizes are estimated to fall below 20 million fish, the assigned F will be computed to permit the fishable stock to attain 20 million as soon as practical."

(See WTG, Meeting Minutes, Sept. 20-21/83, Sandusky, Ohio)

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disturbances of yellow perch and white bass. Evidence exists that this is even now occurring (STC, Meeting Minutes, Feb. 3-4/1982; Knight et al. 1984). It remains to be seen whether the surplus methodology described above facilitates population control and dampens any serious oscillations which may occur. Further steps to managing the Lake Erie fish community were taken by convening a workshop in Bowling Green, Ohio in June 1982 (Koonce et al. 1982).

#### THE CENTRAL BASIN

The surplus production model was predicated on a walleye population confined to the western basin. However, at first gradually but now with gathering speed, walleye have expanded into the Central Basin as far east as Long Point Bay. While initially this phenomena appeared to be due to the emigration of one or more strong year classes (possibly spillover due to high densities in the west), the question is now, are these fish reproducing as local fishermen contend? If so, a strong case exists for raising the total quota. OMNR biologists are skeptical because:

- . strong populations in the central basin have historically coincided with those in the western;
- . there is a paucity of prime spawning locations in the central basin.
- . Most tagged fish recaptured in the central basin came

from its west-central area (Nepszy 1984; LEC Lake Erie Fisheries Report 1984).

An augmented central basin walleye quota would be very welcome to the Port Dover industry, now troubled by the 1984 failure of the smelt fishery. (Recovery is not expected before 1986). Fishermen attribute the decline to burgeoning predator walleye and salmon populations. They also argue that under past conditions of no-quota management they would have weathered the lean years by switching effort to other species such as walleye or perch.

It should also be remembered that any spillover of walleye jeopardizes the validity of stock projections for the western basin; it is important to know which age groups comprise the loss and at what times of the year it is occurring.

The STC has been slow to respond to this walleye expansion some people contend. Two options are open: central basin harvests may be charged to an enlarged western basin quota, or the central basin may be managed as an independent unit. Walleye tagging studies continue, new sampling stations have been established as part of the Interagency Yearling Gillnetting Survey, and electrophoretic studies, aimed at determining stock discreteness, have begun this past year.

#### USER-GROUP ALLOCATION (see Fig.4)

Once the WTG calculates an annual quota figure, it is partitioned among Ontario, Ohio and Michigan. In 1976 Ohio

proposed to allocate to commercial fishermen only that small portion of its share not required by sportsmen. No commercial fishery had existed in Michigan waters, so the state's entire quota went to the sport fisheries (LEC Meeting Minutes, July 21, 1976, Sandusky, Ohio). In Ontario 18% was allocated to the sport fishery, 74% to the industry, and 8% was held in reserve.

Reserve was designed to account for

incidental and unreported commercial harvests and encompassed:

- . processor shrinkage;
- . illegal marketing;
- . incidentals, undersized fish, jumbos and white gills discarded on the lake, and
- . fish seized by OMNR. (McNab, 1982)

In order that the allocation from the GLFC should be meaningful to the user-groups, numbers of walleye are converted to poundage according to a floating conversion factor (reassessed annually). During the first two years, allocation in Ontario was by permit. However, enforcement of permit quotas proved to be legally difficult and in 1979 quotas became a condition of license.

Lacking adequate historical data on use by the sports fishery and on spacial distribution of stocks, Ontario's partitioning among the individual user-groups and between fishing areas necessarily demanded a certain amount of guesswork. The initial quota for Kent County (O.E.2) proved a severe overestimate (Table 3). Underutilization (as well as overexploitation) being regarded as undesirable, the province reassessed the percentage quota division in favour of Essex County at the beginning of the

1977 season. Harvest was reviewed again in October, and Kent County's still remaining surplus was designated to Essex. Kent fishermen were, in fact, not able to fill their quotas until 1980; in 1981 their share was raised to 10% of the province's total share.

Following the assignment of area quotas, fishermen opinion was solicited at the level of individual allocation. The topic was an important one at meetings of the Lake Erie fishermen's associations and in their resolutions to the Ontario Council of Commercial Fishermen (OCCF) early in 1977. Traditionally in fisheries management, various allocation options have existed:

- 1) equal shares;
  - . this is the simplest method but does not take into account the ability of small-time operators to harvest their shares. Underharvesting may result.
- 2) auctioning of quota units;
  - . monopolization by a small group is a danger.
- 3) equal share by vessel or possibly allocation by vessel size;
  - . this does not take into account the greater efficiency of some operations.
- 4) allocation according to capital investment;
  - . again, efficiency may be penalized. Also, "capital investment" is open to many interpretations.
- 5) allocation according to past performance;
  - . a variety of formulas exist, all of which depend upon the

reliability of previous catch records. Incentive for the development of small enterprises tends to be restricted. (see Meeting with Representatives of the commercial fishing associations (Lake Erie) and Representatives of OMNR, Minutes, Sept. 15/80, Aylmer, Ontario).

Certain fishermen of long-standing, especially in Essex, desired a past performance formula. However, because a recent history of fishing had not existed, and because it was hoped that under the new management system the Kent catch could expand, this was considered unfair to the majority.

Finally, in consultation with the industry, quotas within a licence area were assigned as equal shares by boat. Some boats were licensed to fish in both Kent and Essex counties and these fishermen were required to choose between the two licence areas. Most opted for Essex and its higher quotas. In 1981, at the fishermen's request, quotas were reassigned based upon the fishing licence rather than by boat.

#### PROBLEM AREAS

Throughout the pre-1977 process of establishing pickerel quotas the user groups themselves were little involved. Some individuals have argued that the advent of quotas left them unprepared and that more opportunity should have been granted industry groups to discuss strategies for dividing the area allocations. Some saw this as symptomatic of a more general problem of poor lines of communication with government agencies.

Nevertheless, walleye quota management met little resistance when introduced; prior to 1976 the fishery was essentially closed and so even restricted catches were welcomed. As noted above, some fishermen now view the policies of quota review and augmentation as overly conservative and out of step with the more rapidly expanding walleye population. As populations expand eastward, Kent County fishermen have almost annually requested quota increases, while demands from Elgin County are becoming increasingly vocal.

Disturbing both to fishermen and their associations, and to the OMNR, are problems of enforcement.

#### A. Dumping and Blackmarketing:

These were points of major concern expressed at an OCCF workshop in 1980. Such practices are wasteful and reduce market prices. The problem is aggravated by a market which informally classifies pickerel as number ones and jumbos, the latter exceeding 3 lbs and commanding up to 65% lower prices at the packers. Fishermen resort to dumping the larger, lower value fish rather than have them counted against their quota. The OMNR has attempted to reduce dumping by setting a separate quota for jumbos. A small jumbo quota, however, can not prevent blackmarketing by fishermen who believe the overall quota is insufficient for an adequate living.

To meet this problem, check stations employing "port observers" were instituted at Kingsville and Wheatley, the

permitted points of landing for pickerel. Nevertheless some fishermen noted discrepancies between packing house weights and those recorded by the wardens. "It is difficult to obtain up-to-date figures of pounds caught from the local Ministry office." (Wheatley Fisherman's Association 1981 Resolutions, Lake Erie Workshop). Intensified enforcement in 1984, aided by increased co-operation from the processing industry, seems to have gone far in eliminating complaints.

#### B. User Conflicts:

Conflicts between sport and commercial fishermen are pervasive and perennial on the Great Lakes; these represented 18 out of 28 user-group conflicts identified by Berkes et al. (1983). Berkes and Pocock (1980) reported few complaints from the ports of Wheatley and Erieau but "severe" difficulties in the Kingsville area. Sport fishing for walleye in the Pelee Island area is a relatively new phenomena, but interest is increasing, especially among non-residents. Also, more and more people are being drawn to the Rondeau and Port Stanley areas and offshore trolling has increased.

To partially segregate the two user-groups (and to avoid hot weather spoilage), Essex County is closed to walleye commercial fishing between July 15 and the first Tuesday in September. Although fishermen would, of course, like the season to be extended, major conflicts relate to the practice of canning (floating) nets early in the summer season. As noted by



Berkes and Pocock (1980):

"...fishermen are restricted to fishing for white bass. However, if they float their nets too close to the surface they are damaged by sport fishermen and if they drop them lower they catch illegal walleye."

Furthermore, commercial fishing for walleye has until this year (1985) been prohibited prior to May 1 (to protect spawning fish). Following extensive discussion with the industry, spring fishing was introduced in 1985 and limited to waters deeper than 42 feet. Hopefully, this will allow fishermen to become more competitive on the international markets, limit pressure exerted on perch, reduce wastage of incidentally caught pickerel, and reduce commercial effort during the period of summer sport-fishing.

Commercial fishermen have expressed resentment that recreational fishing in Ontario's Lake Erie waters, especially those of Essex County, is dominated by vocal, vacationing Americans, when the greater part of the international walleye quota is already allocated to non-commercial interests in U.S. waters.

#### DISCUSSION

When first introduced in 1976, the limitations of the walleye surplus production model were clearly stated in the SPC's first technical report, and doors were left open for continuing reassessment. Detractors have accused the GLFC of tardiness in first instituting walleye management and its committees of

over-conservatism in effecting necessary changes to the model and in organizing improved stock assessment programs. Nevertheless agencies are committed to establishing a long term data base and refining methods of fish community management. Muth (1979) stressed:

"In fulfilling this duty, we must not let either the complexity of the matter, nor the momentum of the system deter us from new approaches. According to Gulland (1971), 'the provision of scientific advice, and also the management of the fishery, must therefore be a continuing process, perhaps crude at first, but gaining in precision as there is better scientific understanding of the fish stocks, and the catches approach their optimum value'".

There is the danger that once a model, a paradigm, has been established it becomes difficult to evolve beyond it. It is in the nature of "adaptive" management that technique and assumptions be regularly reviewed.

Increasing the role of resource users in policy-making should also be a 'cornerstone of adaptive management.' As noted by Regier and Grima (1985).

"The trend toward more explicit allocation of the use of fish and their habitats is occurring in Canada within a broad process of "negotiation" rather than by coercive enforcement of some new legislation..."

Berkes et al. (1983) further note that in Ontario:

"...where public participation until the 1970s was not a usual part of the policy process, the proliferation in the 1970s and 1980s of programs involving public discussion has been striking."

Although introduced with limited user-group involvement, walleye quota management has evolved during a period of regular meetings between OMNR personnel and fishermen representatives.

The latter have been especially persistent in their demands for continued improvement of biological assessment and quota enforcement.

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REFERENCES

- Berkes, F. and D. Pocock. 1980. Issues and conflicts in fisheries management in Lake Erie. Institute of Urban and Environmental Studies, Brock University.
- Berkes, F., J. Dennis, P. Hayes, R. Morris and D. Pocock. 1983. Ontario's Great Lakes Fisheries: managing the user-groups. Institute of Urban and Environmental Studies, Brock University. UEST Working Paper 19.
- GLFC SPC. 1976. First technical report of the GLFC Scientific Protocol Committee (SPC) on Interagency management of the walleye resource of western Lake Erie. June 15 (also App. Note 4, Addendum 1 and App. 15, Dec., 1976).
- Gulland, J.A. 1970. The fish resources of the ocean. FAO/United Nations Fish Tech. Paper. No. 97: 1-4.
- Gulland, J.A. 1971. Science and fishery management. J. Cons. Int. Expor. Mer., 33(3): 471-477.
- Kendall, S., J.R. Paine and W.F. Sinclair. 1977. Lake Erie fisheries management plan (Draft). O.M.N.R.

Knight, R.L., F.J. Margraf and R.F. Carline. 1984. Piscivory by walleyes and yellow perch in western Lake Erie. Trans. Amer. Fish. Soc. 113: 677-693.

Koonce, J.F., D.B. Jester, Jr., B. Henderson, R.W. Hatch and M.L. Jones. 1982. Quota management of Lake Erie fisheries. A report of the Lake Erie Fish Community Workshop held in Bowling Green, Ohio, June 21-25, 1982. Great Lakes Fishery Commission, Ann Arbor.

Koonce, J.F. and B.J. Schuter. 1983. Application of quota management to yellow perch in Lake Erie. A report submitted to the Great Lakes Fishery Commission.

McNab, W. 1982. Memo to Regional Director, Southwestern Region: Re. Lake Erie Mesh Size Restrictions, March 12.

Muth, K.M. 1979. Recommendations for revising walleye quota analysis procedures. Memo to LEC STC members, June 21.

Muth, K.M. and D.R. Wolfert. 1985. Changes in growth and maturity of walleyes associated with stock rehabilitation in western Lake Erie, 1964-1983. (To be published). Am. J. Fish. Manag. 6., Aug. 1986.

- Nepszy, S.J. 1977. Changes in percid populations and species interactions in Lake Erie. J. Fish. Res. Board. Can. 34: 1861-1868.
- Nepszy, S.J. 1984. Yellow pickerel: distribution and 1984 quota rationale. O.M.N.R., ms
- Nepszy, S.J. 1985. Walleye in western Lake Erie: responses to change in predators and prey. Presented at Council of Lake Committees Plenary Session, Predator-Prey Issues in the Great Lakes, G.L.F.C., Ann Arbor, Michigan, March 20.
- O.M.N.R. and O.C.C.F. 1982. Report of the committee on modernizing Ontario's commercial fishery. Ontario Ministry of Natural Resources and the Ontario Council of Commercial Fishermen.
- Regier, H.A. and A.P. Grima. 1985. Fishery resource allocation: an exploratory essay. Can. J. Fish. Aquat. Sci. 42: 845-859.
- Regier, H.A., J.C. Applegate, and R.A. Ryder. 1969. The ecology and management of the walleye in western Lake Erie. GLFC, Tech. Rept. 15.

- Schneider, J.C. and J.H. Leach. 1979. Walleye stocks in the Great Lakes, 1800-1975: fluctuations and possible causes. GLFC, Tech. Rept. 31.
- Scholl, R.L. 1979. Letter to N. Fogel, Chairman LEC, March 13.
- Shuter, B.J. and J.F. Koonce. 1977. A dynamic model of the Western Lake Erie Walleye (Stizostedion vitreum vitreum) population. J. Fish. Res. Board. Can. 34: 1972-1982.
- Shuter, B.J. and J.F. Koonce, and H.A. Regier. 1979. Modelling the western Lake Erie walleye population: a feasibility study. GLFC, Tech. Rept. 32.

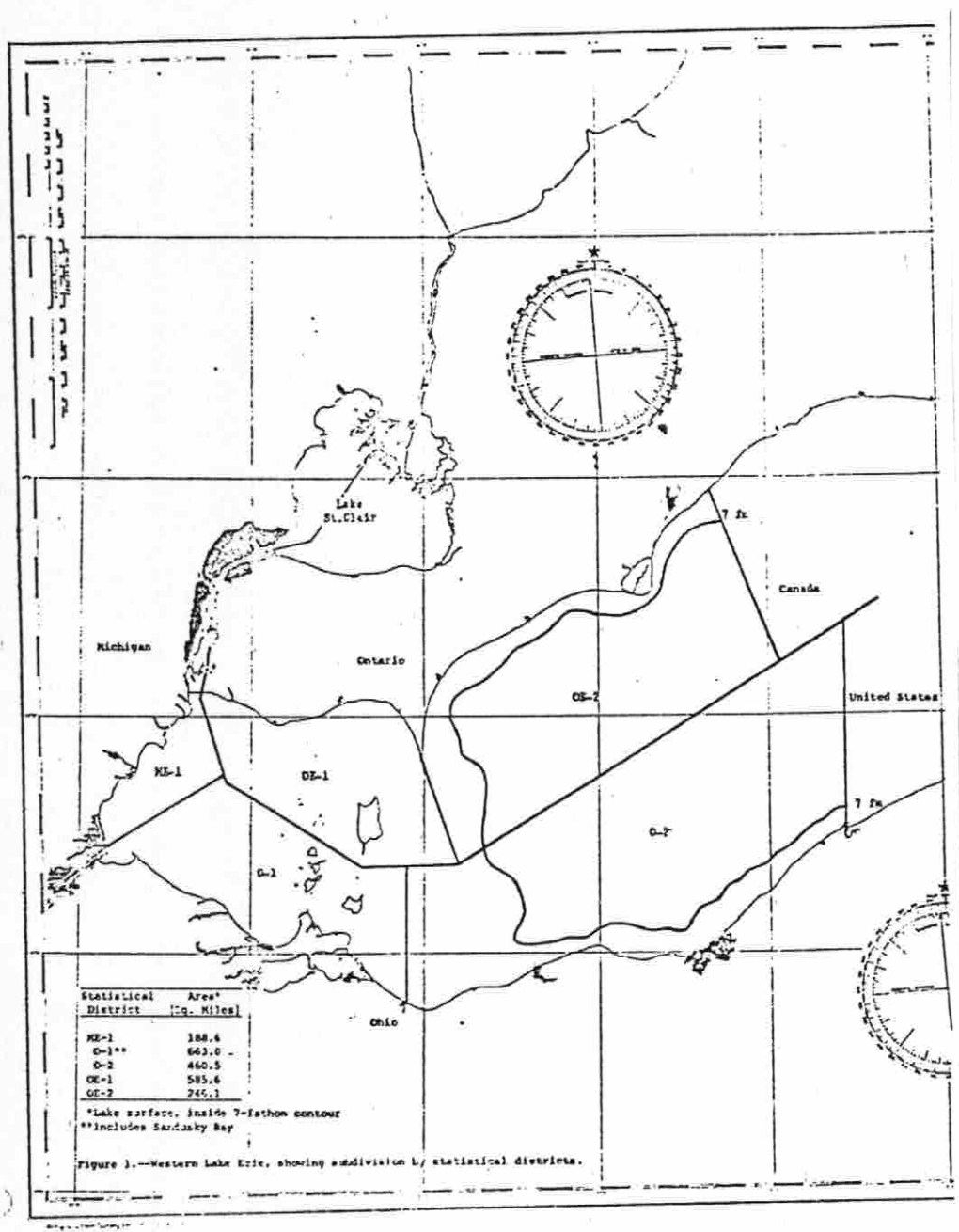


Fig. 1. Western Lake Erie, showing subdivision by statistical districts (GLFC SPC 1976).



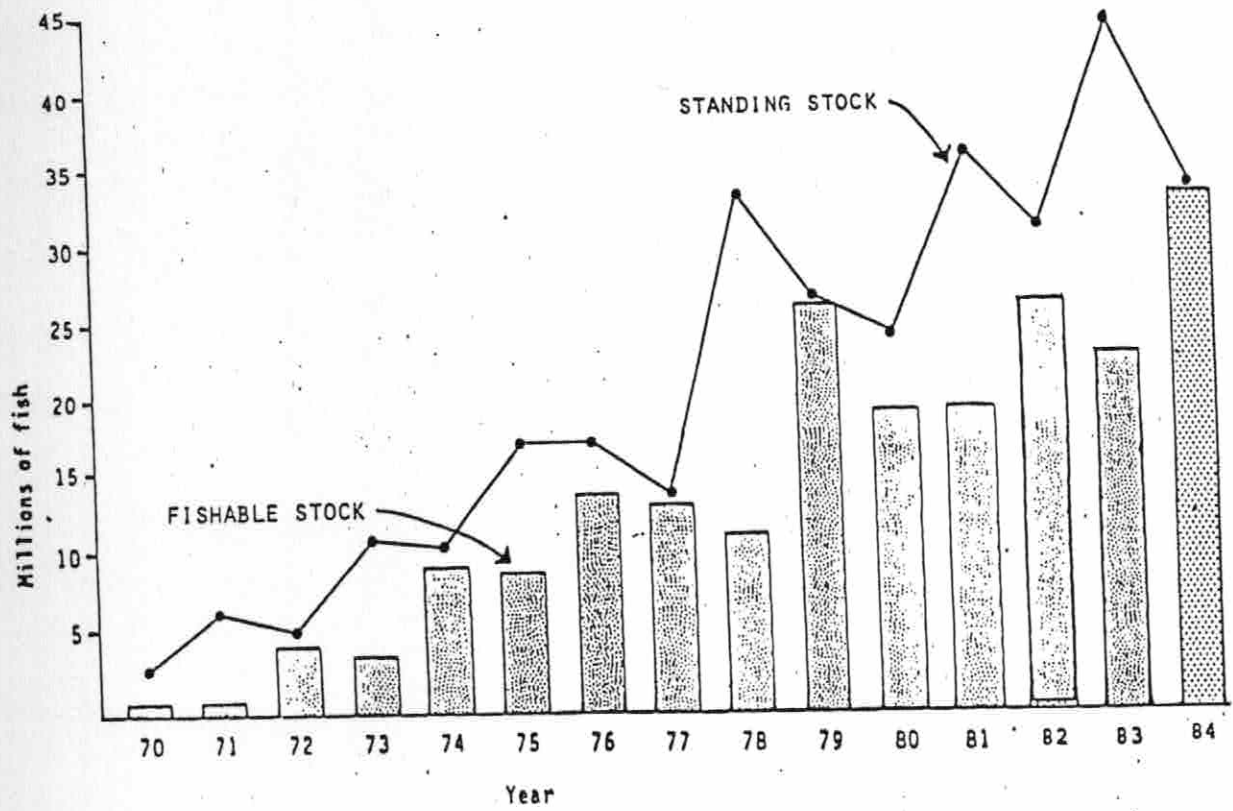


Fig. 2. Estimates of standing stock and fishable stock of walleye from western Lake Erie, 1970 - 1984. (Nepszy, 1985)

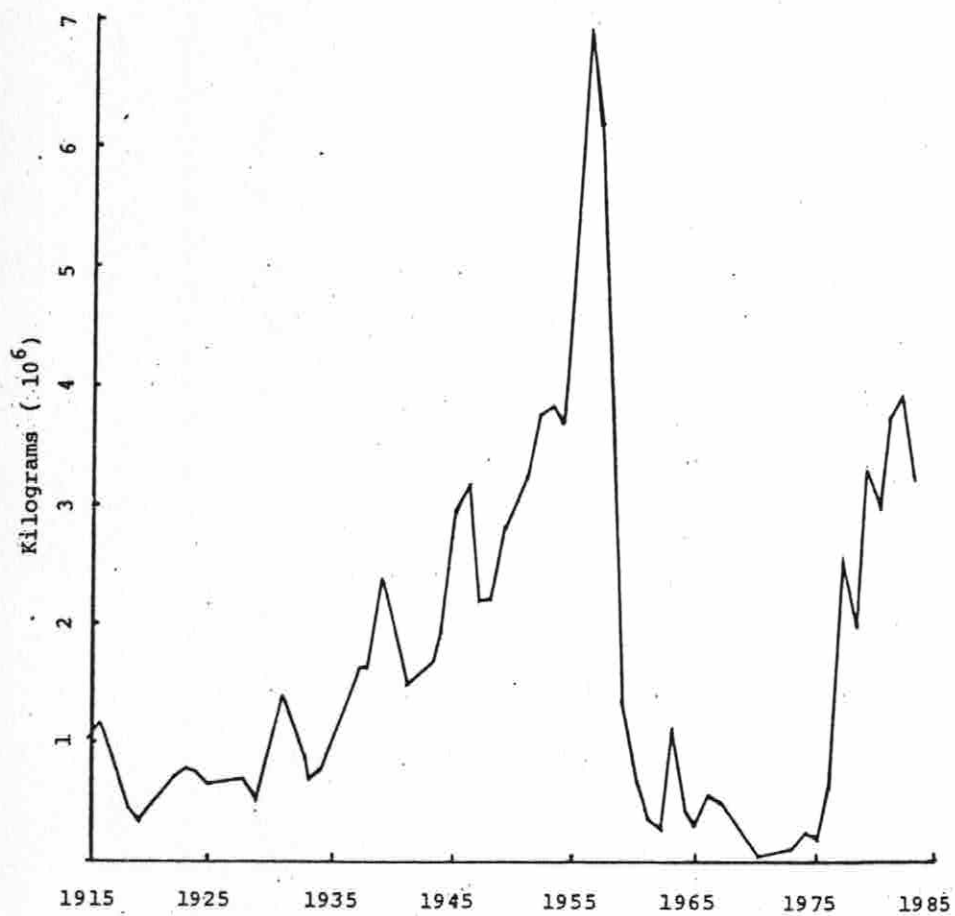


Fig. 3. Reported landings of walleye from the western basin of Lake Erie, 1915 - 1984. (Nepszy, 1985)

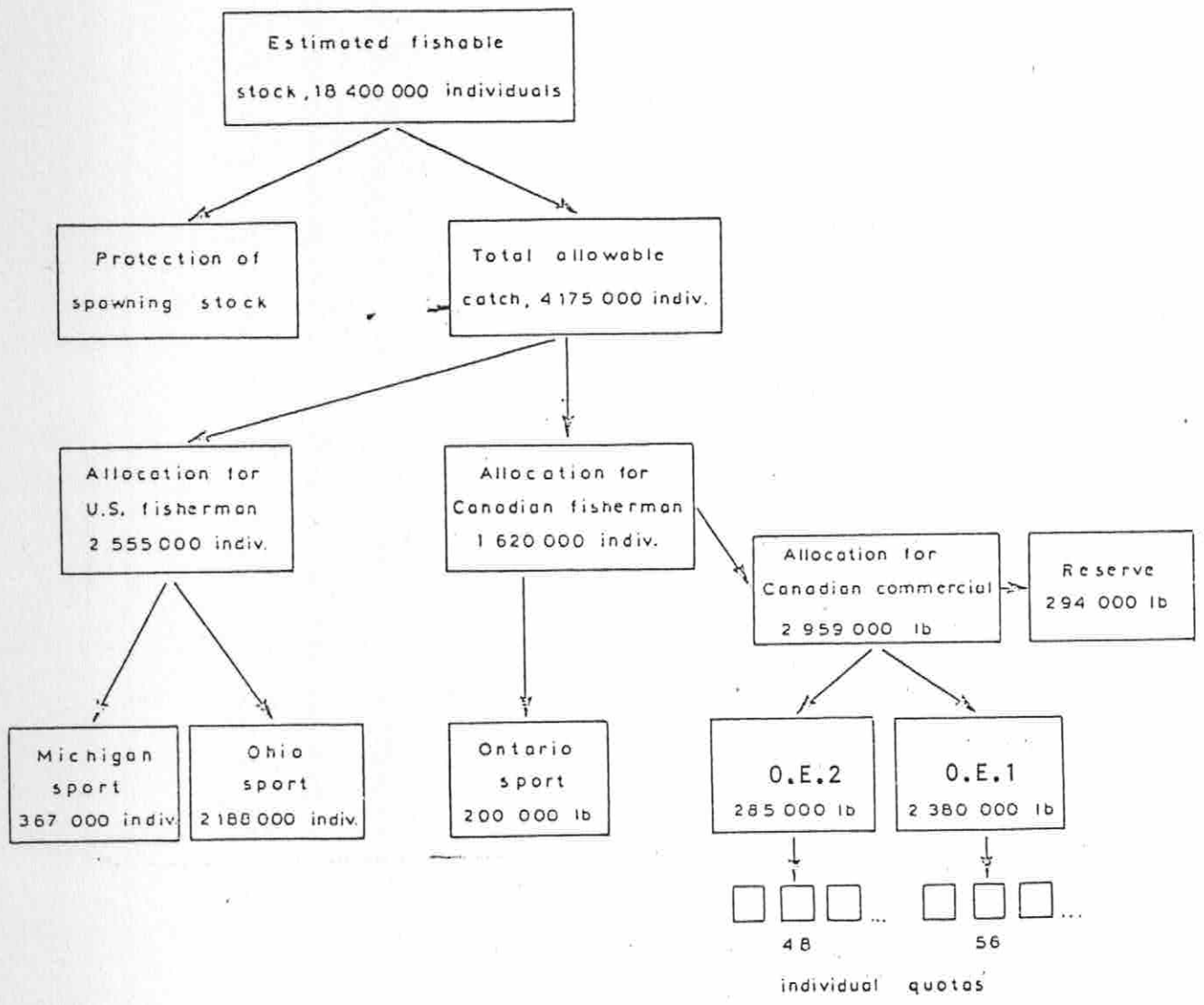


Fig. 4. The allocation of walleye in western and west central Lake Erie - 1981 revised allocation (from: Berkes et al. 1983, after Nepszy 1983; S. Nepszy and M. Petzold, pers. comm.).

TABLE 1: AVAILABLE DATA USED IN CALCULATING THE SURPLUS  
PRODUCTION MODEL (GLFC SPC 1976)

- . Reported catch by all commercial gears - by district and year, 1948-73;
- . Effort and catch by trap/poundnets - by district, season, and year, 1948-70;
- . Effort and catch by large-mesh gillnets - by district, season, and year, 1947-73;
- . Age composition of trap/poundnet catches - by district, season, and year, 1962-69;
- . Age composition of large-mesh gillnet catches - by district, season, and year, 1962-69, and
- . Mean index catch of YOY walleye, 1959-75.

TABLE 2: Revised Sequential Projection of Standing Stocks of Walleyes, Western Lake Erie  
(Revisions: Use of Adjusted OUNR YOY Index Throughout; Use of Inferred Catches,  
1970-1975; Corrected Ohio Sport Catches)

Standing Stock at Start of Year Followed by Change Factors (Statistics of the Fishery) -- Thousands of Walleyes

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	1,837.7	5,011.6	476.6	7,227.2	1,992.2	8,554.0	3,583.0	1,001.2	24,261.9	1,368.5	7,245.8	18,965.9	6,376.3	23,763.1	65.2	7,621.4	7
2	73.0	786.2	3,690.5	372.3	5,838.8	1,529.5	6,864.7	2,861.1	785.2	19,282.5	1,078.7	5,648.9	14,963.9	5,223.1	19,051.0	52.2	6,041.8
3	8.4	31.2	978.9	2,802.8	288.8	4,574.6	1,200.7	5,114.2	1,782.8	498.7	12,669.5	685.0	3,336.3	9,437.1	3,435.3	12,421.3	31.6
4	1.2	3.6	23.0	452.2	2,236.2	226.3	3,591.3	894.5	3,186.8	1,132.2	327.7	8,045.1	404.8	2,116.5	6,239.7	2,239.8	7,514.9
5	0.2	0.5	2.7	18.0	390.8	1,782.0	177.7	2,675.5	557.4	2,023.9	743.9	208.1	4,754.3	296.6	1,392.0	4,068.3	1,355.1
6	-	0.1	0.4	2.1	14.0	274.8	1,375.4	132.4	1,667.2	354.0	1,329.8	472.4	123.0	3,014.2	168.8	907.6	2,461.3
7+	-	-	0.1	0.4	1.9	12.5	225.5	1,192.7	825.7	1,583.2	1,772.8	1,652.7	1,255.8	874.2	2,557.4	1,777.5	1,624.5
Standing Stock	1,920.5	5,833.2	4,772.2	11,255.0	10,682.7	16,923.7	17,018.3	13,821.6	33,367.0	26,243.0	24,666.2	35,678.1	31,416.4	44,734.8	32,909.4	29,035.9	7
Fishable Stock*	82.8	821.6	4,295.6	3,727.8	8,730.5	9,225.1	13,793.6	12,970.5	11,261.3	24,940.9	18,374.4	17,907.0	25,182.1	21,313.7	32,846.6	21,847.8	19,029.2+
Change Factors																	
Adj/YOY Ind	21.4	2.0	32.2	8.3	36.6	15.3	4.3	105.1	5.9	31	81.1	28.1	102	102	0.3	32.6	-
Total Catch	35.2	62.8	111.1	121.1	199.4	190.1	875.9	2,637.0	2,144.0	4,189.0	3,480.3	4,287.3	4,821.9	4,821.9	3,496.2	5,569.6	-
Exploit. Rt.	42.5%	7.6%	2.6%	3.2%	2.3%	2.1%	6.5%	20.3%	19.0%	16.7%	18.9%	23.9%	19.1%	19.1%	16.4%	17.0%	22.4%
F	0.631	0.088	0.029	0.036	0.026	0.024	0.076	0.235	0.236	0.202	0.236	0.308	0.238	0.238	0.201	0.209	0.285
M	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.218
Z	0.849	0.306	0.247	0.294	0.244	0.242	0.294	0.473	0.454	0.420	0.454	0.454	0.526	0.456	0.419	0.427	0.503
g	42.8%	73.6%	78.1%	77.6%	78.3%	78.5%	74.5%	62.3%	63.5%	65.7%	63.5%	59.1%	63.4%	63.4%	65.8%	65.2%	60.5%

\* Fishable stock as defined by the STC, Sept. 6, 1979; 1970-1974, includes no yearlings; 1975-1978, includes 10% of yearlings; 1979 - includes calculated number of yearlings - 14.5 inches in total length.

Table 3: Walleye Quota Commercial Allocation in Ontario

1976	lbs/boat	Total Quota (lbs)	Total Harvest (lbs)
Essex (O.E.1)	6,000	324,000	265,000
Kent (O.E.2)	3,600	81,400	3,900

	lbs/boat	
	Essex (O.E.1)	Kent (O.E.2)
1977*	10,600	3,600
1978*	11,900	3,600
1979	25,500	3,700
1980	38,300	3,700

\* In 1977 and 1978, Kent quotas were not taken by October and so were given to the Essex boats on a pro-rated basis.

APPENDIX 1: Acronyms Used in the Text

GLFC	-	Great Lakes Fishery Commission
LEC	-	Lake Erie Committee
OCCF	-	Ontario Council of Commercial Fishermen
OMNR	-	Ontario Ministry of Natural Resources
SPC	-	Scientific Protocol Committee
STC	-	Standing Technical Committee
TAC	-	Total Allowable Catch
USFWS	-	United States Fish and Wildlife Service
WTG	-	Walleye Task Group
YOY	-	Young-of-the-year

APPENDIX 2: Extracts from Annual Reports of the  
Great Lakes Fishery Commission  
Related to Walleye Management in  
Western Lake Erie

• ANNUAL REPORT FOR 1959

The 1959 year class of walleye is the first of any consequence to appear since 1954, and should produce a significant improvement in the depressed fishery for this species. However, the improvement is likely to be temporary if this age group now entering the fishery is not supported by one of comparable strength.

• ANNUAL REPORT FOR 1960

The sporadic appearance of strong year classes of blue pike and walleye in recent years and the generally low abundance of these prize species in the last decade has led to studies of spawning areas and conditions that might affect early survival of young.

• ANNUAL REPORT FOR 1962

After discussing various biological reports, the Commission agreed that further study was required before any recommendations could be made. The Secretariat was instructed to consolidate the information, including such conclusions as the agencies were prepared to draw from their own data. The Commission would consider the final report at its 1963 Annual Meeting to determine if certain measures should be taken to improve the walleye fishery.

• ANNUAL REPORT FOR 1963

The Chairman advised the Commission that information on the fishery in Canadian waters, which was to supplement reports given at the Interim Meeting, had not been received. Since the Scientific Advisory Committee had asked for the opportunity to study this additional data before reporting, he suggested that consideration be postponed. The Commission, therefore, agreed to defer discussion of the walleye fishery until the Interim Meeting.

• ANNUAL REPORT FOR 1963 - INTERIM MEETING

Additional information on the walleye fishery in Canada was reported. It did not, however, make clear what management action might be taken to improve the fishery. The Commission, therefore, instructed its Secretariat to provide the agencies concerned with a report consolidating the information collected. The agencies were asked to



review the data and suggest: (1) what administrative action might be taken to encourage recovery of the fishery, and (2) what investigations should be undertaken to obtain an understanding of factors controlling the abundance of walleyes in Lake Erie.

• ANNUAL REPORT FOR 1964

The Commission was advised that, in accordance with its request at the 1963 Interim Meeting, representatives of agencies administering the Lake Erie fishery had met with scientific advisors in Ann Arbor on February 11, to review information on the walleye fishery, and, if possible, recommend action to encourage its recovery and investigations to obtain a better understanding of fluctuations in walleye numbers. Agreement on administrative action could not be reached on the basis of the available data and a second meeting was scheduled for July when additional data from spring investigations would be presented.

• ANNUAL REPORT FOR 1965

The Lake Erie Committee was established at a meeting in Sandusky, Ohio on June 3, 1965. Members of the Committee were requested to prepare a statement for consideration at the next meeting which would set out objectives for the fishery in their jurisdiction and indicate the kinds of investigations required to develop the information needed for the application of additional measures to improve the fishery. An early consideration of the walleye problem in Lake Erie and the development of measures to restore the fishery for this species was urgently needed.

• ANNUAL REPORT FOR 1966

The decline of the walleye had been of particular concern in Lake Erie where the catch had fluctuated because of the failure of year classes in two of every five years since 1956. The commercial fishery now depended on a single year class as it reached legal size.

The Management and Research Committee recalled that in 1964 the Commission had assembled and reviewed information on walleye in Lake Erie to see if the factors responsible for the decline could be identified and what steps could be taken to encourage recovery of the population. It was not possible to say what caused the year class failure from the evidence available at that time, but two factors were suspected (1) over exploitation, and (2) major changes in environmental conditions. However, agencies on Lake Erie were unable to agree on management measures for walleyes in the western basin.

- ANNUAL REPORT FOR 1967

Management and regulation of the walleye fishery in western Lake Erie remained a difficult problem but several constructive steps were taken in 1967. A recently completed report entitled "The Ecology and Management of the Walleye in Western Lake Erie" has indicated that an intensive fishery could lead to the marked instability of fish populations noted in Lake Erie.

- ANNUAL REPORT FOR 1968

Management agencies of Ohio, Michigan and Ontario agreed that additional protection was needed for the walleye in western Lake Erie which had not produced a strong year class since 1965. Ohio reviewed the regulatory action taken in its waters in 1968 and urged that Ontario and Michigan adopt appropriate measures for their waters. Ontario representatives explained that additional data collected on the walleye in 1968 and now being analyzed, would probably provide the information needed for developing regulations.

- ANNUAL REPORT FOR 1969

Walleye production dropped to a record low of 472,000 pounds in 1969. The low catch was partly attributed to more restrictive regulations on commercial fishing for walleye in the Western Basin as recommended by the commission.

- ANNUAL REPORT FOR 1974

Since about 1962 the Commission and cooperating state and provincial agencies have wrestled with the walleye problem in an effort to preserve, restore, and enhance stocks of this very valuable species. Publication of "The Ecology and Management of the Walleye in Western Lake Erie" (Great Lakes Fishery Commission, Technical Report No. 15, May 1969) and establishment of the Walleye Scientific Protocol Committee in 1973 have provided a basis upon which to establish a management program which, it is hoped, will prove effective.